Spring 2019 Wildfire Review

Final Report

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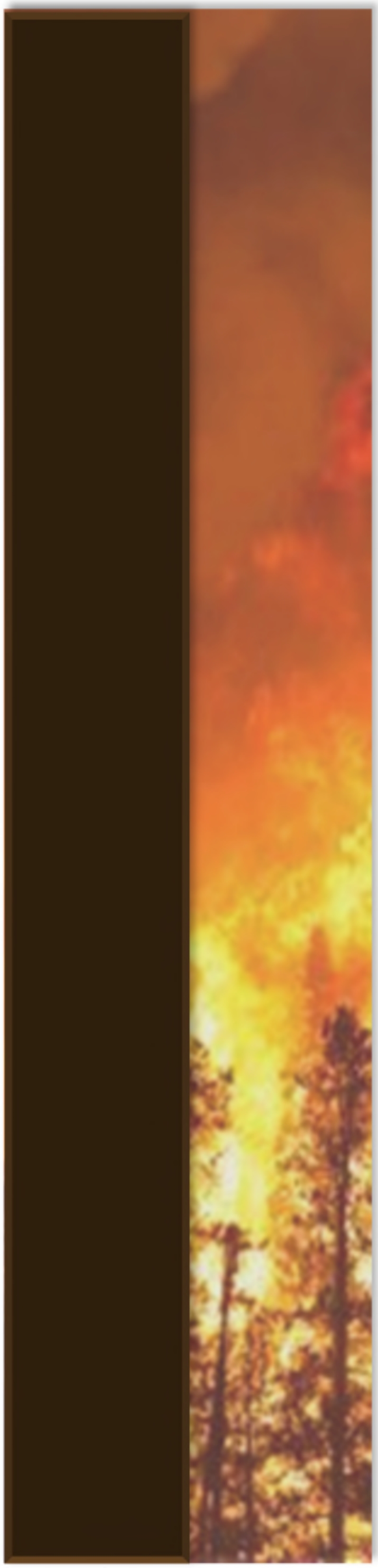

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EXECUTIVE SUMMARY

In the spring of 2019, 993 wildfires burned over 880,000 hectares in Alberta; an area eight times the area burned in California during 2019[1,2]. Over 75 percent of the burned area was from three incidents known as the Chuckegg Creek wildfire, the McMillan complex, and the Battle complex. The 2019 season follows other recent extreme wildfire events in the province including the Flat Top complex in 2011 that affected the Town of Slave Lake and surrounding communities, an extreme fire season in 2015 that saw both a significant number of wildfires and area burned, and the 2016 Horse River wildfire that caused unprecedented damage and the evacuation of Fort McMurray and surrounding areas.

Wildfire has always been a reality in the forested lands of Alberta. The Forest Protection Area (FPA) for which Alberta's Wildfire Management Branch (WMB) is responsible covers approximately 39 million hectares, an area larger than Germany. The Government of Alberta has developed an extensive Wildfire Management program that provides a range of wildfire management services within the Forest Protection Area that are designed to protect Albertans, the communities in which they live and the industries in which they work.

The extreme burning conditions and significant wildfire events in 2019 tested the limits of the Wildfire Management program and impacted many Albertans. In response, Alberta Agriculture and Forestry (AAF), commissioned an independent review of WMB and the extraordinary wildfire activity the organization faced in 2019. This review focused on the operational aspects of the 2019 response to the spring wildfires (specific to the Chuckegg Creek wildfire, the McMillan complex, and the Battle complex); the impact on and perspectives of residents, partners and stakeholders; and an evaluation of the Wildfire Management program in its entirety including the connection of the 2019 experience to past fire seasons and reviews.

Review Methodology

In order to gather a complete picture of the events that took place and their impact on Albertans, approximately 300 members of the public[3] had the opportunity to participate in this review process. This included representatives and community members from impacted municipalities, First Nations and Métis communities, and industry representatives. The review also included engagement with roughly 80 individuals representing WMB, partner organizations within the Government of Alberta, as well as out-of-province wildfire management professionals that participated in the 2019 season. Finally, in an effort to understand how wildfire management activities practiced by WMB compare to neighbouring jurisdictions, the review engaged representatives from British Columbia, Northwest Territories, Ontario and Saskatchewan. The findings from these engagements along with a comprehensive analysis of wildfire and costing data gathered from WMB, guided the analysis and ultimately, the development of findings, recommendations and opportunities for improvement.

Key Statistics from the 2019 Spring Wildfire Review

Fire hazard conditions early in 2019 were extreme. There were several indicators in the winter and spring months of 2019 that signaled an early and potentially severe spring fire season including

[1] California Department of Forestry and Fire Protection https://www.fire.ca.gov/incidents/2019/

[2] As in Alberta, the California fire season is reported per calendar year. Wildfires in 2019 were reported in California January 1, 2019 to November 30, 2019.

[3] Approximately 175 individuals attended the townhall sessions with MNP and the Minister of Agriculture and Forestry, with the remaining 125 participating in one-on-one or group interviews with MNP.

underlying drought in northwestern Alberta[4] and abnormally dry, windy conditions in April and early May.

The extreme weather conditions culminated in the northwest portion of the province the weekend of May 11-12, initiating an extended period of wildfire starts and aggressive fire behaviour that stretched WMB to its limits. There were 301 new wildfires in May and three major wildfire incidents burning concurrently under extreme conditions.

The three major wildfire incidents were not the only wildfires WMB was dealing with. The 2019 fire season took WMB well beyond the typical fire season. Even though the total number of wildfires for 2019 was 993 — below the nine-year average of 1,364 — the total area burned of 883,414 hectares (almost all burned by the end of May) far exceeded the nine-year seasonal average of 355,678 hectares.

The month of May was characterized by a rapid increase of fire danger conditions throughout northern Alberta. The wildfire growth on May 29 and 30 was so extreme that it warranted a separate analysis (presented in Appendix E). The available fire behaviour prediction tools were not built to recognize these extreme conditions and underestimated this significant wildfire growth.

Key Findings of the Wildfire Management Program Evaluation

Complementary to the review of the WMB response to the 2019 spring wildfires in Alberta, an overarching program evaluation was carried out based on staff and stakeholder input, document and data analysis and comparisons to leading practices. The focus of the evaluation was to identify program refinements and enhancements as part of the Branch's commitment to continuous learning and improvement.

In relation to the 2019 fire season, the program evaluation identified several areas where WMB must evolve to be prepared for future wildfire situations:

The Wildfire Management program is effective overall on behalf of Albertans, though conditions in 2019 severely tested its limits and exposed areas for focused improvements.

Certainly, many staff, partners and contractors worked with skill, dedication and success on behalf of Albertans. In 2019, challenging weather conditions, fire behaviour, and timing (i.e., the development of three large wildfire events simultaneously) drove many of the costs and impacts experienced. When the situation escalates to an extreme level, as was experienced in 2019, any organization would show signs of strain and weakness. Certainly, some of WMBs systems and methods were tested to a breaking point in 2019. In this sense, the 2019 season can be viewed as a "stress test" for the organization, a test providing insight into the organization's ability to respond effectively to the next (inevitable) challenge. Wildfire management organizations cannot be measured on an "average" day. They are measured (by most outside reviewers) at the limits of their capability and under the most extreme conditions.

While extreme, the conditions in 2019 were not unprecedented. Extreme wildfire activity has become more frequent in recent years. The Wildfire Management program must adapt and make changes to ensure that it addresses the opportunities for improvement that have emerged from the 2019 fire season, as well as from previous reviews of extreme seasons. Current scientific research and trend analysis of recent wildfire seasons indicate that wildfire conditions like those faced in 2019 will occur again.

[4] Based on the North American Drought Monitoring System provided by the National Oceanic and Atmospheric Administration (NOAA).

When wildfires become public emergencies, it is vital for all parts of government to work together seamlessly to represent community interests—sharing the right information, keeping the public informed and protecting their well-being.

Members of the public and other partner agencies are not concerned with interagency distinctions within government (e.g. WMB vs. AEMA vs. Provincial Operations Centre (POC)). They view the government as a single entity, which makes trust and relationship building a government-wide initiative.

Over the course of the program evaluation many public stakeholders described their concern and frustration about an absence of information, or when information was shared, about the confusing nature of much of the messaging and data. In situations when this information was accompanied with additional context, public stakeholders felt better able to interpret and understand the information, leading them to feel their well-being was being considered.

Several improvements have been made to the approach and capacity for public communications in recent years including filling WMB's Team Lead Information Officer position for the first time in four years; filling this role has given the organization more leadership and capacity to deliver communications services.

In addition to in-person communication, WMB has several platforms used to communicate with the public. However, at the time of this report, WMB lacks the data needed to determine the strategic effectiveness of these tools. Given the public perception of limited access to information, WMB must define its key audiences and then ensure the most effective channels and mediums are being used to reach those audiences.

Investment in proactive, strategic preparedness ahead of a wildfire situation will reduce impacts and losses felt by the public and the economy and will save the government costs in the long run.

Effective preparedness ensures that a wildfire organization is well-equipped and ready to respond to rapidly developing hazards. The existing framework for preparedness planning has been in place since the 1980s and while in most situations it is effective, in the extreme conditions experienced in 2019, shortcomings were apparent. In 2019 this framework restricted the ability of WMB staff to respond strategically and contributed to the high costs associated with sustained action on the three concurrent major wildfire incidents. A risk-informed approach that considers fire occurrence and values-at-risk would address these challenges.

Improved coordination between the fire weather and behaviour sections of WMB is necessary to ensure better integration of the science into field operations and decision-making—particularly while hazards are high early in the fire season and during extreme wildfire and weather events. In situations where there are multiple wildfires on the landscape, the use of probabilistic forecasting that goes beyond the favoured three-day weather forecast currently in use, would enable improved situational awareness among wildfire operations staff. In hindsight, there was a five-day window of opportunity to achieve a perimeter around the Chuckegg Creek wildfire before a major wind event arrived that ultimately pushed the wildfire beyond WMB resourcing capabilities. In this situation, earlier coordinated messaging on risks would have helped decision-makers.

Finally, the potential benefits of timely and effective Initial Attack supports additional investment in strategic preparedness. These benefits include reduced area burned, fewer losses to values on the landscape and significantly reduced wildfire suppression costs. The findings of the program evaluation clearly indicate that wildfires that are actioned on time and contained in the first burning period (a key performance target for WMB) result in much lower costs and area burnt.

Fully embracing a culture of safety is essential for any organization facing emergency situations and dealing with dangerous natural events.

Wildfire management in Alberta relies on a significant number of aircraft to move crews, equipment and water to the fireline. While this can be an effective approach, it introduces risks of a crowded airspace, particularly where helicopters are working with buckets and moving quickly both horizontally and vertically, and where airtankers may be active on the same wildfire. Though staff are in place to manage these situations, there are occurrences when too many aircraft are working in a confined space leading to increased risk of mid-air collisions.

With respect to safety incidents related to fireline, basecamp, or logistics operations, any categorization or analysis of trends for 2019 was not available to this review. However, during interviews with staff, concerns over high-risk operating conditions and a lack of resolution following safety events was expressed. At a minimum, some saw a missed opportunity to debrief and educate staff with safety-related lessons and insights. It appears WMB has yet to build a 21st century safety management system and associated culture.

WMB has an opportunity to look at the culture of its own organization and its relationships with staff, contracors and partners to embrace excellence in the face of risk and uncertainty. "High-reliability organizations" (HROs) (Wieck and Sutcliffe, 2007) succeed in avoiding failures in environments that exhibit higher-than-normal risk and complexity. Studies of organizations that operate in these environments, including wildfire management agencies, have led to clear understandings of the organizational principles that provide for success.

The theoretical framework and real-life application of HRO principles can be an input to efforts to become more strategic and to make decisions informed by a fuller appreciation of risk management. Realization of cultural change will be an outcome of that effort.

The following pages provide the combined highlights of the 2019 wildfire season review and the Wildfire Management program evaluation including key findings, recommendations, actions or opportunities for improvement. A complete list of Recommendations and associated Actions can be found in Appendix K, page 260.

Overview

During the 2019 wildfire season, thousands of Albertans were displaced due to wildfire threat and tens of thousands more were impacted, whether by smoke, highway closures, or evacuations.

In order to gather a thorough picture of the events that took place and their impact on Albertans, approximately 300 individuals were engaged in the review process through interviews, focus groups, workshops, and roundtable meetings. Participants included representatives from the impacted municipalities, First Nations and Métis communities, industry representatives, the Government of Alberta staff and the public.

Throughout the three major wildfire events, the Battle complex, McMillan complex, and Chuckegg Creek wildfire, it is worth acknowledging that despite the often-traumatic experience for those involved, no loss of life was attributed to the incidents. Many stakeholders acknowledged this in the course of interviews and discussions.

Most concerns expressed by those interviewed were related to the impact of evacuation decisions and procedures on the public, including those who were forced out of their homes, those who were forced out of hospitals and care facilities and those who were outside of the evacuation areas, but dependent on the evacuation centre for food, fuel and supplies.

It is important to understand the lived experience of the 2019 Wildfire Season. Public perceptions should not be discounted or set aside as an opinion, but rather recognized as the way stakeholders experienced the fire season. This distinction is critical in improving the policies and processes that govern the wildfire program. Afterall, perception is important in shaping personal experience and in shaping the response to future events.

Key Findings

- Effective emergency management depends on constructive working relationships and trust.
- A one government approach to wildfire management is critical to meeting the needs of Albertans.
- Some stakeholders are concerned with the level of engagement by WMB.
- Some stakeholders disagree with the strategies, priorities, and the suppression tactics employed on large wildfires.
- Local governments exhibited inconsistent levels of preparedness and post-event support.
- Inconsistent resources, approaches and decision-making as Incident Management Teams (IMTs) changed made forming relationships and maintaining knowledge continuity between community leaders and Incident Commanders difficult.
- Defining the role of elected officials is essential to guide their efforts to support communities.

WMB Opportunities for Improvement

- In order to build relationships and avoid potential challenges, WMB, in collaboration with AEMA and colleagues in Agriculture and Forestry, should engage with agriculture industry partners to improve plans regarding agriculture and livestock operations during a wildfire event.

Government-Wide Opportunities for Improvement

- More training is require to ensure that all Government of Alberta elected officials, communication staff, partners and stakeholder understand and use ICS information principles as a best practice.
- Explore ongoing support programs that could include post-event support and mental health services and intermunicipal support agreements that provide work-relief for impacted local governments.
- Offer provincial elected officials the same required emergency management training as requested for municipal officials immediately upon election to ensure they understand their roles in such an event.

PREVENTION, MITIGATION & COMMUNICATION

Overview

In Alberta, Wildfire Prevention includes several activities directly or indirectly related to reducing the number of wildfires occurring in the province and mitigating the impacts of wildfire on values and people. For expediency, communication is included with the review of this subprogram area, although communication is a part of all wildfire management program areas. This section of the review includes general prevention programming, prevention related outreach and communications, issuing fire permits, enforcement, department led FireSmart activities and stakeholder communications.

Key Findings

- Human caused wildfires represent significant preventable risk to public safety and values.
- FireSmart has become central to wildfire prevention and loss mitigation in Alberta but needs broader government and community support to become more effective.
- Incendiary wildfires are prevalent in Alberta and require a targeted solution.
- Public engagement and communications have improved over the past eight years, however, there is a need to continually improve in this area.

Opportunity for Improvement

- Focusing the province's prevention efforts on the community zone and continuing a focus on recreational and residential wildfires is clearly supported by data. This can be accomplished through continued ground patrols, continued enforcement during fire bans, and targeted communications.

	Recommendations	Actions
Government-Wide	1. Immediately implement a government wide, disaster resilience and prevention focused task force to enhance the adoption of FireSmart activities and principles across government, at the community level and to incorporate fire prevention in community services.	• Identify and implement alternative building codes for vulnerable communities. • Identify and implement modified subdivision development rules for vulnerable communities. • Identify and implement further risk-sharing programs for communities that continue to develop further into forested areas. • Formally incorporate FireSmart into a broader provincial disaster resiliency strategy to improve community engagement in preventing wildfires. • Continue to work with Industry and relevant associations to prevent and mitigate industry caused wildfires — this could include increasing the cost-recovery programs. • Determine specific key performance indicators (KPIs) for reducing human-caused wildfires and mitigate industry caused wildfires. • Implement the November 2018 Auditor General Recommendations and report on progress accordingly.
	2. Immediately develop a comprehensive strategy for incendiary fire prevention to reduce the number and severity of incendiary fires.	• Increase the number of ground patrols in high risk community zone areas to limit the opportunity to set wildfires and increase speed of detection. • Work with Community and Industry leaders to develop education and enforcement programs targeted to at-risk communities. • Increase a targeted media campaign to encourage public reporting and outlining increased enforcement and compliance measures that will be taken including consequences for offenders.
Government-Wide	3. Conduct a more comprehensive review of WMB communications and stakeholder engagement strategies, systems and processes with an objective of improving the experience of community members and stakeholders who are directly or indirectly being impacted by wildfire or other natural disasters.	• Conduct an audience analysis to determine if the tools are enabling messages to reach their intended targets effectively. • Once Wildfire Management Branch has identified their intended audiences it would be prudent to develop outcome-based strategies to determine their effectiveness, with a continuous improvement model. • Ensure flexibility from normal government communication protocols during emergency time periods; identify and implement specific strategies to utilize social media venues. • Continue to work with recreation areas and relevant associations to improve awareness and ultimately prevention of recreation wildfires. • Improve consistency of stakeholder management across Forest Areas. Many leading practices exist across the province, and each could benefit from further sharing. • Clarify the role of the Industry Liaison across Forest Areas. • Clarify the role of the Information Officer across Forest Areas. • Review communication protocols and ensure they are set well in advance of the fire season and respect the specialized nature of emergency communications. Set specific direction for all government agencies to follow during periods of Unified Command.

Overview

In order to achieve the Wildfire Management program objectives of containing all wildfires within the first burning period, prompt detection and immediate reporting is necessary. Recognizing this need, the mandate of the detection subprogram has been established to "report all fires to the respective fire centres within five minutes."

Detection in Alberta consists of four key detection methods: Aerial Patrol, Ground Patrol, Lookout Towers, and Unplanned/Public Reporting. These detection methods become closely linked to preparedness and suppression activities as detection is the initial event triggering a response and subsequent action.

Key Findings

- Early detection and reporting of spring wildfires are critical to successful management of wildfires.
- Alberta's detection performance targets need to be updated.
- There is an opportunity to explore new technology for wildfire detection.
    - The lapsed renewal of the lookout observer exemption in Employment Standard Regulations impacted the overall efficacy of the detection network in 2019.
    - Increasing health and safety concerns and a limited number of returning, highly trained lookout observers may challenge the detection network in upcoming years.
- There is an opportunity to manage aerial detection more efficiently.

Opportunities for Improvement

- Continue to operate a multi-method detection network with the ability to detect and report wildfire in a variety of landscapes and conditions.
- Establish performance metrics that measure how effective the detection network is in relation to the Program Area priority of detecting difficult to locate wildfires in high hazard conditions. Performance metrics should include time, cost and outcomes that support analysis of detection performance between methods, landscapes, and areas of risk (e.g. Community Zones).
- Investigate detection options that reduce Program Area dependency on the lookout system.
    - Look to alternative detection methods that require less capital expenditure than that of the lookout tower system and that mitigate the labour regulation and safety concerns associated with the operation of the tower system.
- Work with partners to put specific measures in place to mitigate delays in the renewal of the lookout observer Employment Standard Regulation exemption when the anniversary date for the current exemption occurs.
- Continue to evaluate the application and use of emerging wildfire detection technology on Alberta's landscapes.
- Acquire data-informed Decision Support Tools to optimize aerial detection routes based on historical, current, or predicted hazard conditions such that aircraft can be used in a more efficient and cost-effective manner.

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Overview

Preparedness is a key element of the success of any wildfire management organization. It encompasses the annual activities that take place to prepare the program for each new fire season, including strategic planning, hiring of contracts, training of staff, and initiating procedures and routines. Preparedness also responds to the unique factors of each new fire season. A keen awareness of current and forecasted wildfire hazards and weather, ignition potential, and values at risk is critical to drive daily adjustments to prevention messages, detection approaches, and the number and allocation of firefighting resources.

In some respects, preparedness is about a high state of readiness this afternoon and tomorrow. In other respects, preparedness is focused on forecasting the situation many days ahead such that, as the situation changes, firefighting resources can be increased, moved ahead of the need for dispatch, or released strategically. Effective preparedness ensures an organization is well-equipped to meet their performance targets.

The stated performance objective for wildfire operations in Alberta are to initiate wildfire suppression action before the wildfire exceeds two hectares in size and contain wildfire spread by 10h00 the following day (represented by a Being Held status).

Key Findings

- The Preparedness Planning Framework performance is challenged in times of stress and needs to be updated.
- Wildfires in 2019 behaved more aggressively than the Fire Behaviour Prediction (FBP) System and associated models projected, pointing to necessary refinements.
- Fire Weather and Fire Behaviour sections require better integration.
- Wildfire Operations are lacking strategic direction with respect to values at risk and priorities that can be improved by approved Strategic Wildfire Management Plans (SWMPs).

Recommendations	Actions
4. Develop and implement a new preparedness planning framework that balances risk, hazard, values and cost to improve overall outcomes.	• Reduce the heavy reliance on coverage assessment in the Presuppression Preparedness System (PPS) and increase emphasis on risk analysis based on forecasted workload, weather, and fire behaviour. • Evaluate the new system under worst-case wildfire occurrence and fire behaviour scenarios. • Develop and support staff understanding of how a new PPS can support risk management during periods of uncertainty.
5. Improve quality and integration of Fire Weather and Behaviour functions to support strategic preparedness and response.	• Combine weather and fire behaviour functions at Alberta Wildfire Coordination Centre (AWCC) under one organizational structure to ensure improved forecasts, integration of information flow, and utilization of staff. • Utilize probabilistic forecasting for preparedness planning with required 3 and 5 day forecasts. • Implement daily forecasts that better combine weather and fire behaviour forecasts. • Improve products that increase staff awareness of predicted fire behaviour during early fire season hazard and during extreme events. • Improve fuels mapping in and around communities and critical assets. Consider improved resolution (25 metres) for 10 to 20 kilometres around these values.
6. Accelerate the development and approval of the remaining Wildfire Management Plans (WMPs) to have them completed in the shortest possible timeframe.	• Prioritize northern Forest Area WMPs due to increased risk of large conflagration incidents. • Increase the direct involvement of key stakeholders including communities and industry in the development of these plans. This will create better integration of their concerns, improve understanding of the risk management decisions being made, and provide support for the tactics and strategies used. • WMPs at the Forest Area level should be in place to provide the overarching guidance to inform the incident level plans.

Overview

Wildfire suppression encompasses the most publicly visible operational activities of WMB and though a small percentage of wildfire starts in Alberta require sustained action, this section of the program is typically the costliest. Suppression resources include:

- Personnel—wildland firefighters and support
- Aircraft—rotary wing, fixed wing and airtankers
- Retardant and fuel
- Heavy equipment
- Camps and associated equipment for housing crews
- Wildfire suppression tools and equipment
- Wide variety of contract services

Clearly the weather conditions confronting firefighters in the spring of 2019 were challenging. In many cases, fire behaviour made direct attack on the ground ineffective and unsafe. Although the extreme conditions were not unprecedented, having three major incidents all burning simultaneously and over an extended period is somewhat unique for Alberta. The situation presented a major strain on resourcing and management systems.

Key Findings

- Progression from Initial Attack to Sustained Action on HWF042 and PWF052 lacked in planning and focused execution.
- WMB's tactics and strategies exhibit a bias towards a direct attack and full suppression approach, when indirect attack and modified suppression are sometimes more appropriate.
- Hand ignition tactics are underutilized, resulting in ineffective outcomes.
- Heavy equipment can be used more efficiently and effectively.
- Clearer direction is needed regarding declarations of wildfire status – specifically the "Being Held" status.
- There were challenges with Incident Management Team (IMT) resourcing as well as IMT transitioning.
- There is no common radio system for responders, causing efficiency and safety concerns.
- High likelihood of future significant safety events is a cause for concern.
- Highway closure processes were problematic in 2019.
- Protecting structures and assets from wildfire requires a stronger integrated approach among partners.

Opportunities for Improvement

- The two fire agencies of the provincial government (AAF and OFC) should combine their resources and leadership to support the municipal effort with training and equipment. Rather than define a segmented "who does what", the partners should discuss "how we are in this together" and focus on a quality program for all Albertans. These provincial agencies, along with a strong presence from municipalities, should stay connected and committed to building on the good work done in 2019 .

Recommendations	Actions
7. Establish a standard operating procedure (SOP) for situations when a wildfire escapes Initial Attack during the high risk conditions and where there are significant values at risk. The SOP would identify that a more experienced Incident Commander be assigned immediately to assume command of the wildfire until the first Incident Management Team assumes control.	• Tactical training is required for all mid and lower level Incident Commanders specific to the integration of more indirect suppression tactics, including hand ignition, and to ensure that management support and resources for this approach are realized.

8. Revise standard tactics and strategies for sustained attack to have better, safer, and more cost-effective results.	• Ensure visible senior leadership support for indirect attack strategies recognizing the risks associated.
	• Review and revise policies to support the merits and appropriate use of direct and indirect tactics and strategies.
	• Develop proactive public education on the value and use of indirect attack, including ignition (hand and aerial). Ensure Incident Management Teams take a deliberate approach to educating and informing public stakeholders why it is being used.
	• Encourage the use of hand ignition and ensure all SOPs, operational guidance and training reflects this support.
	• Revise current practices and standards for use of heavy equipment in fireline construction. Consideration should be given to the following:
	  ○ Comprehensive approach to fireline construction that embraces indirect attack strategies where appropriate.
	  ○ Ensure reporting structures for the Heavy Equipment Group Supervisors and associated activities are better integrated and closely coordinated by reporting up through each division within the standard Incident Command System structure.
	  ○ Emphasis on providing ground support to heavy equipment fireline construction as soon as possible adopting a build, burn out and mop up systematic approach.
	  ○ Increased emphasis on cost effectiveness in all aspects of heavy equipment use.
	• Complete the standard template and process under development for Strategic Incident Action Plans for IMTs that are supported by reliable, timely data and forecasting that includes consideration of longer-term risk management strategies and provides continuity from one team to the next as a large wildfire progresses.

9. Review current policy and provide direction to wildfire management staff regarding wildfire status to clarify stages of control and the status of wildfires being monitored.	• WMB should adopt the practice of reporting the *percentage containment for all Out of Control wildfires* to reduce the pressure to declare a wildfire Being Held prematurely and to clearly communicate the risk related to future control problems. • WMB should clarify with all Incident Commanders a consistent approach to declaring wildfires Being Held or Under Control and consider providing additional clarity around this process. • Efforts should be made to communicate wildfire status to the public to improve their understanding.

	Recommendations	Actions
Government-Wide	10. Develop and train staff, including staff from other ministries, to support Incident Management Team (IMT) deployments and Forest Areas under escalating workloads.	• Develop a roster and train staff outside the Forest Areas to fill IMT and Forest Area support positions (Planning, Logistics, and Finance and Admin Sections) to ensure enough staff are available for deployments. • To develop Incident Management support capacity for wildfires and any other incidents, the Alberta government, led by Alberta Emergency Management Agency, should provide targets outside WMB for managers across the government to make staff available to be trained for support positions on incidents. A structured program should be created to help recruit, train and mentor these government staff, so they are ready for deployment to wildfires or other emergencies on an annual basis. • WMB and Alberta Environment and Parks (AEP) should review and improve the model for support of WMB during the fire season. Dedication of wildfire financial expertise is required (similar to Recommendation #4 in the 2015 Program Review). • Redevelop training materials to ensure staff have the training and development to successfully implement these shifts in strategies from past practices.
Government-Wide	11. Implement a common mandatory radio communication plan and system for all WMB wildfire personnel, municipal firefighters and first responders working on wildfire incidents.	• Implement as soon as possible.
	12. Accelerate the development of a safety culture that values incident reporting, hazard assessments, workplace committees and inspections, and the engagement of front-line staff in conversations designed to protect their health and well-being.	• Senior management should take a lead role and be visible in leading this initiative. • Assign senior management champions to accelerate measures underway to improve the overall safety system in WMB (i.e., do not assign to safety staff). • Key areas of focus are incident reporting, thorough investigations, and communicating lessons learned. • A process to review, learn from, and communicate to staff about aviation or fireline "near misses" or tactical withdrawals should be developed, tested with staff, and implemented. • Conduct an immediate review of the current policies and procedures dealing with air space to develop specific and deliberate measures to address this significant safety concern. Ensure this process considers lessons learned as a result of the Horse River fire review.

Overview

MNP review eight information management systems that are used by WMB. These systems include: FIRES, Dispatch, AWARE, Wildfire Mapping Program, Alberta Wildfire Website, FireBans, Inventory Management Information System, and FireWeb.

During MNP's review of key WMB systems, it was determined that WMB is in the process of modernizing their software systems. Fujitsu Consulting Canada (Fujitsu) was hired in 2018 to review the existing systems and develop a roadmap to aid in the modernization of these systems. The review focused on the identification of gaps between the business requirements and functionality provided by WMB's existing systems. A final report was delivered to WMB in 2019 that provided an overview and assessment of the current state, target state vision, road map, and costs. Fujitsu's conclusion was that the key challenges of WMB's existing systems are that:

- Most systems are old, written in legacy technologies and in a state that makes it difficult or impossible to take advantage of emerging technologies.
- Systems employ manual and cumbersome processes with a significant amount of paper.
- Significant data duplication exists between systems.
- Systems are siloed with limited data integration.
- The key FIRES system lacks GIS functionality.
- Network connectivity is lacking in remote areas.

Key Finding

- Based on the high-level review MNP performed of WMB's systems, MNP agrees with the assessment made by Fujitsu.

Recommendation

13. WMB should continue with the legacy modernization program to provide functionality required by WMB to help improve the delivery of wildfire management activities and help reduce the impact of wildfires in Alberta.

Overview

Over the 2019 wildfire season WMB spent a total of $438.6M*. This amount is significant and is the highest of the most recent five years, even surpassing costs related to the 2015 fire season and the 2016 fire season, which included the Horse River wildfire.

Suppression and preparedness expenses together are the vast majority of overall program costs roughly, roughly contributing to over 95% of annual spending in 2019. This includes both the base wildfire management budget and discretionary suppression funding.

Deeper analysis reveals a more complex picture. The work undertaken as part of this review to quantify the costs and benefits of wildfire suppression, while not supported by as many data points as one might desire, reveals two key findings.

**The expenditures for fiscal year 2019-20 (April 1, 2019 to March 31, 2020) used in this report were based on preliminary information (actual expenditures and estimated commitments) AAF provided to MNP in November 2019. WMB's total expenditures for the 2019-20 fiscal year were approximately $570 million. This includes approximately $109 million base budget expenditures, and $461 million contingency funding expenditures for wildfire presuppression and response.*

Key Findings

- Investment in successful initial attack saves money.
- Improved program cost-effectiveness may be achieved through more efficient use of aircraft and heavy equipment.

Recommendation	Actions
14. Undertake a deeper cost-benefit analysis of program spending with a focus on major suppression items.	• Conduct a detailed evaluation of costs and benefits of wildfire suppression including total costs under various conditions and total losses, including those that are not easily quantifiable. • As a starting point, focus on the use of helicopters and heavy equipment as areas of high-potential cost-effectiveness improvement

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Overview

WMB was effective at many levels in addressing the wildfires in 2019. It is clear from a post-season review that the current organizational model, and the decision-making culture that is imbedded within it, works well in most wildfire situations. When the situation escalates to an extreme level, as was experienced in 2019, it is eminently understandable that any organization will show signs of strain and weakness. In this sense, the 2019 season can be viewed as a stress test for the organization — a test providing insight into the organization's evolution towards a more resilient response in the future.

In wildfire response, management layers should typically support operational structures at each level. Alberta Wildfire Coordination Centre (AWCC) leadership are best suited to focus on strategic analysis and leadership. It is apparent that sometimes, as the situation becomes more critical, management layers add complexity and uncertainty for operational staff.

Managers at the AWCC, for example, are best positioned to support strategic analysis, decision making and leadership. Provincial Duty Officers (PDOs) should be the agents of senior management to carry out the strategic plan. Area Managers should support local Area Duty Officers who are their agents for planning with AWCC and other areas. Added complexity arises when the regular daily planning system comes under stress and is not able to deal with some of the critical decisions. This is typical of emergency response organizations at critical times. IN these situations, management needs to support the operational system to find solutions. Simple management direction communicated with and through operational staff builds the system up, resolving issues and communicating directly among managers, but outside the operational system (i.e. without Duty Officers) undermines operational confidence.

The Sustained Action Planning Group (SAPG) had made progress since the 2016 Horse River wildfire but needs to mature even further, moving from situation updates and setting wildfire and resourcing priorities to planning for the mitigation of risks. The SAPG should lead the AWCC in strategic decisions to get ahead of escaped wildfires, empowering Provincial Duty Officers and Area Duty Officers to develop a unified long-term plan that manages the risk and different resource allocation decisions.

Key Findings:

- Senior leadership and the Alberta Wildfire Coordination Centre (AWCC) need to focus on strategic risk management in their decision-making and support strong operational structures.
- The AWCC Intelligence Unit requires increased support and structure to provide the level of intelligence, data analysis and predictive services required to support strategic risk management decision-making throughout the fire season.

Recommendation	Actions
15. Accelerate the development and organization of the Intelligence Unit in the AWCC to support strategic risk management and resource planning.	• Reinforce the need for senior leaders to rely on current command structures and work within the operation systems for decision making. • Review and improve the role of the AWCC to include more decision-making authority and cost oversight to make provincial planning more strategic. • Strengthen the role and capabilities of the Intelligence Unit in the AWCC including bringing all predictive services (including weather and fire behaviour) under one organization and structure. Increase the investment in the tools and resources required.

Overview

This review has observed that WMB staff and their partners delivered many successes over several difficult days during the 2019 fire season. Still, the occurrence of wildfires close to communities and values led to some significant damages and losses, costs to taxpayers and stress on residents of northern Alberta. Observations in this review suggest outcomes could be better.

This review has made a number of concrete recommendations that, when acted upon, should improve outcomes in future difficult wildfire situations. Success in the future will not come, however, from a few action items and some good fortune. WMB should also take steps to look at the culture of its own organization and its relationships with staff, contractors and partners to embrace excellence in the face of risk and uncertainty. When a fire season like 2019 (or 2011, 2015, or 2016) emerges again — which is a question of when not if — how can the organization better rise to the challenge?

"High-reliability organizations" (HROs) (Wieck and Sutcliffe, 2007) succeed in avoiding failures in environments that exhibit higher-than-normal risk and complexity. Studies of organizations that operate in these environments, including wildfire management agencies, have led to clear understandings of the organizational principles that provide for success. These studies continue to offer useful insights to guide wildfire management.

These principles can offer a paradigm for improving organizations and systems used in managing extreme wildfire situations:

- Continuous learning and improvement based on experiences and studies related to wildfire events such as the spring 2019 situation.
- Clarifying management structures and effective chain-of-command, supporting decision-making and encouraging a more strategic approach to wildfire operations.
- Entrenching a science-informed risk management approach to wildfire management by leadership that supports proactive planning, effective and efficient resourcing and strategic decision-making and priority setting in preparedness and suppression operations.
- Committing to organizational resilience by building trust, respect and transparency at all levels of the organization, respecting a diversity of skills and opinions, and being aware of biases.

The HRO model is an example of something that WMB can work towards — an aspirational vision of the type of organization WMB would like to be. In some respects, this would represent a significant leap for WMB in that it requires a persistent effort to create a fundamental shift for an organization the size of WMB. In other respects, this review has observed WMB staff and partners are ready to move beyond historical practices and embrace the risk-laden complexity of wildfire management in new ways.

Opportunity for Improvement:

- WMB should adopt HRO principles and embrace it as one of its key strategic priorities to be implemented. Raising awareness amongst WMB personnel and partners of this intent, and, over time, implementing policies, procedures, and practices will support the transformation to a more risk-aware and resilient organization.

NOTE TO READER

Throughout the document a number of terms and abbreviations are used. Appendix A provides a glossary of terms to assist the reader in the review of this report.

Additionally, over the course of our review the project team had access to data from multiple systems. A note on data limitations can be found on page 134, Table 21.

With respect to scope, this report is solely focused on the spring of 2019 and the programs that were in place at that time. All data, including financial data, is respective to that period and was not influenced by budget and policy changes subsequent to the 2019 fire season.

Note that the decisions, impacts, and responses to the fall 2019 Provincial Budget were out of scope for this review.

Finally, the figures in the report are based on data provided by AAF as of November 13, 2019. As this is well before the end of the government fiscal year, variances from the final 2019-20 government expenditures should be expected. On June 18, 2020 AAF reported the final total WMB expenditures for the 2019-20 fiscal year to be approximately $570 million (includes base budget and contingency funding).[5]

[5] WMB provided the following financial information that was analyzed by MNP: 1) financial information from FIRES (estimated amount and date of expenditures; this information was not identified by fiscal year) and 2) financial information from IMAGIS (actual amount of expenditure and date of payment by fiscal year).

2 | Introduction

INTRODUCTION – WILDFIRE IN ALBERTA

Alberta has an extensive Wildfire Management program that protects a relatively high degree of settlement, public use and resource development activity in the east slopes of the Rocky Mountains and boreal forest areas of the province.

The Wildfire Management program is generally well regarded by Albertans and other jurisdictions. However, with increasing fire season lengths in North America combined with increased public and industrial development adjacent to flammable forest fuels, wildfire management agencies face a significant challenge ahead.

The program has been tested with frequent severe wildfire situations in recent years, including 2011, 2015, and 2016 and in 2019. The most recent spring fire season was particularly challenging because of the size and complexity of three large wildfire incidents that burned throughout May and resulted in significant area burned, threats to values-at-risk and the evacuation of over 20 communities. Alberta Agriculture and Forestry (AAF), WMB tendered a Request for Proposal for a third-party review in response to these events. MNP was the successful proponent, selected to carry out this independent review considering: the operational aspects of the 2019 response to spring wildfire activity (specific to the three major incidents); the impact on and perspectives of residents, partners and stakeholders; and the connection of the 2019 experience to past fire seasons and reviews.

Figures 1 and 2 show the annual number and area burned by wildfires in Alberta over the past nine years. In context, 2019 had a relatively low number of wildfires (993) and very high area burned (883,414 hectares). To better understand the 2019 season — and the risks for Alberta in future seasons — it is useful to look at the nature of the landscape of Alberta and the seasonal characteristics of wildfire activity.

Alberta is home to six distinct Natural Regions (Figure 3); Boreal Forest, Rocky Mountain, Foothills, Canadian Shield, Parkland and Grassland. The forested area in Alberta is roughly 39 million hectares, with a significant portion covered by Boreal Forest (the area depicted in green in Figure 3). The Forest Protection Area (shown by Forest Areas in Figure 4) is the area where WMB is responsible for wildfire management, and closely mirrors the Boreal Forest and Foothills Natural

Figure 1: Number of Wildfires in Alberta, 2011-2019

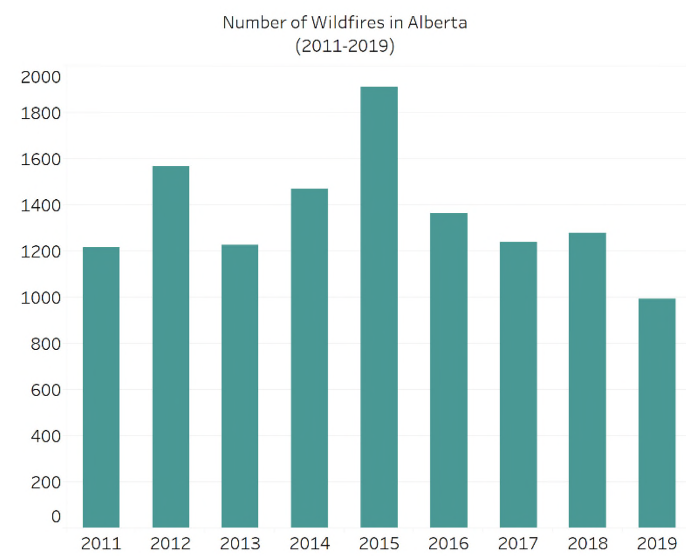
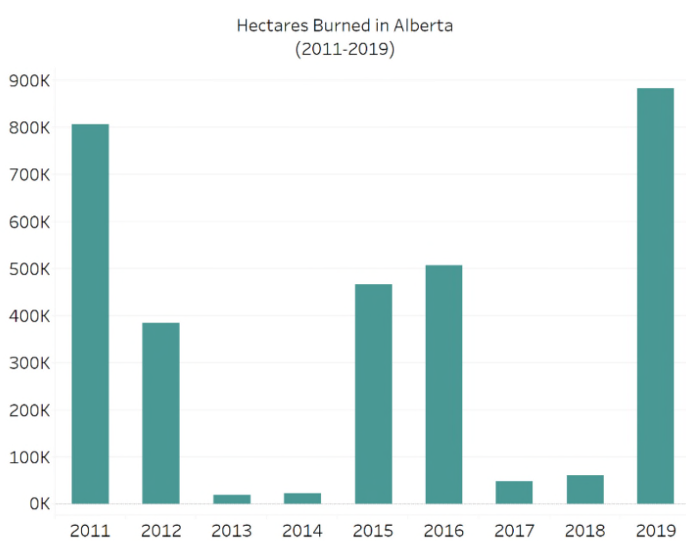


Figure 2: Hectares Burned in Alberta, 2011-2019



Regions. While wildfire is a natural component of all ecosystems across the province, in some areas, agriculture is the predominant land use and therefore is not part of the Forest Protection Area.

Many of the residents living within the Forest Protection Area, particularly those in rural locations, have come to experience the risk of wildfire as a common factor in spring and summer months[6]. As development into the wildland continues and the number of values-at-risk on the land grow, the interface between the wildland and human assets and economic interests, known as the Wildland Urban Interface[7] or WUI, increases in complexity and extent.

Figure 3: Map of Alberta's Natural Regions

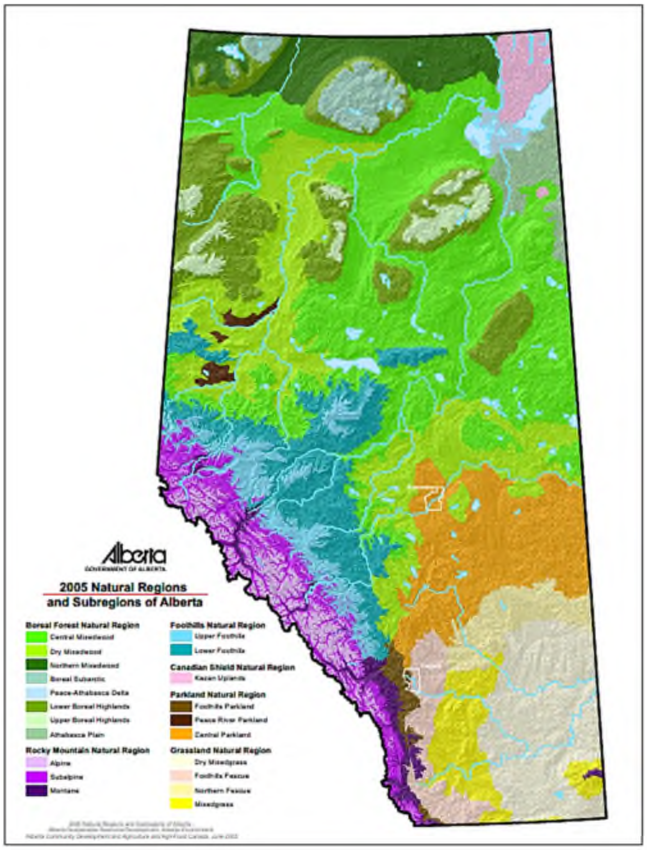
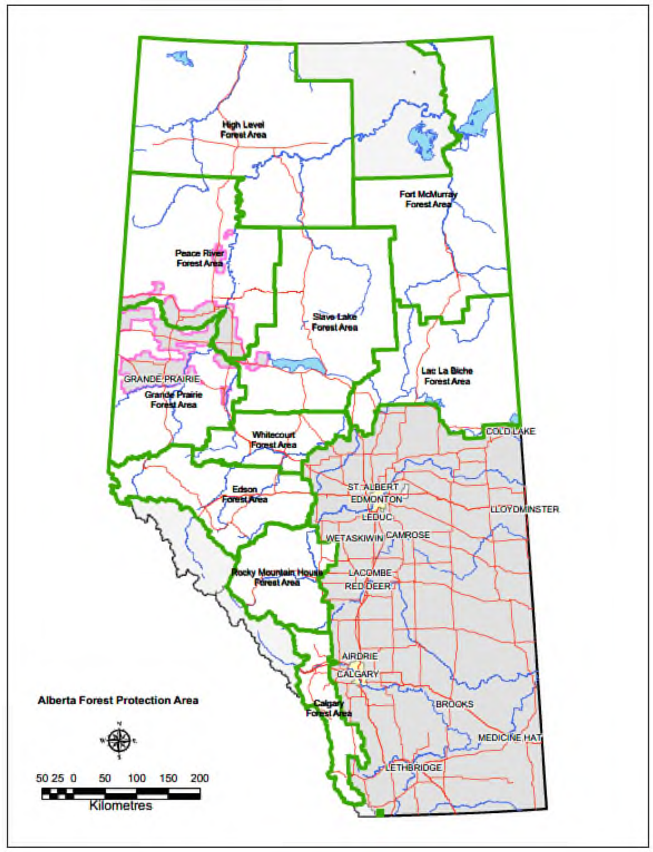


Figure 4: Map of Alberta's Forest Protection Area



[6] Alberta's fire season runs from March 1 to October 31 annually.

[7] Sometimes referred to as the Wildland Infrastructure Interface.

Wildfire regimes and the nature of the wildfire threat to human values is distinctly different between the Boreal Forest and Foothills regions[8]. Figures 5 through 8 show the total hectares burned by wildfires and the total number of wildfires started in each month for these two natural regions.[9] The figures demonstrate two important factors relevant to the 2019 situation: there are more wildfire starts and area burned in the Boreal than in the Foothills, particularly in the spring, and the greatest area burned over the last decade is in the Boreal Forest in spring before deciduous foliage "green up". Summer wildfire activity, typically driven by lightning, can create some challenges for WMB in both the Boreal and Foothills regions. But the greatest risk for large, expensive wildfires that pose a threat to communities is in May in the Boreal Forest natural region. Extreme wildfire situations in the spring are driven by underlying fuel conditions and daily weather patterns. In the spring in Canada, snow melt typically leaves most forest fuels wet and then those fuels dry out according to spring weather conditions. Suspended fine fuels, such as grass and needles on coniferous trees, can dry out very quickly at this time of year and are susceptible to wildfire after a few sunny days and some wind. In some years, winter starts with an underlying drought and snowfall can be minimal. Even with normal snowfall, high temperatures in March and April can lead to an early start to wildfire activity. The typical spring situation of dry fine fuels can be exacerbated by dry heavier fuels on the ground (as it was in the northwest part of Alberta in 2019). Somewhat unique to northwestern Alberta, as well, are the episodic occurrence of exceptionally dry air masses (see Appendix B on 2019 weather conditions). Recent notable or extreme spring fire seasons in Alberta include 1968, 1972, 1980, 2001, 2002, 2011, 2015, 2016, and 2019. Wildfire management agencies use the Canadian Forest Fire Danger Rating System (CFFDRS) to track both long-term drying trends and daily fire danger potential.

Figure 5: Area Burned by Wildfires in the Boreal and Foothills by Month, 2019

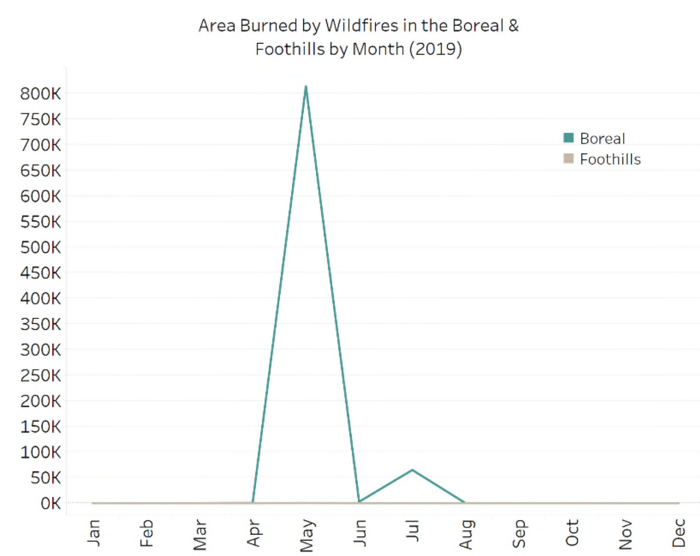
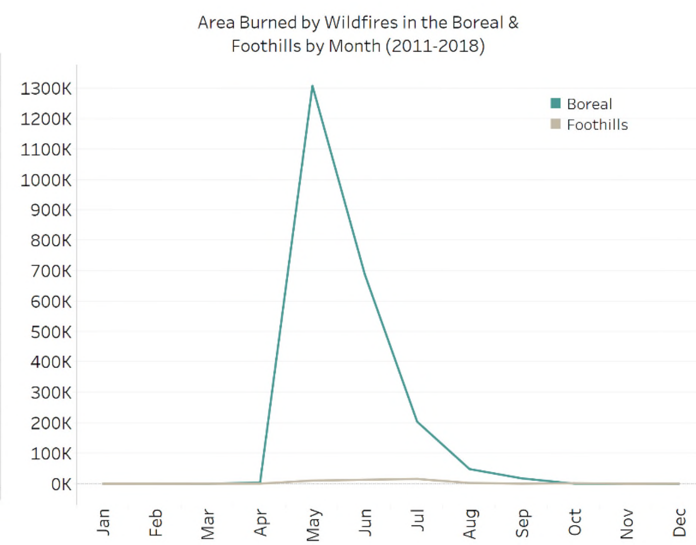


Figure 6: Area Burned by Wildfires in the Boreal and Foothills by Month, 2011-2018



[8] For the purpose of this report the Foothills region includes Calgary, Edson, Grande Prairie and Rocky Mountain House Forest Areas, while the Boreal includes Fort McMurray, High Level, Lac La Biche, Peace River, Slave Lake and Whitecourt Forest Areas.

[9] Due to data limitations, the number of wildfires burned in each month was not available to calculate. Note that only a small number of wildfires remain active for many months.

Figure 7: Number of Wildfires in the Boreal and Foothills by Month, 2019

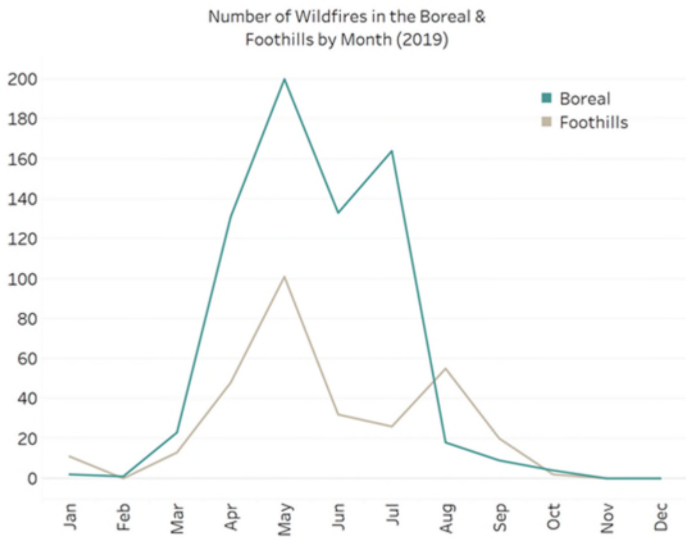
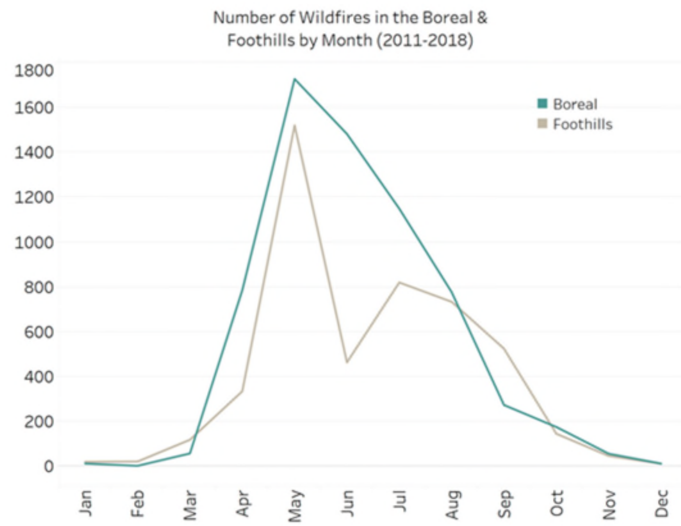


Figure 8: Number of Wildfires in the Boreal and Foothills by Month, 2011-2018



The Fire Weather Index (FWI) System is a component of the CFFDRS and was first used in Canada in 1970. It is used for daily wildfire management planning during the fire season. The FWI System depends primarily on weather readings and provides an indication of fire danger throughout forested and rural areas.

The FWI System consists of three codes and three indices that account for the effects of fuel moisture and wind on fire behaviour indices (Table 1). The first three components are fuel moisture codes and the final three are fire behaviour. In general, the values of these indices increase as fire danger increases.

Table 1: FWI Values in Relation to Low, Moderate, High, Very High and Extreme Fire Danger Ratings

Fire Danger Rating	FFMC Fine Fuel Moisture Code	DMC Duff Moisture Code	DC Drought Code	ISI Initial Spread Index	BUI Build Up Index	FWI Fire Weather Index
Low	0-76	0-21	0-79	0-1.5	0-24	0-4.5
Moderate	77-84	22-27	80-189	2-4	25-40	4.5-10.5
High	85-88	28-40	190-299	5-8	41-60	10.5-18.5
Very high	89-91	41-60	300-424	9-15	61-89	18.5-29.5
Extreme	92+	61+	425+	16+	90+	29.5+

From the CFFDRS, Head Fire Intensity (HFI) can be estimated as a summary measure of all the weather and fuel factors that contribute to wildfire spread and the difficulty of controlling a wildfire. HFI, measured in kilowatts per metre (see Appendix C on HFI Classes) is subdivided into six Fire Intensity Classes, with 1 being the easiest wildfires to control and 6 considered beyond most wildfire control efforts and tools. WMB relies heavily on HFI and HFI classes in daily planning and communicating changes in the severity of the wildfire potential when firefighters, aircraft and heavy equipment are deployed across the province.

Figures 9 and 10 show average HFI by month from the fire danger data provided by WMB. These figures reinforce the differences in weather and fuel conditions that drive fire season preparedness and response in Alberta. Although conditions vary from year to year and day to day, Alberta typically experiences more extreme conditions in the Boreal region during the month of May, and in the Foothills later in the summer.

Another means of assessing hazard conditions is through the use of the Daily Severity Rating (DSR). The DSR is a linear transformation of the daily FWI in which higher FWI values receive more weight in the calculating DSR, emphasizing the increasing contribution of high to extreme FWI values to overall wildfire severity. The DSR is therefore a simple power function of the FWI that gives greater weight to higher values than lower ones and is intended to reflect the amount of effort required to suppress a wildfire. Daily values of the DSR can be summed to obtain a cumulative value (CDSR) and averaged over any desired period, which can give wildfire managers a sense of how a fire season is developing in comparison to recent seasons.

However, unlike HFI, DSR does not include an estimation of fuel type. For this reason and because of its use as a wildfire planning metric, HFI will be used throughout this report to discuss hazard conditions.

For further information on the interpretation and application of DSR values, please reference Appendix B: Situational Analysis of Environmental Conditions.

Figure 10: Average HFI in the Boreal and Foothills by Month, 2011-2018

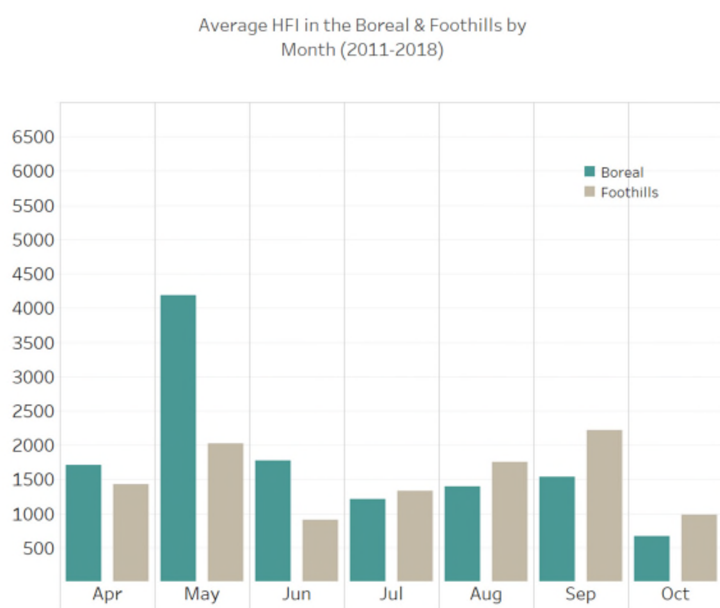


Figure 10: Average HFI in the Boreal and Foothills by Month, 2019

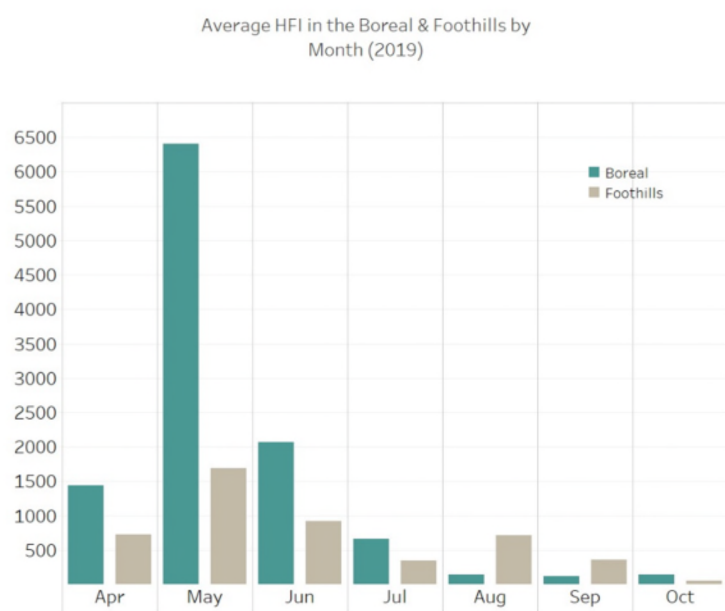
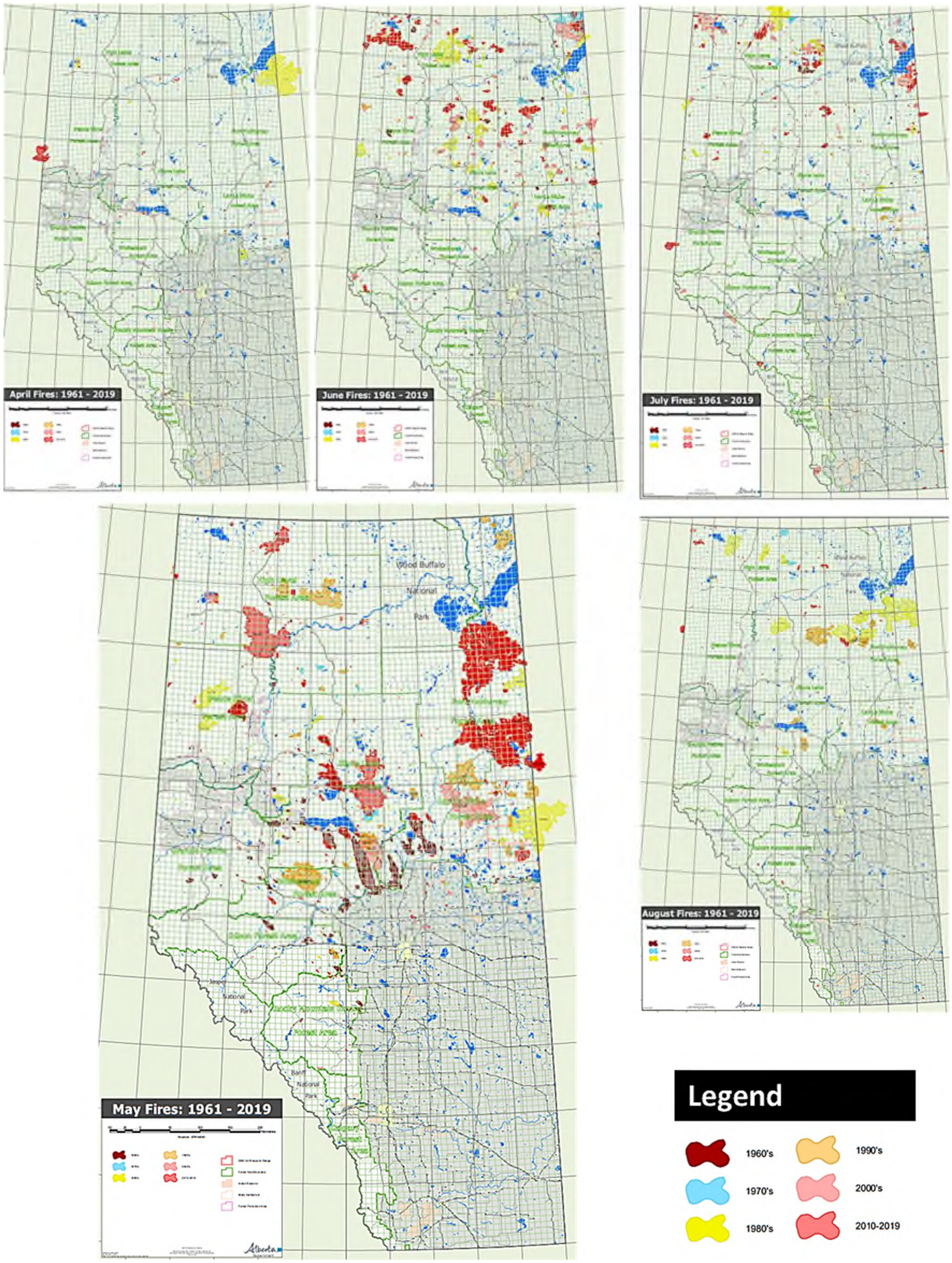


Figure 11 shows the spatial distribution of wildfires, by month, in Alberta since 1961. The predominance of wildfires in May is evident.

Figure 11: Spatial Distribution of Wildfires, by Month, in Alberta since 1961



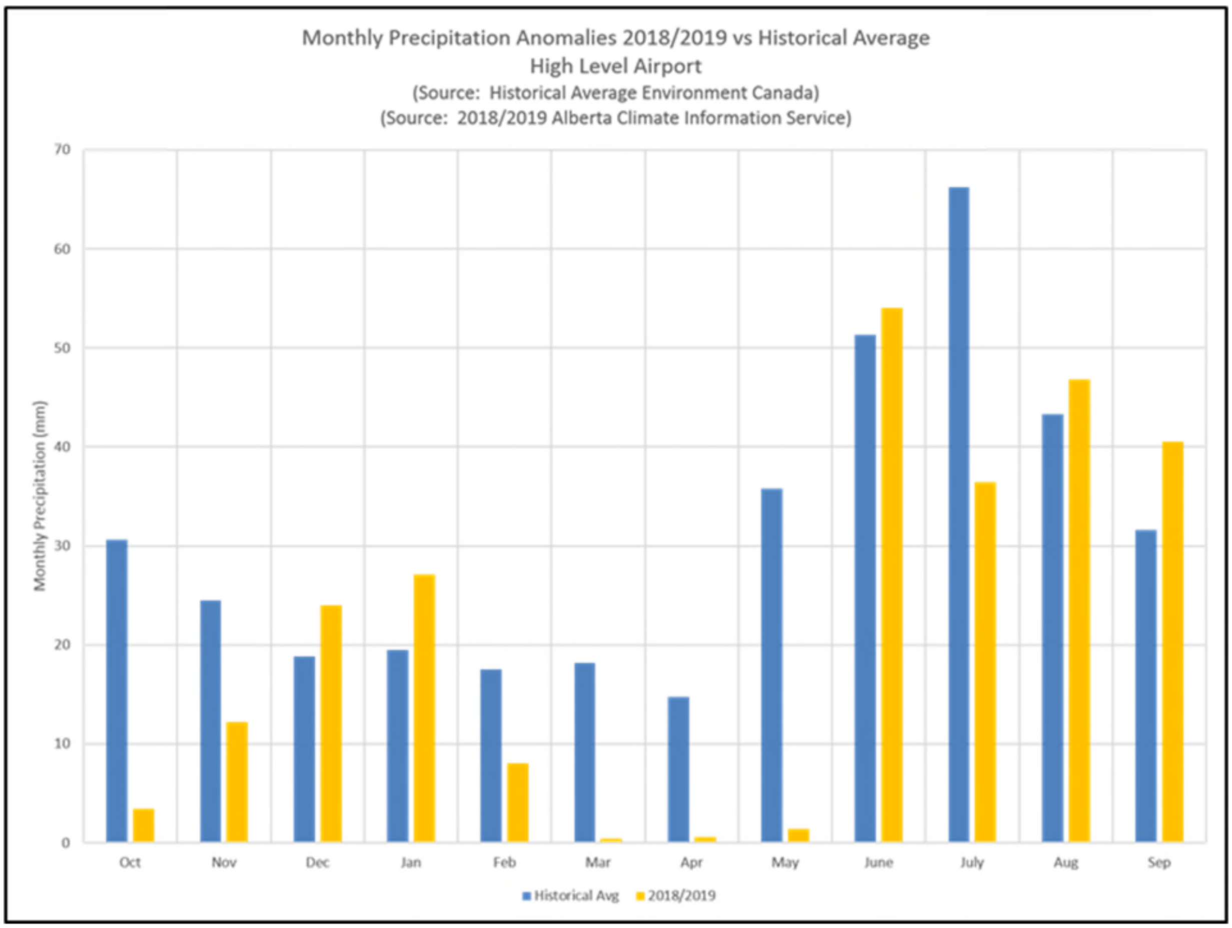
SPRING 2019 WILDFIRE CONDITIONS

This section presents an overview of the environmental conditions leading up to the 2019 fire season. A comprehensive review of the spring 2019 wildfire conditions can be found in Appendix B: Situational Analysis of Environmental Conditions.

There were several indicators in the winter and spring months of 2019 that signaled an early and potentially severe spring fire season. These indicators include the underlying drought in northwestern Alberta[10] and abnormally dry, windy conditions in April and early May.

In the High Level Forest Area, long-term drought conditions were apparent beginning as early as September 2016. This was further exacerbated in 2019 by the lack of precipitation and warm temperatures during the months of March, April and May. Figure 12 shows these monthly precipitation anomalies against a 30-year historical average for High Level.

Figure 12: 2018/2019 Monthly Precipitation Anomalies for High Level Environment Canada Airport Station



[10] Based on the North American Drought Monitoring System provided by the National Oceanic and Atmospheric Administration (NOAA).

Consistent with several previous spring wildfire experiences in Alberta, the month of May 2019 was set up for extreme wildfire events. The extreme weather conditions came to a head in the northwest portion of the province the weekend of May 11-12. This kicked off more than a month of aggressive fire behaviour that stretched WMB to its limits, including 301 new wildfires in May and three major wildfire incidents burning concurrently under extreme conditions. Table 2 shows the number of new wildfire starts (and the percentage that were successfully held by 10h00 following discovery) in April and May 2019; for comparison Table 3 shows the average number of wildfire starts and the percentage contained from 2011 to 2018. The three major wildfire incidents[11] were not the only wildfires WMB was dealing with. The 2019 fire season took WMB well beyond what a typical fire season entails. Although the total number of wildfires for 2019, at 993, is well below the nine-year average of 1,364, the total area burned of 883,414 hectares — almost all burned by the end of May — far exceeds the nine-year average of 355,678 hectares.

Maps showing the spatial distribution of fire danger conditions, using Fire Weather Index Codes, are developed and distributed daily across Alberta.[12] Duty Officers have indices and estimates of HFI for three time periods each day: PM forecasts, AM revised and PM actuals. These indices are intended to illustrate trends in fire danger conditions for pre-suppression planning purposes.

Figure 13 shows the Drought Codes for May 10 and June 3, 2019. Drought Codes are carried through the winter in Alberta, and the high and extreme Drought Codes on May 10 were unusual. High to Extreme values (reds and purples on the maps) indicate any wildfire that does start will burn heavy fuels on the ground as well as standing trees and will be difficult to control. The Drought Codes on June 3 show how the long-term drying continued in the Boreal Forest throughout May to levels typical of August or September in most parts of Canada.

Table 2: New Wildfire Occurrences in April and May 2019 and the Percentage of Those Wildfires That Were Being Held (BH) by 10h00 the Day Following Detection

Month	New Wildfires	BH Success Rate
April	179	98.88%
May	301	94.68%

Table 3: Average New Wildfire Occurrences in April and May 2011-2018 and the Percentage of Those Wildfires That Were Being Held (BH) by 10h00 the Day Following Detection

Month	New Wildfires	BH Success Rate
April	140	99.69%
May	406	96.79%

[11] A complex is a group of wildfires in close proximity that are managed by one Incident Management Team. In 2019, the McMillan and Battle complexes were made up of groups of wildfires that merged together.

[12] There are three intervals of daily FWI codes: end of day forecast, morning revised forecast, and end of day actuals.

Figure 13: Provincial Drought Code Maps for May 10 and June 3, Showing the Underlying Drought that Supported Extreme Fire Behaviour in May 2019

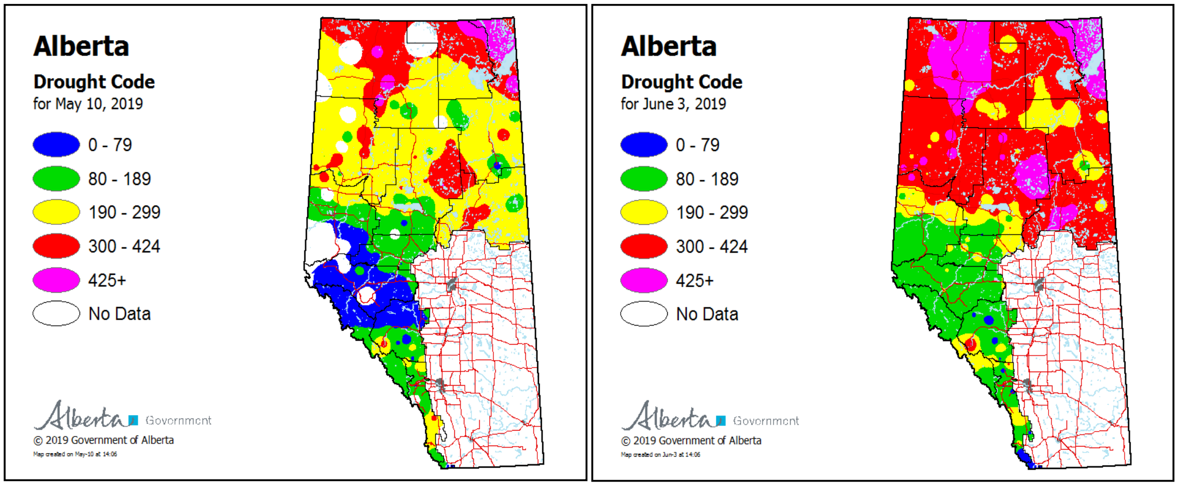


Figure 14 shows the Initial Spread Index[13] (ISI) for key dates during the month of May:

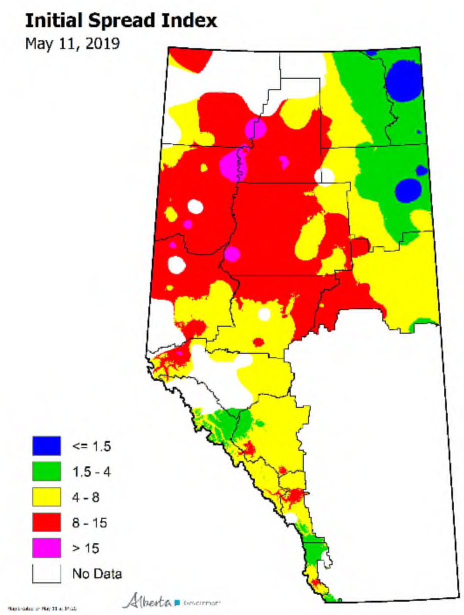
- May 11 and 12, the days High Level Forest Area wildfire (HWF) 042 (Chuckegg Creek), and Peace River Forest Area wildfires (PWF) 052 and 054 (Battle), were discovered;
- May 17 and 18 when Chuckegg Creek and Battle wildfires went Out of Control (OC) and when Slave Lake Forest Area Wildfires (SWF) 049 and 050 (McMillan[14]) started;
- May 29 and 30 when all three wildfire incidents took major runs.
    - These major runs, ranging between 12,000 hectares and 80,000 hectares with a total of 192,000 hectares burned, are discussed in further detail in the sections to follow and in *Appendix E: Satellite Fire Behaviour Observations*.

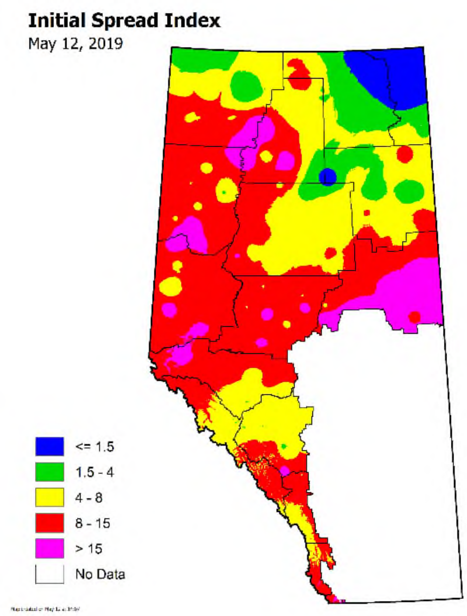
[13] ISI – a combination of the Fine Fuel Moisture Code and wind speed — is directly related to rates of spread and can change quickly when fine fuels are dry and the wind changes

[14] McMillan complex also consisted of SWF 069 (May 26), 078 (May 30), 079 (May 30), 090 (June 2), and 099 (June 5).

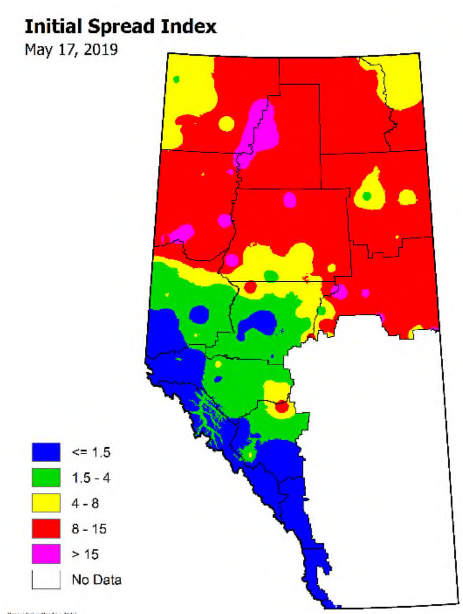
Figure 14: Provincial Initial Spread Index Maps for Significant Wildfire Spread Events in May 2019.

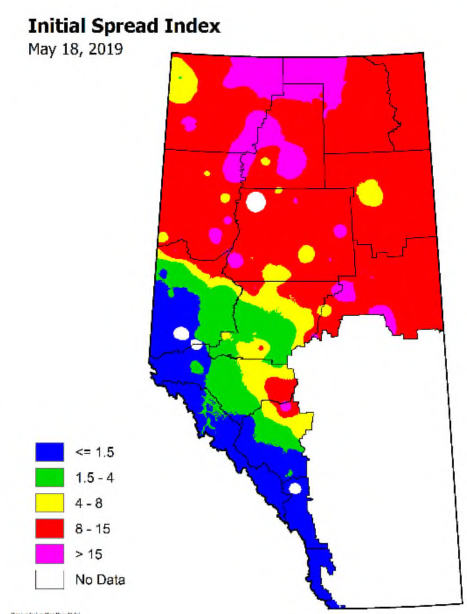
May 11 and May 12



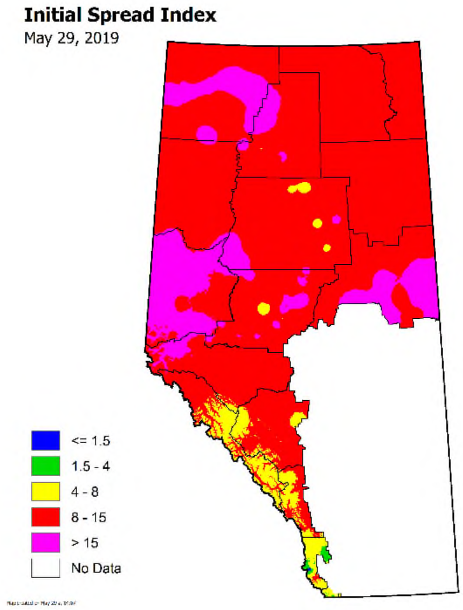


May 17 and May 18





May 29 and May 30



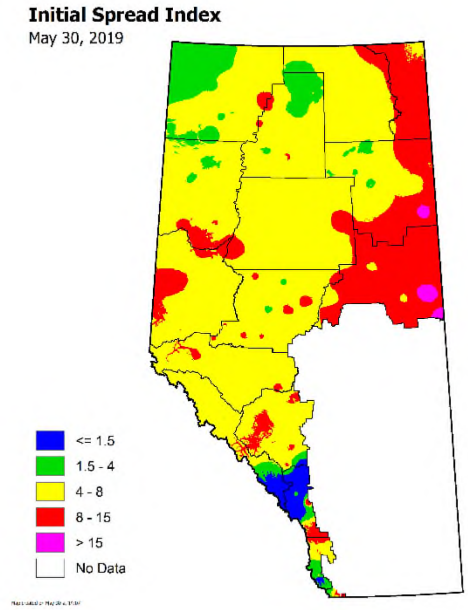
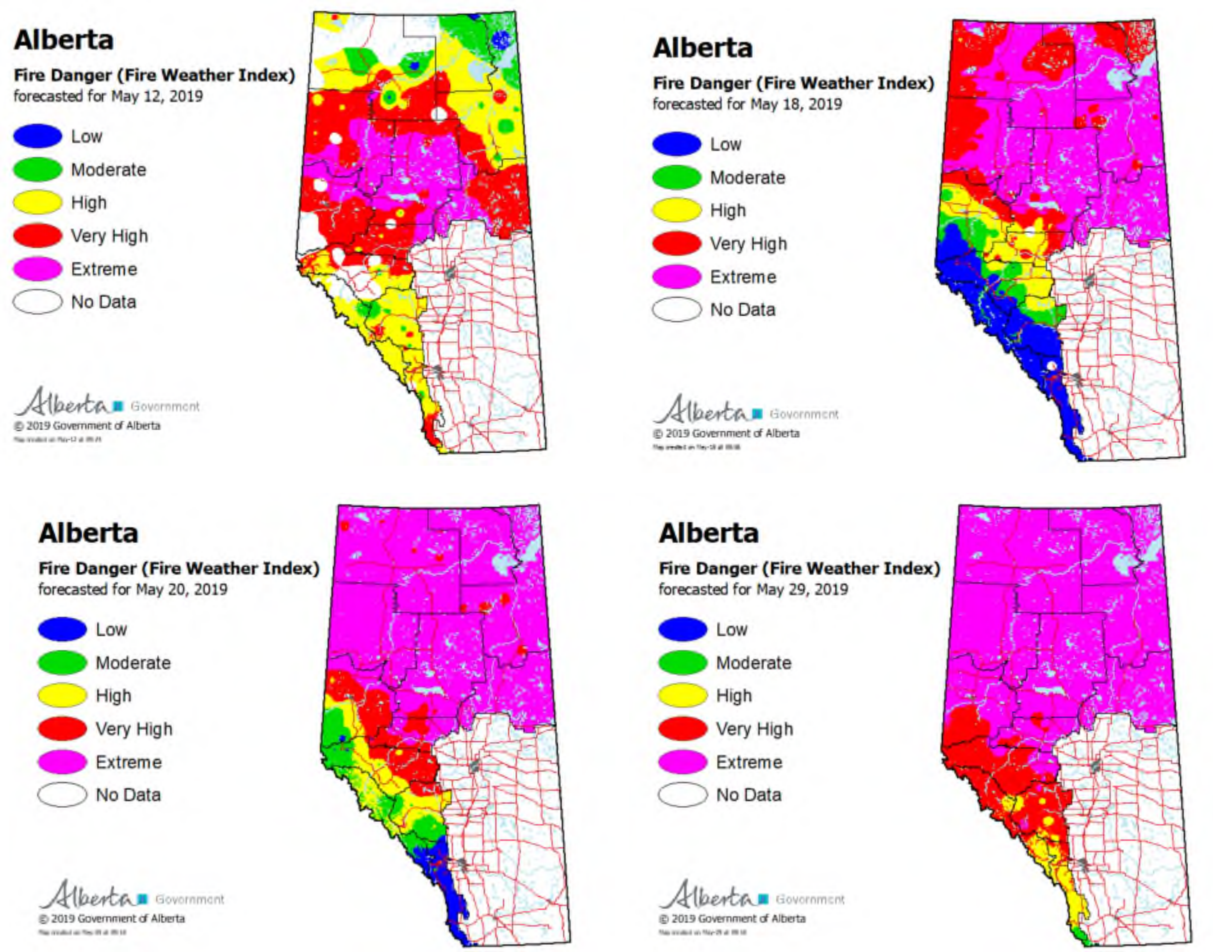


Figure 15 shows the Fire Weather Index — an overall indicator of fire intensity — for select days in May.

Figure 15: Provincial Fire Weather Index Maps for Significant Wildfire Spread Events in May 2019



In summary, the environmental conditions leading up to the May 2019 wildfire situation were severe, though it is common in Alberta for fire indices to be very high to extreme in the spring. Major wildfires visible in Figure 11 (page 24) burned under similarly extreme fire behaviour conditions.

SUMMARY OF 2019 MAJOR INCIDENTS

This section presents a summary overview of the 2019 fire season and the three incidents reviewed—Battle complex, Chuckegg Creek wildfire and McMillan complex. A detailed account of the 2019 fire season can be found in Appendix D: Overview of 2019 fire season.

Overview

Extreme hazard conditions in northern Alberta were well understood by WMB staff going into the month of May. Early season wildfires are expected to be very fast moving whenever pushed by winds and are typically active under moderate winds, because of the amount of dry fine fuel available before deciduous plants and grasses green up. These extreme weather conditions came to a head in the northwest section of the province the weekend of May 11 and 12.

Figure 16, below, depicts the timeline for the three major wildfire incidents included in the scope of this review. An overview of the three major wildfire incidents is presented in Table 4.

Figure 16: Summary of 2019 Wildfire Major Events

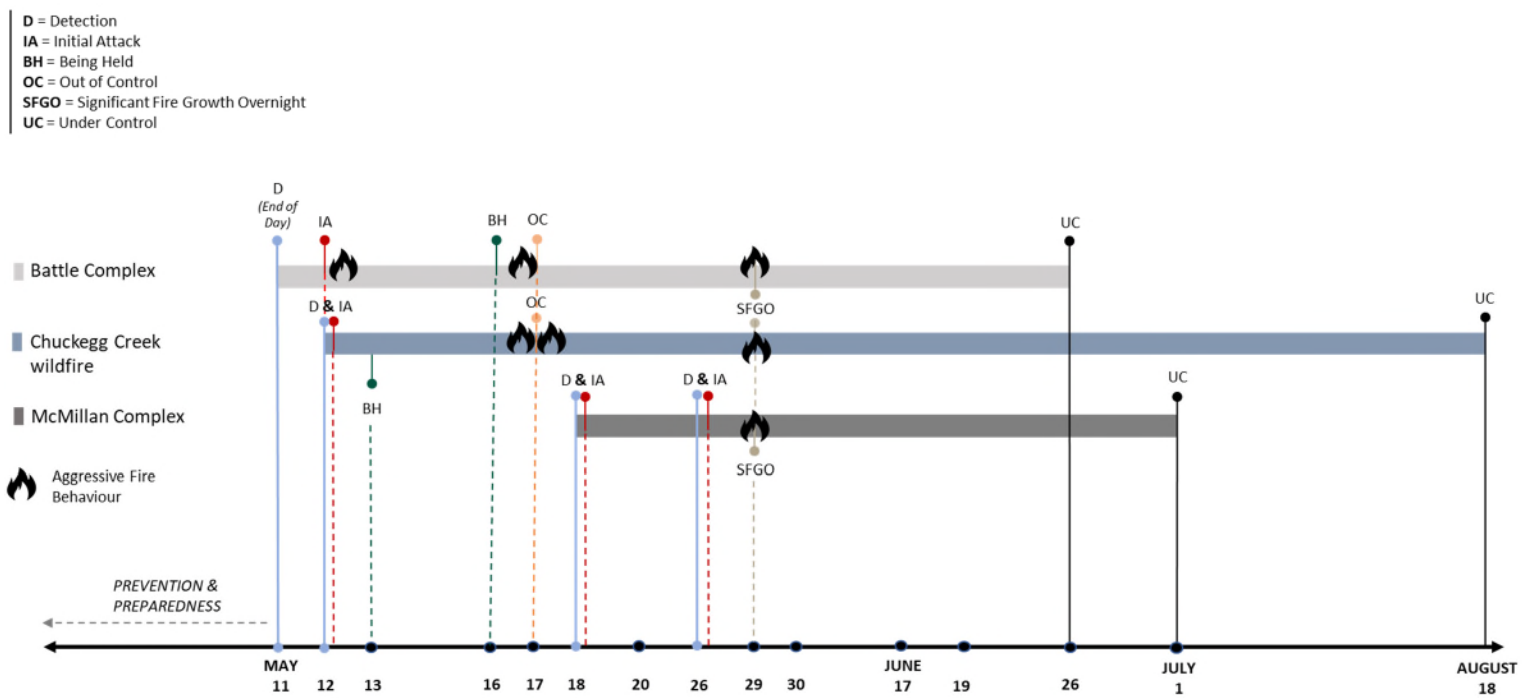


Table 4: Summary of 2019 Wildfire Events

Overview of Battle, Chuckegg Creek and McMillan								
Wildfire	**Fire Numbers**	**Forest Area**	**Start Date**	**HFI at Discovery**	**Total Area Burned (ha)**	**# of Days Out of Control**	**# of IMT Shifts**	**# of Out-of-Province IMT Shifts**
Battle complex	PWF052 PWF054	Peace River	May 11	3	52,606	46	5	3
Chuckegg Creek wildfire	HWF042	High Level	May 12	5	350,135	98	8	1
McMillan complex	SWF049 (includes SWF050 SWF069) SWF078, 079, 090, 099	Slave Lake	May 18	6	273,045 1,331	44	6	4

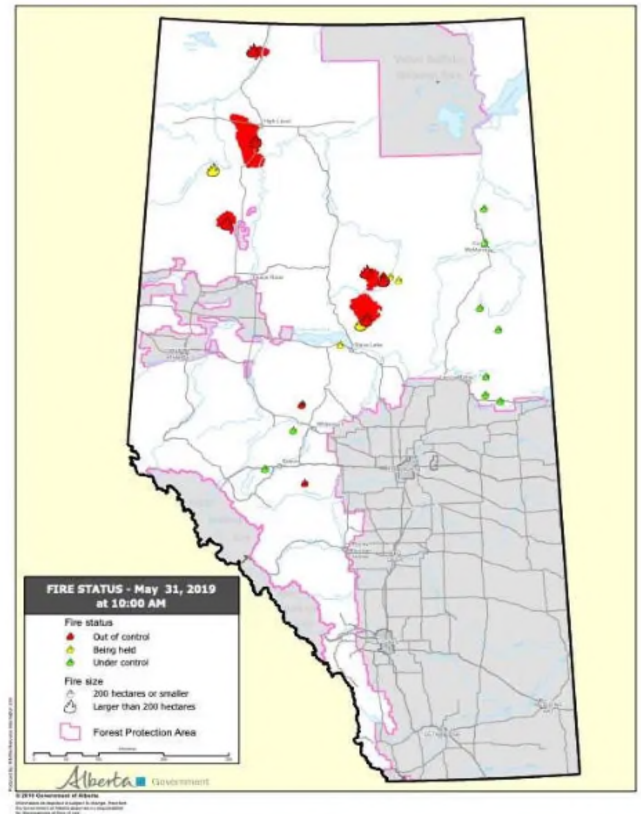
Despite the three major incidents that occurred in 2019, WMB was very successful in controlling most wildfires that started during the same time period. In addition to the Chuckegg Creek wildfire, and the Battle and McMillan complexes, there were 301 other wildfires that occurred in the month of May, 285 of which were controlled immediately. Figure 17 illustrates those wildfires that grew to more than 200 hectares in size during the month of May.

Four[15] OC[16] incidents, including the northernmost Jackpot Creek wildfire, required sustained action at the same time and caused most of the operational concerns. The concurrent nature of these incidents combined with a period of extreme weather conditions made resourcing sustained action while maintaining capacity for initial attack (IA) extremely challenging for WMB.

Initial Response

The first major wildfire incident, PWF052 (Battle), was detected late in the day on May 11 (Figure 18). This wildfire would eventually become part of the Battle complex. Lightning, likely from earlier in the evening at 19h43, caused this wildfire. The wildfire was detected at 21h10 by ground patrol staff in Manning. Approximately 25 minutes later, a second smoke report, PWF054 (Battle), was reported by Deadwood lookout just north of PWF052. Due to the late time of day that both wildfires were detected, only a quick aerial reconnaissance was possible before aircraft reached grounding time for the night. IA forces were mobilized but lack of access and approaching nightfall prevented their ability to deploy. A heavy equipment group was mobilized closer to the area that evening to improve access for IA the following morning.

Figure 17: Map of Alberta Fire Status—May 31, 2019



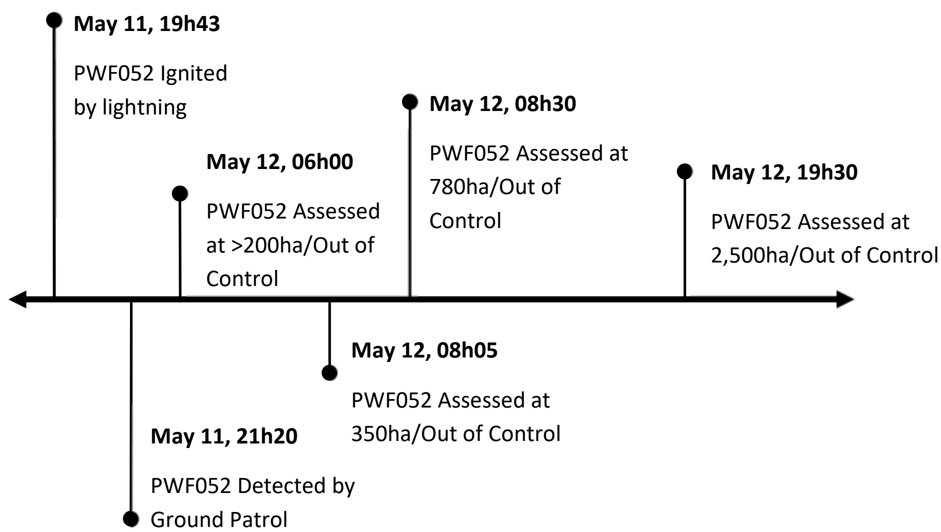
Early the following morning, an Incident Commander (IC), Unit Crew and supporting aircraft and heavy equipment were assigned to PWF052 and PWF054. The initial reconnaissance at 06h00 determined that PWF052 was beyond resources immediately on hand and assessed at over 200 hectares in size. Just north of PWF052, PWF054 was estimated to be between 50 and 75 hectares with containment considered achievable. As a result, priority for ground crews was assigned to PWF054 as a new strategy was being developed for PWF052.

[15] Note wildfires SWF049 and SWF069 were just joining in the McMillan complex at the time the map was made.

[16] A wildfire is defined as Out of Control when the wildfire is not responding to suppression action such that the perimeter spread is not being contained.

The HFI of PWF052 in the morning of May 12 was assessed to be HFI 5. Unusually dry overnight conditions coupled with high winds early in the day caused PWF052 to grow exponentially in the hours to come.

Figure 18: Initial Progression of PWF052 (Battle Complex)

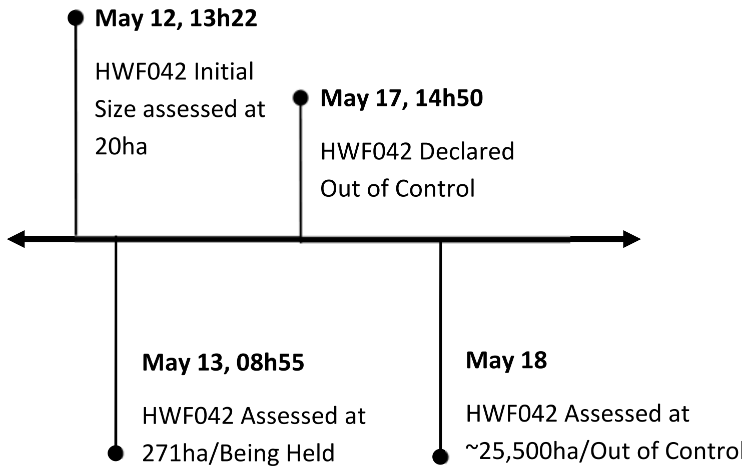


Airtanker operations on PWF052 commenced at 08h50 with multiple groups and continued action until 13h45, when air attack was suspended because the action was proving ineffective given the extreme fire behaviour. By 19h30 on May 12, PWF052, was estimated at 2,500 hectares. A Type 1 Incident Management Team (IMT) arrived during the day on May 13, effectively taking over the incident by that evening. Aside from some hand ignition work undertaken late in the day on May 12 to help protect a grazing lease to the south, no ground crews were deployed on PWF052 until May 14. Dozer guard construction commenced the morning of May 12 and continued throughout the first days. Aerial suppression using helicopter buckets continued throughout the period with additional airtanker support provided periodically where achievable objectives could be determined. Once the IMT assumed command of the incident, concentrated ground resources commenced on May 14. By May 15, 121 firefighters were resourced to PWF052.

On the same day that PWF052 and PWF054 IA were underway, HWF042, known later as the Chuckegg Creek wildfire, was detected by a lookout at 13h22 and assessed to be 20 hectares in size (Figure 19). While detected on May 12, HWF042 was likely started at 18h08 the previous evening following a lightning strike, which held over and grew during the daytime heating. The IA was immediate upon detection and included two Helitack (HAC) crews and one Firetack (FTAC) crew along with wildfire officers, heavy equipment and helicopter support. Airtankers were requested but were delayed because of other wildfire priorities. The first airtanker arrived at 15h15, three hours and 43 minutes after detection.

HWF042 grew overnight to an estimated 271 hectares and was declared Being Held (BH) at 08h55 on May 13. For the next four days of HWF042, under modest winds and because of suppression efforts, the wildfire burned within the recognized perimeter and did not grow significantly.

Figure 19: Initial Progression of HWF042 (Chuckegg Creek)



Late afternoon on May 17, high winds caused HWF042 to escape. These winds were forecasted prior to the escape, but the tactics employed were not sufficient to secure containment, given the sudden and dramatic change in wind condition. HWF042 was declared OC at 14h50 of May 17. It spread rapidly, growing to 1,800 hectares by 21h00. By 21h00 the following day, it had reached a size of over 25,000 hectares.

Categorizing the wildfire as BH on the morning of May 13 may have been premature and potentially created a false sense of security around the wildfire status for many stakeholders. BH is defined by WMB Standard Operating Procedures as follows: "a wildfire that is identified as "being held" is when sufficient resources are currently committed and sufficient action has been taken, such that the wildfire is not likely to spread beyond existent or predetermined boundaries under prevailing and forecasted weather and fire behaviour conditions." This definition, while consistent with other wildland fire agencies in Canada, has many sub-components that not only have a variety of potential operational impacts, but can also be misinterpreted by public stakeholders.

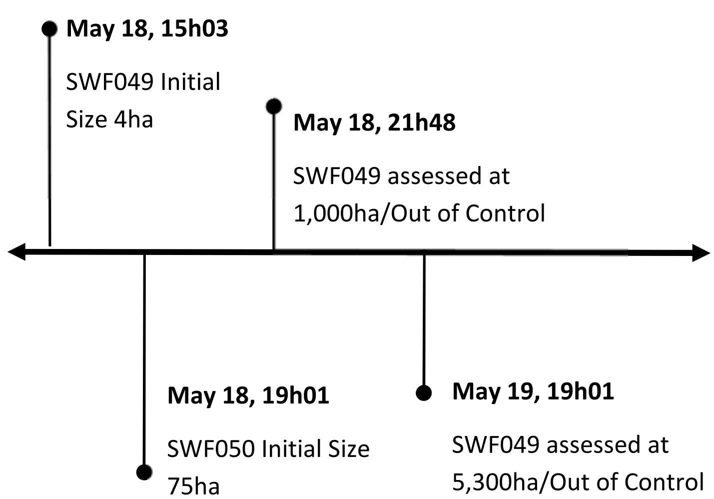
By May 18, extremely dry conditions were well established in northern Alberta. New and existing wildfires were challenging suppression resources – particularly whenever the winds picked up. The existing Battle complex and Chuckegg Creek wildfire grew considerably on May 17 and were burning OC. The forecast for May 18 included a Red Flag Watch for the Red Earth weather zone, with forecasted southeast winds of 25 kilometres / hour gusting to 45 kilometres / hour. With WMB already challenged by the wildfires in High Level and Peace River, resources became further stretched with the ignition of new wildfires northeast of Slave Lake. This ultimately became the McMillan complex (Figure 20).

While the cause of SWF049 and SWF050 remain Under Investigation[17], at approximately 14h00 on May 18, grass was ignited in several places along the north side of Highway 754 that runs between Marten Beach and Wabasca. Other members of the public who were travelling the same highway quickly spotted the wildfires and SWF049 and SWF050 were reported via the 310-FIRE reporting line by 14h14. The HFI forecast for the area was 6 at the time of detection. Teepee Lake wildfire lookout confirmed the location and staff traveling to SWF048 (a power line-caused wildfire reported an hour earlier) reported "two good columns" — suggesting the wildfires were getting a good push from the steady winds in extremely dry conditions.

IA resources were dispatched from Wabasca and air attack was requested and dispatched from Fort McMurray to respond to SWF049 and SWF050. The CL215T airtanker group positioned in Slave Lake for the day, like other groups across the province, was working other wildfires when SWF049 and SWF050 were reported. Ground crews, air attack and heavy equipment were well coordinated in the first 36 hours. A decision was made to focus on SWF050 because it was determined to be more likely to hold — this determination was valid. With heavy equipment supported by ground crews and helicopter buckets, SWF050 was held over the following two days growing to 1,540 hectares (its final size) by the end of day on May 19 and declared BH on May 27. SWF049 was much more challenging; by the end of day on May 18, SWF049 was estimated to be 1,000 hectares in size. Ground forces were working at the rear while airtankers and helicopters tried to hold the wildfire against McMillan Lake. On May 19, when winds continued to push the wildfire, SWF049 spread around McMillan Lake and grew to 5,300 hectares by the end of the day, setting the stage for the large complex that would persist for several weeks.

In the case of SWF049, appropriate WMB Operations Section staff were assigned and provided continuity as an IMT arrived days later. However, the Forest Area was unable to resource support positions for Logistics, Finance and Administration, and Plans Sections — both in the Forest Area office and at the incident itself. Interviews indicated the shortage of skilled and able staff to support Alberta IMTs was chronic in 2019. IMTs from other provinces arrived with support staff – a total of 19 people – yet Alberta teams were dispatched with eight people, assuming resource positions would be sourced at the local level.

Figure 20: Initial Progression of SWF049 and SWF050 (McMillan Complex)



[17] Under Investigation refers to the status of a wildfire with an unknown cause where there are ongoing efforts to determine said cause.

Sustained Action

Chuckegg Creek Wildfire (HWF042)

On May 17, 2019 the Chuckegg Creek wildfire was declared OC and an IMT assumed command May 20. A total of eight IMT's were deployed in successive tours on Chuckegg Creek, with a total of 5,333 personnel deployed to action the wildfire to bring it under control.

This wildfire was extremely active throughout the month of May and into June, presenting significant challenges for wildfire and emergency response organizations. There were, however, two extreme periods of fire behaviour that stand out. The first occurred between May 17 and 20, when the wildfire grew and took a 25-kilometre run, growing from approximately 2,300 hectares to over 71,400 hectares. Evacuation Orders were issued by Mackenzie County, the Town of High Level and the Dene Tha' First Nation, displacing over 3,000 residents from their homes.

These evacuations triggered the establishment of Unified Command for the Chuckegg Creek incident, which was enacted on May 21 with an Incident Command Post (ICP) in the Town of High Level. This first period of Unified Command was terminated on May 29. The timing of this termination proved extremely challenging due to aggressive fire behaviour that same day.

The initial set-up of Unified Command came with challenges as partners formed relationships and familiarized themselves with Unified Command protocol. Municipalities, admittedly, "possessed limited Incident Command System (ICS) knowledge and experience", particularly in the context of ICS protocol, which impacted efficiency when setting priorities and making decisions.[18] However, the first execution of Unified Command was reported to be effective and well-received. A clear example of the effectiveness of Unified Command was illustrated during the 6,000 hectares burn out operation that was conducted on the northern flank of the wildfire. This exemplified the product of all jurisdictions working together and was instrumental in protecting the Town of High Level. The residents evacuated from Chuckegg Creek in May — Mackenzie County, the Town of High Level, Dene Tha' First Nation, Keg River and Carcajou areas — returned to their communities between June 2 and 5 following weeks of evacuation.

The second major run occurred on May 29, when Chuckegg Creek ran 30 kilometres overnight. The wildfire conditions were extreme — wildfire growth of this extent overnight is very uncommon. One area that presented a significant challenge to firefighters was a horseshoe-shaped area immediately adjacent the Peace River.

This was an area of approximately 80,000 to 90,000 hectares in size of contiguous fuel, without any access points and little available water except the river itself. Different strategies were deployed to deal with this situation but ultimately the emphasis on aerial ignition proved to be the most successful given the options available. This technique raised many concerns with local stakeholders given the increased risk and smoke concerns associated with aerial ignition but was ultimately implemented with some success. Despite the firefighting efforts, the wildfire spread beyond control lines before the horseshoe area could be adequately addressed.

Unified Command was established again between Mackenzie County and WMB on June 18. Rapid wildfire growth forced additional communities to evacuate between June 17 and 19, including the Hamlet of La Crete, Beaver First Nation and the community of Blue Hills. These were the last evacuations of the 2019 major incidents.

Chuckegg Creek wildfire, however, continued to burn OC until it was held on July 25 and eventually declared Under Control (UC) on August 18 — 98 days after detection. Chuckegg Creek burned a total area of 350,135 hectares with structures lost on the Paddle Prairie Métis Settlement and Mackenzie County in the area around Thompkins Landing/Blue Hills.

[18] *Unified Command Observations & Recommendations* (2019), Alberta Emergency Management Agency.

PADDLE PRAIRIE MÉTIS SETTLEMENT

The Paddle Prairie Métis Settlement (PPMS) suffered significant loss that devastated their community as a result of the Chuckegg Creek wildfire.

Community Profile

The Paddle Prairie Métis Settlement is a Métis settlement in northern Alberta along the northern boundary of the County of Northern Lights and is home to nearly 800 members. It is located along the Mackenzie Highway (Highway 35), approximately 72 kilometres south of the Town of High Level and is the largest and most northerly of eight Métis Settlements in the province. The Settlement consists of approximately seventeen townships or nearly 175,000 hectares. It is bounded by the Peace River on its eastern border, with access across the river provided by the La Crete ferry. The land of the community is rich in wildlife, boreal timber, natural gas production and has multiple agricultural uses. Hunting is a primary source of food and a way of life for many community families, supplemented by fishing and trapping.

Impacts of the 2019 Fire Season

Overall, PPMS felt that they "fell through the cracks" during the 2019 fire season. As a Métis Settlement, they are not connected to Indigenous Services Canada as a First Nations Reserve would be, nor are they governed by the *Municipal Government Act* as a municipality would be. Métis Settlements are unique communities within the province, by virtue of the *Métis Settlements Act*, with distinct status, rights, and jurisdiction. However, due to this legislative distinction, Métis Settlements like Paddle Prairie are left without direction or support in many cases, including during natural disasters. Consequently, during the wildfire events of the 2019 season, the roles, responsibilities and communication between PPMS and the WMB were unclear at times. While PPMS declined to join the Unified Command established between the Town of High Level, Mackenzie County and WMB, the community had a minimum of once-daily communication with Unified Command to maintain a level of situational awareness as it related to Chuckegg Creek.

On May 21, the community made the decision to evacuate a portion of community members due to air quality concerns for seniors and persons with disabilities. On May 26, the remainder of the community's 800 residents were evacuated. Community members were unable to return for 26 days, the longest evacuation period in the 2019 fire season.

Despite the efforts of neighbouring Town of High Level and of WMB, PPMS suffered serious loss and struggled with lack of resources to deal with the trauma it faced. Out of approximately 250 homes in the community, 16 were destroyed. Nine homes suffered some sort of damage and several outbuildings were lost. Impacts of the devastation included the loss of several traditional medicine gathering sites and worries of significant reduction in wildlife activity and harvestable timber.

Overall, Paddle Prairie Métis Settlement was uniquely and adversely affected by the 2019 fire season. The community, like many affected by wildfire in 2019, continues to heal from the impacts of the 2019 season.

Battle Complex (PWF052)

The first IMT took command of the Battle complex on May 13, 2019. A total of five IMTs were deployed on this wildfire in succession and, at its peak, over 490 personnel, 23 helicopters and 60 pieces of heavy equipment were deployed to fight Battle.

The first few days of the Battle complex showed some progress and the wildfire was declared BH at 08h00 on May 16 at 2,271 hectares. When the unanticipated challenges of the wind event occurred on May 17, it returned to OC at 15h30 that day, spreading to the northwest to an estimated size of 5,271 hectares. This change of the wildfire's control status from BH back to OC in such a short timeframe reduced the public's confidence in WMB's response and the suppression actions being taken.

The second major run Battle took was on May 29 as a result of a frontal passage — the same weather pattern that affected all three major incidents. Once again, firefighters were caught off guard and the wildfire size increased by more than 12,500 hectares overnight. The spread was so unexpected that it caused the immediate evacuation of the main wildfire camp as a precautionary measure. Although specific communities were not immediately threatened by Battle, evacuation orders were issued for the more rural areas of the Keg River and Carcajou. There were also significant timber values in the immediate area along with several specific industry assets such as the TC Energy camp, which self-evacuated for precautionary measures.

Initially, wildfire suppression tactics on the Battle complex focused on a direct attack approach, but this eventually shifted to an indirect attack approach and the aggressive use of aerial ignition. This created major concerns with several stakeholders, especially the forest industry in the immediate area, given their concerns around further loss of timber supply from the ignition process. Ultimately, given the fire behaviour and conditions on the ground, the decision to use indirect attack proved successful.

Another significant concern occurred on the east flank of the wildfire where several farms and a concentration of agriculture values existed. Dozer guards were constructed along this flank to provide a contingency containment line in case the wildfire was to run in that direction. However, communications with the stakeholders affected were limited and concerns were raised around the level and necessity of damage to their assets.

Ultimately the Battle complex was declared BH for the final time on June 13 and declared UC on June 26, totalling 46 days until UC with a total burned area of over 55,000 hectares.

McMillan Complex (SWF049 (including SWF050 and SWF069), SWF078, SWF079, SWF090, SWF099)

SWF049 was managed by an Incident Commander 3 and staff from the Slave Lake Forest Area until May 22, when the first Alberta IMT took over. A total of six IMTs were deployed on this complex. At its peak, more than 600 personnel (115 related to heavy equipment operations) and 45 helicopters were deployed to this complex.

In the days following May 19, SWF049 continued to spread to the north and east supported by winds and dry fuels. Progress was made to hold SWF050 and build line from the highway at the rear of SWF049. On May 26, a lightning wildfire (SWF069) was reported directly north of SWF049 and west of Teepee Lake lookout (southeast of the community of Trout Lake) at 17h36 — the peak of the burning period. Because of burning conditions, this new wildfire escaped IA. SWF069 was given lower priority for firefighting resources because of the unmet demands of the higher priority wildfires already underway (including Battle and Chuckegg Creek). The IMT dispatched to the wildfire was given a priority to protect values immediately at risk, including any communities nearby.

A second significant event occurred at McMillan on the afternoon of May 29 and into May 30. Good progress had been made on sections of SWF049 with heavy equipment, but a cold front — the same frontal passage that affected Battle and Chuckegg Creek — passed in the afternoon of May 29 bringing a significant shift in wind speed and direction. By the morning of May 30, SWF049 and SWF069 had, in total, added about 100,000 hectares of burned area. Subsequently, SWF069 and SWF049 were combined into one wildfire. McMillan would grow to over 273,000 hectares with almost 900 kilometres of perimeter in the days to follow.

Extreme Fire Behaviour May 29 and 30, 2019

The month of May was characterized by a rapid increase of fire danger conditions throughout northern Alberta. Ultimately, more than 528,460 hectares burned in the second half of that month in the three wildfire incidents. Table 5 shows the growth in area burned over critical periods of days. The wildfire growth on May 29 and 30 warranted separate analysis, presented in *Appendix E – Satellite Fire Behaviour Observations.*

On the surface, the weather was forecasted to change with a frontal passage19 and wind shift. These events, with any combination of thunderstorms, long periods of drought, low humidity, high temperature and a high fuel load, have the potential to cause extreme fire weather and fire behaviour. The significance of this event may have been underestimated by some, even using available fire behaviour prediction tools. Nonetheless, the unexpected overnight growth in area burned placed stress on incident management staff and caused a shift in priorities and thinking on May 30. This rapid wildfire growth quickly endangered more communities from the McMillan complex, forcing numerous evacuations on May 30, including the Hamlet of Wabasca and Chipewyan Lake Village in the Municipal District of Opportunity, the Hamlet of Marten Beach in the Municipal District of Lesser Slave River and Trout Lake of the Peerless Trout First Nation, in addition to those already evacuated across the province.

[19] Frontal passages "cause strong sustained and gusty winds and an abrupt wind shift. Of heightened concern are dry cold fronts that have these characteristics, but little or no rainfall, and expected when there are on-going wildfires or prescribed burns." (United States National Weather Service – *Fire Weather Criteria*).

Table 5: Estimates of Significant Area Burned Days with the Three Wildfire Incidents

Wildfire	Timeframe	Estimated Area Burned[20]
Chuckegg Creek wildfire (HWF042)	May 12 – May 31	237,000 hectares (Total)
	May 17 – May 20	68,729 hectares (Increase)
	May 29 – May 30	80,000 hectares (Increase)
Battle River complex (PWF052)	May 11 – May 30	52,606 hectares (Total)
	May 29 – May 30	12,052 hectares (Increase)
McMillan complex (SWF049)	May 20 – May 31	155,600 hectares (Total)
	May 29 – May 30	59,446 hectares (Increase)
McMillan complex (SWF069)	May 29 – May 30	40,345 hectares (Increase)
Note: *SWF050 and SWF069 joined SWF049 on June 1 and June 2 respectively.*		

Understanding Extreme Fire Behaviour

Fire behaviour is a function of three fire environment factors: weather, topography and available fuels. In May 2019, considerable fuel was available because of the underlying drought conditions. Almost all fuels in forested ecosystems were available for burning with high intensities in this time period — even normally wet areas were dry and susceptible to wildfire spread and consumption of both plants and organic material in the ground. To many, wildfire is a phenomenon that travels across forested landscapes, driven by the wind. However, it is important to understand how wildfire interacts with the fuels and atmosphere in three dimensions. As wildfires develop, the release of heat and moisture from burning fuels begins to interact with the upper air, winds aloft and the development of unusual weather events. One of the most impactful weather events that occur in these conditions are pyrocumulonimbus convective storms.

Pyrocumulonimbus (pyrocb) are wildfire-related (pyro-) convective storms that have similarities to towering cloud formations (cumulonimbus) associated with thunderstorms. The pyrocb is typically anchored to a large crowning wildfire and persists as long as the energy release of the wildfire is sufficient to maintain the high convection column. Despite being well understood by the scientific community, their infrequent occurrence makes experiencing or predicting a pyrocb event unusual in one person's lifetime. These events — where fire behaviour is driven by convective activity — are relevant to wildfire management because of the potential for significant spread rates that challenge Fire Behaviour Prediction (FBP) models and field experience.

As part of this review, a number of pycrobs were analysed using satellite imagery during major runs of both the Chuckegg Creek wildfire and McMillan complex on May 29 overnight into May 30. This analysis is summarized here using the major pyrocb that developed over SWF069 (to become part of the McMillan complex) as an example.

[20] The hectares displayed here reflect the estimated area burned over the given time frame.

Forecast conditions for the McMillan complex for May 29 indicated that a dry (15 percent relative humidity) cold front would pass over the wildfire later in the day with winds of 20 kilometres/hour gusting to 35 kilometres/hour out of the northwest. Fire behaviour forecasts from this weather forecast were largely accurate for SWF049 wildfire, when compared to spread rates measured later from sequential satellite overpasses. However, SWF069 wildfire just north of SWF049 grew substantially during this period, in an explosive manner that was not forecasted nor anticipated. Satellite measurements between 18h07 and 23h39 show a large increase in area burned and spread rates on SWF069 during this period.

This unexpected fire behaviour was due to the effects of a pyrocb storm that formed directly over SWF069. This was clearly an intense pyrocb that influenced the area growth and spread of SWF069. Dry lightning (lightning that occurs without a rain event) associated with the pyrocb was observed in the immediate area around SWF069 when the pyrocb was most active. The strong vertical development of convection columns leading to pyrocb storm development resulted in extreme winds and lightning. This pyrocb started ten new lightning wildfires east of the McMillan complex. This is an unpredictable development not captured directly in weather and fire behaviour forecasts.

Following the unexpected significant growth of SWF069 overnight on May 29, WMB fire behaviour modellers began to investigate potential factors that may have influenced this event. They determined elapsed times and spread rates from satellite hotspot detections, and noted an extreme wildfire spread rate between 21h20 and 22h55. During this short period the wildfire appeared to spread at a rate of 10.7 kilometres/hour, which is a spread rate rarely observed on wildfires. This time interval coincides with the development of the strong and violent pyrocb storm and increasing spread rates observed in the satellite imagery described earlier.

WMB fire behaviour modellers are now planning to communicate the lessons from this event, including the importance of using upper air observations to forecast fire behaviour when they expect convection column interactions with the upper atmosphere, which may result in stronger winds at the surface.

PUBLIC AND COMMUNITY ENGAGEMENT

Wildfires are managed to protect citizen health and well-being, community security and socio-economic and natural resource functions and values. During the 2019 fire season, thousands of Albertans were displaced due to wildfire threat and tens of thousands more were impacted, whether by smoke, highway closures or supporting evacuations.

In order to gather a clearer picture of the events that took place and their impact on Albertans, in total, approximately 300[21] individuals had the opportunity to participate in the public engagement process. In the case of the townhall sessions[22], the Minister of Agriculture and Forestry and the local MLAs participated in the dialogue. This is a summary of what we heard from the individuals, industries and communities affected by wildfires in 2019.

The following summary identifies the reoccurring and/or core themes that emerged from those interviews.[23] The interviewees included representatives from the impacted municipalities, First Nations and Métis communities, industry representatives and Government of Alberta.

Throughout the three major wildfire events, the Battle complex, McMillan complex, and Chuckegg Creek wildfire, it is worth acknowledging that despite the often-traumatic experience for those involved, no direct loss of life was attributed to the incidents. Many stakeholders acknowledged this in the course of their interviews.

It is important to understand the experiences undergone in the 2019 fire season. Public perceptions should not be discounted or set aside as an opinion, but rather recognized as the way stakeholders experienced the fire season. This distinction is critical in improving the policies and processes that govern the wildfire program. Afterall, perception is critical in shaping personal experience and their experience is critical in shaping their response to future events.

Most concerns expressed by those interviewed were related to the impact of evacuation decisions and procedures on the public, including those who were forced out of their homes, those who were forced out of hospitals and care facilities and those who were outside of the evacuation areas, but dependent on the evacuated centre for food, fuel and supplies. Other themes more directly related to WMB are identified as key findings:

Key Findings

1. Effective emergency management depends on constructive working relationships and trust.
2. A one government approach to wildfire management is critical to meeting the needs of Albertans.
3. Some stakeholders are concerned with the level of engagement by WMB.
4. Some stakeholders disagree with the strategies, priorities, and the suppression tactics employed on large wildfires.
5. Local governments exhibited inconsistent levels of preparedness and post-event support.
6. Inconsistent resources, approaches and decision-making as Incident Management Teams (IMTs) changed made forming relationships and maintaining knowledge continuity between community leaders and Incident Commanders difficult.
7. Defining the role of elected officials is essential to guide their efforts to support communities.

[21] Approximately 175 individuals attended the townhall sessions with MNP and the Minister of Agriculture and Forestry, with the remaining 125 participating in one-on-one or group interviews with MNP.

[22] A total of three townhall sessions were hosted in High Level, La Crete, and Slave Lake . A summary of these sessions is attached in Appendix F.

[23] A full list of the interviewees and a more comprehensive "What We Heard" document are attached in Appendix G.

Effective Emergency Management Depends on Constructive Working Relationships and Trust

Whether dealing with inter-agency cooperation or interacting with the public, trust is paramount to effective emergency management. While this is also true in regular human interactions, it becomes especially critical when safety, security and livelihoods are at risk. Equally challenging is establishing expectations that can be consistently met, especially in the dynamic wildfire environment. Trust is broken when expectations do not match experience. Perhaps even more challenging is re-establishing trust that has been damaged or broken. These trust relationships are required among individuals and organizations. Communities and WMB staff brought forward concerns related to the interpersonal relationships required for effective planning and response, and the need to improve inter-agency relationships. It should be noted that many of the interviewees recognized the improved relationship between WMB and the Alberta Emergency Management Agency (AEMA) in 2019.

As explored in Key Theme 1 of *Appendix G - What We Heard*, while in many cases the trust relationship with WMB improved throughout the emergent events, this was not universally the case. At the extremes, this lack of trust resulted in a breakdown of a well-coordinated response. From the interviews conducted, the trust relationship between government agencies has improved, but it must improve further.

A One Government Approach to Wildfire Management is Critical to Meeting the Needs of Albertans

Members of the public and other partner agencies are typically not aware of or concerned with interagency distinctions within government (e.g., WMB vs. AEMA vs. Provincial Operations Centre (POC)). They view the government as a single entity, which makes trust and relationship building a government-wide initiative. For most interviewees, WMB is the face of the government in wildfire related situations, however, confusion over jurisdiction and roles was a feature in many interviews.

As is commonly the case in multi-agency response, points of crossover between provincial bodies (e.g., AEMA/POC, other divisions of WMB, Community and Social Services, etc.) resulted in back and forth communication between communities and government, negatively impacting timely service provision during and after the wildfire incidents. Furthermore, it was unclear to many First Nations and Métis communities which governmental body — federal or provincial — they should look to for service provision and financial support.

A "one government approach" is meant to describe a desired state whereby regardless of internal jurisdictions across the Government of Alberta, the province operates in a fully coordinated fashion, throughout the prevention, mitigation, response, and recovery cycle.

In recent years, significant effort has been put into improving the delivery of Unified Command in times of emergency. Given the unique, multijurisdictional nature of the Chuckegg Creek wildfire, Unified Command was utilized three times during this incident. Most of the impacted agencies and communities saw the Unified Command structure utilized in the High Level Forest Area as effective — this and the underlying improvements in the working relationship between AEMA and WMB are important, positive steps for handling these types of public emergencies. There were concerns, however, stemming from perceptions of inappropriate political involvement that was a contributing factor to Unified Command being stood down early in the event. That said, Unified Command was eventually re-established.

Overall, the most common area of concern expressed by those interviewed related to evacuation decisions and communications during the evacuation time period. No concerns were expressed regarding WMB's advice to those responsible for making evacuation decisions. While out of the scope of WMB, it is critical to acknowledge the interrelation of evacuations with the wildfire event. Municipalities, First Nations and Métis communities, with the support of AEMA, WMB, Alberta Health and a number of other agencies, are all involved with evacuation decisions regardless of the fact that the ultimate decision to evacuate is with a local governing body.

Local governments relied on the advice of AEMA and WMB in making these evacuation decisions, however some municipalities were concerned with the length of time required to coordinate with all relevant partner agencies both on evacuation and return. A greater integration across agencies required for a successful evacuation and return, in a unified command type structure could alleviate these concerns in the future.

Some Stakeholders are Concerned with the Level of Engagement by WMB

Over the course of this review it became apparent that there is a gap in understanding between the public and public safety partner organizations (e.g., WMB, AEMA and municipalities) with regard to wildfire response. Most community members had a confident self-assessment as to their understanding of wildfire; however, the experience of some was that WMB and partners did not communicate with them sufficiently, in both amount and quality of information shared. This creates an imbalanced and incompatible set of expectations and experiences that are explored in greater detail in *Appendix G - What We Heard*.

Interviewees often described an inconsistent communications approach from WMB. It should be noted that those interviewed perceived the communications philosophy from WMB, directed by senior political and department officials, was to limit the contextual information provided and to restrict WMB communications to technical wildfire data. This is directly counter to the expectations and described needs of the public.[24] This is not restricted to formal communications procedures — interviewees spoke to a pattern of inconsistency in informal communications as well. In certain cases, partner agencies described circumventing designated contacts when trying to attain clarity or "more useful" information with which to make planning decisions. Stakeholders were critical that communication from WMB was overly technical, and lacked the context required to educate and reassure the public as to what was happening and why. Additionally, there were initial challenges to clarify communication roles given the amount of turnover in various positions. The Government of Alberta's Communications and Public Engagement Division, Forestry Division Information Officers, Forest Area Information Coordinators, IMT Information Officers and political communications staff were all involved in various ways throughout the incidents.

While communication protocols exist, their underlying philosophy was felt to be overly restrictive and internal advocacy was required just to allow the Forest Area Information Coordinators to speak to the technical nature of the wildfire or to use useful and common tools, such as Facebook. Further, Out-of-Province IMT Information Officers were accustomed to operating under a different set of guidelines and procedures, creating additional challenges.

While consistency of message was generally achieved by the government, it was perceived to be done at a cost of usefulness and timeliness. Many partners and local governments spoke to the length of time required to make decisions.

In areas that faced an evacuation, some municipalities felt they needed to work around WMB to communicate useful information and context to their citizens. They did not feel that the

[24] This topic is further explored in the Prevention, Mitigation, and Stakeholder Communication section of this report.

information provided by WMB was what the public they served was looking for.

Social media was viewed as an important tool for disseminating information, however, social media presents an issue by providing a platform for misinformation — a challenge that should be proactively managed. This misinformation often spread in instances where communication protocols did not allow for contextualization and technical accuracies to be provided in a timely fashion by WMB and partners.

It should be noted that WMB had put a lead person into place for wildfire communications months before the fire season began, after a four-year vacancy in this position. The experience and expertise gained from the 2019 spring wildfires should influence corporate processes and communication culture, which will help guide WMB communications.

Opportunity for Improvement – Government Wide:

More training is required to ensure that all Government of Alberta elected officials, communication staff, partners, and stakeholders understand and use ICS information principles as a best practice.

Some Stakeholders Disagree with the Strategies, Priorities, and the Suppression Tactics Employed on Large Wildfires

In the complex environment of wildfire management, communicating priorities to partners and the public continues to present challenges. External partners and the public are seldom afforded a complete view of the intricate challenges WMB faces every fire season, nor should they be expected to understand wildfire at a detailed technical level.

For this reason, when envisioning successful outcomes for each fire season, WMB must appreciate that public perception needs to be addressed and managed much like the wildfire incidents themselves.

WMB's priorities are to protect human life and reduce the risks and threats of wildfire to communities, watersheds and sensitive soils, natural resources and infrastructure[25]. Many acknowledged and framed their comments around an appreciation for the efforts of WMB in prioritizing human safety. Furthermore, WMB was seen by many as effective in suppressing wildfires throughout the 2019 fire season, and it was given respect for its dedicated work on the three major incidents.

Those interviewed that were more familiar with wildfire management regarded wildfire communication efforts as timely and technically sound. Several forest industry partners were complimentary of the content and timeliness of WMB's communications efforts.

A small number of interviewees felt that WMB was not effective in suppressing wildfires and expressed a deep concern over strategies, tactics and communication style. Questions arose over the IA of Chuckegg Creek wildfire, the efficacy of back-firing (and controlled ignition efforts in general), and the perception of ignoring local knowledge and labour in favour of importing resources. These frustrations were a component of the complex, technical, and often urgent nature of resourcing wildfire operations. Optimizing local resources continues to be a challenge for WMB and its community partners.

Communication was not always easily understood by the general public. Often too technical in nature, ineffective communication damaged the trust between government and the public in some cases.

A consistent theme heard throughout the interviews was the perceived limited time spent "fighting the fire." Many were often critical that the tactics and

[25] WMB Strategic Plan, Page 5.

strategies employed by WMB restricted the time spent trying to control the wildfire.

Furthermore, some questioned what was taken into consideration in determining the values-at-risk to be protected by WMB activities. This included questions as to how cultural values are considered in decision-making.

There is a perception among some that wildfire management in Alberta has a perverse incentive to not actually extinguish a wildfire. Some described wildfire management in Alberta as a "lucrative business." Commentary included perceptions there is an inherent disincentive for those employed — directly or indirectly — by WMB to extinguish a wildfire, as they may have a greater financial gain the longer a wildfire is active. There may be several explanations behind this viewpoint: a general lack of public trust with government; public comments from or behaviours of certain wildland firefighters and contractors; and a lack of understanding of wildfire management practices and realities.

Opportunity for Improvement:

In order to build relationships and avoid potential challenges, WMB, in collaboration with AEMA and colleagues in Agriculture and Forestry, should engage with agriculture industry partners to improve plans regarding agriculture and livestock operations during a wildfire event.

One consideration of note concerns feedback received from municipal partners and the agricultural industry indicating their perceived gap in consideration by WMB and AEMA for agricultural land, specifically livestock operations during wildfire operations, response and evacuation. This perceived disconnect reportedly resulted in frustration and tension between livestock operators and WMB due to impacts to operations and concerns about property.

Local Governments Exhibited Inconsistent Levels of Preparedness and Post-Event Support

There was a significant diversity in the level of preparedness for a large-scale emergency among the many Alberta municipalities and communities affected by wildfires in 2019. Though this preparedness has been a focus of Alberta Municipal Affairs, not every municipality has the same level of capacity, experience, training, emergency response planning and relationship building with key agencies and regional partners.

Existing, positive relationships among agencies and local governments were integral to effective communication and operations during the wildfire. In these instances, where a strong relationship was pre-existing, multi-stakeholder emergency planning at the outset of the 2019 fire season typically resulted in cohesive regional action. The Northwest Regional Incident Management Team, Canada Taskforce Two were both relied on to provide support to impacted communities.

That said, stakeholders indicated that relationships that were strained prior to the event caused further difficulty in coordinating wildfire responses.

Conducting emergency planning or joint exercises in advance of the fire season among key partners (such as fire departments, police services, AEMA, industry, utility companies, WMB and bordering communities) helped to establish relationships and accountabilities that expedited the communities' abilities to access and act upon accurate, timely information.

ICS training enabled more effective communication; however, maintaining sufficient, trained resources on a consistent basis has been challenging for many communities.

Regional partnerships with neighbouring municipalities were critical for sharing of information, resources and expertise. Where these partnerships had been established, communities were better prepared to manage their emergency response efforts throughout wildfire events and evacuation. Further focus on developing regional capacity could build off the successes seen in 2019.

Communication was generally challenging for those without established relationships, and for those who were not involved in regional planning. Often times, the more remote the community, the greater the communication gap seemed to be, leaving stakeholders feeling disconnected and disregarded by WMB and other provincial bodies.

Unlike imported staff and firefighters, local personnel (including municipal administrations) are presented with a confluence of additional challenges: they may have suffered loss themselves; their friends and neighbours are looking to them for information and leadership; they shoulder responsibility for the event as well as the continued administration of the community; and they are left with the requirement to complete additional, disaster recovery work. This puts excessive burdens on a few individuals and small organizations, most of whom are invested in shouldering that burden on behalf of their community.

Mental health and organizational supports are limited, especially post-event and this can have profound impact on those individuals. Supports ought to be provided during and following the event. Traditionally, post-event capital projects are built on a "build back better" philosophy, and the same philosophy ought to be recognized for the people impacted by these experiences.

Opportunity for Improvement –Government Wide:

Explore ongoing support programs that could include post-event support and mental health services, and intermunicipal support agreements that provide work-relief for impacted local governments. This is a one government opportunity.

Inconsistent Resources, Approaches and Decision-Making as Incident Management Teams Changed Made Forming Relationships and Maintaining Knowledge Continuity Between Community Leaders and ICs Difficult.

Nearly every partner organization, community and member of the public mentioned their frustrations with WMB and IMTs not utilizing local knowledge or resources. This is explored in depth in Theme 4 of the *Appendix G: Stakeholder Engagement – What We Heard*. Local knowledge of operating on the challenging northern landscape was perceived as being dismissed. With all things equal, local stakeholders expressed the importance and potential for efficiency of understanding the conditions, access points, landscapes and other key aspects of fighting wildfire around their communities.

In times of transition of incident management staff, information about previous circumstances and decisions were not always relayed from one IMT group or community representative to another, resulting in inconsistencies in the nature and level of information and support provided to impacted communities. These knowledge gaps were further influenced by the use of out-of-province resources with different protocols and procedures, providing local decision-makers with changing or conflicting information. For example, a community located near the Battle complex reported that the change-over between local Alberta and British Columbia (BC) IMTs was "clunky," due to different procedures for structural protection. Both the BC IMT and the community struggled with understanding whether Structural Protection Units (SPUs) were to be sub-contracted (as they are in Alberta) or operated as part of the IMT (as in BC), causing confusion and inefficient operations.

Finally, discrepancies in communications were reported most commonly at shift change. Communities cited that as WMB contact persons were changed, communicating with an individual new to the community or situation who did not have strong background knowledge became a challenge.

Defining the Role of Elected Officials is Essential to Guide Their Efforts to Support Communities

As cited in the What We Heard report, and as recognized in the AEMA Unified Command report, elected officials are not always clear on their role during an event. While the Province of Alberta has taken steps at the municipal level to ensure a minimum standard of training is required for elected officials and certain municipal administration officials, the same is not true for provincially elected officials.

Opportunity for Improvement – Government Wide:

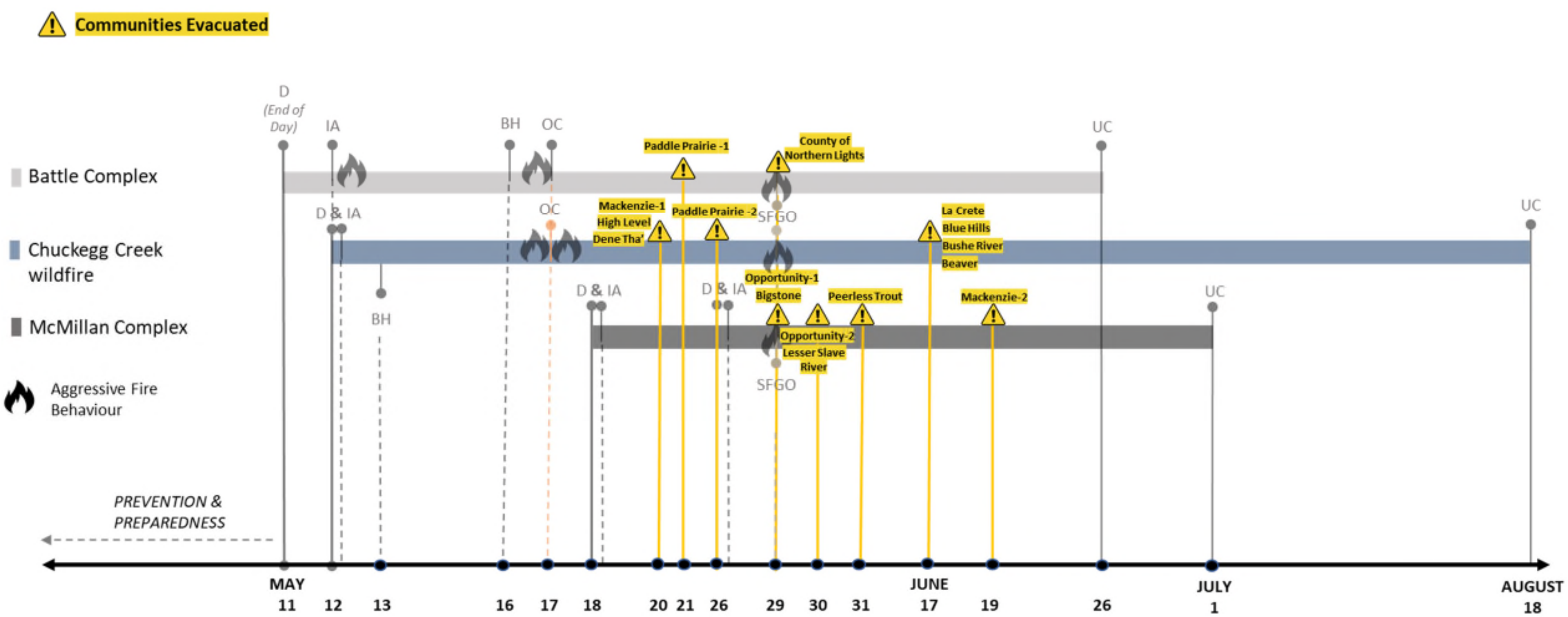
Offer Provincial Elected Officials the same required emergency management training as is required for municipal officials, immediately upon election to ensure they understand their roles in such an event.

Post-Wildfire

Returning Home

Evacuees returned home throughout the month of June, following one of the most extreme fire seasons in recent history. The three major incidents in spring 2019 forced the evacuation of approximately 15,000 people (Figure 21).

Figure 21: 2019 Evacuation Timeline



**Note that in addition to those communities listed above, additional evacuees who did not declare a home address registered in Slave Lake, Fort Vermilion, and Grande Prairie.*

Additional Considerations of 2019

Along with the operational commentary above, several additional areas of consideration surrounding the 2019 fire season were revealed as part of this review. While many of these issues are not part of the WMB mandate, they play a significant role as part of WMB's operational response. Furthermore, they have a significant impact on WMB stakeholders and the perceptions of WMB and its partners.

Evacuations

While not within the scope of the 2019 Spring Wildfire Review, the number and length of evacuations related to the three incidents is grounds for discussion. In total, approximately 15,000 Albertans were displaced from their homes due to threat of wildfire from Chuckegg Creek, and Battle and / or McMillan complexes. For some, this threat is a seasonal reality of living in the Wildland-Urban Interface. For others, the events of the 2019 season had a lasting impact on those who were forced to leave as well as those who stayed behind.

In order to understand the experiences of communities affected by wildfire, it is important to expand the scope of what constitutes "affected." Those facing imminent danger were forced to leave their homes and seek refuge, an experience that is undeniably traumatic. Because of the degree of impact and uncertainty an evacuation can have on an individual, there are several government and agency supports and existing protocols in place to manage this process. While these supports cannot eliminate the mental, emotional and physical toll on evacuees, they recognize and address the immediate needs of a displaced population.

However, and perhaps unique to the remote communities of Alberta's north, evacuations have a ripple effect on residents in the surrounding areas of evacuated communities. Many smaller communities within a large radius of the limited number of major centres in the northwest region depend on these centres for access to water, fuel, food and other services.

While these populations may be beyond the evacuation line, residents interviewed say they become "refugees in [their] own homes" — stranded without access to basic needs. This challenge is often exacerbated by road closures that severely limit access to and from remote communities, posing a risk to residents' basic needs and means of escape in the event of elevated wildfire threat.

These circumstances question the current standard for evacuated populations. While a population may not be within immediate danger of wildfire, they may still be adversely affected by it. The scope of influence of an evacuation is critical to the basic needs of many populations in Alberta's north and therefore can be considered an equally important component of local and provincial disaster planning.

Additional Considerations of 2019 (Continued)

Impacts to Local Resources

A key point following the 2019 fire season was the experiences of local incident management resources. As already described, unlike imported resources, local resources (including local administrations) are presented with a confluence of additional challenges; they may have suffered loss themselves, their friends and neighbours are looking to them for information and leadership, they shoulder responsibility for the event and the continued administration of the community. Additional work is also required to complete disaster recovery applications. This puts a burden on individuals and organizations. Mental health and organizational supports are limited, especially post-event. This can have profound impacts on those individuals and post-event supports ought to be explored. The experiences of these individuals during the 2019 fire season affirm this challenging reality, having expressed difficulty with returning to their personal and professional lives following the incidents.

Understanding the Impacts

Addressing these concerns is outside of the WMB mandate, however, the general public does not necessarily perceive these boundaries. Because of this, incident management outcomes are judged not only by the efficacy of wildfire management operations, but of incident management overall. This perception reinforces the need for strong partner relationships. Moreover, achieving positive incident management outcomes is a responsibility shared between many WMB partners, including Municipal Affairs, Alberta Emergency Management Agency, Alberta Health Services, Community and Social Services, Indigenous Relations, Indigenous and Northern Affairs and other incident agencies.

3 | Wildfire Management Program Evaluation

WILDFIRE MANAGEMENT PROGRAM EVALUATION

Complementary to the review of the WMB response to the 2019 spring wildfires in Alberta, an overarching program evaluation was carried out based on staff and stakeholder input, document and data analysis and comparisons to leading practices (see *Appendix I – Evaluation Approach*). The focus of the evaluation was to identify program refinements and enhancements as part of the Branch's commitment to continuous learning and improvement.

The program evaluation methodology involved the creation of a structured framework to guide the evaluation activities from the outset. The framework includes the identification of evaluation criteria, evaluation questions and the approach to data collection. The information gathered over the course of the exercise enabled evaluators to draw conclusions on various aspects of the program and make recommendations where appropriate.

The broad evaluation criteria included:

- Relevancy—the extent to which objectives of the projects or program are consistent with overarching stakeholder needs and overarching mandate.
- Efficiency—a measure of how resource/inputs (funds, expertise, time, etc.) are converted into outputs.
- Effectiveness—the extent to which a project or program achieves its objectives and outcomes.

Evaluation activities included holding interviews with internal program staff and external stakeholders, conducting desktop research of background or guiding documents, benchmarking practices against comparator jurisdictions and performing analysis of performance-related information and expenditure data.

WMB's mission statement is to:

Manage wildfire threats and opportunities to reduce risk to human life, communities and promote healthy ecosystems.

As a starting point, the purpose of WMB is to mitigate the risk and impact of wildfire in Alberta's Forest Protection Area. It does this through four core subprograms[26]:

- Prevention — activities to reduce the number and impact of human-caused wildfires in the Forest Protection Area, despite population growth and escalating wildfire start potential.
- Detection — actions to rapidly and accurately detect and report all wildfires in the Forest Protection Area.
- Preparedness — activities focused on the timely and effective initial action to contain wildfires within the first burning period.
- Suppression — actions to ensure all wildfires will be responded to and managed to accomplish specific resource objectives as outlined in an approved management plan or standard operating procedures.

In addition to our review of the four core subprograms, the program evaluation also included a high-level jurisdictional comparison of wildfire management activities as well as a review of information technology systems (see *Appendix J: Benchmarking Summary and IT Systems Overview*).

[26] Wildfire Management Policy, SOPs March 2019.

3.1 Prevention, Mitigation & Communication

PREVENTION, MITIGATION AND COMMUNICATION

Overview of Wildfire Prevention in Alberta

In Alberta, wildfire prevention includes several activities directly or indirectly related to reducing the number of wildfires occurring in the province and mitigating the impacts of wildfire on values and people. For expediency, communication is included in the review of this subprogram area, though communication is a part of all Wildfire Management program areas. In the context of this review, wildfire prevention includes general prevention programming, prevention-related outreach and communications, issuing fire permits, enforcement, prescribed burning, department-led FireSmart activities and stakeholder communications.

Due to differences in accounting practices, national benchmarking for prevention and mitigation does not provide a clear comparison. Philosophically, prevention and mitigation programs are aligned as each province has adopted FireSmart Canada's principles, however, the delivery of these programs varied dramatically.

Preventing wildfires reduces the demand for detection and suppression efforts and expenditures; however, there are no objective outcome-based performance measures currently used to assess this impact or to determine the optimal level of spending on prevention.

In addition to the prevention and mitigation activities conducted by WMB, grant funding is allocated to the Forest Resource Improvement Association of Alberta (FRIAA). The funding supports the FRIAA FireSmart Program, which provides funding to communities and community organizations throughout Alberta for FireSmart projects. Since 2011, a total of $40 million has been transferred to FRIAA and this funding has been committed to over 315 FireSmart project activities at the community level, as shown in Table 6 below.

Table 6: Summary of FireSmart Commitments & Expenditures to Date

Area	Total
Project Funds ($)[27]	$36,990,114
Number of Proponents[28]	103
Number of Projects[29]	315
Number of Locations[30]	817

In addition to the FRIAA program, the WMB spent over $20 million on prevention and mitigation related activities in five years since 2015, which represents approximately 2.5 percent of all branch spending. Table 7 outlines the details of spending on wildfire prevention in Alberta since 2015 with a breakdown of specific activities. Spending has ranged from $3.8 million to $5.2 million each year, with the spending for 2019 yet to be finalized.

[27] Project Funds represents payments and commitments to complete and in progress FireSmart Projects as of March 2, 2020.
[28] Number of Proponents represents the number of unique proponents.
[29] Total number of FRIAA FireSmart Projects.
[30] Location types include Hamlets, Subdivisions, First Nations, Métis Settlements, Towns etc.

Table 7: Costs per Year (in CAD) per Prevention Activity/Item

	2015	2016	2017	2018	2019 (Part)
Enforcement	39,972	87,708	1,315,821	330,126	324,780
Fire Permits	655,742	737,572	687,015	708,078	574,778
Fire Prevention General	415,277	160,176	37,996	55,267	84
FireSmart	349,204	721,746	151,048	185,763	50,913
FireSmart Assessment	7,363	10,376	294,371	360,303	89,563
FireSmart Treatments or Projects	316,266	916,793	655,193	663,233	22,659
Interagency Cross Training / Mock Wildfire Exercises	9,582	12,566	14,777	20,448	14,930
Prescribed Fire	1,598,846	904,084	995,754	2,396,985	431,022
Prevention Education	131,045	26,580	22,086	31,028	11,983
Prevention Engineering	10,370				
Prevention Plans	324,538	262,992	784,204	458,560	75,110
Grand Total	**3,858,204**	**3,840,594**	**4,958,264**	**5,209,790**	**1,595,821**

Key Findings

In reviewing the prevention program implemented in Alberta four key findings are made:

1. Human-caused wildfires represent significant preventable risk to public safety and values.
2. FireSmart has become central to wildfire prevention and loss mitigation in Alberta, but needs broader government and community support to become more effective.
3. Incendiary wildfires are prevalent in Alberta and require a targeted solution.
4. Public engagement and communications have improved over the past eight years; however, there is a need to continually improve in this area.

Human-Caused Wildfires Represent Significant Preventable Risk to Public Safety and Values

Since 1990, Alberta has experienced an average of 1,266 wildfires a year. Of those, 44 percent are naturally occurring (lightning wildfires) and the remaining 56 percent are human caused, with various specific factors at play. More than half of all wildfires in Alberta are preventable — the threat to values and public safety is much greater than it should be. Human-caused wildfires place a high demand on Alberta's resources, cause significant losses, represent significant risk to human life and well-being and are largely preventable. In addition, human-caused wildfires are often close to communities and therefore represent a greater threat to human safety than lightning-caused wildfires. This reality drives

WMB "to balance prevention, mitigation, and preparedness to create safer communities and healthier forests."[31] Figure 22 summarizes the wildfire occurrences by year and by cause. The figure shows a variable number of total wildfires from year to year and a proportion of the total wildfires caused by humans to be more than 50 percent in all years.

The prevention program has targeted recreation and residential caused wildfires over the past ten years and it appears to be effective. Figure 23 shows the trend in recreation and residential caused wildfires. Alberta experienced 289 recreational and residential wildfires in 2019 compared to the 9-year average of 517. This is a 40 percent reduction from the peak in 2012. Though, admittedly the latter half of the 2019 fire season saw significant precipitation, we should be cautious in speculating how these weather patterns affected recreation and residential wildfire occurrence. Afterall, the general trendlines for both "cause" categories indicate an overall downward trend.

While resident and recreation wildfires are decreasing, other human causes of wildfires have remained roughly the same over time (Figure 24). This helps provide some focus to wildfire prevention efforts. In terms of industry-caused wildfires, the single most significant contributor relates to power lines followed by oil and gas. The two are closely linked in that it involves industrial activity in forested areas. Policies and prevention programming currently address these sources of human-caused wildfires and it will be important to continue focusing prevention efforts in these areas.

Figure 22: Wildfires by Type 2011-2019

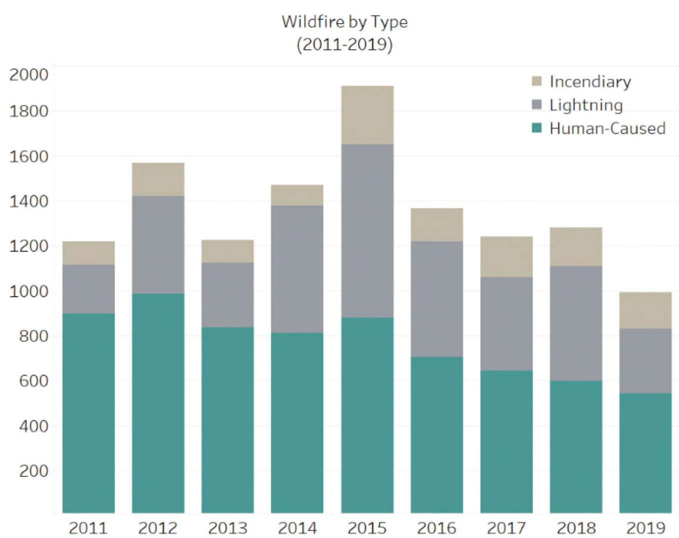
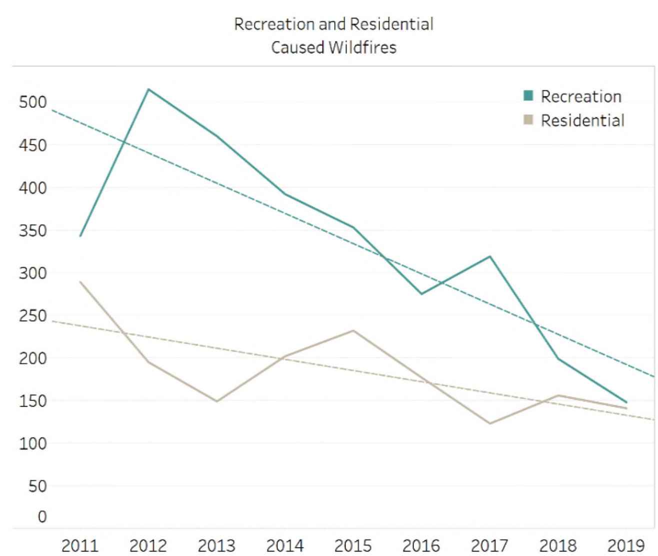
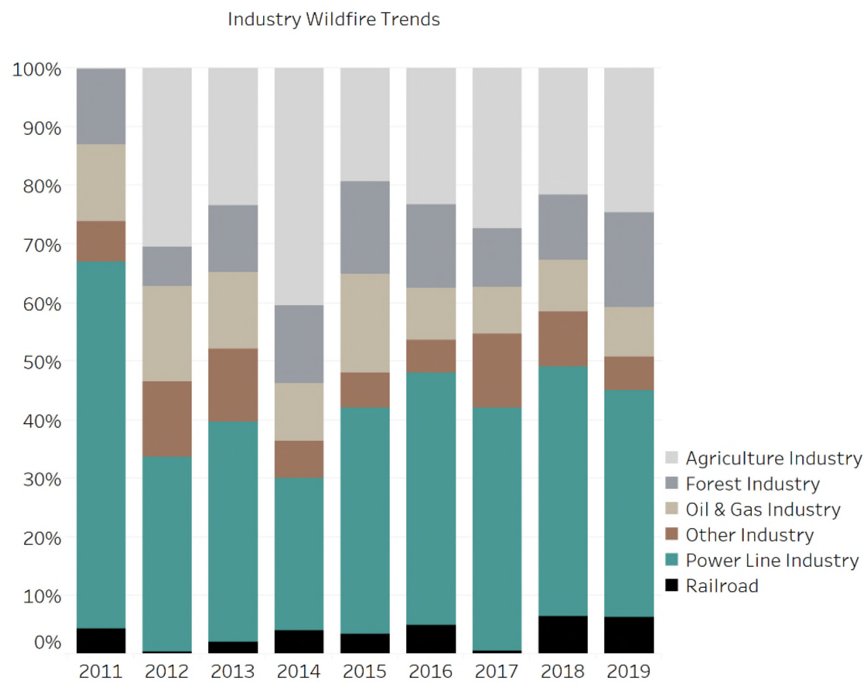


Figure 23: Recreation and Residential Wildfire Trends



[31] Wildfire Prevention Strategic Plan Page 1, 2015

Figure 24: Industry Wildfire Trends

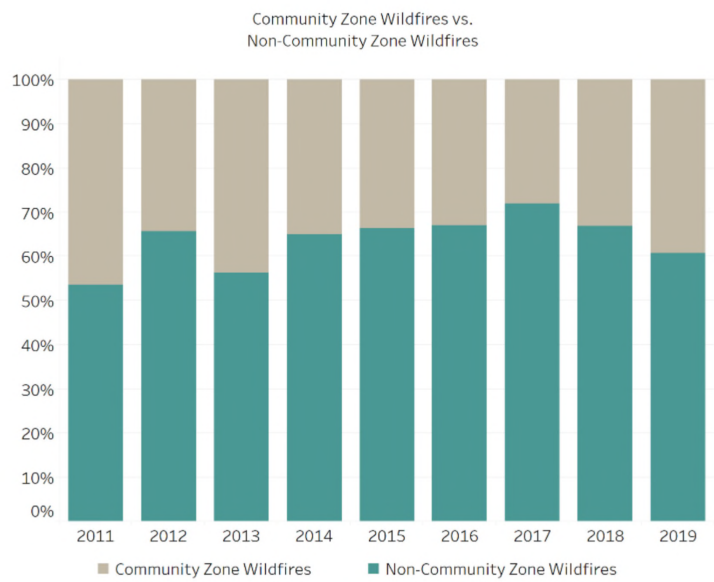


Human-caused wildfires have a significant effect on community safety. One way to measure this is to assess the number and causes of wildfires in the community zone. The community zone is a 10-kilometre area around the edges of a municipality in the Forest Protection Area. Approximately one-third to one-half of all wildfires in the Forest Protection Area are started within this zone, and therefore pose a real threat to community infrastructure and public safety. Figure 25 shows the prevalence of wildfires in the community zone since 2011.

Opportunity for Improvement:

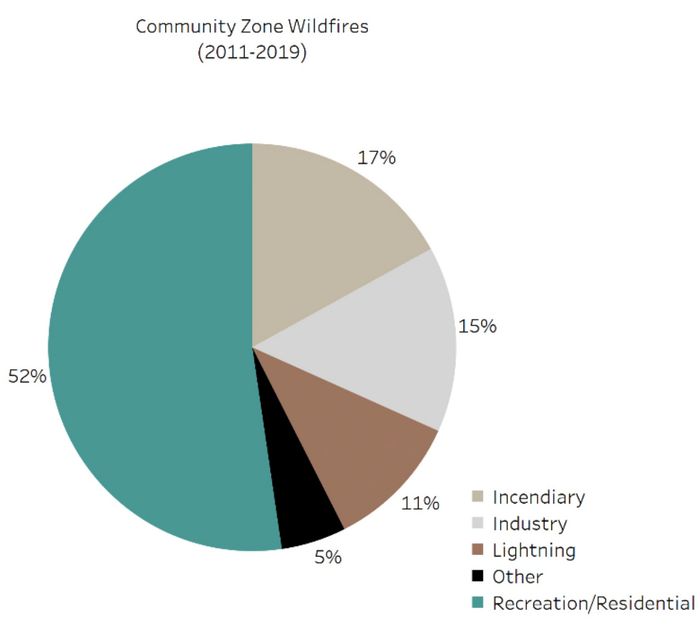
Focusing the province's prevention efforts on the community zone and continuing a focus on recreational and residential wildfires is clearly supported by data. This can be accomplished through ground patrols, enhanced enforcement during fire bans, and targeted communications.

Figure 25: Community Zone Wildfires vs. Non-Community Zone Wildfires



Over 67 percent of all wildfires in the community zone are human-caused and are therefore preventable. Most human-caused wildfires in these areas are classified as recreation and residential in nature as outlined in Figure 26 below.

Figure 26: 2011-2019 Community Zone Wildfires



FireSmart has Become Central to Wildfire Prevention but Needs Broader Government and Community Support to Become More Effective

Though often included as part of prevention, FireSmart is a set of activities on its own, addressing a breadth of prevention and mitigation challenges at a community level. FireSmart was originally developed in response to the growing appreciation of the vulnerability of many Alberta communities to wildfire[32] and is built on a foundation of seven disciplines that address prevention and mitigation as described in Table 8.

In 2019, 70 FireSmart activities were carried out through FRIAA funding, and involved predominantly vegetation management programs. A breakdown of these activities is included in Table 9, which outlines funded projects of FRIAA's FireSmart program since its inception[33]. The November 2018 Auditor General of Alberta review of WMB "Processes for Prevention and Review and Improvement" concluded "the department funded FRIAA FireSmart program is well administered."

Table 8: Summary of FireSmart Disciplines

Discipline	Description
Education	Public education programming, including school programs, public awareness and any activity that raises the understanding of wildfire management practices.
Emergency Planning	The development of emergency response plans and conducting table-top exercises.
Vegetation Management	Clearing potentially hazardous fuels from high-risk areas to mitigate risks.
Legislation	Using the legislative and regulatory power of government to mitigate wildfire risks. In addition to bylaws and legislation, this can include the authority for fire bans or off-highway vehicle bans (referred to as ministerial orders), cost-recovery programs and enforcement programs (i.e. ticketing or levying fines).
Development	Ensuring that land use planning is carried out with wildfire mitigation in mind.
Interagency Cooperation	Emphasizing that wildfire prevention and mitigation is a shared responsibility—underlining the importance of ongoing engagement of all stakeholders to implement mitigation strategies.
Cross Training	Familiarizing all emergency services with the strategies, procedures, and equipment in advance of an event in order to ensure safe and effective response to emergencies.

[32] Government of Alberta, *Guidebook for Community Protection. 2013,* Page 1

[33] FRIAA 2018-2019 Annual Report https://friaa.ab.ca/wp-content/uploads/2019/06/FRIAA-2018-19-AR_web_ready.pdf Page 8

Table 9: Summary of FireSmart Activities in Alberta

Discipline	Active (March 31, 2019)	Completed	Total
Community Planning (Development)	12	48	60
Public Education	17	31	48
Legislation	2	1	3
Inter-agency Cooperation and Cross-Training	4	7	11
Vegetation Management	35	95	130
Emergency Planning	0	1	1
Total	**70**	**183**	**253**

All Canadian provinces and territories are involved in FireSmart in some manner. Many of these provinces rely to a great extent on FireSmart Canada for programming information, materials and support. FireSmart Canada is a not-for-profit organization that represents more than 100 member organizations, including government departments, municipalities and their associations, trade associations and international associations.

A common challenge across Canada is determining how to expand prevention and FireSmart activities across government departments to better incorporate these principles into day-to-day community services. Currently in Alberta, WMB leads the coordination of government funded wildfire prevention and FireSmart activities. This approach has limitations as many FireSmart activities are under the control of departments and agencies outside of WMB or under the direct control of communities themselves. Of the seven disciplines of FireSmart, vegetation management is the only one predominantly in the domain of WMB.

Examples of how this challenge has been addressed in other jurisdictions can be found in Ontario and British Columbia (BC). In an effort to build broader involvement and support for FireSmart activities and principles in BC, a FireSmart committee made up of representatives from BC Wildfire Services, the Office of the Fire Commissioner, the union of BC Municipalities, the Fire Chiefs' Association of BC, Emergency Management BC, Forest Enhancement Society of BC and First Nations' Emergency Services Society of BC sets priorities and directs funding for FireSmart work in BC. Further, the Government of BC has introduced the BC Community Resiliency Investment Program (CRI), which replaced the more narrowly focused Strategic Wildfire Prevention Initiative (SWPI) in 2018. The CRI has moved away from a focus on fuel modification and cost sharing arrangements, to fully funding a broader array of FireSmart activities.

In Ontario, the *Forest Fire Prevention Act* and the Ontario Regulation 207/96 Outdoor Fires were amended in 2016 to increase the accountability of industrial stakeholders in wildfire prevention. This legislation includes the requirement for a Fire Prevention and Preparedness Plan and sets safety and training standards. Further, the legislation, like Alberta's, grants the Crown the ability to levy a fine for disobeying or neglecting the provisions of the Act.

In response to the 2016 fire season, the Alberta *Forest and Prairie Protection Act* and the subsequent regulations were amended, fully coming in to force in 2017, to increase penalties for individuals and industrial users found in contravention of the act. In addition to increased fines, new enforcement tools to address regulatory compliance issues were incorporated; namely, the ability to issue violation tickets and administrative penalties for *Forest and Prairie Protection Act* offences. Furthermore, in 2018 WMB enhanced its Memorandum of Understanding (MOU) with the RCMP to create the Forestry Crimes Unit which focuses on incendiary related wildfires within and outside of the FPA. As such, the WMB enforcement program is much broader in scope than before these changes and addresses a range of wildfire prevention issues. It is too early to determine what impact this will have on the occurrence of incendiary wildfires, but this is a notable step in the right direction.

RECOMMENDATION – GOVERNMENT WIDE

1. Immediately implement a government wide, disaster resilience and prevention focused task force to enhance the adoption of FireSmart activities and principles across government, at the community level and to incorporate fire prevention in community services.

ACTIONS:

- Identify and implement alternative building codes for vulnerable communities.
- Identify and implement modified subdivision development rules for vulnerable communities.
- Identify and implement further risk-sharing programs for communities that continue to develop further into forested areas.
- Formally incorporate FireSmart into a broader provincial disaster resiliency strategy to improve community engagement in preventing wildfires.

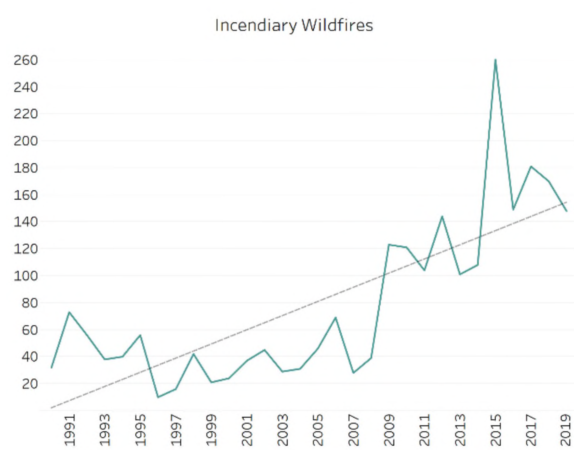
ACTIONS (CONTINUED):

- Continue to work with industry and relevant associations to prevent and mitigate industry caused fires — this could include increasing the cost-recovery programs.
- Determine specific key performance indicators (KPIs) for reducing human-caused wildfires and mitigate industry caused wildfires.
- Implement the November 2018 Auditor General Recommendations and report on progress accordingly.

Incendiary Wildfires are Prevalent in Alberta and Require a Targeted Solution

Incendiary wildfires are wildfires that are deliberately and maliciously set by people. This cause has been increasing over the years and, like all human-caused wildfires, creates a significant risk to public safety and well-being. Figure 27 shows a statistically significant trend in incendiary wildfires increasing since 1990.

Figure 27: Incendiary Wildfires



Since 2011, incendiary and wildfires under investigation or of undetermined cause had a total cost burden of $280 million to extinguish.

From 2011 to 2019, Alberta has had more than nine times as many incendiary starts as Ontario had in the same period from 2011 to 2019[34]. The cause of this discrepancy, and the upward trend is not clear, but the problem is costly. This issue requires attention — the immediate development of a comprehensive strategic incendiary wildfire prevention plan to curb this problem is needed.

RECOMMENDATION

2. Immediately develop a comprehensive strategy for incendiary fire prevention to reduce the number and severity of incendiary fires.

ACTIONS:

- Increase the number of ground patrols in high risk community zone areas to limit the opportunity to set fires and increase speed of detection.
- Work with community and industry leaders to develop education and enforcement programs targeted to at-risk communities.
- Increase a targeted media campaign to encourage public reporting and outlining increased enforcement and compliance measures that will be taken including consequences for offenders.

Public Engagement and Communications Have Improved Over the Past Eight Years; However, there is a Need to Continually Improve in This Area

Several improvements have been made to the approach and capacity for communications with the public. As an example, WMB has filled the Team Lead Information Officer position for the first time in four years, giving the organization more leadership and capacity to deliver communications services. In addition to people, WMB has several platforms used to communicate with the public. These are summarized in Table 10, and the respective websites related to the Wildfire App and Firebans App are described in *Appendix J*: *Benchmarking Summary and IT Systems Overview.*

A more thorough review of WMB's communication tools is required. WMB lacks useful data at the time of this report, making it difficult to confidently determine the strategic effectiveness of these tools. Currently, WMB measures outputs of communications programs (i.e. number of presentations, number of Facebook followers, minutes of paid airtime and audience reach, etc.) but it does not measure the outcomes from these programs to determine whether the appropriate tools or techniques are being implemented to meet their objectives.

[34] Based on the benchmark data provided.

Table 10: Overview of Core Communication Platforms in Alberta

Platform	Description	Comments
Firebans App	The Firebans App is a Government of Alberta mobile application the public can use to see where ministerial orders are in effect.	The Firebans App user data does not provide a clear picture of its usefulness, though usage tends to peak in tandem with a wildfire event. At its peak usage there were 12,000 downloads (on both Apple and Android devices) but it is not clear who is accessing this data and where the users are located. These usage patterns make it difficult to determine the App's effectiveness in preventing wildfires. For example, it appears a wildfire event heightens the public's awareness and may impact their behaviour, but there is no indication that the public's behaviour is impacted prior to such an event. Furthermore, in the case of a wildfire event, this information is duplicated by the Wildfire App, on Hubspot and at Wildfire.alberta.ca
Wildfire App	The Wildfire App is a Government of Alberta mobile application the public can use to receive alerts and a platform through which they can access the Hubspot updates.	Based on the available user data, the Wildfire App becomes a reasonable platform reactively, but does not appear to have much prevention benefit as, like the Firebans App, downloads correlate with events after they have happened not before. That said, it would appear that during a wildfire event audiences look to various mediums, including the Wildfire App for information. Very few external stakeholders mentioned either the Wildfire App or the Firebans App as a source for information over the course of the fire season.
Social Media	WMB operates a Facebook and Twitter account on the provincial level. This platform is bolstered by the use of the Minister's accounts and the Alberta Agriculture and Forestry Accounts. There are no accounts at the Forest Area level.	The Alberta Wildfire Facebook page has 96,461 total "fans," which includes an 8,046 net-growth in likes over the fire season. The Alberta Wildfire Twitter page has more than 15,500 followers (including a net growth of nearly 3,000 through the 2019 fire season). Again, it is not possible to say precisely how effective these channels are being used for prevention but given the significant audience growth over the season, there is potential to bolster their use in the lead up to fire season.

Platform	Description	Comments
Hubspot	Hubspot is the platform WMB Information Officers use to distribute their Forest Area updates.	While a lot of data is communicated through Hubspot, the information was very technical in nature and rarely provided the context that would be helpful to a layperson's understanding. This contributed to a perception that information was being withheld. This sense of overly technical communication permeated stakeholder feedback and created issues of trust and confusion with the public.

Given the concern that stakeholders described in their perception of limited access to information, WMB must determine its key audiences and then ensure they are using the proper channels and mediums to reach that audience. Conducting an audience analysis to determine the demographic makeup of their target audiences ought to be localized by Forest Area and message type. Once it is clear who WMB hopes to communicate to (i.e. recreational users, industry representatives, residents in the WUI, etc.) and on what topic (prevention, emergency communication, etc.) they can determine a strategy for how best to communicate with them. Through this process, it will become clearer not just who WMB ought to be communicating with, but how. This does not just reference the medium (i.e. mobile applications, earned media, paid media, websites, and social media) but also the tone of the communications.

Assuming your audience will come to you is an ineffective strategy for topics like prevention and mitigation that require a push strategy. Push communication is a type of communication, like a broadcast, where the sender is in control of how the message is sent. Alberta Emergency Alert system is an example of push communications. Self-service apps like the Wildfire App, without an activated notification function is an example of what is commonly referred to as a pull strategy, one where the receiver is in control of how or when they receive the information.

A thorough strategy requires the integration of both push and pull communications.

In that case, WMB could also consider leveraging partnerships with regionally or community specific communication channels like municipally run social media pages and local media partnerships to amplify their message in established channels.

WMB communicates a lot of data, however, that data is of little use to the public, especially during a wildfire event. Stakeholders interviewed spoke most favourably of WMB communications when the data communicated was accompanied by additional context as to what this data means, and why it is important.

Once WMB has identified their intended audiences it would be prudent to develop outcome-based strategies to determine their effectiveness, with a continuous improvement model. Download rates, Facebook likes, and total paid airtime do not demonstrate if the system is working. Developing outcome-based key performance indicators will better inform future communications strategies and inspire innovation in the process.

Another key function of WMB's information coordinators and industry liaisons is to develop relationships with stakeholders in each Forest Area. Each Forest Area engages their stakeholder relationships and uses the available tools differently. Off-season work, carried out to build relationships with industry and municipalities, creates a difference in the experience of community members and stakeholders during emergency events.

Some industry stakeholders who have interests in multiple Forest Areas point to the lack of consistency as a source of frustration and confusion. A leading example of this is the inconsistent use of industry liaisons, who are intended to serve as a link between wildfire managers or incident teams and industry stakeholders. Forest Areas with strong and active industry liaisons have better relationships with industry stakeholders. Sharing of best practices for stakeholder communication and relationship building amongst Forest Areas would better prepare all stakeholders involved in future fire seasons.

Additionally, as Alberta's fixed election period will always coincide with the start of fire season, it is important that both prevention and emergency communications protocols are established well before the election period, and immediately upon election of a government, to ensure all government communication personnel understand their role and the leading practices related to emergency communication.

RECOMMENDATION—GOVERNMENT-WIDE

3. Conduct a more comprehensive review of WMB communications and stakeholder engagement strategies, systems and processes with an objective of improving the experience of community members and stakeholders who are directly or indirectly being impacted by wildfire or other natural disasters.

ACTIONS:

- Conduct an audience analysis to determine if the tools are enabling messages to reach their intended targets effectively.
- Once WMB has identified their intended audiences it would be prudent to develop outcome-based strategies to determine their effectiveness, with a continuous improvement model.
- Ensure flexibility from normal government communication protocols during emergency time periods; identify and implement specific strategies to utilize social media venues.
- Continue to work with recreation areas and relevant associations to improve awareness and ultimately prevention of recreation wildfires.
- Improve consistency of stakeholder management across Forest Areas. Many leading practices exist across the province, and each Forest Area could benefit from further sharing.
- Clarify the role of the Industry Liaison across Forest Areas.
- Clarify the role of the Information Officer across Forest Areas.
- Review communication protocols and ensure they are set well in advance of the fire season and respect the specialized nature of emergency communications. Set specific direction for all government agencies to follow during periods of Unified Command.

3.2 | Detection

DETECTION

Overview of Wildfire Detection in Alberta

In order to achieve the Wildfire Management program objectives of containing all wildfires within the first burning period[35], prompt detection and immediate reporting is necessary. Recognizing this need, the mandate of the detection subprogram has been established to "report all wildfires to the respective wildfire centres within five minutes."

Similar to other wildfire management agencies across Canada, Alberta relies on several detection methods to provide effective coverage based on wildfire hazard, risk and landscapes. For example, in an area near a community where the risk of human-caused wildfires is higher, public (unplanned) detection is more common as a detection method. In recognition of this fact, WMB operates an easily accessible phone line to connect the public with the appropriate agency. Conversely, in a remote or mountainous area, a lookout can provide continuous monitoring of a large area and find wildfires before they become large enough for public to notice. For that reason, no single province-wide detection method is optimal; a variety of detection methods are important for effective and cost-efficient wildfire detection.

Detection in Alberta consists of four key methods: Aerial Patrol (AIR), Ground Patrol (GRP), Lookout (LKTS), and Unplanned / Public Reporting (UNP). A description of each is presented in Table 11.

Table 11: Overview of Alberta Detection Methods

Detection Method	Sub-Categories	Primary Function and Description
Aerial Patrol (AIR)	Fixed Wing Rotary Wing (Loaded Patrol)	• Patrols are either: o *Rotary Wing (Loaded Patrol)*: equipped with resources and crew prepared to execute IA; typically follow lightning storms or during extreme-hazard conditions to detect and action potential ignitions immediately. o *Fixed Wing*: a light aircraft patrol to provide accurate location and wildfire data in low-visibility areas or zones screened from lookouts. Fixed wing aircrafts are infrequently used for detection purposes in Alberta. • Both aircraft methods are informed by lightning monitoring systems to target patrols in areas of lightning activity.
Ground Patrol	Forest Officer	• Predominantly used for monitoring and controlling recreation and residential ignitions.

[35] Wildfire Operations Standard Operating Procedures have two key program objectives: 1) Action all wildfires by 2 hectares or less and 2) Contain all wildfires by 10h00 the following day (*Wildfire Operations Standard Operating Procedures*, March 1, 2019).

Detection Method	Sub-Categories	Primary Function and Description
(GRP)	Guardian Patrolman	• Ground Patrol also performs a compliance (prevention) function related to campfire and burning rules. • May be assigned to investigate area of recent lightning strikes.
Lookout (LKTS)	N/A	• Strategically located to maximize "seen area" and provide continuous coverage. Lookouts are a network, working together to pinpoint smoke locations. Primary method of wildfire detection in Alberta; 127 lookouts throughout the province. • Provide wildfire and weather monitoring.
Unplanned Reporting (UNP)	310-FIRE Forestry Personnel General Public Other Government Agency Unplanned Forestry Aircraft Unplanned Industry Unplanned Public Aircraft	• Public, industry, or interagency reported wildfires closely aligned with public engagement and education on wildfire prevention and management.

While each detection method in use in the province is an important component in the continuous coverage of Alberta's landscapes, the cost of each detection method is not equal. Costs of detection are summarized in Table 12. While aerial patrols and lookouts account for 12 percent and 30 percent of wildfire detection discoveries respectively, together they make up 99 percent of costs.

Table 12: Summary of Average Costs Fiscal Years 2015 to 2019 (Fire Years 2016 to 2020)

Detection Method	Percent of Wildfires Detected 2015-2019	Percent of Total Cost	Average Manpower Annual Cost 2015-2019	Average Aircraft Annual Cost 2015-2019	Average Equipment Annual Cost 2015-2019	Average Contract Supplies and Services Annual Cost 2015-2019	Average Total Annual Cost 2015-2019
Aerial Patrol	12.2%	56.8%	$168,529	$9,469,501	$0	$0	$9,638,030
Ground Patrol	15.1%[36]	0.2%	$38,671	$0	$0	$0	$38,671
Lookout	30.2%	42.2%	$4,341,600	$2,711,277	$6,499	$88,539	$7,147,915
Unplanned	42.6%	0.2%	$2,744	$28,445	$0	$0	$31,190
General Detection	N/A	0.6%	$58,784	$44,445	$0	$0	$103,229
Total Detection	**100%**	**100%**	**$4,610,329**	**$12,253,668**	**$6,499**	**$88,539**	**$16,959,035**

Key Findings

In reviewing the detection program implemented in Alberta, four key findings are identified:

1. Early detection and reporting of spring wildfires are critical to successful management of wildfires.
2. Alberta's detection performance targets need to be updated.
3. There is an opportunity to explore new technology for wildfire detection.
   a. The lapsed renewal of the lookout observer exemption in Employment Standard Regulations impacted the overall efficacy of the detection network in 2019.
   b. Increasing health and safety concerns and a limited number of returning, highly trained lookout observers may challenge the detection network in upcoming years.
4. There is an opportunity to manage aerial detection more efficiently.

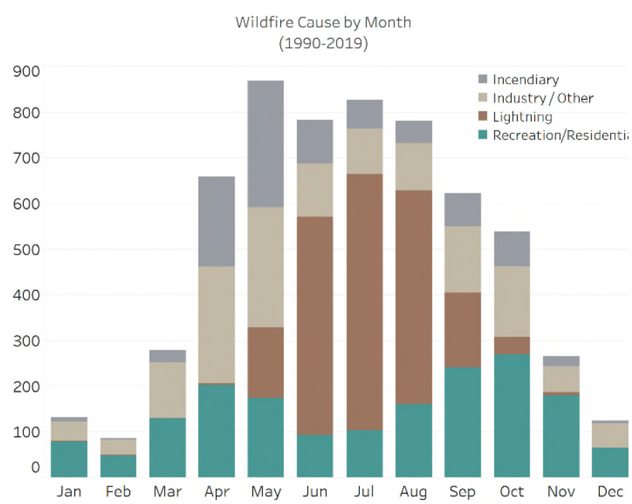
Early Detection and Reporting of Spring Wildfires are Critical to Success

Early detection and reporting are important at any time of the year, with increased effort when wildfire hazard increases. Detection early in the fire season,

[36] Note that due to the nature of wildfires detected by Ground Patrol, primarily residential and recreation wildfires, Ground Patrol makes up a large portion of wildfires detected. However, this is in part attributable to the large number of small wildfires detected in populated areas, which are typically detected and reported quickly. Because of these factors, Ground Patrol reports a large number or wildfires, but that does not necessarily equate to an equally-large impact on wildfire management.

when large wildfires are more likely, is a priority. During the fire seasons of 2011 to 2019, 23 percent of all reported wildfires occurred in May, a trend that aligns with historical data depicted in Figure 28. Of the large proportion of wildfires occurring in May, the severity and spread rates of these wildfires in the early season is often very high. This places increased demands on early detection and prompt IA in order to contain wildfires within the first burning period.

Figure 28: Count of Wildfire Cause by Month 1990-2019



Alberta generally plans to open lookouts ahead of spring snow melt. In addition, aerial patrols are used early in the season to augment lookout coverage or to cover off a short period of time between snowmelt and lookout opening. As the timing of spring snow melt is variable and difficult to predict, it's important WMB remain flexible and responsive in order to open lookout facilities in certain areas earlier than planned and to be able to employ aerial patrols early in the season.

OPPORTUNITY FOR IMPROVEMENT

Continue to operate a multi-method detection network with the ability to detect and report wildfire in a variety of landscapes and conditions.

Alberta's Detection Performance Targets Need to Be Updated

Detection objectives are stated as "Reporting all wildfires to the respective wildfire centres within five minutes." Exceptions are those identified by the Forest Area as permanent smokes or those covered by a fire permit.[37] This objective and metric are not an effective way to measure detection program performance — it may be a good objective for WMB staff to report wildfires quickly, but it does not address the key performance issue of detecting wildfires as soon as possible after ignition, in order to support IA containment objectives.

In addition to existing metrics, a more thorough understanding of WMB performance concerns should inform more accurate and effective performance objectives. A better detection objective and set of metrics would address the effectiveness of the detection activity in terms of timeliness, cost and outcome.

Detection objectives should consider the following key factors:

- **Reporting Accuracy**: Is the detection method able to accurately confirm the location of the detected wildfire/smoke?
- **Time to Assessment**: Is the detection method able to complete an assessment upon detection to inform dispatchers?
  - If not, what actions and resources are required to complete an initial assessment?

[37] *Wildfire Operations Section Wildfire Management Standard Operating Procedures, Section 5.1. Performance Objectives (2019).* Wildfire Management Branch.

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- How long does it take to complete an initial assessment following the time of detection?

- **Hazard Conditions**: In what conditions is the detection method most effective? Most ineffective?
- **Cost Efficiency**: Is the cost of the detection method appropriate for the risk profile, environmental conditions and ignition source?

In order to introduce these factors into an updated objective and set of performance metrics, current performance needs to be measured in these terms.

OPPORTUNITY FOR IMPROVEMENT

Establish performance metrics that measure how effective the detection network is in relation to the Program Area priority of detecting difficult to locate wildfires in high hazard conditions. Performance metrics should include time, cost and outcomes that support analysis of detection performance between detection methods, landscapes, and areas of risk (e.g. Community Zones).

There is an Opportunity to Explore New Technology for Wildfire Detection

Lookouts have been used for nearly a century in the province, acting as a critical part of WMB's detection system. The network of 127 wildfire lookouts as of 2019 are staffed during a portion of the fire season to detect and report smoke and wildfires in remote areas.

In addition to their detection function, lookouts are used as points of data collection in difficult to access geographies, support wildlife and weather monitoring, and are a critical part of Alberta's communication network, including Alberta's First Responder Radio Communications System.

On average[38], the lookout system costs $7 million annually to operate. WMB capital budgeting has also allocated approximately $6.9 million to refurbish the lookout towers over the next five years.[39]

The significant operating and capital expenditures associated with the lookout network requires consideration in terms of their ongoing relevance and performance in achieving WMB priorities. While the lookouts are generally an effective means of detection for the areas in which they operate, there are three key areas of concern for their current level of performance and capability, as summarized in Table 13.

OPPORTUNITY FOR IMPROVEMENT

Investigate detection options that reduce program dependency on the lookout system. Look to alternative detection methods that require less capital expenditure than that of the lookout system and that mitigate the labour regulation and safety concerns associated with the operation of the towers.

[38] Based on a five-year average from Fiscal Year 2016 to Fiscal Year 2020 (Fire Year 2015 to Fire Year 2019).

[39] Note that recent changes to WMB investment are expected to eliminate the staffing of 26 lookouts throughout the province, and invest alternative technology and methods, such as cameras and additional aerial patrols. These changes are likely to impact the allocation of and decrease overall total of detection operating and capital expenditures.

Table 13: Lookout Tower Network Areas of Concern

Area of Concern	Details of Concern
Labour Regulation and Workplace Safety	• Despite being exempt under Alberta Employment Standards Regulation, employment for lookouts constitutes long working hours and extensive periods of isolation. With a general trend toward increased workplace safety legislation, WMB must consider the possibility of additional health safety requirements, including mental health, that may be introduced in years to come. o *Note: The implications of changing Employment Standards Regulation were demonstrated in 2019 with the expiration of a legislative exemption that permits wildfire lookout observers to work longer hours in a day than other workers in the province. Wildfire lookouts rely on trained staff to provide constant observation of the surrounding area during fire season. Under a past exemption under Section 1 of the Alberta Employment Standards Regulation, lookout observers were able to work longer hours than prescribed because of the nature and location of the work. However, in November 2018, this exemption expired and was not restored before the start of the fire season (restored in July 2019), causing uncertainty and disruption for returning staff and forcing changes to schedules for a critical early period of the 2019 fire season. As a result, many experienced staff left their positions and did not return. This meant that lookouts did not have the same staffing as past fire seasons, leaving some lookouts unstaffed during mandatory days off, increasing reliance on other wildfire detection strategies. During these imposed days off, 23 new wildfires were detected by secondary methods in the immediate area of unstaffed lookouts. Some might suggest that detection of these wildfires may have been slower than if the lookouts were staffed when these wildfires started. However, with the data available, no correlation was possible between staffing of lookouts and any avoidable or unavoidable outcome. None of these 23 wildfires were the ignition source of any of the three major incidents of 2019. Nonetheless, this gap in the lookout observer exemption from Employment Standard Regulations may have had a material impact on the overall efficacy of the detection network in 2019. Furthermore, there has been a lasting impact, that will likely carry over to future fire seasons, on WMB's ability to staff lookouts due to this erosion of trust between experienced staff and WMB caused by the employment disruption in 2019.* • The lookout tower system requires a large amount of ongoing capital infrastructure spending in order to maintain safe, high-functioning towers. o At present, the Detection Program has focused on shifting the lookout system staffing away from high-cost, low-priority lookouts.[40] This is expected to

[40] As aforementioned, the Government of Alberta has announced its intention to reduce staffing levels at the 26 highest cost, lowest priority lookouts in order to increase the cost-effectiveness of the lookout system. Will use them if hazard dictates.

Area of Concern	Details of Concern
	increase the cost efficiency of the tower system and reduce overall spending on towers, focusing investment on high-priority towers. • While the marginal cost of staffing the lookouts is now relatively low, there is a possibility that future labour regulations may require additional staffing rather than a single employee per lookout to meet labour legislative requirements. Because of this, the cost effectiveness of resourcing lookouts may decrease in future years.
Recruiting and Training	• Because of the increasing importance being placed on safety for matters such as working alone, protection of mental and physical wellbeing, and other aspects of Operational Health and Safety, lookout observer positions may become more challenging to recruit to in the years to come than it has been historically. • Due to the seasonal turnover of lookout observer and significant training period to reach sufficient skill, there may be a challenge to maintain numbers of highly skilled staff.
Performance and Technology	• Lookouts are an important component of the overall detection system in Alberta. However, there are several technologies, such as cameras and satellites, that can support wildfire detection in ways that increase the safety of employees and the accuracy of detection. • As Alberta looks at investing in the future of detection, it is prudent to continuously leverage existing and / or emerging technology to optimize its investment.[41] *Note: These technologies are discussed in detail in Appendix H: Best Practices and Emerging Technology in Detection.*

OPPORTUNITY FOR IMPROVEMENT

Work with partners to put specific measures in place to mitigate delays in the renewal of the lookout observer Employment Standard Regulation exemption when the anniversary date for the current exemption occurs.

When compared to other Canadian jurisdictions, Alberta's reliance on lookouts as a primary means of detection is unique. As technology develops in the areas of remote sensing and camera surveillance, there are an increasing number of alternative, high-performing detection methods that require less ongoing capital expenditure than that of the lookout system. In addition, the alternative methods mitigate the labour regulation and safety concerns associated with the operation of the towers. Other jurisdictions are actively investigating and testing these options. Looking to the future of detection methods, there may be an opportunity to shift away from the extensive network of physical structures.

OPPORTUNITY FOR IMPROVEMENT

Continue to evaluate the application and use of emerging wildfire detection technology on Alberta's landscapes.

[41] WMB has indicated plans to explore additional detection technologies for potential incorporation into the detection network.

There is an Opportunity to Manage Aerial Detection More Efficiently

Given that aerial patrols make up the majority of detection costs, examining aircraft expenditure by type helps to understand the cost in relation to the number of wildfires detected. According to WMB reports, approximately 99 percent of aircraft used by detection are rotary wing. Rotary wing patrols (RWPs), also known as loaded patrols[42], are perceived to be advantageous in high hazard conditions because of their ability to conduct an immediate IA when a wildfire is detected. In other jurisdictions, RWPs are deployed infrequently and follow lightning storms during high hazard times to detect potential lightning-caused ignitions. In combination with a lightning monitoring system, RWPs may be an effective detection method; however, RWPs are a very expensive form of detection.

Flying a slow-moving loaded patrol without a data-informed route has limited effectiveness and a high associated cost. Without a specific purpose, such as following a lightning storm, the probability of an RWP detecting and actioning a wildfire is low. Despite this, RWPs are a significant portion of Alberta's detection program. This is unique compared to other jurisdictions, where fixed-wing aircraft are more commonly used. Fixed-wing aircraft can be flown at a much lower cost and provide better coverage because of their higher speed. While these aircraft do not have the ability to conduct IA, from a cost perspective, they are better suited for routine patrol than RWPs.

The inefficient use of RWPs as a detection method suggests one or more of the following perceptions regarding the use of this tool:

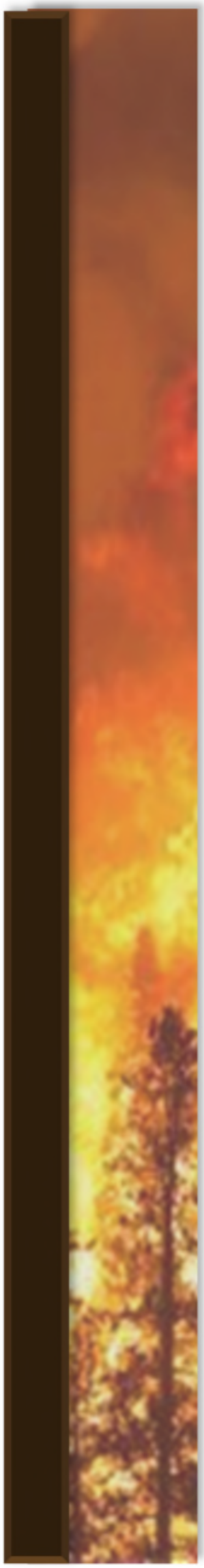
- Overall IA is improved because the detection method brings IA along;
- Prompt assessment of a new detection improves decision-making (lookout observers cannot assess the wildfire)
- Helicopters are relatively inexpensive because a surplus of them are on hire due to Preparedness Planning guidelines.

The counter argument to these perceptions is that the R/W aircraft on patrol may be lower in fuel when a wildfire is detected resulting in limited ability to support the IA crew when deployed. In addition, while the use of surplus R/W aircraft time for RWP may be efficient on an opportunistic basis, it is not efficient on a planned basis.

OPPORTUNITY FOR IMPROVEMENT

Acquire data-informed Decision Support Tools to optimize aerial detection routes based on historical, current, or predicted hazard conditions such that aircraft can be used in a more efficient and cost-effective manner.

[42] Loaded patrols are type of aerial patrol where the helicopter carries a crew and equipment to conduct IA immediately upon detection.



3.3 | Preparedness

PREPAREDNESS

In May 2019, 94.7% (285 wildfires) of new starts were BH by 10h00 the morning following discovery

Preparedness is a key element of the success of any wildfire management organization. It encompasses the annual activities that take place to prepare the program for each new fire season, including strategic planning, hiring of contractors, training of staff and initiating procedures and routines. As a state of readiness, preparedness also encompasses responsive activities to address the particular conditions of each new fire season; a keen awareness of changes in weather and forecasts as well as the developing hazard and wildfire activity. As a result of this awareness, daily adjustments are made to prevention messages, detection efforts and the number and location of firefighting resources. In some respects, preparedness is about maintaining the optimum state of readiness today and tomorrow. In other respects, preparedness is focused on forecasting the situation many days ahead such that, as the situation changes, firefighting resources can be moved ahead of the need for dispatch, augmented or released strategically.

Effective preparedness ensures an organization is well-equipped to meet their performance targets. The stated performance targets for wildfire operations in Alberta are to:

1. Initiate wildfire suppression action before the wildfire exceeds two hectares in size, and
2. Contain wildfire spread by 10h00 the following day.

Containment of a wildfire by 10h00 the next burning period, such that the wildfire status becomes BH[43], is the focus of IA. If most wildfires achieve this status in the given time frame, it indicates successful preparedness, detection and response. Conversely, wildfires that are not BH by 10h00 the next day require sustained action and resources for longer-term suppression efforts.

Key Findings

In reviewing the preparedness program implemented in Alberta, four key findings are made:

1. The Preparedness Planning Framework performance is challenged in times of stress and needs to be updated.
2. Wildfires in 2019 behaved more aggressively than the Fire Behaviour Prediction (FBP) System and associated models projected, pointing to necessary refinements.
3. Fire Weather and Fire Behaviour sections require better integration.
4. Wildfire Operations are lacking strategic direction with respect to values-at-risk and priorities that can be improved by approved Strategic Wildfire Management Plans (SWMPs).

The Preparedness Planning Framework Performance is Challenged in Times of Stress and Needs to be Updated

Alberta formalized daily preparedness planning in the 1980s. In 1989, the Intelligent Fire Management System (IFMS) was implemented province-wide and included "coverage assessment" as the key preparedness planning tool. Coverage is based on a calculation of the time it takes for a crew in a helicopter to dispatch from their base and reach any point in the Forest Area. If a crew is calculated to arrive at a wildfire location before the wildfire

[43] Though there is no size standard, this generally means that the size is a few hectares or less when BH.

reaches 2.0 hectares in size (a key IA performance target), that section of the Forest Area is deemed to be "covered". If two crews from different bases can reach a potential wildfire location, the location is "double" or "over" covered.

When the coverage calculation is carried out in cells (small geographic areas) across the whole of the Forest Area, the total percentage of the Forest Area "covered" (i.e., within a target distance for IA dispatch and travel) can be calculated. In 2019, the older, GIS-based Spatial Fire Management System (SFMS) was replaced with Alberta Wildfire Anticipation and Readiness Engine (AWARE) software. This represents a modernization of tools for preparedness planning in Alberta, but underlying methods (i.e., reliance on the coverage assessment) are basically the same as in previous versions.

Forest Areas add fire crews and helicopters to alert status and deploy them among fire bases as the fire danger (measured by HFI) increases. This resourcing is dictated by the Presuppression Preparedness System (PPS) and coverage assessment. There were few examples in 2019, if any, where crews and helicopters were not available for IA when a wildfire occurred.

Such a heavy reliance on coverage assessment as the key preparedness planning tool has been shown to be problematic. As a method to indicate the transition required from low fire danger to moderately high fire danger, coverage assessment may be appropriate. But in two critical circumstances, that is, when wildfire intensity is extreme (HFI 5 or 6) and/or when multiple new wildfires occur within a small area in a single burning period (e.g., following lightning storms), the coverage assessment process is inadequate for planning or measuring preparedness, as seen in the aside figures.

Once HFI reaches class 2, 3 or 4 (i.e., 11 to 4000 kilowatts/metre), Forest Areas are expected to add resources such that 80 percent of the Area is "covered." Only on the quietest days (HFI class 1) are Forest Areas able to satisfy the PPS coverage.

Whether intended or not, 80 percent coverage is one of the few measurable targets that drive alerts for crews and the hiring and positioning of helicopters, heavy equipment and other contracted resources. Once HFI reaches 5 or 6, Forest Areas are expected to provide greater than 80 percent coverage and at that point, the coverage model begins to fail as a tool for preparedness decisions (Figures 29 and 30). Duty Officers require a strategic, risk-based process for daily preparedness planning. At HFI Class 5 or 6, there are rarely enough resources

Figure 29: Average Coverage Levels by HFI (2011-2019)

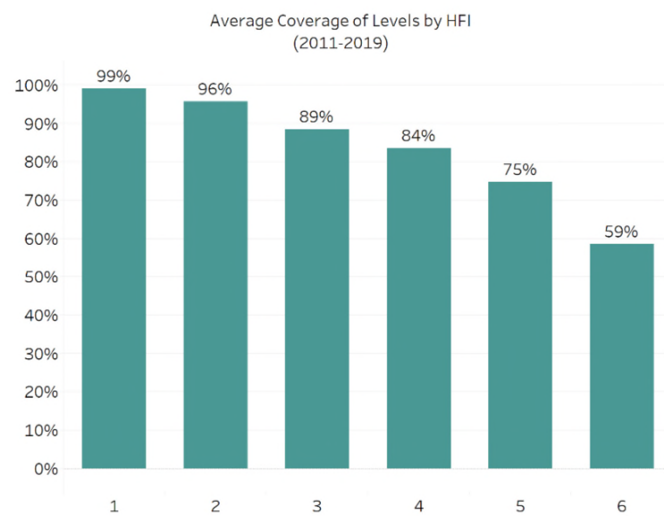
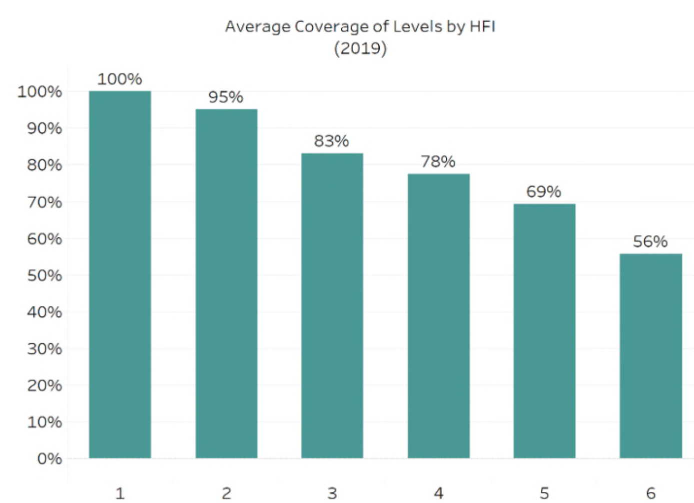
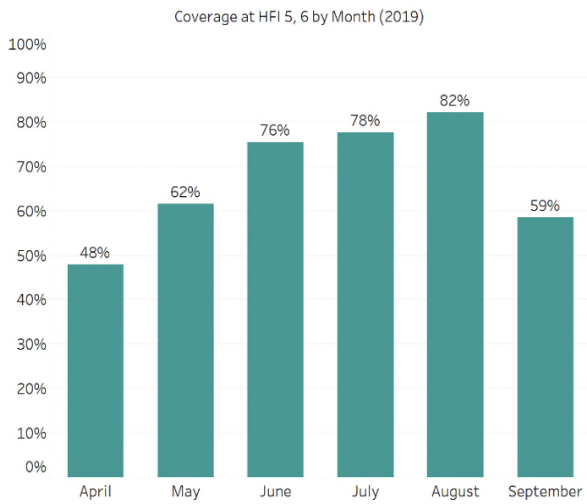


Figure 30: Average Coverage Levels by HFI (2019)



or bases to provide greater than 80 percent coverage. This is especially true when there are active wildfires requiring resources at the same time.

Figure 31: Coverage at HFI 5, 6 by Month (2019)



Upon review, the 80 percent coverage target seems arbitrary and is not sensitive to changing fire behaviour conditions and fire load. At HFI 1, Forest Areas can satisfy the PPS with any coverage less than 80 percent. In fact, at HFI 1, coverage is easily achieved and usually exceeds 80 percent. As HFI surpasses Class 4, adding resources to bases does not keep coverage above 80 percent, as seen in Figure 31. At HFI categories 5 and 6, policy requires Forest Areas keep coverage greater than 80 percent.

In fact, as fire danger becomes extreme, as it did in May of 2019, coverage falls (Figure 31) even though all bases are staffed, and more resources are being added.

Furthermore, the current coverage model assumes that wildfires are likely to start in all areas of the province equally. Particularly in the spring, human-caused wildfires are more likely near communities and along travel corridors. Many remote cells do not require "coverage", a situation that can be addressed in the PPS by use of "modifiers" or business rules that allow reduced coverage where not needed. Such modifiers are used as codes to communicate "standard reasons" for deviation from typical coverage assessment. Most often, modifiers explain rationale for adding one or two resources to extend coverage because of perceived risk of multiple wildfire occurrence, changing weather, etc.

Detection and response should be focused on the areas most likely to have wildfires, particularly areas where wildfire could impact values-at-risk. Similarly, lightning-caused wildfires are best indicated by recent lightning activity, which is available to wildfire managers on a map. Based on this data many cells will not require significant coverage.

Additional challenges related to utilizing a coverage model for preparedness planning are found in Table 14.

Table 14: Challenges with the Coverage Model for Preparedness Planning

Multiple Wildfire Situations If only one wildfire occurs in a covered area, then coverage is correct. If multiple wildfires are expected to occur (like on a weekend in the spring, or related to a lightning storm), coverage assessment may not be an accurate portrayal of the need for resources to be deployed.	**Role of Airtankers** The current coverage assessment does not include the role of airtankers, a key resource as the fire danger increases and heavier IA weight is required.
Backfilling Coverage The current coverage assessment is not dynamic such that once crews and helicopters are dispatched, new gaps develop in coverages that should be backfilled.	**Possibility of Over-Demand** Coverage assessment does not consider resources required in the day for escaped or ongoing wildfire priorities. If two separate planning channels are in play, one for IA and one for sustained action, there is a risk they will compete for resources, or the whole system will demand more resources than are cost-effective or available.

The problems with the coverage assessment and PPS may lead to several unintended consequences:

- Local Forest Area Duty Officers add crews and helicopters to IA alerts even though they may not make IA more effective.
- To compensate for the theoretical gaps in the coverage assessment, managers and Duty Officers will apply "modifiers" or provide for "over-coverage" without fully considering the cost or benefit of such actions.
- Once HFI exceeds Class 4, Forest Areas usually do not maintain, let alone exceed 80 percent coverage. This renders a key target ineffective and reduces credibility of the policy directing preparedness planning.
- As fire danger increases, wildfires exceed the capability of ground crews. Airtankers are a key resource that may be underestimated on critical days, such as those experienced in May 2019. Focus on helitack coverage may lead to under-valuing the need for additional airtanker capability.
- Once HFI exceeds Class 4, Forest Areas are likely holding resources to meet coverage targets that could be more cost-effectively used on recently escaped wildfires. While a focus on IA success is laudable to minimize the number of escaped wildfires, holding too many crews in IA at the expense of effective response to recent escapes is not strategic management of all risks.
- When local managers feel resources need to be freed up from coverage elsewhere to move to priorities in their Forest Area, they must work outside the PPS system and talk directly to other managers to release resources or achieve efficiency across Forest Areas. That is, the PPS is not effective as a platform for province-wide risk management or discussion of a unified plan. When managers must find workarounds to achieve logical changes in the plan, the credibility of the PPS is degraded.

During the 2019 fire season, cases were identified in which:

- PPS policies led to Forest Areas holding too many resources on alert in areas of lower risk. Staff and managers at various levels confirmed the PPS based on an 80 percent coverage target led to Forest Areas holding more resources on IA than is efficient.
- Forest Areas see large wildfires developing in other Forest Areas and respond by adding more resources, creating an even a greater shortage of resources provincially.
- Managers were forced to work around the response planning system to move critical resources.
- Resources were unavailable to advance sustained action but seemed to be more than adequate in total across the IA system.
- Resource levels set to achieve 80 percent or greater than 80 percent coverage were not the most cost-effective method to address the risk.
- The PPS does not regularly provide for provincial oversight of decisions to add resources or share resources across borders. At times, the Alberta Wildfire Coordination Centre (AWCC) seems to be reviewing the PPS plans rather than actively engaged in the best strategy.
- PPS planning seemed satisfied with helitack coverage (even though coverage was falling below 80 percent) when the key to success may lay with additional airtankers, which became stretched once wildfires started occurring.

In summary, 80 percent coverage is a de facto performance measure in the PPS that drives costly decisions as the wildfire situation escalates. The current approach is no longer appropriate for strategic risk analysis — the organization should rely on a more flexible approach that considers the probability that IA will fail, and how that risk can be mitigated. At extreme fire danger, that preparation may also lead to better preparation and utilization of resources for dealing with escaped wildfires.

RECOMMENDATION

4. Develop and implement a new preparedness planning framework that balances risk, hazard, values and cost to improve overall outcomes.

Actions:

- Reduce the heavy reliance on coverage assessment in the PPS and increase emphasis on risk analysis based on forecasted workload, weather, and fire behaviour.
- Evaluate the new system under worst-case fire occurrence and fire behaviour scenarios.
- Develop and support staff understanding of how a new PPS can support risk management during periods of uncertainty.

Wildfire in 2019 Behaved More Aggressively than the Fire Behaviour Prediction (FBP) System and Associated Models Projected, Pointing to Necessary Refinements

The month of May was characterized by a rapid increase of fire danger conditions throughout northern Alberta. Ultimately, more than 528,460 hectares burned in the second half of that month in relation to the three wildfire incidents we reviewed.

Forecast conditions for May 29 included moderate wind speeds (15-25 kilometres/hour), a wind shift associated with a frontal passage, high temperatures (28-30^{0}C) and low humidity values (15 percent). Using this information, the FBP System predicted spread rates of up to 2 kilometres/hour. Though this spread rate was largely accurate for SWF049

(McMillan) and Battle complex wildfires, SWF069 (McMillan) wildfire just north of SWF049 and HWF042 (Chuckegg Creek) grew substantially in an explosive manner that was not forecasted nor anticipated.

As described earlier in the report, the unexpected fire behaviour experienced on May 29 on SWF069 and HWF042 was due to the effects of convective fire behaviour that interacted with conditions in the upper atmosphere to form a pyrocumulonimbus (pyrocb[44]) storm that formed directly over the wildfires. Similar conditions developed as the front passed the Chuckegg Creek wildfire. As a result of these conditions, wildfire perimeters grew rapidly — for SWF069 an estimated 33,804 hectares in approximately five and a half hours with a total area burned on May 29 and May 30 exceeding 50,000 hectares. Furthermore, lightning from the SWF069 column resulted in numerous new wildfire starts downwind.

Similarly, on May 29 and 30 both the Chuckegg Creek wildfire and Battle complex experienced extraordinary spread rates not forecasted. On May 29, the Chuckegg Creek wildfire ran 30 kilometres overnight. The Battle wildfire grew 12,500 hectares overnight. Furthermore, when fire behaviour specialists tried to model these extreme events at this time, the available modelling tools underestimated the situation, suggesting the need to learn from this experience and look at the science to help develop better predictive services in the future.

A case study completed on SWF069 (McMillan) by WMB after the wildfire events found that between 21h20 and 22h55 an extreme and rarely observed rate of spread of 10.7 kilometres / hour significantly exceeded the FBP prediction of 0.2 to 0.6 kilometres / hour. This case study suggests that a two-dimensional view of the FBP system is limited in predicting wildfire spread rates when fire behaviour is driven by third dimension factors, such as convection column thermal physics, upper level winds and atmospheric instability. As a result, WMB fire behaviour modellers are now planning to use upper air conditions to forecast fire behaviour in incidents when convection column and upper atmosphere interactions are expected. Weather forecasting that includes analysis of upper air conditions should become routine.

Fire Weather and Fire Behaviour Sections Require Better Integration

Recurring and predictable spring weather patterns are historically responsible for most large wildfires in Alberta[45] — this was the case in 2019 as well. Forest Areas in northern Alberta were aware of the drought codes and building fire behaviour conditions in the spring 2019. Recognition of these weather patterns and preparedness to respond will be key to reducing damage in future fire seasons.

WMB still heavily favours the use of three-day weather forecasts as opposed to longer-term, more probabilistic five-day or 10-day forecasts. In our assessment, planning is often looking only two days ahead. In situations where there are multiple wildfires on the landscape, the lack of attention to longer-term forecasts hampers the ability of WMB to be strategic in prioritizing IA and ongoing sustained action. In hindsight, in the case of the Chuckegg Creek wildfire, there was a five-day window of opportunity to achieve a perimeter around the wildfire before the wind event arrived on May 18. This is one example where better availability and integration of weather and fire behaviour forecasts may have provided wildfire operations with better situational awareness for success.

Although some work has taken place to better integrate the weather and fire behaviour products,

[44] Pyrocumulonimbus (pyrocbs) are wildfire-related, intense convective storms with strong indrafts and downdrafts, suppressed precipitation, and major lightning activity, which can drastically intensify fire behaviour at surface levels.

[45] Notably in the years 1968, 1981, 1982, 1998, 2001, 2002, 2011, 2015, 2016.

the Weather Section and Fire Behaviour Specialists for the most part operate as separate entities producing distinct products that are not well integrated. One example of this is the "Blow-up Fire Potential" fire behaviour reference in the weather forecast, which has no measurement criteria. Fire Behaviour Analysts (FBANs) working in the Forest Areas should also be able to influence the information and outlook period for forecast products from the Weather Section. An integrated product or set of products would provide Forest Area Duty Officers, Incident Commanders, Operations Chiefs and FBANs with information to make critical decisions. Having these two programs operating as one fully integrated team is essential to ensure the best possible forecasting, situational awareness and development of tools and products going forward.

RECOMMENDATION

5. Improve quality and integration of Fire Weather and Behaviour functions to support strategic preparedness and response.

ACTIONS:

- Combine fire weather and behaviour functions at Alberta Wildfire Coordination Centre (AWCC) under one organizational structure to ensure improved forecasts, integration of information flow, and utilization of staff.
- Utilize probabilistic forecasting for preparedness planning with required 3 and 5 day forecasts.
- Implement daily forecasts that better combine weather and fire behaviour forecasts (e.g. including upper air conditions).
- Improve products that increase staff awareness of predicted fire behaviour during early season hazard and during extreme events.
- Improve fuels mapping in and around communities and critical assets. Consider improved resolution (25 metres) for 10 to 20 kilometres around these values.

Wildfire Operations are Lacking Strategic Direction with Respect to Values-at-Risk and Priorities That Can Be Improved by Approved Strategic Wildfire Management Plans (SWMPs)

Strategic Wildfire Management Plans (SWMP) are designed to be completed at the Forest Area level and provide direction to a wildfire management organization on strategies, tactics, acceptable levels of risk and a clearer inventory of values on the landscape. WMB defines this planning in the Strategic Plan as:

"WILDFIRE MANAGEMENT PLANNING: The systematic, technological and administrative management process of determining the organization, facilities, resources and procedures required to protect people, property and forest areas from wildfire, and to use wildfire to accomplish forest management and other land use objectives."

A SWMP provides direction to the wildfire suppression teams, ensuring tactics and strategies are consistent with what is required to manage risk to the key values on that landscape consistent with higher level direction. They also allow for a broad range of input from across senior levels of government and stakeholders to adequately discuss the trade offs that may have to occur. This kind of discussion can't always be done during an emergency response to a large wildfire, given decision making must occur quickly and time for information gathering, debate and consultation is limited.

Alberta has recognized the need to have this higher level of planning in place and this need has been highlighted in previous independent reviews (Flat Top, Horse River). The need to complete these plans was also identified in the WMB Strategic Plan 2017-2019, Goal 1.3 *"Complete all area Wildfire Management Plans by March 2019."* To date, a total of five plans of the total 10 Forest Areas have been completed and notably the High Level and Peace River Forest Area Wildfire Management Plans

(WMPs) are incomplete, and the Slave Lake Forest Area WMP has not been started.

In the absence of an approved WMP, Incident Management Teams (IMTs) gather information on the fly and take their direction from provincial Standard Operating Procedures (SOPs), dispatch, and the Letter of Authority issued by the Forest Area Manager. Provincial SOPs are not tailored to a specific situation and letters of authority are usually general in nature. A common concern expressed by IMTs is a lack of a comprehensive inventory of the human and natural values-at-risk. In addition, the lack of a predetermined strategic plan that includes stakeholder perspectives contributes to a lack of understanding with communities and stakeholders around tactics and strategies being utilized by suppression staff.

Further examples of how SWMPs support good decision-making include:

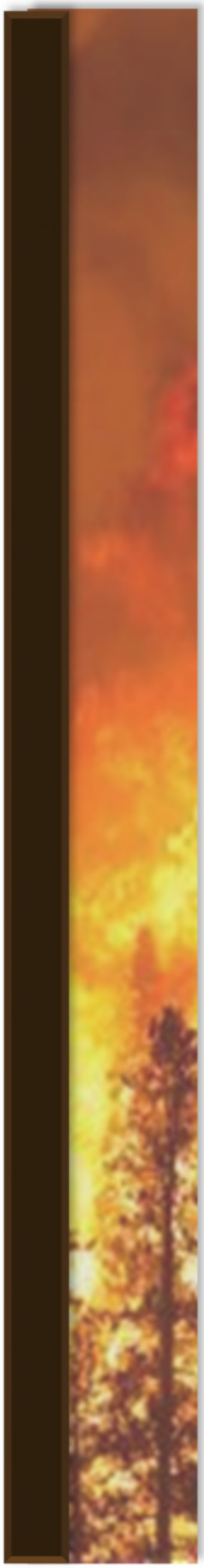
- SWMPs provide direction to the wildfire management staff and managers on how to apply provincial policy including appropriate strategies, tactics and acceptable levels of risk. As part of a SWMP, an inventory of values-at-risk on the landscape helps build preparedness and suppression strategies.
- When firefighting resources are limited, information in a SWMP can be used to set priorities such that limited resources are used appropriately.
- Though important tools to support decision-making, plans can also constrain thinking; they should be treated as information and a valuable input into operational decisions but not as a strict policy constraint.

RECOMMENDATION

6. Accelerate the development and approval of the remaining Wildfire Management Plans (WMPs) to have them completed in the shortest possible timeframe.

ACTIONS:

- Prioritize northern Forest Area WMPs due to increased risk of large conflagration incidents.
- Increase the direct involvement of key stakeholders including communities and industry in the development of these plans. This will create better integration of their concerns, improve understanding of the risk management decisions being made, and provide support for the tactics and strategies used.
- WMPs at the Forest Area level should be in place to provide the overarching guidance to inform the incident level plans.



3.4 | Suppression

SUPPRESSION

Suppression, or sustained action, takes place once IA activities have been unable to contain a wildfire start[46]. Wildfire suppression encompasses the most publicly visible operational activities of WMB and though a small percentage of wildfire starts in Alberta require sustained action, these activities are often the costliest. Suppression resources include:

- Personnel — wildland firefighters and support
- Aircraft — rotary wing, fixed wing and airtankers
- Retardant and fuel
- Heavy equipment
- Camps and associated equipment for housing crews
- Wildfire suppression tools and equipment
- Wide variety of contract services

Clearly, the weather conditions confronting firefighters in the spring of 2019 were challenging. In many cases, fire behaviour made direct attack on the ground unsafe. In addition, having three very large incidents to deal with simultaneously over such a long time period tested the organization and structures in place to the extreme.

Key Findings

In reviewing the suppression program implemented in Alberta, the following key findings are made:

1. Progression from Initial Attack to Sustained Action on HWF042 and PWF052 lacked in planning and focused execution.
2. WMB's tactics and strategies exhibit a bias towards a direct attack and full suppression approach, when indirect attack and modified suppression are sometimes more appropriate.
3. Hand ignition tactics are underutilized, resulting in ineffective outcomes.
4. Heavy equipment can be used more efficiently and effectively.
5. Clearer direction is needed regarding declarations of wildfire status – specifically the "Being Held" status.
6. There were challenges with Incident Management Team (IMT) resourcing as well as IMT transitioning.
7. There is no common radio system for responders, causing efficiency and safety concerns.
8. High likelihood of future significant safety events is a cause for concern.
9. Highway closure processes were problematic in 2019.
10. Protecting structures and assets from wildfire requires a stronger integrated approach among partners.

Progression from Initial Attack to Sustained Action on HWF042 and PWF052 Lacked in Planning and Focused Execution

INITIAL ATTACK: BATTLE COMPLEX

Review of the initial response to Battle (PWF052 and PWF054[47]) identified several areas for improvement:

1. Establishing a ground attack with crews in conjunction with dozer line construction and aerial attack is essential once IA has failed. Both aerial attack and dozer line construction measures have limited effectiveness on larger wildfires in extreme conditions unless followed up by aggressive containment tactics from ground crews. It

[46] Note: although IA is typically included within the response and operations phase of wildfire management, for the purpose of this report we have included successful IA in analysis related to preparedness and unsuccessful IA in analysis related to suppression.

[47] Decisions were made to focus on PWF054 with reduced effort on PWF052.

was not until May 14 that wildfire crews were established on the fireline. Initially, it was felt that fire behaviour made safety too high a risk for ground attack to be implemented, but that is inconsistent with the decision to have heavy equipment working during the same time period without ground support. In addition, fire behaviour was more active on May 12, but a much lower intensity existed on May 13.

2. Dozer line construction implemented in the first few days focused on "tight lining" the wildfire edge, creating numerous fingers and left unburnt fuels close or adjacent to the dozer line. This, combined with the lack of ground crew follow up, resulted in several escapes and ineffective containment of the wildfire.
3. Incident staff assigned in the early days of the wildfire performed well, considering their skills and experience, but the system must ensure an Incident Commander with appropriate certification be in place until an IMT has arrived.
4. Given the conditions that were present, nearby values-at-risk (VAR), and forecasted weather, a more senior level officer should have been considered to take on the IC role during these early stages. More senior officers were present periodically to undertake assessments, but this doesn't replace the continuous presence and strategizing of senior expertise on the ground.

INITIAL ATTACK: CHUCKEGG CREEK WILDFIRE

Review of the initial response to HWF042 identified several areas for improvement:

1. HWF042 was declared BH on May 13 at 0855 despite little evidence that there were established and supported containment lines that could be held during an increased wind event, which was forecasted later in the week. The current Being Held (BH) policy states the following:

   "When sufficient resources are currently committed and sufficient action has been taken, such that the wildfire is not likely to spread beyond existent or predetermined boundaries under prevailing and forecasted weather and fire behaviour conditions."

   The decision to declare HWF042 BH on May 13 only considered the current and immediately forecasted conditions, which were a lower threat, and did not adequately consider the forecasted increased wind conditions that were anticipated in four to five days. This early declaration of BH had a bearing on the level of priority given to this incident relative to others that were characterized as Out of Control (OC).

2. Given the relatively calm conditions between May 13 and 17 and the forecasted increased winds expected to present a major challenge to wildfire control on May 17, the period between May 13 to 17 was a critical suppression time period. Furthermore, given the challenge of containing a wildfire of 270 hectares in extremely dry conditions, the number of ground resources deployed was inadequate to accomplish the goal of securing a high percentage of the perimeter before the weather shift arrived. Securing the perimeter needed to be the primary objective.
3. There was a significant reliance on aerial attack with helicopters, and in some cases airtankers, to help contain the wildfire along much of the perimeter. This is a reasonable approach during periods when ground crews are getting established; however, this tactic is a short-term measure that requires follow up with ground crews as its effectiveness diminishes quickly as winds increase, as seen on May 17.

4. Traditional direct attack tactics were used on HWF042, which can be effective if enough manpower is available. A more expedient approach to consider when facing time constraints and limited manpower is to build straighter containment lines. This limits the risk presented by irregular dozer lines adjacent to unburnt fuels and the associated high risk for spotting across the line. When a "straight line" approach is used, hand ignition to burn out the fine fuels widens and reinforces the dozer line, reducing the spotting potential. In areas where heavy equipment cannot be used because of ground conditions, consideration should be given to hand line construction or the use of retardant lines to burn from. Recognizing the need to consider the use of this kind of an indirect approach requires a more senior level of expertise. Less experienced staff may not recognize the need for this approach or the use of hand ignition as it is not a common practice in Alberta.
5. Relatively inexperienced ICs (IC 4 or lower) oversaw HWF042 until after the wildfire escaped on May 17. While these individuals performed well and implemented their tactics to the highest degree possible with the resources available, they may not have recognized the need to shift approaches given their experience levels. With the values, risks and conditions that existed during this early time period, more senior leadership should have been assigned to more effectively manage the complexities of the wildfire on the ground. In contrast, progression from IA to Sustained Action on SWF049 and SWF050 was appropriate.

INITIAL ATTACK: MCMILLAN COMPLEX

A review of the detection and response to these wildfires suggests the Slave Lake Forest Area (and their partner agencies — a truck from Slave Lake Fire Department working near Marten Beach also responded to the wildfire) responded appropriately with available resources. Staff assigned to assess the wildfire, heavy equipment and aircraft all responded within the first hour. The greatest factor contributing to the escape was the weather conditions under which the wildfire was purposefully ignited.

IA was dispatched from Wabasca and air attack was requested and dispatched from Fort McMurray to respond to SWF049 and SWF050. The CL215T group positioned in Slave Lake for the day, like other groups across the province, were already working other wildfires when SWF049 and SWF050 were reported. Ground crews, air attack and heavy equipment were well coordinated in the first 36 hours. A decision was made to focus on SWF050 because it was more likely to hold — this determination was valid. With heavy equipment supported by ground crews and helicopter buckets, SWF050 was held over the following day or two. SWF049 was much more challenging. Ground forces were in the rear while airtankers and helicopters tried to contain the wildfire against McMillan Lake. On May 19, when winds continued to push the wildfire, SWF049 spread around McMillan Lake, setting the stage for the large complex that would persist for several weeks.

RECOMMENDATION:

7. Establish a standard operating procedure (SOP) for situations when a wildfire escapes Initial Attack during the high risk conditions and where there are significant values-at-risk. The SOP would identify that a more experienced IC be assigned immediately to assume command of the wildfire until the first IMT assumes control.

ACTIONS:

- Tactical training is required for all mid and lower level IC specific to the integration of more indirect suppression tactics, including hand ignition, to ensure that management support and resources for this approach are realized.

WMB's Tactics and Strategies Exhibit a Bias Towards Direct Attack and a Full Suppression Approach when Indirect Attack and Modified Suppression are Sometimes More Appropriate

In general, wildfire suppression involves an aggressive direct attack on the wildfire perimeter with ground crews using fire pumps, hose, hand tools, airtankers, helicopters with buckets and heavy equipment.

Alberta has a long history of a full suppression approach: the launching of heavy equipment, multiple aircraft and crews to the greatest extent possible whenever a wildfire occurs with an emphasis on putting out every smoke around and within the perimeter of a wildfire. This direct attack strategy to achieve full suppression works well during initial attack on a smaller wildfire or when conditions are less extreme, but often breaks down when conditions are extreme on very large wildfires, as was the case in spring 2019.

The experience of most firefighters starts with direct attack as most wildfires are small and manageable when crews and aircraft arrive soon after the wildfire is detected. In fact, 94 percent of new wildfires detected in May 2019 were successfully contained using direct attack. This drives the trend for wildfire crews, pilots and equipment operators to immediately default to direct attack tactics when confronted with a new wildfire situation. This direct approach is generally appropriate during the early stages of an incident, but once the wildfire has escaped IA and is clearly becoming a large campaign wildfire, strategies need to adjust quickly. Recognizing the need to shift from a direct attack on the wildfire's perimeter to tactics that step back from the perimeter and are more strategic is a challenge for wildfire management staff. This transition in tactics can be critical to success, safety and developing a cost-effective approach to minimizing the damage to values-at-risk. There is substantial evidence from 2019 that WMB's tactics and strategies exhibit a bias towards a direct attack and full suppression approach over more indirect approaches. There were also examples in 2019 where burning out from strategic positions was used with success.

The direct approach may hold appeal as it is an easier decision to make with less immediate uncertainty and is easily understood by other wildfire management staff and public stakeholders. In contrast, taking a more strategic indirect approach to suppression comes with greater uncertainty around tactics such as ignition to remove fuels next to the wildfire perimeter. In an era of bigger, more frequent and more intense wildfires, this indirect approach has distinct advantages. The risk of suppression failure and incurring greater costs increase exponentially using a direct, full suppression approach as the number and size of wildfires grow.

Adopting a more strategic, indirect approach comes with its own set of challenges and risks, including concerns from stakeholders and the public regarding hand and aerial ignition or perspectives that WMB is not being aggressive enough. This emphasizes the need for better communication and education regarding the rationale for some of these strategies and tools.

There are two critical phases of an incident's development when decision-making around direct attack becomes critical. The first is when a wildfire escapes IA and is "in transition" to sustained attack. At the time the wildfire escapes, command is usually in the hands of a Type 4, 5 or 6 IA Incident Commander. Their usual experience is direct attack. During this interim period —usually 36 to 48 hours — the Incident Commander may be waiting for arrival of an IMT with more experienced leadership. During that transition period, it is critical that Type 2 or Type 3 operational leadership with skills and training in indirect attack be assigned to the incident so they can evaluate all available options.

The second critical phase is when the incident becomes very large and is clearly not going to be fully resourced around the full perimeter. At that time, strategic planning for wildfire containment and minimization of impact on values-at-risk should begin.

In some cases, direction to IMTs was for full suppression (i.e., to put out all the wildfire within the perimeter) even after the wildfires became very large. This goal is simply not possible on wildfires the size of those experienced in 2019, no matter how many resources an agency might deploy. Furthermore, taking this kind of approach is extremely costly and much of this expenditure is highly questionable. A more strategic indirect approach is likely to be a more successful control technique and much more cost effective.

Given the duration of operations on the three large incidents, there were numerous IMTs deployed in succession and, as a result, continuity of planning, strategies and tactics was often lacking. In two cases in 2019, one IMT attempted to improve strategic planning for these large incidents – with limited success. This observation identifies the need for the organization to embrace longer-term Strategic Incident Action Plans (SIAP) as a practice that could address the need for long-term strategies on these types of incidents. These plans would then become the agreed approach to manage the wildfire and public safety risks with the firefighting resources that are realistically available to the management team. This plan can be passed along to the incoming IMT who then would build on that plan while ensuring a level of consistency and efficiency on the ground. These plans can take direction from the SWMP if one is in place, Letters of Authority and other strategic direction provided by senior management.

Year end IMT / operations debriefs were held near the end of 2019. A commitment was made to establish a template for these SIAPs, which will include a standard approach to their development for the future. This will be an excellent step to close the gap that was present in 2019, and ensure an opportunity to take a more strategic approach with an emphasis on indirect attack where appropriate.

Hand Ignition Tactics are Underutilized, Resulting in Ineffective Outcomes

WMB has a well-structured aerial ignition program that includes well-defined training and certification requirements and a strong deployment and practices program. This program has been in place for some time and proved its value again in 2019 on the three large-scale incidents.

In contrast to aerial ignition, the practice of hand ignition by staff is not commonly used in Alberta. There is no clear rationale for this gap, but it may be tied to the tendency to undertake direct attack on wildfires — an approach that does not often require ignition. Unlike aerial ignition, hand ignition can be very precise and used in close quarters with other ground activities, such as dozer line construction.

This is especially true in conditions experienced in early May of 2019, when most of the fuels that contributed to wildfire spread can be characterised as fine fuels and are relatively easy to ignite and control. Once an area is burned, the area has very little ability to sustain another wildfire spread. Well planned and implemented ignition can effectively speed up the process of containment and control.

A critical component to hand ignition is that the fire crews involved need to be comfortable with the practice. This usually comes with increased experience in its use. Alberta staff often get this experience conducting hazard reduction burning near communities. Equally important is the support to use this tool by leadership, especially given there are some inherent risks.

Ignition techniques, both aerial and hand, are often not well understood by the public and stakeholders. Public concerns with respect to the use of ignition was evident on HWF042 and PWF052. This concern largely revolves around the risks for escape, and with the potential damage to values within the burn area, such as timber values. Ultimately, the best way to address these concerns is to ensure the stakeholders understand how planned ignition is integral to the control strategy, what is being done to mitigate the risk, and to provide a better understanding as to what the risks are if ignition isn't used. Public education around this firefighting technique can often help to pre-empt these concerns before a wildfire has even occurred.

Heavy Equipment Can Be Used More Efficiently and Effectively

Use of heavy equipment in Alberta is prevalent, as much of the terrain is conducive to its use. In addition, the industrial presence on the land base typically ensures equipment is readily available. There is a well-defined model in place to establish heavy equipment groups, ready them, and deploy them as required, under the supervision of a Heavy Equipment Group Supervisor (HEGS). In Alberta, the HEGS are generally experienced and well-versed in the use of heavy equipment on the fireline.

Where environmental conditions allow for the use of heavy equipment, it is an effective tool in creating fireguards and is utilized most effectively when the fireguards are supported by ground crews. This requires close coordination between the HEGS, the Division and Branch supervisors to ensure that the equipment use is effectively integrated with ground operations including ignition tactics. In most parts of Canada, heavy equipment work is deemed the first step in a two-step process, where, after the dozer line is constructed, the fuel is burned out between the bare soil of the dozer line and the approaching fire front. In this way, the effective suppression line is quite wide, and fine fuels that can support fast spread or spotting across the dozer line are removed. Once fuels are removed, crews can work safely to patrol and mitigate any spot wildfires that develop near the line.

It is apparent that in 2019, in several cases, the use of heavy equipment was disconnected from operations. At times, this led to the creation of dozer lines that couldn't be supported by ground crews and were not effective in containing the wildfire. Division supervisors on HWF042 (Chuckegg Creek) expressed concerns that they had little connection to the heavy equipment, and often felt their strategies weren't well-integrated. This was largely due to the HEGS working as an independent entity with a separate reporting relationship up through the chain of command. The lack of coordination between heavy equipment and ground crews resulted in inefficiencies and reduced effectiveness.

Consistent with the direct attack culture, the principle approach used by the HEGS is to tight line the wildfire perimeter (i.e., build a guard tightly following the wildfire perimeter), which invariably results in an irregular or spaghetti line that traces the wildfire's irregular perimeter. When a wildfire jumps the line to create a new finger, the heavy equipment is forced to go back to surround the new outbreak, which creates one or more "donuts." This irregular fireline is often considered supported if helicopters wet down hot spots. This practice provides a false sense of security because, as wildfire increases in intensity, the aerial support process can't keep up and the wildfire escapes.

These tendencies, when repeated, are indications that the heavy equipment and ground crews are not well integrated and may compromise the safety of heavy equipment operations. The existence of spaghetti lines and donuts are caused by the heavy equipment operation advancing faster than the rest of the ground operations. This tends to make the fireline extremely difficult to hold, particularly in dry conditions, during major wind events or when fire behaviour is notably aggressive. It is also an indication of a focus on direct attack where alternatively building straighter lines and then removing unburnt fuels with the use of ignition in a systematic and deliberate manner, followed up with mop up on the perimeter, would prove much more effective on large wildfires.

Heavy equipment use represents the second largest direct wildfire cost next to aviation, totalling $78.3 million in 2019 (see Cost Management section for additional details). Interviewed participants frequently questioned the amount of equipment hired and deployed, especially once the wildfire was BH or UC. There was a common perception that, like helicopter resources, WMB was quick to build up their heavy equipment levels but slow to downsize as the circumstances warranted.

RECOMMENDATION:

8. Revise standard tactics and strategies for sustained attack to have better, safer, and more cost-effective results.

ACTIONS:

- Ensure visible senior management support for indirect attack strategies recognizing the risks associated.
- Review and revise policies to support the merits and appropriate use of direct and indirect tactics and strategies.
- Develop proactive public education on the value and use of indirect attack, including ignition (hand and aerial). Ensure IMTs take a deliberate approach to educating and informing public stakeholders on why it is being used.
- Encourage the use of hand ignition and ensure all SOPs, operational guidance and training reflects this support.
- Revise current practices and standards for use of heavy equipment in fireline construction. Consideration should be given to the following:
  - Comprehensive approach to fireline construction that embraces indirect attack strategies where appropriate.
  - Ensure reporting structures for the Heavy Equipment Group Supervisors and associated activities are better integrated and closely coordinated by reporting up through each division within the standard ICS structure.
  - Emphasis on providing ground support to heavy equipment fireline construction as soon as possible adopting a build, burn out and mop up systematic approach.
  - Increased emphasis on cost effectiveness in all aspects of heavy equipment use.
- Complete the standard template and process under development for Strategic Incident Action Plans for IMTs that are supported by reliable, timely data and forecasting that includes consideration of longer-term risk management strategies and provides continuity from one team to the next as a large wildfire progresses.

Clearer Direction is Needed Around Declarations of Wildfire Status – Specifically the "Being Held" Status

WMB depends on terminology to indicate the status of a wildfire. The use of this terminology is an important means of communicating across the organization and with the public when multiple wildfires are occurring that require resources and prioritization. The change in a wildfire's status from Out of Control to Being Held (OC to BH) is a key operational distinction, sending a signal across the organization that the wildfire is no longer spreading, is responding to control and will likely not be contentious in the future.

In 2019, as an example, HWF042 (Chuckegg Creek) was declared as BH on May 13th at 08h55 (less than 24 hours after the wildfire was discovered) and then returned to OC on May 17th. The early declaration of BH likely led to a lower priority being assigned to the wildfire which resulted in a less aggressive approach to resourcing and strategies on the ground. PWF052 (Battle) was declared BH at 08h00 May 16th at 2,271 hectares and returned to OC on the 17th.

According to the *Alberta Wildfire Management 2019 Policy and Standard Operating Procedures*,[48] the Wildfire Status of BH is defined:

"A wildfire that is identified as "being held" is when sufficient resources are currently committed and sufficient action has been taken, such that the wildfire is not likely to spread beyond existent or predetermined boundaries under prevailing and forecasted weather and fire behaviour conditions."

This broad definition is consistent with some other wildland fire agencies in Canada. However, the Alberta policy and SOPs also provide further insight into BH as a measure and indicator of wildfire status:

"Being held status can also be applied to:

1. *wildfires that have not increased in size since the time of discovery or first assessment by the end of the first burning period, 10h00 the following day,*
2. *wildfires that are meeting landscape management objectives as stated in the wildfire analysis strategy (WAS) regardless of manpower levels. Predetermined boundaries must be identified on the WAS form for all wildfires,*
3. *wildfires where the primary objective is specific value protection and only enough resources have been deployed to accomplish this.*

In situations two and three, it is understood that the wildfire area could continue to increase until it reaches under control status.

"Being held" wildfires will have an Incident Commander assigned as a minimum despite the level of suppression required."

With respect to these additional applications of BH, it should be noted that one of the key performance measures of the WMB program is that wildfires are declared BH by 10h00 the morning after the wildfire is reported to WMB. In most parts of Canada, ICs are cautious in declaring a wildfire BH until a solid containment line is around the wildfire. That is, BH is a stage of *control*, indicating that suppression action has been sufficient to confidently change the status of the wildfire. Still, in most areas of Canada, having the wildfire BH by the next morning is a key measure of performance for IA. In some parts of Canada, as an interim step, a percent contained terminology is used to help qualify how much progress is being made on the wildfire until it is declared BH.

The declaration of a wildfire as BH sends a signal to other parts of the organization (including staff and contractors working on the wildfire) that the wildfire is not likely to spread, that resources are somewhat

[48] March 1, 2019 Version WILDFIRE OPERATIONS SECTION Pages 12 and 13 of 54 Subsection 7.2

adequate for the situation, and the wildfire is not a "priority concern." From May 13 to 18, HWF042 was listed as a project wildfire on the High Level Presuppression Preparedness System (PPS). There was less formal recognition of the wildfire as a priority until May 19 after the wildfire became OC. At the time, there was no evidence of a strong containment line on some of the wildfire's perimeter. The first day the Sustained Action Planning Group (SAPG) met, on May 19, HWF042 was listed as second provincial priority. HWF042 became top priority on May 20.

One other important aspect of the terminology and policy around BH and OC is the public perception that it creates. Within the department and with contractors, once a wildfire is declared BH there is sometimes a sense that the worst is over. There is often an even bigger assumption made by the public that BH means the situation is under control or that the risk is over. Then, as was the case on both HWF042 (Chuckegg Creek) and PWF052 (Battle), when the status flips back to OC it feeds a perception that someone or something has failed.

Interviews with staff and other analysis suggests there are several effects of declaring a wildfire BH:

- Decision-makers in the Forest Area and the province may assume the wildfire does not need additional resources and will allocate scarce resources elsewhere.
- Staff on the wildfire may change their behaviour or attitude on the ground, resulting in less aggressive activities.
- New resources arriving on the wildfire may underestimate the risk posed by the wildfire.
- The public, community leaders, and partners may have a false perception that the wildfire is Under Control (UC), as they are not familiar with the difference. The implication of false confidence is loss of public trust in the WMB when the wildfire subsequently returns to OC.

RECOMMENDATION:

9. Review current policy and provide direction to wildfire management staff regarding Wildfire Status to clarify stages of control and the status of wildfires being monitored.

ACTIONS:

- WMB should adopt the practice of reporting the *percentage containment for all OC wildfires* to reduce the pressure to declare a fire BH prematurely and to clearly communicate the risk related to future control problems.
- WMB should clarify with all ICs a consistent approach to declaring wildfires BH or UC and consider providing additional clarity around this process.
- Efforts should be made to communicate Wildfire Status to the public to improve their understanding.

There were Challenges with IMT Resourcing as well as Transitioning

Twenty-one IMT deployments in Alberta in a single fire season is unusually high. In 2019, all Alberta IMTs had multiple deployments and several teams from outside the province were also deployed. For the most part, the intelligence gathered from IMTs focused on the challenging fire behaviour and the complexity of dealing with large wildfires that threatened communities or other values.

Most teams struggled to transition to / from another team. At the same time, Forest Areas reported difficulty on demobilization planning and logistics to support team changes. In several cases, continuity was not managed between teams with respect to tactics and strategies for the incident. This led to gaps in understanding of values-at-risk and key stakeholder engagement. Communication with the public also shifted with IMT changes, which at times eroded public or stakeholder confidence.

Just prior to the fire season Alberta changed their deployment strategy related to Type 1 and Type 2 IMTs and the categorization of incidents. Staff described to us that WMB IMTs are now “Type 2” teams that may be deployed to either Type 1 or Type 2 incidents. This shift in terminology has not improved clarity for staff, and several expressed uncertainties about how the IMT system works.

At the same time, WMB suggests a local “Type 2” or “Type 3” team will be deployed quickly to an escaped wildfire to be absorbed by a Type 1 team when one arrives. In that way, support positions should be in place, record-keeping will have been started and local operational staff will be familiar with the wildfire surroundings and available to provide local knowledge.

In most cases in 2019, there were no Type 2 or Type 3 teams locally rostered for dispatch to be absorbed by a more experienced team as the incident became more complex. Operational Forest Area staff were dispatched to manage the wildfire and a rostered (Type 1 or Type 2, depending on your terminology) IMT was ordered. Typically, the rostered teams take a few days to arrive to assume command of the wildfire.

At the McMillan complex, the Slave Lake Forest Area dispatched appropriate Type 2 and Type 3 operations staff to manage the wildfires until a Type 1 IMT arrived and absorbed those operations section staff. The lack of an organized Type 2 or Type 3 response to fill the performance gap until a rostered team arrived may have contributed to a gap on the Chuckegg Creek wildfire and Battle complex in the days after IA was unsuccessful. Recommendations following the 2016 Horse River wildfire suggested an SOP be developed to specifically manage the time period from when IA fails until an IMT is put in place. More attention is required to this 2016 recommendation to address this critical phase in the life of a wildfire.

While out-of-province IMTs arrived with 19 people (as do the Alberta All-Hazard IMTs) including support positions (e.g., Supervisors, Unit Leaders, and Branch Directors), Alberta IMTs arrived with only eight leadership staff. A shortage of support staff appears chronic and there were occasions where individuals were required to multitask around the clock to try to support expanding field operations. The shortage of support staff, particularly people trained on the use of information systems and in financial administration was also an issue in Forest Area offices.

Shortages of support staff also led to continuity and record-keeping gaps. When an out-of-province team departed, taking their 19 positions with them, an Alberta team would arrive with eight people to replace them and immediately be faced with re-building the support organization. Problems with resource orders, contracts and record keeping were commonplace.

Themes concerning support to IMTs extends to Finance and Administration support to Forest Areas. Before 2016, WMB transitioned to a new Ministry and left financial and administration staff in the Ministry of Environment and Parks (AEP). This arrangement is not working well for regular tasks nor is it faring well in terms of support for escalated WMB wildfire activity. As time passes, the experience of AEP staff is changing and their connection to the operational mandate of WMB is eroding. Considerable spending over a short period of time requires additional attention to on-time processing and controllership.

RECOMMENDATION:

10. Develop and train staff, including staff from other ministries, to support IMT deployments and Forest Areas under escalated workloads.

ACTIONS:

- Develop a roster and train staff outside the Forest Areas to fill IMT and Forest Area support positions (Planning, Logistics, and Finance and Admin Sections) to ensure enough staff are available for deployments.
- To develop Incident Management support capacity for wildfires and any other incidents, the Alberta government, led by Alberta Emergency Management Agency, should provide targets outside WMB for managers across the government to make staff available to be trained for support positions on incidents. A structured program should be created to help recruit, train and mentor these government staff, so they are ready for deployment to wildfires or other emergencies on an annual basis.
- WMB and Alberta Environment and Parks (AEP) should review and improve the model for support of WMB during the fire season. Dedication of wildfire financial expertise is required (similar to Recommendation #4 in the 2015 Program Review).
- Redevelop training materials to ensure staff have the training and development to successfully implement these shifts in strategies from past practices.

There is No Common Radio System for Responders Causing Efficiency and Safety Concerns

Firefighters on the ground and in the air need to be able to quickly and clearly communicate by radio. This is essential from both safety and operational effectiveness:

- The wildfire operating environment is spatially complex and risk-laden. Wildfires move quickly across the landscape and firefighters need to be connected so they do not become separated from their crew or risk being burnt over.
- Smoke can obscure the visibility of crews around the wildfire, both to other crews and to aircraft.
- Experienced wildfire suppression staff are often in aircraft overhead, helping direct and support the movement of ground forces.
- Airtankers arrive overhead to drop heavy loads of fire retardant. Communication with firefighters on the ground is critical for airtanker personnel to ensure it is safe to make their drops and help provide them guidance on precise targets.
- Coordinating response efforts across multiple jurisdictions is essential to ensure effective operations that are fully integrated.

The need for a common radio frequency becomes even more important under Unified Command where municipal and wildland firefighters must operate seamlessly with each other. During the Chuckegg Creek wildfire (HWF042) and particularly during the time period where High Level was being threatened, the lack of radios on the ground with a common frequency was evident. One good example of this was during the aerial ignition operations adjacent to the town boundary. The local Fire Chief was forced to communicate with municipal forces via text who were working in cooperation with WMB crews because they didn't have radio communications. On one occasion, he was forced to land to be able to communicate with his ground forces to ensure proper coordination. This not only created operational deficiencies but also safety concerns. The integration of operational activities effectively and safely demands a common radio communication plan.

Alberta has created a system presumably to augment this role, called the Alberta First Responders Radio Communications System (AFRRCS). The following is a direct excerpt for the public website that provides a brief explanation as to what the system is designed to do.

Overview

The Alberta First Responders Radio Communications System (AFRRCS) is a two-way radio network for first responders in municipal, provincial and First Nations agencies across the province. The Alberta government is funding the network's construction, operation and maintenance, and it became operational on July 1, 2016.

Public safety agencies using AFRRCS include:

- first responders, such as police, fire and ambulance services
- secondary responders, such as public works and public transit

Agencies using AFRRCS are able to:

- fully coordinate joint responses to emergency scenes
- improve and integrate radio communication among first responders from different agencies
- reduce the cost of radio system infrastructure
- use robust, resilient radio technology in day-to-day operations

Source: https://www.alberta.ca/alberta-first-responder-radio-communications-system.aspx

Public safety agencies are encouraged to use AFRRCS, but their participation is voluntary.

First responder agencies are eligible to use the system on a no-cost basis. Secondary responders are able to use the system with a fee, which is scalable. On the surface this AFRRCS system seems to be the solution but it has not been universally adopted by partner agencies. Ultimately, for any universal system to be successful, it must be adopted by everyone however to be a universal system, it must meet the business needs for all users. Our review did not explore all the technical reasons for this and the system has not been adopted by all municipal departments. Regardless for the reason behind this lack of universal adoption, emergency personnel operating together must be able to communicate. Even if an individual needs to be issued two radios, no one without radio communication should be able to leave the staging area. WMB should work with the Office of the Fire Commissioner (OFC) and Alberta Emergency Management Agency (AEMA) on an affordable solution.

RECOMMENDATION:

11. Implement a common mandatory radio communication plan and system for all WMB wildfire personnel, municipal firefighters and first responders working on wildfire incidents.

ACTION:

- Implement as soon as possible.

High Likelihood of Future Significant Safety Events is a Cause for Concern

Safety is paramount in wildfire operations, considering the risks posed by extreme fire behaviour, aircraft and topography, among others. Like many other high-risk work environments, a safety culture must be measured by how the organization treats minor incidents, or "near misses," as an opportunity to avert more serious harm.

Aviation support to wildfire operations comes with obvious benefits. Airtankers provide attack weight that can make the difference once wildfire intensities reach high and extreme levels. Helicopters are vital for moving crews into remote locations quickly and providing bucketing support to ground operations.

While there are many benefits to using aircraft in wildfire suppression, there are serious safety concerns related to too many helicopters flying in limited airspace, particularly where airtankers are operating. This observation appears to be a consensus among operational staff and air attack leaders.

The frequency and nature of these safety concerns make it paramount that immediate corrective action is taken to address the associated risk.

Three main sources of information led to a more careful look at the use of aircraft. First, is the high number of rotary wing aircraft hired and hours flown in 2019. Second, a sample of 103 Aviation Occurrence reports on file were reviewed to look for issues that are repeated or particularly serious. Third, interviews with operations staff include discussions around aviation management.

Typically, Alberta uses many aircraft to move crews, equipment and water to the fireline. While this can be effective at one level, it introduces risks of a crowded airspace, particularly where helicopters are working with buckets and moving quickly horizontally and vertically, and airtankers may be active on the same wildfire. It was obvious WMB uses ICS positions, such as Helicopter Coordinators (HELCOs) and Air Operations Branch Directors (AOBDs), to manage these operations and reduce risks. Staff indicated, when interviewed, that there are situations when there are too many aircraft working in a confined space and close calls are sometimes accepted as a risk of this type of operation. Certainly, airtanker (and bird dog) pilots notice the problem as they arrive at wildfires at higher rates of speed. As described earlier, of the 103 Aircraft Occurrences reported in 2019, 37 fell in the sub-category of Loss of Separation, Near Collision, Potential Collision, or Communications Error. We expect several of the 19 "Other" and blank subcategories are variants of this issue. 55 and 39 Aviation Occurrences were reported in 2018 and 2017 respectively. Staff indicate that rotary wing pilots are not inclined to always report Loss of

Separation occurrences, suggesting the overall number of incidents reported is conservative. An increase in reporting in 2019 could be a good thing — that incidents are being reported more diligently.

Crowded airspace was also apparent on the Horse River wildfire in 2016, and the review of that wildfire recommended bringing forward the airspace management lessons for future wildfires. While some effort has been made, there is still work to be done. Alberta has a good system of following up on Aviation Occurrences individually. The challenge is to look at the systemic root causes that may contribute to risk. Under-reporting is a considerable (and not uncommon) safety culture problem and can become pervasive if left unchecked. Diligence in managing the number of helicopters on a wildfire and putting aviation management ICS positions in place (HELCO, AOBD, or Air Tactical Group Supervisor (ATGS)) with a mandate to manage for safety will be required.

With respect to safety incidents related to fireline, basecamp, or logistics operations, a summary categorizing and analysing trends for 2019 was not available to this review. Interviews suggest there were roughly 230 incidents after March 2019 that have been submitted for compilation. Forestry Division underwent a safety audit conducted by external Canadian Registered Safety Professionals (CRSP). This effort, which looks comprehensively at safety management systems in place, is a good practice and superseded work on statistical compilation of 2019 incidents. Forestry Division (which includes WMB and Forest Stewardship and Trade Branch) had 238 and 210 reported occupational health and safety incidents in the April to September months of 2018 and 2017, respectively. From limited statistics reviewed, there are many smaller incidents and it appears many are being reported and resolved by managers. However, it appears WMB has yet to build a 21st century safety management system and associated culture. WMB is engaged in a risk and hazard laden business where safety needs to be a high priority.

One area of concern that we observed is the issue of tactical withdrawals of ground crews or heavy equipment in the face of a change in fire behaviour. For large wildfires under difficult-to-control fire behaviour, these events can happen and need to be managed. Of concern in interviews with staff was the apparent lack of resolution of these events so staff had a common understanding of the observable trigger points for evacuation, severity of the incident and steps that should be taken to avoid such risks in the future. The experience level of staff and field leadership can have considerable influence on whether an incident was "a well managed retreat," frightening, or very dangerous.

After firelines were breached (and one piece of heavy equipment lost) on the McMillan complex around May 29, experienced dozer bosses and HEGSs were used to help inexperienced operators understand the experience and return to work confidently. We could not find evidence the evacuation events were documented with an eye to debrief staff and communicate lessons learned for future situations. In another case, we are aware that the evacuation of crews on the Chuckegg Creek wildfire was delayed and inefficient, leaving several firefighters concerned about how the incident was handled.

Again, we were unable to find any evidence the organization took an organized approach to document and resolve the understanding of staff to prevent such issues in the future. However, we are aware such an effort was undertaken at a home location with some of these crews because the practice of reporting and reviewing such incidents is commonplace in other wildfire organizations.

These issues result in reliable and meaningful safety incident information not being readily available — neither from WMB staff nor external reviewers.

RECOMMENDATION:

12. Accelerate the development of a safety culture that values incident reporting, hazard assessments, workplace committees and inspections, and the engagement of front-line staff in conversations designed to protect their health and well-being.

ACTIONS:

- Senior management should take a lead role and be visible in leading this initiative.
- Assign senior management champions to accelerate measures underway to improve the overall safety system in WMB (i.e., do not delegate to safety staff);
- Key areas of focus are incident reporting, thorough investigations, and communicating lessons learned.
- A process to review, learn from, and communicate to staff about aviation or fireline "near misses" or tactical withdrawals should be developed, tested with staff, and implemented.
  - Conduct an immediate review of the current policies and procedures dealing with air space to develop specific and deliberate measures to address this significant safety concern. Ensure this process considers lessons learned as a result of the Horse River fire review.

Highway Closure Processes Were Problematic in 2019

On May 12, during IA on HWF042 (Chuckegg Creek), the wildfire spread to the southeast and eventually crossed over Highway 35. Prior to the wildfire crossing the highway, the IC recognized the threat this would cause to public safety and requested that Alberta Transportation officials be notified to take action to close the highway. The Forest Area Duty Officer made every attempt to follow protocol and contact their local Transportation official but was not able to reach them. After approximately three hours, they contacted the RCMP who enacted closure of the highway. By the time this occurred, the wildfire had crossed the highway, presenting some risk to the travelling public until such time as the highway was closed.

There is a logical protocol in place to cover off these types of events as detailed in the Memorandum of Understanding (MOU) "Highway Traffic Management during Wildfire Operations" (October 23, 2017) established between Alberta Transportation and WMB. It set out measures to be followed if a wildfire conflicts with a public highway and provides contact information. It also requires an annual meeting between the parties prior to March 1 to exchange information and ensure the contact information is up to date.

From the information gathered during our review, it is not clear why the process did not work as well as it should, but at some point the current protocol failed. It is likely that the local official can not be expected to be available at all times (the wildfire was discovered on a weekend), and alternative measures were either not in place or failed in this instance. Further, when a wildfire breaches a public highway, it presents a serious public risk and every measure should be taken to ensure this risk is mitigated as much as possible.

Protecting Structures and Assets from Wildfire Requires a Stronger Integrated Approach Among Partners

Significant wildfires in Alberta's past (1998, 2011, 2016) have required WMB and its partners — municipal, industrial firefighters, OFC, and AEMA — to focus on cooperation to protect structures and communities from wildfire. Alberta has been a leader in development and implementation of FireSmart programs, which include principles aimed at improving interagency cooperation to reduce losses when wildfire encroaches on communities and other assets. Recent reviews have listed several key recommendations aimed at continuing this effort across organizational lines:

- In the 2015 Program Review, "Revisit the province's strategy respecting FireSmart, with an increased emphasis on a long-term vision for FireSmart within the province, community responsibility, multi-agency collaboration and an outcomes-based approach to implementing FireSmart projects."
- In the 2016 review of the Horse River Wildfire, a recommendation was directed at improving both the level of response to wildland-urban threats, and the relationships of the partners the public expects to work together: "Direct agencies and services involved in wildfire suppression in relation to the Wildland Urban Interface to establish SOPs for the implementation of an Incident Command System (ICS) and processes following the model provided by ICS Canada for future incidents like the Horse River wildfire." And "Emphasize a long-term vision for FireSmart within the province that includes community responsibility, multi-agency collaboration and an outcome-based approach to implementing FireSmart projects. Ensure all seven disciplines of FireSmart are addressed."

In 2019, we saw several examples where the lessons of 2016 were implemented and protection of communities, isolated structures and infrastructure was better. For example, lessons learned from the 2016 Horse River wildfire were the subject of table-top exercises in Hinton just before the 2019 fire season. Participation in that training exercise set the stage for excellent cooperation by some of the same individuals when they met in High Level a few weeks later. Work at the McMillan complex also demonstrated WMB and partners in the Slave Lake Forest Area had progressed from lessons learned in 2016 and their own 2011 experience.

Although there are good examples of firefighting being more integrated and cooperative across organizations, there is still work to do. A lesson *heard* by some is not necessarily *learned* by the organizations who must work together. Some observations from 2019:

- Where structural protection was brought under the wildfire IMT, as part of the Operations Section, it worked well.
- Unified Command worked well when set up, but may have been removed too early, in some cases.
- Inexperience with community protection was observed with some of the smaller communities, but all were fully committed to the job.
- Firefighters brought in to help with community protection (particularly officers filling Structural Protection Branch Directors (SPBD)) should have appropriate training and have qualifications checked on arrival at the wildfire.
- Command and control related to IC is sometimes poorly understood outside WMB staff. Divisions between WMB and OFC / municipal responsibilities led to inefficiencies and logistical challenges. For example, Structural Protection Branches within an IMT were directed to order equipment outside the IMT's Logistic Section, which is operationally unreasonable.
- Structural Protection Unit (SPU) trailers (considered Type 2), while good for small responses of fewer than 30 structures, will be inadequate if a large deployment is required. Alberta does not maintain a Type 1 SPU.

Clearly, when the need exists, WMB and Municipal Fire Department firefighters work together to "get the job done" — and in 2019 with relatively good success. However, as a year-round program designed to provide the best outcome for Alberta residents and businesses, the focus on structural protection remains under-resourced and fragmented. Following the experience at Fort McMurray in 2016, the OFC, WMB and the Alberta Fire Chiefs Association (AFCA) developed Alberta Structure Protection Program Operational Guidelines (2018). We observed these guidelines are not well understood or followed. For example, the process for ordering resources through the OFC and/or obtaining approval from WMB before additional resources are ordered can lead to inefficiencies and misunderstandings.

WMB officially claims to have no role in structural protection but clearly does have a role as they are managing large wildfire incidents that include structural protection branches. As one senior IC from WMB stated, "officially we don't have a role in structural protection until we find ourselves in the role of structural protection." Operationally, WMB can make structural protection better, or more difficult, depending on how that work is organized in the field. Policy barriers are in place, for example, that restrict WMB firefighters from deploying structural protection units on buildings. A policy line has been drawn that only municipal firefighters do that segment of the work. In 2019, we are aware of situations where wildland firefighters were or could be deployed efficiently to support structural protection because they were nearby.

OFC generally sources and deploys its resources to support local municipal resources at incidents. Clearly, support from the OFC and AEMA's operation centre (which provides 24/7 contact for OFC and inter-municipal support) to the three large incidents in 2019 was much improved compared to the 2016 experience.

In our discussion with staff, it is evident WMB, OFC and AEMA draw lines dividing responsibilities among the provincial agencies. In some ways, the official approaches are contrary to the intent of their own Operational Guidelines and FireSmart principles that the same agencies are promoting. The public and municipalities are looking for a reliable and efficient "one government" approach for support and response. The more officials draw lines between their own role and that of the other department in supporting municipalities, the more opportunity for inefficient, or worse, ineffective response to wildfires at the wildland-urban interface. Since the OFC has very limited capacity, the Structural Protection Unit capacity and infrastructure (i.e., some 42 trailers with equipment in various states of readiness) is largely supported by municipal fire departments who do most of the equipping, training and responding. More of the operational experience and capacity to lead a provincial Structural Protection Program lies with WMB — and WMB is the best operational lead once an incident gets underway.

OPPORTUNITY FOR IMPROVEMENT

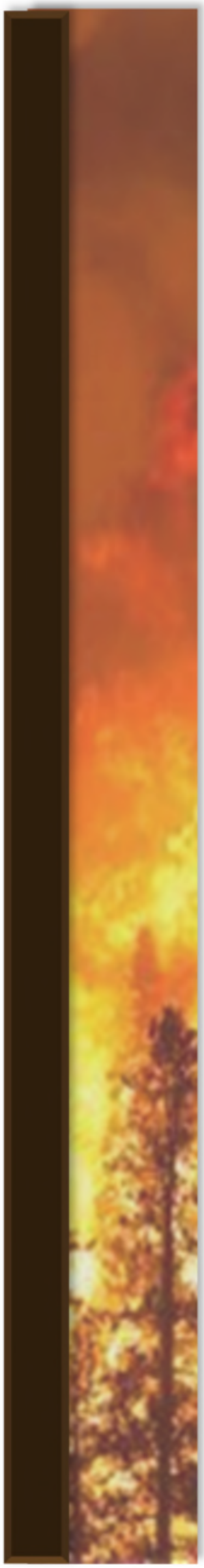
The two fire agencies of the provincial government (AAF and OFC) should combine their resources and leadership to support the municipal effort with training and equipment for the protection of structures. Rather than define a segmented "who does what", the partners should discuss "how we are in this together" and focus on a quality program for all Albertans. These provincial agencies, along with a strong presence from municipalities, should stay connected and committed to building on the good work done in 2019.

4 | Strategic Program Management

STRATEGIC PROGRAM MANAGEMENT

A variety of program management related topics span across WMB program areas and are important to the overall function of the program. Five core commentaries provide insight into other ways the program can be improved in years to come. These commentaries are:

1. Information Technology Systems—including a high-level overview of eight information management systems used by WMB.
2. Cost Management – which includes a high-level cost-benefit analysis of IA activities.
3. Risk Management & Strategic Operations – which provides a summary review of the program and its core components, tying together several key themes and findings at a strategic level.
4. High Reliability Organizations – which outlines a theoretical framework to which WMB may consider aspiring.
5. Implementation of 2015 and 2016 Wildfire Review recommendations – which assesses WMB's progress towards achieving the recommendations and "opportunities for improvement" identified in the two previous external reviews completed for WMB by MNP.



4.1 Information Technology Systems

INFORMATION TECHNOLOGY SYSTEMS

MNP reviewed eight information management systems that are used by WMB. These systems include: FIRES, Dispatch, AWARE, Wildfire Mapping Program, Alberta Wildfire website, FireBans, Inventory Management Information System, and FireWeb. Key functionality of each system was identified, including the strengths and weaknesses of each system. This section includes an overall system assessment. A more fulsome, detailed assessment, including a comparison of these systems to other jurisdictions can be found in Appendix J.

Overall System Assessment

During MNP's review of key WMB systems, it was determined that WMB is in the process of modernizing their software systems. Fujitsu Consulting Canada (Fujitsu) was hired in 2018 to review the existing systems and develop a roadmap to aid in the modernization of these systems. The review focused on gaps between the business requirements and functionality provided by WMB's existing systems. A final report was delivered to WMB in 2019 that provided an assessment of the current state, target state vision, road map, and costs. Fujitsu's conclusion was that the key challenges of WMB's existing systems are that:

- Most systems are old, written in legacy technologies and in a state that makes it difficult or impossible to take advantage of emerging technologies.
- Systems employ manual and cumbersome processes with a significant amount of paper.
- Significant data duplication exists between systems.
- Systems are siloed with limited data integration.
- The key FIRES lacks GIS functionality.
- Network connectivity is lacking in remote areas.

Key Finding

1. Based on the high-level review MNP performed of WMB's systems, MNP agrees with the assessment made by Fujitsu.

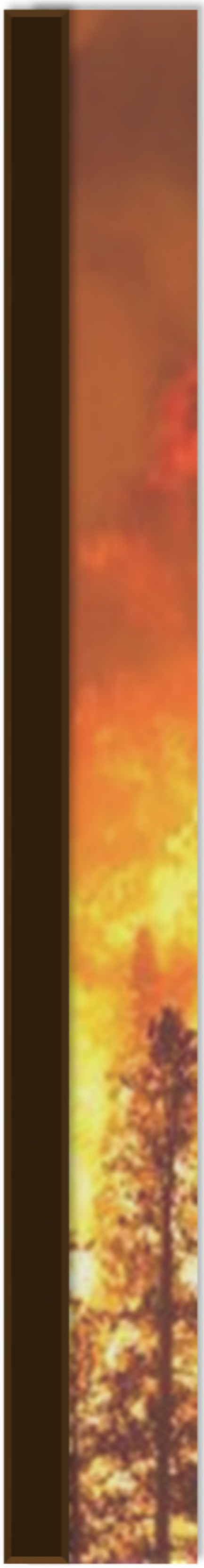
Three of the core systems, FIRES, Dispatch, and IMIS, are approximately 25 years old and are using legacy technologies that are difficult to maintain. FIRES and IMIS were written in the software development tool called PowerBuilder that has compatibility issues with Windows 10 and potential compatibility issues with other future operating systems. Additionally, PowerBuilder systems are difficult to maintain due to a lack of skilled PowerBuilder developers.

The main system, FIRES, is a very large system used to track wildfire details, aircraft contracts, aircraft details, employee training certifications, employee pay rates, and fire permits. It has siloed data, a difficult to learn user interface, a lack of GIS functionality, and an inability to make use of newer technologies, such as linking to mobile devices, downloading data collected by drones and integrating with workflow and document management systems.

AWARE is the most advanced implementation of the Canadian Forest Fire Danger Rating System in Canada. It is a web browser-based application that is deployed to a central server. This makes system updates easier when changes only need to be made to a central server. Compared to a desktop application, AWARE does not need to be installed and deployed to each workstation. Its user interface is easy to use.

RECOMMENDATION:

13. WMB should continue with the legacy modernization program to provide functionality required by WMB to help improve the delivery of wildfire management activities and help reduce the impact of wildfires in Alberta.



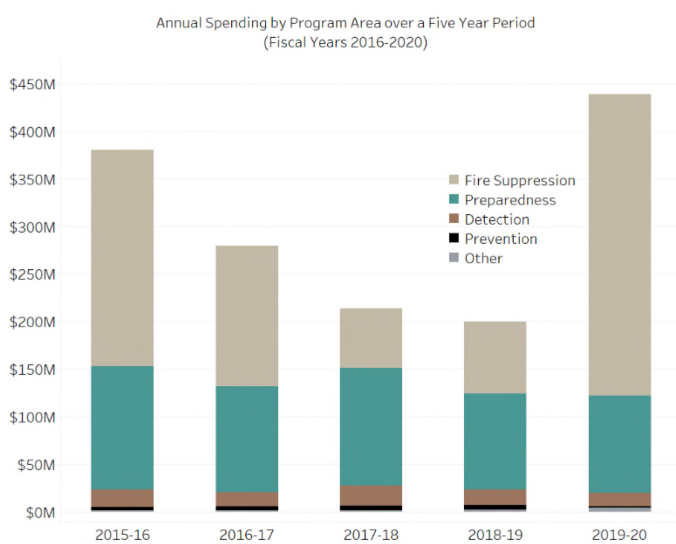
4.2 | Cost Management

COST MANAGEMENT

Overview of Expenditures

Over the 2019 fire season WMB spent a total of $438.6 million.[49] This amount is significant and is the highest of the most recent five years, even surpassing costs related to the 2015 fire season (extreme wildfire activity and conditions) and the 2016 fire season (including the Horse River wildfire).

Figure 32: Annual Spending by Program Area over a Five Year Period (Fiscal Years 2016-2020)



As illustrated in Figure 32, suppression and preparedness expenses together comprise the majority of overall program costs, contributing to approximately 95 percent of annual spending in 2019 (and a similarly high percentage in previous years). This includes both the base wildfire management budget and contingency (emergency) funding for wildfire presuppression and response.

Compared to other Canadian jurisdictions, Alberta's annual expenditure on preparedness and suppression (per wildfire and in total) is within the range of other programs – less than the expenditure level in British Columbia and more than the expenditure level in Ontario (Figures 33 and 34).

Figure 33: Average Annual Preparedness and Suppression Expenditures per Wildfire in Alberta, Ontario and BC (Fiscal Years 2016-2020)[50]

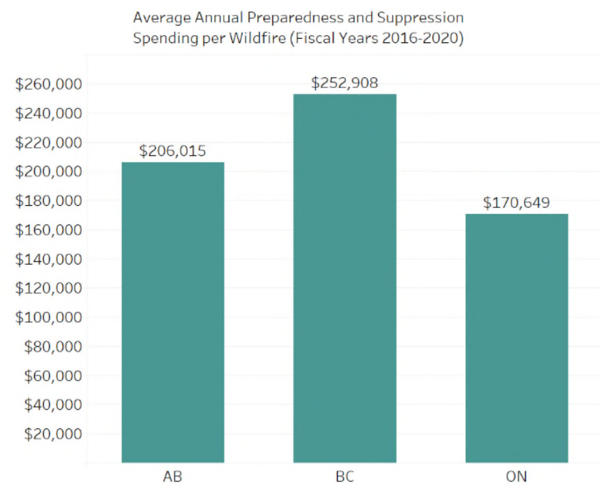
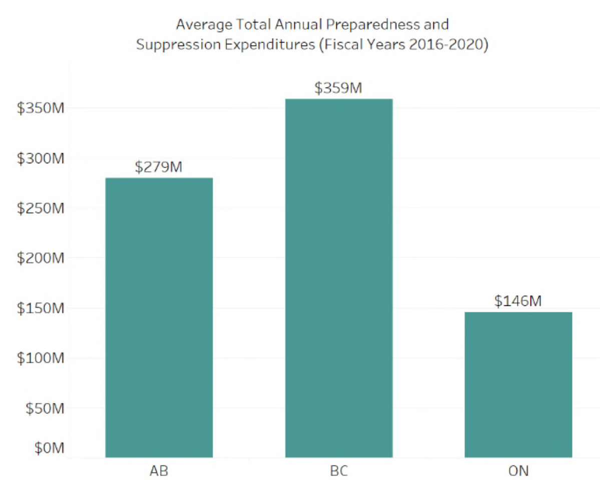


Figure 34: Average Total Annual Preparedness and Suppression Expenditures in Alberta, Ontario and BC (Fiscal Years 2016-2020)[50]

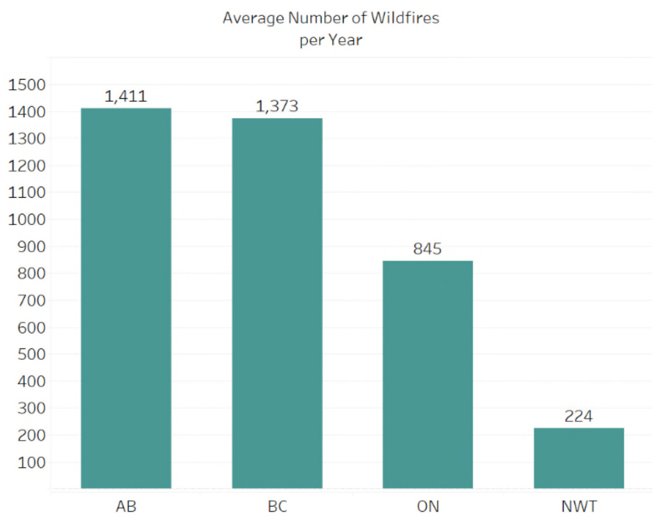


[49] The expenditures for fiscal year 2019-20 (April 1, 2019 to March 31, 2020) used in this section were based on preliminary information (actual expenditures and estimated commitments) AAF provided to MNP in November 2019. WMB's total expenditures for the 2019-20 fiscal year were approximately $570 million. This includes approximately $109 million base budget expenditures, and $461 million contingency funding expenditures for wildfire presuppression and response.

[50] NB: Based on available data which is not over the same time period in each of the provinces analyzed: BC data is comparable to Alberta Fiscal Years 2015-19. Data not available for NWT.

This annual spending on preparedness and suppression corresponds closely with the total number of wildfires experienced over the same period (Figure 35). Over this five-year period, preparedness and suppression expenditure per wildfire in Alberta was lower than British Columbia, despite a similar number of annual wildfires in both provinces.

Figure 35: Average Number of Wildfires per Calendar Year in Alberta, Ontario, BC and NWT (2010-2019)



This data is indicative of the decision of the Government of Alberta to allocate significant budget (base budget and additional contingency funding for wildfire presuppression and response) to actively manage and suppress wildfire.

Deeper analysis reveals a more complex picture. The work undertaken as part of this review to quantify the costs and benefits of wildfire suppression reveals two key findings.

Key Findings

1. Investment in successful IA saves money.
2. Improved program cost-effectiveness can be achieved through more efficient use of aircraft and heavy equipment.

Intuitively, it makes sense that prevention, early detection and early containment of wildfires are major controllable factors in reducing the area impacted by wildfire. It is difficult, however, to measure the benefit of investing in these aspects of a Wildfire Management program since a comparison of successful and unsuccessful IA requires assumptions and projections regarding IA performance. This supports a case that WMB should continue to analyze the optimal resourcing types, resource levels, resource locations, contract durations and terms[51], out-of-province support, and other items influencing the efficacy and cost of IA. That said, a cursory analysis of costs and benefits indicates that investment in IA improves outcomes and reduces overall costs.

Cost Benefit Analysis Approach/Methodology

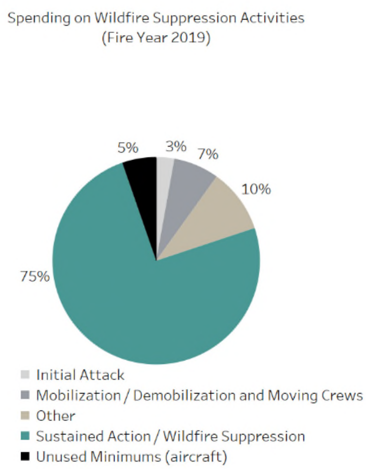
An understanding of the full costs and overall benefits of suppressing wildfires helps government develop strategic direction and policies regarding wildfire management. In addition, understanding some of the details of costs and benefits combined with program level strategy helps wildfire managers set priorities and make decisions with limited resources and competing interests. The starting point to understanding costs and benefits lies in identifying the true costs and the essential benefits derived from suppressing wildfires.

Costs associated with wildfire suppression are both direct and indirect (see Figure 36 for the breakdown of these costs in 2019 in Alberta). Direct costs are those costs incurred by a wildfire agency to prepare for wildfire and to take action once wildfires occur. Indirect costs are losses and impacts that are experienced at different levels of suppression and

[51] A detailed analysis of existing contracts / contract terms and their impact on program costs (e.g. through unused minimums) was beyond the scope of this review. That said, WMB would benefit from a full understanding of the impact of contracting policies and practices on cost-efficiency.

that are neither associated with wildfire suppression nor easily expressed in dollar terms. Examples of direct costs are those associated with firefighting crews and aircraft used to suppress wildfires. Examples of indirect costs include lost values, such as structures and natural resources, costs associated with evacuations and other emergency measures and wildfire related impacts to people, communities and others (such as public health, recreation opportunities, the environment and aesthetic values).

Figure 36: Suppression Expenditure Breakdown in Alberta (Fire Year 2019)



Benefits associated with wildfire suppression are both quantifiable and non-quantifiable and represent losses or impacts that are avoided due to wildfire suppression efforts. Regardless of our ability to put a value on the benefits, both are important. Quantifiable benefits are losses and costs avoided by suppressing wildfires that can be described in dollar terms. Quantifiable losses and costs include losses of structures, private or public property and natural resources.

Avoided costs associated with evacuation, post-wildfire recovery efforts and other necessary responses are also quantifiable. Non-quantifiable benefits are losses and impacts that are avoided by suppressing wildfires and that cannot be described in dollar terms. These include costs and impacts described above.

Understanding the costs and benefits of wildfire suppression is aided by considering two distinct components of wildfire suppression. The first component relates to the core wildfire program and organization that is put in place to prevent, detect, contain and extinguish wildfires before they do significant damage (i.e. core program activities up to and including IA). The second component consists of the decisions and actions that commit substantial resources and effort to suppressing wildfires that are not contained by IA efforts. This relates to larger "escaped" wildfires that are impacting landscapes, values-at-risk and communities and reflects decisions to commit resources over periods of weeks or sometimes months.

A cost-benefit analysis of each component of wildfire management must compare costs of wildfire suppression with the quantifiable and non-quantifiable benefits associated with avoided losses and impacts. The concept is clear and identifying costs of wildfire suppression is relatively straight forward. Most wildfire agencies track costs at a relatively detailed level and can categorize costs for the core program and for overall suppression efforts. On the other hand, identifying losses and impacts that are avoided by suppressing wildfires is a challenge. The challenge arises from the need to develop two types of estimates: 1) the size and configuration of wildfires at different levels of suppression effort (including no effort) and 2) the values lost and impacts at the different sizes and configurations of wildfires. In other words, how much bigger would a wildfire be without suppression and how much more would be lost. These estimates require a series of projections, assumptions and estimates.

Wildfire growth projections under various assumptions are needed as a basis for identifying what the difference in area burnt under different suppression scenarios and what the difference in losses and impacts would be. Estimating the types, locations and densities of values on the landscape is required to estimate the difference in losses and impacts. Assigning dollar amounts to these values is necessary. Assumptions about the non-quantifiable impacts and costs associated with wildfires are needed, as well as to address the impacts on health, wellness and disruption to communities and businesses. Using existing data and a few assumptions and estimates, some insight can be provided.

BENEFITS OF TIMELY AND EFFECTIVE INITIAL ATTACK

Analyzing the cost effectiveness of IA efforts starts with analyzing the performance of IA. In Alberta, all wildfires are subject to IA efforts, with an expectation of arriving at the wildfire before it reaches two hectares in size (on-time IA). Size is chosen rather than time to measure the performance of IA because quicker response times are needed and expected under higher hazards. The overarching IA objective is to contain wildfires within the first burning period — which means being able to classify the wildfire as Being Held (BH) by 10h00 the next day. In analyzing IA on wildfires according to the performance measure and objective above, relevant conditions can be split into two separate categories — high stress wildfire load conditions (defined as 50 or more active wildfires in the province at one time) and low stress fire load conditions (defined as fewer than 50 active wildfires in the province at one time). For the purpose of our analysis, recreational and residential wildfires are excluded because they lend themselves to a different and separate analysis. Table 15 outlines the relative success rates of containing the wildfire within the first burning period (Being Held (BH) success rate) at different wildfire loads and hazard levels.

Where high stress wildfire load conditions exist and IA efforts result in crews reaching the wildfire on time, the wildfire is contained within the first burning period 91 percent of the time under high hazard conditions (HFI 5 and 6). Where high stress conditions exist and IA efforts result in reaching the wildfire late (not on-time), the wildfire is contained within the first burning period 39 percent of the time. The data shows that under all wildfire loads and hazard conditions, arriving at the wildfire on time substantially improves the containment success rate. Clearly, the linkage is strongest during high stress wildfire load conditions and high hazard levels.

Table 15: BH Success Rate by Category for Calendar Years (2011-2019), Non-Recreation/Residential Wildfires

		HFI 1-2		HFI 3-4		HFI 5-6	
High Stress Fire Load		BH Failure	BH Success	BH Failure	BH Success	BH Failure	BH Success
	On Time	2%	98%	5%	95%	9%	91%
	Not On Time	38%	62%	29%	71%	61%	39%
Lower Stress Fire Load		BH Failure	BH Success	BH Failure	BH Success	BH Failure	BH Success
	On Time	1%	99%	2%	98%	4%	96%
	Not On Time	17%	83%	23%	77%	51%	49%
All Fires		BH Failure	BH Success	BH Failure	BH Success	BH Failure	BH Success
	On Time	1%	99%	3%	97%	6%	94%
	Not On Time	22%	78%	25%	75%	57%	43%

Table 16: Average Suppression Cost ($CDN) per Category for Calendar Years (2011 - 2019), Non-Recreation/Residential Wildfires

		HFI 1-2		HFI 3-4		HFI 5-6	
High Stress Fire Load		BH Failure	BH Success	BH Failure	BH Success	BH Failure	BH Success
	On Time	$300,312	$24,931	$1,006,338	$20,726	$927,570	$26,023
	Not On Time	$768,894	$91,313	$409,131	$127,305	$2,464,593	$170,219
Low Stress Fire Load		BH Failure	BH Success	BH Failure	BH Success	BH Failure	BH Success
	On Time	$320,731	$12,087	$6,134,274	$20,275	$6,835,506	$33,099
	Not On Time	$527,000	$92,706	$1,716,085	$179,938	$3,607,021	$175,939
All Fires		BH Failure	BH Success	BH Failure	BH Success	BH Failure	BH Success
	On Time	$311,202	$15,271	$3,097,996	$20,422	$2,671,818	$29,733
	Not On Time	$613,391	$92,487	$1,175,276	$162,193	$2,879,201	$172,813

Table 17: Average Hectares Burned per Category for Calendar Years (2011 - 2019), Non-Recreation/Residential Wildfires

		HFI 1-2		HFI 3-4		HFI 5-6	
High Stress Fire Load		BH Failure	BH Success	BH Failure	BH Success	BH Failure	BH Success
	On Time	27	29	1,808	59	1,569	60
	Not On Time	116	1,833	2,961	96	12,907	273
Lower Stress Fire Load		BH Failure	BH Success	BH Failure	BH Success	BH Failure	BH Success
	On Time	39	1	11,664	3	27,037	20
	Not On Time	281	108	5,459	1,090	6,906	233
All Fires		BH Failure	BH Success	BH Failure	BH Success	BH Failure	BH Success
	On Time	33	8	5,828	21	9,088	39
	Not On Time	222	379	4,425	754	10,730	255

Table 18: Total Suppression Savings (Land Value and Suppression Costs), for Calendar Years (2011 – 2019), from Consistent IA Success

	HFI 1-2	HFI 3-4	HFI 5-6
High Stress Fire Load	$5,826,125	$18,924,751	$274,090,720
Low Stress Fire Load	$8,788,906	$93,901,535	$156,047,359
All Fires	$14,552,231	$112,524,790	$424,522,976

The next layer of analysis relates to the costs associated with IA effectiveness. Table 16 outlines an analysis of Alberta's data from the past nine years showing the average cost of suppressing wildfires at different wildfire load conditions and hazard levels. In addition, Table 17 provides the average hectares burned (final wildfire size) within each category.

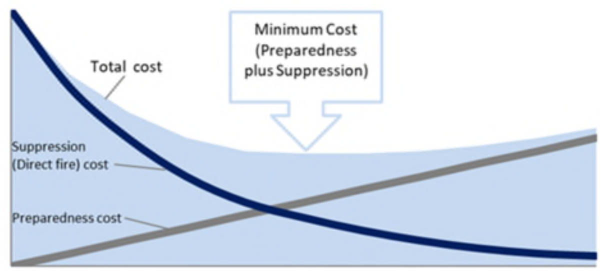
Clearly, wildfires that are actioned on time and contained in the first burning period result in much lower costs and area burnt than wildfires that are not. Overall, the difference between containment success and failure is between $1 million and $3 million per wildfire at moderate to high hazard levels.

In addition to lower total firefighting costs, timely and effective IA results in less area burned and fewer losses to values on the landscape. Estimating the total value of a hectare of forest requires significant effort, however as a start point, assumptions can be made. We estimate the average timber resource value of a hectare of forest land to be $105[52]. Applying this value to the average wildfire size and combining the amount with the average cost per wildfire provides us with the "full" cost of each wildfire (suppression costs and land value as represented by the timber value). By simply managing IA efforts to action all wildfires "on-time" and maintaining the same success rates, an annual benefit of over $61 million is realized ($551.6 million over 9 years – 2011 to 2019).

The combination of avoided wildfire costs and avoided timber resource losses represents a starting point for considering benefits of a robust IA program. This estimate is very conservative as there are many other values on the forested land base other than timber. An investment in IA that improves the timeliness of actioning a wildfire both increases the probability of containing the wildfire within the first burning period (and therefore costing less) and decreases the cost of firefighting overall even if containment is not achieved in the first burning period. In addition, less area is burned resulting in lower values lost. Given an estimated $61 million in benefits associated with arriving at all wildfires on-time compared to the current on-time rate, investment in IA to achieve full timeliness is warranted provided up to this amount.

Given the current level of expenditures on IA efforts of $8.86 million (2019/20), developing some means of enhancing IA capability during high stress situations would likely prove to be economical from a cost-benefit perspective. For example, if an additional $10 million in preparedness and IA capability could produce a 25 percent better on time success rate in high stress situations, the pay back would be more than twice that ($21.5 million). This relationship has been studied in the past and has been referred to as the Least-Cost-Plus Theory as presented in Figure 37. In this model, IA is considered a part of preparedness.

Figure 37: The "Least-Cost-Plus-Loss Theory"[53]



The challenge of determining the "optimal" level of investment in preparedness and IA (i.e., the point of diminishing returns) is outlined in the least-cost-plus model above. Increases in preparedness costs alone do not necessarily result in lower suppression costs. It is essential that preparedness efforts be efficient and targeted in order to move toward cost optimization. In addition, it is important not to rely on preparedness spending alone to bring down direct suppression costs as there are many opportunities to improve efficiency and cost reductions by focusing on efficient resource utilization and by employing strategic approaches to suppression of escaped wildfires.

Costs and Benefits of Sustained Action After IA Failure

Once a wildfire has failed to be contained by IA efforts, identifying the costs and benefits of continuing

[52] This is derived from the Alberta 2016 Forest Industry GDP of $2,372.2M over 2016 timber harvest level of 25.525 million m^3, average forest growth rate of 1.54m^3/ha per year and 73.4% of Alberta's forests classified as productive. All data from Statistics Canada, National Forestry Database, 2019 Cross Border Analysis of Stumpage and Log Prices and Provincial Stand tables.

[53] BC Wildfire Management Branch, "British Columbia Wildfire Management Discussion Paper," January 2011, p.10.

suppression efforts is also complex and difficult to assess. Costs of actioning escaped wildfires can vary greatly depending on hazard levels, weather, and other key conditions such as winds and values-at-risk. To identify both potential firefighting costs and losses of values, the following is required:

- Predictions of hazards and conditions over the coming days and possibly weeks.
- Projections of wildfire growth under various assumptions.
- Estimates or assumptions of values-at-risk in areas potentially affected by wildfire.
- Quantification of values-at-risk.

For these inputs, a significant level of effort is required in the areas of wildfire growth modelling, inventory of values-at-risk and quantification of values.

Improved Program Cost-Effectiveness Can be Achieved through More Efficient Use of Aircraft and Heavy Equipment

In Alberta in 2019, $209.8 million was spent on aircraft for wildfire preparedness and suppression and $78.3 million was spent on heavy equipment. Together, these represent 33 percent (24 percent aircraft and 9 percent heavy equipment) of the total preparedness and suppression expenditure in 2019. Rotary wing costs for suppression alone were over $145 million (or 46 percent of all suppression expenditures) in 2019. Heavy equipment expenditures, for suppression only, were more than 21 percent of the total suppression spend. These costs are summarized in Table 19, Figure 38 and Figure 39.

Table 19: Summary of Fiscal Year 2020 Aircraft Preparedness and Suppression Costs (Millions [M])

Spend Category	Airtankers	Fixed Wing Aircraft	Rotary Wing Aircraft	All Costs (aircraft and other)
Preparedness	$16.81M	$5.16M	$25.43M	$101.77M
Suppression	$14.75M	$1.87M	$145.84M	$316.91M
Total	**$31.56M**	**$7.03M**	**$171.27M**	**$418.68M**

Figure 38: Aircraft and Non-Aircraft Suppression Spending (Calendar Years 2015-2019)

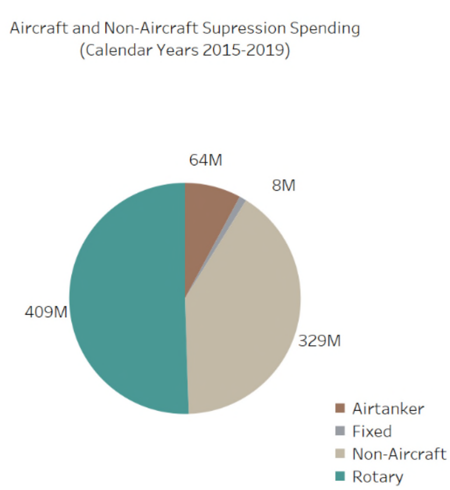
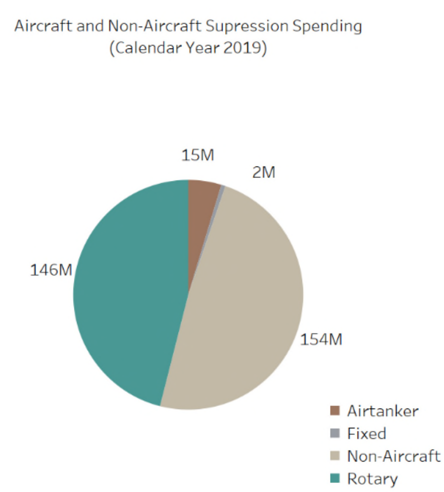


Figure 39: Aircraft and Non-Aircraft Suppression Spending (Calendar Year 2019)



While a detailed review of these costs and the potential associated savings was not conducted as part of this review, the magnitude of the cost of aircraft and heavy equipment, especially in suppression, can be interpreted as an area where more strategic spending could generate significant savings.

As described earlier in the Suppression section, there were several cases in 2019 where the use of heavy equipment was seen to be disconnected from operations resulting in a lack of coordination with ground crews and may have contributed to wildfire jumping constructed fire guards. These occurrences combined with the high costs of heavy equipment reflect inefficiencies resulting from this lack of coordination and integration.

The total expenditure on aircraft and equipment in Alberta is similar to the expenditure in British Columbia and higher than the expenditure in Ontario (Figure 41). There may be some room to strategically reduce Alberta's reliance on aircraft and equipment. As an example, unused minimum flying hours (unused minimums) on aircraft contracts was $16.75 million in 2019. This represents 12 percent of total rotary wing-related suppression costs (Figure 42).

An overview of the relationship between the number of rotary wing aircraft and unused minimums in 2019 clearly highlights inefficiencies in the system (Figure 40). As fire behaviour in late May became extreme, the number of rotary wing aircraft on hire by WMB increased. The three simultaneous major wildfire incidents stressed the system and rather than highlighting effective utilization of rotary wing, the graph shows spikes in unused minimums. It took until early June for WMB to find a better balance in aircraft utilization where unused minimums dropped significantly.

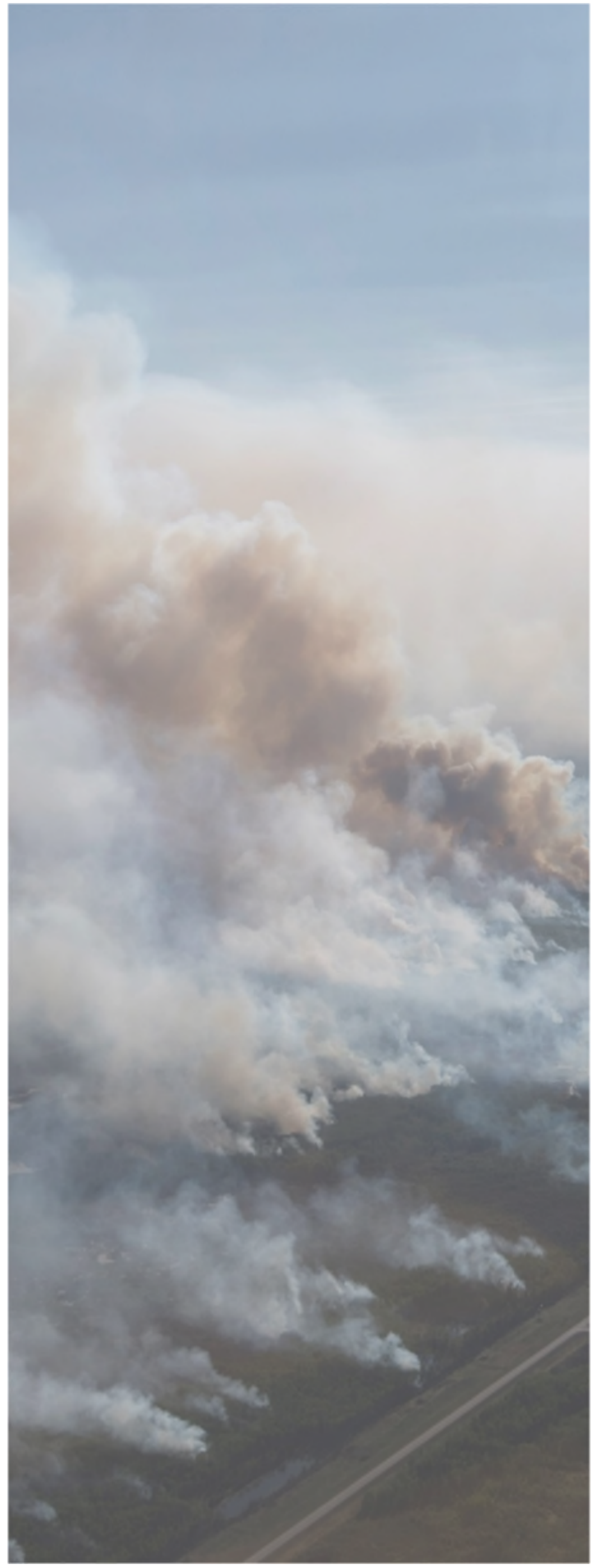


Figure 40: Total Active Rotary Wing Units Per Day Compared to Unused Minimums

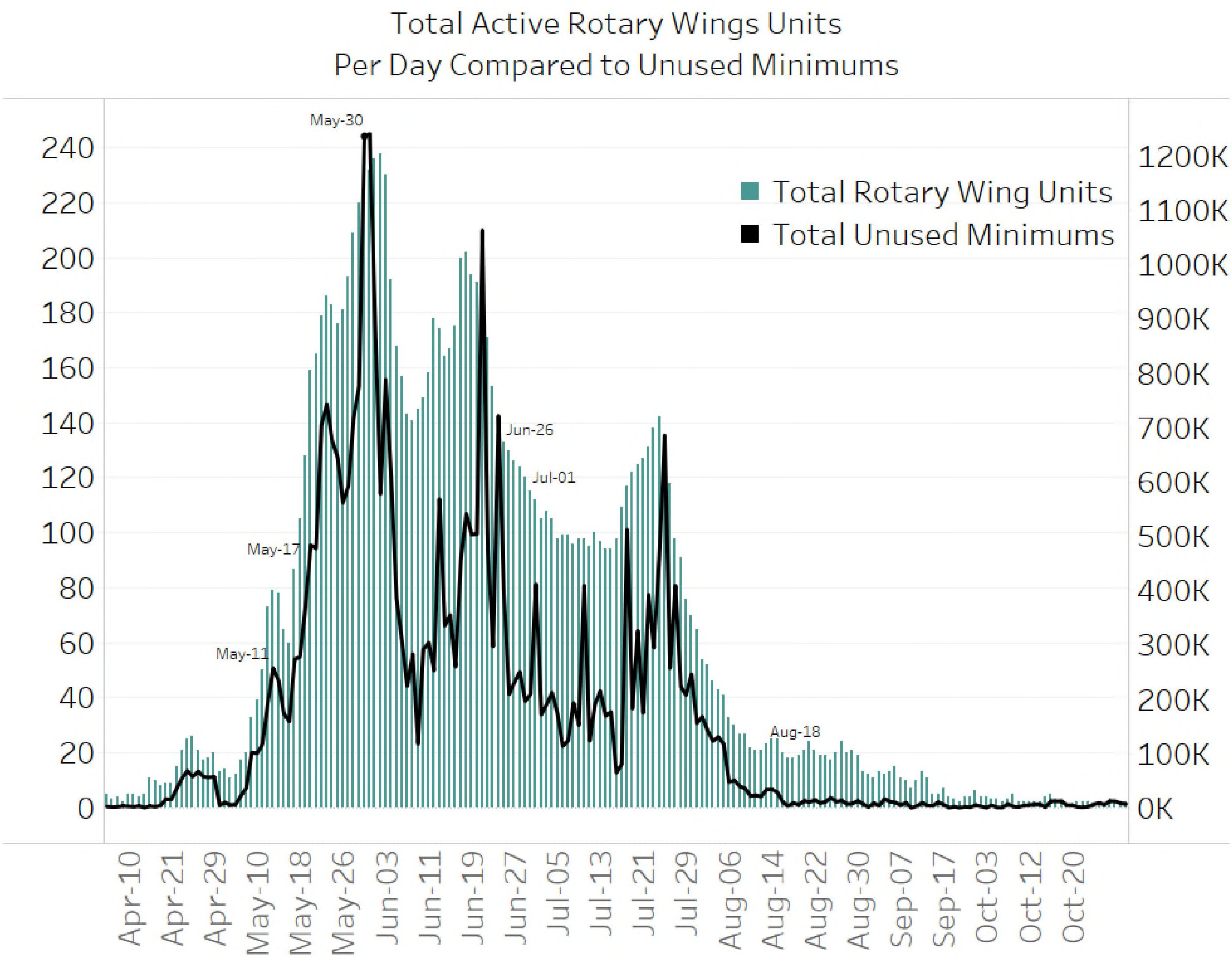


Figure 41: Total Suppression and Preparedness Spending in Alberta, BC, and Ontario for Fiscal Years 2016-2020

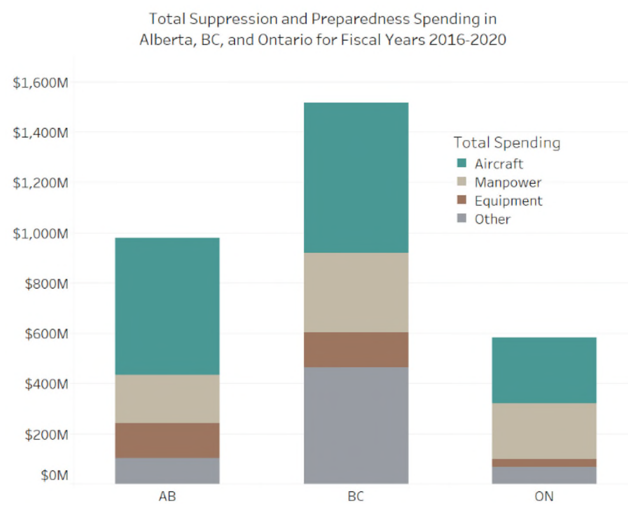
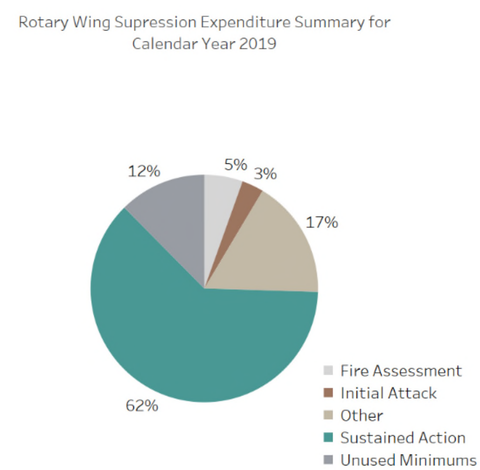


Figure 42: Rotary Wing Suppression Expenditure Summary for Calendar Year 2019



While eliminating unused minimums altogether is not realistic, nor something WMB should aspire to, it is worth asking what percentage of this significant annual expenditure could be avoided through more careful planning and contracting policies. It is not only how many hours these aircraft are used (or are on standby) that impacts cost-efficiency. Anecdotally, evidence was provided over the course of the review that this high-cost equipment isn't always being utilized for the tasks to which it is best suited. For example, one can look at loaded patrols (rotary wing patrols with IA teams and resources) and their effectiveness in detection and supporting IA. While a critical component of the greater detection network, Alberta's extensive use of rotary wing aircraft for detection is unusual. Where other jurisdictions typically employ more cost-efficient aerial detection methods, such as a fixed wing aircraft, Alberta uses exclusively rotary wing aircraft. When asked about this unique use of high-cost aircraft, detection program decision makers indicated that because this aircraft was already contracted and a guaranteed number of hours were already paid for, that they would otherwise not use, the detection program makes use of the aircraft for aerial patrols. Another example discussed over the course of the review was that rotary wing equipment was used frequently to haul water between locations in the absence of ground crews and trucks to undertake the same work at a much lower cost.

At the time of writing, data is not available to further evaluate these points, yet, a simple understanding of the high cost per hour of these specialized pieces of equipment suggests this may be an area warranting further investigation in the future as WMB seeks to find cost-efficiencies; changes which could also drive improved effectiveness.

The emphasis on preparedness and initial attack as well as improved utilization of aircraft and heavy equipment may be the most obvious and potentially impactful areas on which to focus cost-efficiency improvements. However, other areas for strategic spending that could be expected to result in better program outcomes may include:

- Cost accounting and controllership
- Auditing performance on cost management
- Resourcing (support positions on the fireline, office)

RECOMMENDATION:

14. Undertake a deeper cost-benefit analysis of program spending with a focus on major suppression items.

ACTIONS:

- Conduct a detailed evaluation of costs and benefits of wildfire suppression including total costs under various conditions and total losses, including those that are not easily quantifiable.
- As a starting point, focus on the use of helicopters and heavy equipment as areas of high-potential cost-effectiveness improvement.

4.3 | Risk Management & Strategic Response

RISK MANAGEMENT AND STRATEGIC RESPONSE

WMB was effective at many levels in addressing the wildfires in 2019. It is clear from a post-season review that the current organizational model, and the decision-making culture that is imbedded within it, works well in most wildfire situations. When the situation escalates to an extreme level, as was experienced in 2019, it is eminently understandable that any organization will show signs of strain and weakness. In this sense, the 2019 season can be viewed as a stress test for the organization — a test providing insight into the organization's evolution towards a more resilient response to the next inevitable challenge.

Key Findings

Our findings in this regard relate to WMB's ability to effectively manage risk and to consistently develop strategic responses to the challenges it faces throughout the fire season. These findings are:

1. Senior leadership and the Alberta Wildfire Coordination Centre (AWCC) need to focus on strategic risk management in their decision-making and support strong operational structures.
2. The AWCC Intelligence Unit requires increased support and structure to provide the level of intelligence, data analysis and predictive services required to support strategic risk management decision-making throughout the fire season.

Senior Leadership and the AWCC Need to Focus on Strategic Risk Management in their Decision-Making and Support Strong Operational Structures

In wildfire response, management layers should typically support operational structures at each level. AWCC leadership are best suited to focus on strategic analysis and leadership. It is apparent that sometimes, as the situation becomes more critical, management layers add complexity and uncertainty for operational staff.

"The adoption of a risk-based appropriate response is a result of disastrous fire seasons and subsequent reviews and policy change recommendation of the ecological role of wildfire, and the need to control costs." (Wildfire Management in Canada: Review, challenges and opportunities. Tymstra et al, 2020. p.3)

Provincial Duty Officers (PDOs), for example, should be the agents of the senior management in Edmonton to support a strategic plan. Forest Area Managers should support their local Duty Officers who are their agents for planning with AWCC and other Forest Areas. Added complexity arises when the regular daily planning system comes under stress and is not able to deal with some of the critical decisions. This is typical of emergency response organizations at critical times. In these situations, management needs to support the operational system to find solutions. Simple management direction communicated with and through operational staff builds the system up, resolving issues and communicating directly among managers, but outside the operational system (i.e., without Duty Officers) undermines operational confidence.

For example, it appears one key role of the AWCC Provincial Duty Officers is to review the Presuppression Preparedness System (PPS) plan created in each Forest Area. If managers at the Forest Area level or at AWCC see a gap or overlap, their approach is to deal with the issue by direct contact with other managers, sometimes leaving the Area Duty Officers at both levels to figure out the change in direction after. Instead, AWCC should evolve to engage with the Forest Areas in developing a more strategic provincial plan for the day. AWCC would require more decision-making authority to build a more strategic and cost-effective provincial plan to effect this change. This more strategic role of the AWCC will require further evolution of the AWCC

Intelligence Unit, which has been initiated following 2016 recommendations. As the wildfire situation escalates, AWCC managers, and senior leaders up to the Executive Director and Assistant Deputy Minister should leverage their roles by maintaining lines of authority to support operational plans and decisions.

In a year like 2019, there is considerable interaction between levels of the organization — particularly operational engagement between AWCC in Edmonton and the ten Forest Areas, and between Forest Areas and IMTs. In some cases, it was evident that, with the best of intentions, there was direct operational engagement from senior levels directly to incidents. In some cases, that operational direction caused a change in firefighting tactics, reduced confidence of subordinate layers in their objectives or tactics, or reduced morale. Regardless of which person may have been more correct in any particular situation, the organization must set out to be both strategic at the right levels, and to build confidence in the field leadership to deliver on that direction. Several observations were made:

- Letters of direction were often "boilerplate policy" or generic. To plan and execute, IMTs require clear outcomes / objectives that can be matched to resourcing expectations that match provincial priorities. For example, if a wildfire is lower priority and cannot be resourced because crews must work elsewhere, then objectives should be clear and align with what is achievable.
- Changes in IMTs resulted in abrupt changes in approach or resourcing demands. This would indicate the perspective of the changing IMTs was more influential than the objectives and priorities set by the Forest Areas or supported by WMB.
- Interviewees pointed out that management direction to IMTs at times caused sudden shifts in direction (for example, whether direct or indirect attack was the best approach). This would suggest earlier direction or approach by the IMT was not clearly understood or not supported by management.
- Excellent work was done by at least one IMT on developing a strategic plan for the complex that provided for a risk-based strategy considering the fuels, values-at-risk, suppression opportunities and cost-effective use of government resources. Implementation of such plans was inconsistent, particularly once the IMT changed. We understand the WMB has embraced this approach and will be refining and expanding it to all incident management for the future. This work should be supported to develop a standard template around long term strategic wildfire planning for individual incidents that embraces opportunities for modified or risk-based approaches. With such a guideline, strategic plans can be communicated / approved by the Forest Area and transferred from IMT to IMT to provide consistency among teams and with stakeholders and the public.

From our observations and interviews, the Sustained Action Planning Group (SAPG) has made progress from the 2016 Horse River wildfire and should mature into a truly Strategic Action Planning Group that:

- Leads and supports the AWCC in strategic decisions to get ahead of escaped wildfires and sustained action. That is, SAPG should engage earlier, but strategically, empowering Provincial Duty Officers and Provincial Aviation Coordinators to develop a unified plan with the Forest Area Duty Officers that manages risk.
- Moves from situation updates and set simple wildfire and resourcing priorities to plan for the mitigation of risks. Change should include working with Forest Areas and key ICs to communicate and clarify

objectives for wildfires or complexes and discuss expected resourcing levels. Currently, the SAPG offers a simple priority list of the wildfires of note, without any notation to clarify objectives or the expected resourcing level, how the requests from other agencies may address shortages (or not) so that Forest Areas and IMTs understand how that priority list matches actions being taken. This should avoid the problem of managers visiting the field to provide direction that may be surprising or inconsistent with field understanding.

STRATEGIC RESPONSE IN OTHER JURISDICTIONS

Other jurisdictions in Canada are working to improve planning efficacy as part of an increasingly strategic approach to wildfire management. This is driven by an understanding that wildfires are an annual feature on the landscape and that cost pressures in the management of wildfires will continue to grow.

In Ontario, risk-informed decisions are being more overtly made. Strategic decisions are informed by more accurate predictive fire behaviour analysis as well as suppression cost projections. Wildfire management personnel in the province are working towards a wildfire-by-wildfire plan and response that accounts for risk tolerance. This means combining and considering fire data from all provincial weather stations, GIS maps of fuel types and resource locations as well as a density grid of values-at-risk, short-term and longer-term forecasts and wildfire management personnel information. Along with current incident planning, an additional support system is in development that will use this information to generate probability contours for each individual wildfire.

In Saskatchewan, priority is given to providing front-line personnel with the information they require for informed decision-making. This means comprehensive and real-time information wherever possible in respect to fire behaviour, wildfire history, weather and conditions, wildfire management personnel locations and skillsets, resource locations and capacity and values-at-risk. The current approach to preparedness has been in place since 2013 and is noted for improving decision-making in respect to resource deployment and overall wildfire management strategy (e.g., direct vs. indirect attack) for each incident.

The AWCC Intelligence Unit Requires Increased Support and Structure to Provide the Level of Intelligence, Data Analysis and Predictive Services Required to Support Strategic Risk Management Decision-Making Throughout the Fire Season

Within the scope of the AWCC, our review looked at the integration of available predictive science (i.e., weather, fire behaviour, wildfire occurrence prediction, estimates of initial attack success). Recommendations from the 2015 review and the 2016 Horse River wildfire pointed to improvements in this area. Our observations are that some progress has been made, but these services are still not responsive or integrated sufficiently to support critical wildfire situations. These functions, particularly at AWCC, must work as a cohesive collaborative section. For example:

- Field staff believe feedback on weather forecasts are not actively considered. There is a lack of trust among staff — field staff are commonly trying to source other information. Internal weather, fire behaviour and intelligence services should strive to be the trusted source of information for the field.
- Daily weather forecasts continue to provide only a two-day outlook. The Weather Section communicates reluctance to go beyond deterministic level of confidence to use ensemble forecasting that can be used to forecast confidently longer than five days.

- Intelligence staff should, at times, forecast fire behaviour and wildfire occurrences out 10 to 14 days (or longer) for strategic planning purposes of the SAPG.
- Opportunities were missed to strategically add to the intelligence capacity commensurate with the severity of the situation. For example, three large incidents were active, and available radiosonde equipment with a weather specialist could have been deployed to the field to better understand convective conditions and upper air to improve spot forecasts.

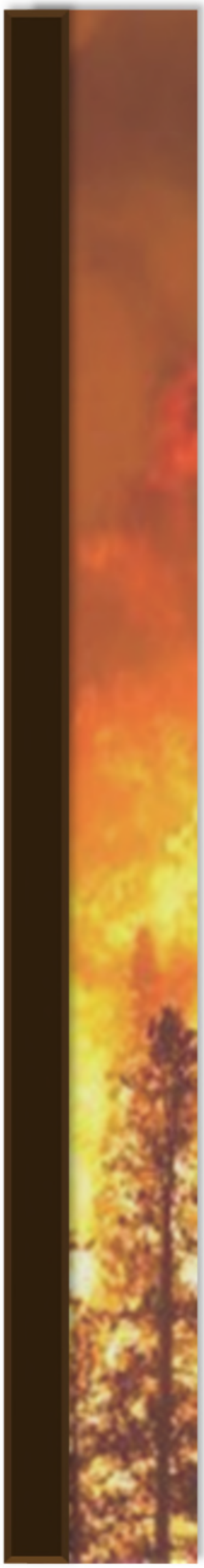
To accomplish this, WMB should look again at progress on developing the role of the AWCC and the SAPG.

RECOMMENDATIONS:

15. Accelerate the development and organization of the Intelligence Unit in the AWCC to support strategic risk management and resource planning.

Actions:

- Reinforce the need for senior leaders to rely on current command structures and work within the operation systems for decision making.
- Review and improve the role of the AWCC to include more decision-making authority and cost oversight to empower them to make provincial planning more strategic.
- Strengthen the role and capabilities of the Intelligence unit in the AWCC including bringing all predictive services (including weather and fire behaviour) under one organization and structure. Increase the investment in the tools and resources required.



4.4 High-Reliability Organization

WMB AS A HIGH-RELIABILITY ORGANIZATION

This review has observed that WMB staff and their partners delivered many successes over several difficult days during the 2019 fire season. Still, the occurrence of wildfires close to communities and values led to some significant damages and losses, costs to taxpayers and stress on residents of northern Alberta. Observations in this review suggest outcomes could be better.

This review has made a number of concrete recommendations that, when acted upon, should improve outcomes in future difficult wildfire situations. Success in the future will not come, however, from a few action items and some good fortune. WMB should also take steps to look at the culture of its own organization and its relationships with staff, contractors and partners to embrace excellence in the face of risk and uncertainty. When a fire season like 2019 (or 2011, 2015, or 2016) emerges again — which is a question of when not if — how can the organization better rise to the challenge?

"High-reliability organizations" (HROs) (Wieck and Sutcliffe, 2007) succeed in avoiding failures in environments that exhibit higher-than-normal risk and complexity. Studies of organizations that operate in these environments, including wildfire management agencies, have led to clear understandings of the organizational principles that provide for success. These studies continue to offer useful insights to guide wildfire management.

Research into HROs has included nuclear power plants, air traffic control systems, aircraft carriers, and more recently, health organizations.[54] As a recent example, the U.S. Bureau of Land Management Aviation and Fire Management Program has embarked on adopting the five principles of HROs. These principles are:

1. Preoccupation with failure – don't overlook red flags, signs of potential weakness in the system.
2. Reluctance to simplify – create a more complete and nuanced picture of your business and environment.
3. Sensitivity to operations – focus on results, actual operations regardless of intentions, designs, and plans.
4. Commitment to resilience – organizations are not error-free but bounce back to provide service in difficult situations.
5. Deference to expertise – cultivate diversity, push decision making down and around to the people with the most expertise, regardless of their rank.[55]

These principles can offer a paradigm for improving organizations and systems used in managing extreme wildfire situations:

- Continuous learning and improvement based on experiences and studies related to wildfire events such as the spring 2019 situation.
- Clarifying management structures and effective chain-of-command, supporting decision-making and encouraging a more strategic approach to wildfire operations.
- Entrenching a science-informed risk management approach to wildfire management by leadership that supports proactive planning, effective and efficient resourcing and strategic decision-making and priority setting in preparedness and suppression operations.

[54] HRO is a concept that originated in the U.S., and as such, is most commonly discussed in the context of U.S. organizations. However, HRO principles are gaining traction in Canada, particularly in the healthcare industry. Wildfire organizations such as Ontario Wildland Fire and the Great Lakes Forest Fire Compact have also introduced HRO training in recent years.

[55] Weick and Sutcliffe, pp. 7-15.

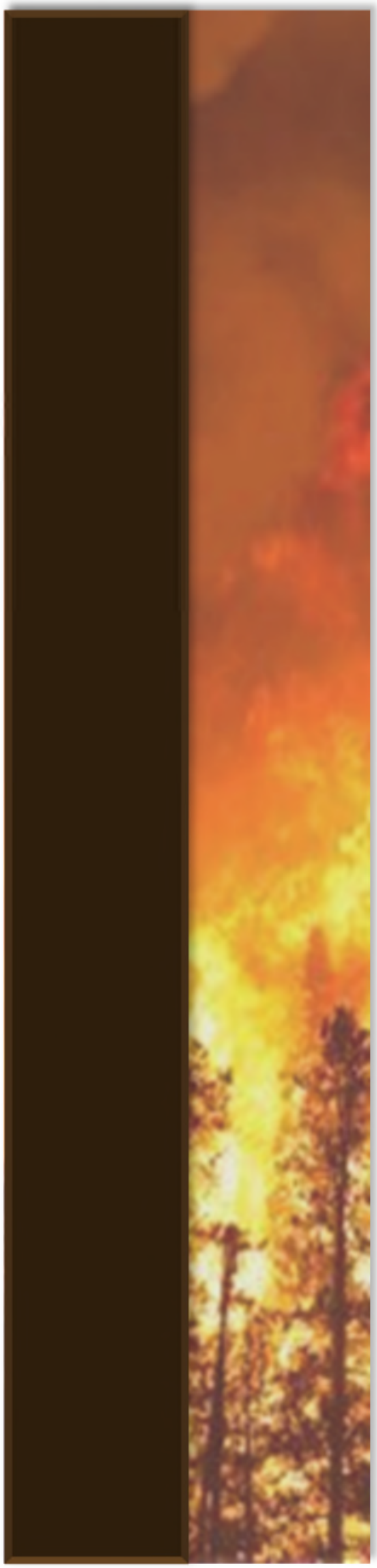
- Committing to organizational resilience by building trust, respect and transparency at all levels of the organization, respecting a diversity of skills and opinions, and being aware of biases.

The theoretical framework and real-life application of HRO principles can be an input to efforts to become more strategic and to make decisions informed by a fuller appreciation of risk management. Realization of cultural change will be an outcome of that effort. We bring this concept to the reader's attention so that it might serve as a lens through which to view and link together many of the specific discussion items throughout this report.

The HRO model is an example of something that WMB can work towards — an aspirational vision of the type of organization WMB would like to be. In some respects, this would represent a significant leap for WMB in that it requires a persistent effort to create a fundamental shift for an organization the size of WMB. In other respects, this review has observed WMB staff and partners are ready to move beyond historical practices and embrace the risk-laden complexity of wildfire management in new ways.

OPPORTUNITY FOR IMPROVEMENT

WMB should adopt HRO principles and embrace it as one of its key strategic priorities to be implemented. Raising awareness amongst WMB personnel and partners of this intent, and, over time, implementing policies, procedures, and practices will support the transformation to a more risk-aware and resilient organization.



5 | Implementing Change

IMPLEMENTING CHANGE

Review of the Implementation of the 2015 and 2016 Recommendations

A total of 14 recommendations were made in the 2015[56] and 2016[57] reviews commissioned by WMB. Of those 14 recommendations, WMB reports that nine have been implemented and the remainder are in progress. MNP's review and comments on the status of each recommendation are contained in the following table. Several of the recommendations in this report re-emphasize recommendations from past reviews.

Table 20: Review of 2015 and 2016 Recommendations

	Recommendations	**WMB Reported Status (Pre-Fire Season)**		**Review of WMB Status**
2015 Recommendations				
R1	Revisit the province's strategy respecting FireSmart with an increased emphasis on a long-term vision for FireSmart within the province, community responsibility, multi-agency collaboration and an outcomes-based approach to implementing FireSmart projects.	In Progress	Winter 2020	WMB has made headway in actioning this recommendation. A primary emphasis on fuel management and community protection planning must continue to shift towards other FireSmart disciplines, such as Interagency Cooperation and Cross-training; multi-agency collaboration should be a key focus going forward.
R2	Develop robust communication plans and protocols for both pre-fire season prevention awareness, as well as facts and advisories associated with wildfire events.	Implemented		The effort towards proactive communications planning (including both preseason and during wildfire events) is notable including annual communications plans submitted by each Forest Area. However, the review found no evidence of "robust communication plans" prior to the 2019 fire season. In 2019 WMB filled the Wildfire Information Unit Lead position for the first time in four years and this should be considered a positive step. A communications plan was developed and published in January 2020, and while

[56] *2015 Wildfire Program Review*
[57] *A Review of the 2016 Horse River Wildfire*

	Recommendations	WMB Reported Status (Pre-Fire Season)		Review of WMB Status
				there is potential for improvement this is a positive step forward. WMB's ability to communicate with the public continues to be hampered by corporate-level government restrictions, such as the limitations experienced during the lead up to the 2019 provincial election as well as hesitation over using social media as a tool. Real-time communication from a trusted source is essential in emergency management warranting more latitude for emergency programs.
R3	Develop and implement a formal wildfire risk management framework.	In Progress	Late 2020	Only five of 10 Forest Area Wildfire Management Plans have been completed to-date; notably the three Forest Areas that became the focus for this review have not had the Wildfire Management Plans completed.
R4	Establish an analyst role within the Forestry Division that can provide assistance in the area of cost analysis, cost control and efficiency. The individual or group must have capabilities in financial management and operational wildfire program delivery and must remain at arm's length from the operations organization.	Implemented		WMB has established a business analyst role. The Business Analyst position is necessary to support WMB's efforts for continuous improvement and effective and efficient programs. This position should address the need for cost analysis, cost control and efficiency.
2016 Recommendations				
R1	Continue Agriculture and Forestry's strategic direction to be fully prepared and ready to respond to wildfires the week after snow disappears or May 1 annually, whichever date is expected sooner. This may mean	Implemented		The status of this recommendation should be reclassified as "ongoing challenge". The analysis from 2019 indicates that crews were not fully ready until May 15th at the earliest.

Recommendations		WMB Reported Status (Pre-Fire Season)	Review of WMB Status
	changes to the activation dates for aircraft and firefighting crews.		
R2	Improve fire weather forecast materials by extending the length of the forecast outlook period and working closely with the Alberta Wildfire Coordination Centre, Planning Section to design products that directly link weather forecasts with predicted wildfire behaviour.	Implemented	This recommendation has not been implemented; the current standard and operational forecast remains three-days. Regional five-day forecasts and spot forecasts are only available upon request. Fire weather and fire behaviour units continue to operate in silos.
R3	Enhance and expand the Planning Section in the Alberta Wildfire Coordination Centre to be operational March 1 annually, commencing in 2017, to provide daily fire behaviour and wildfire occurrence predictions to decision makers and to coordinate situation updates.	Implemented	The status of this recommendation should be reclassified as "in progress". The Fire Behaviour Service Centre roster does not fully meet the intention of the recommendation; although the Intelligence Section has been established, it is not performing in a connected fashion.
R4	Establish a standard operating procedure across Agriculture and Forestry which requires, when a wildfire escapes from initial attack and interface risks are present, the immediate assignment of a senior Incident Commander to undertake tactical planning for wildfire containment and risk mitigation.	Implemented	Wildfire Operations SOP 8.1 and IMT Business Rule 2 has been updated to address this recommendation. This has not been implemented. The analysis from 2019 indicates this procedure did not take place during actioning on the Battle complex nor the Chuckegg Creek wildfire.
R5	Develop an improved procedural model for airspace management where confined airspace over a community or airport is involved.	Implemented	To date no SOP's specific to confined airspace over a community or airport have been created or amended. Since 2016 many of WMB's airspace management related SOP's and business rules have been updated to improve safety/efficiency of air operations.

	Recommendations	WMB Reported Status (Pre-Fire Season)		Review of WMB Status
				In 2019, WMB has identified 18 airspace management safety initiatives. Of the 18, five have been completed, and the restricted airspace SOP was not completed until November 2019 and a maximum aircraft SOP has been proposed. WMB has updated three training courses, the Air Support Management Course, Air Attack Officer Strategies and Tactics Workshop, and Helicopter Coordinator Program. This has not been implemented to the degree that is necessary and should be considered the number one safety concern to be addressed. The analysis from 2019 indicates this failed to be implemented in 2019 fire season. This needs to be improved from both safety and cost-effectiveness perspectives.
R6	Continue to develop risk management frameworks as the foundation for wildfire management policy. This would include reviewing the list of five provincial priorities as the central policy and emphasizing a risk and consequence approach.	In Progress	Spring 2020	This remains in progress and will continue well past Spring 2020. The Forest Area Wildfire Management Plans are in-progress but our review found no evidence of the five provincial priorities as central policy being reviewed.
R7	Direct agencies and services involved in wildfire suppression in relation to the Wildland Urban Interface to establish standard operating procedures for the implementation of an Incident Command System (ICS) and processes following the model provided by ICS Canada for future incidents like the Horse River wildfire.	Implemented		Not fully implemented. Many positive steps have been made and as a result there were some good outcomes in the 2019 fire season. Efforts need to continue and expand to a broader group of stakeholders across Alberta with an emphasis on increased workshops and requirements for all jurisdictions to take part.

Recommendations		WMB Reported Status (Pre-Fire Season)		Review of WMB Status
R8	Emphasize a long-term vision for FireSmart within the province that includes community responsibility, multi-agency collaboration and an outcome-based approach to implementing FireSmart projects. Ensure all seven disciplines of FireSmart are addressed.	In Progress	2020	Agree that this is in progress. FireSmart Council—work is underway but challenged due to reliance on cooperation from other ministries, including Municipal Affairs.
R9	Establish a joint Wildfire Planning Task Team comprised of senior Agriculture and Forestry staff and major industrial stakeholders (such as oil sands, energy, forestry, and utility companies) from across Alberta.	In Progress	Spring 2019	Agree that this is in progress. Given the substantial values-at-risk on the landscape more urgency is required though industry involvement and is key to success.
R10	Complete and implement a unique and tailored landscape wildfire management planning process for the northeast of the Alberta.	Implemented		Fort McMurray Wildfire Management Plan was prioritized in development of the Forest Area Wildfire Management Plans.

NOTE ON DATA LIMITATIONS

Over the course of our review, the project team had access to a significant amount of data from multiple systems, which included current and historical information. Due to the various data sets we were working with, we have prepared the following table to outline some of the limitations impacting our analysis.

Table 21: Summary of Data Limitations

Data Type	Description	Discussion / Impact
Fire Danger Data	• Data including daily Head Fire Intensity (HFI) provided was for the 2011-2019 fire seasons • Fire Danger data by region was not available for many days between 2011-2019	• HFI related analysis was limited to the 2011-2019 fire seasons • Wildfire analyses pertaining to HFI statistics excluded wildfires for which HFI data was not available • Provincial weighted average HFI figures by month and year excluded days where HFI data for all regions was not available
Wildfire Data	• Wildfire data that included suppression cost data per wildfire was provided for the 2011-2019 fire seasons • Wildfire data without suppression cost data per wildfire was provided for the 1990-2019 fire seasons	• Wildfire analyses pertaining to the suppression costs of wildfires could only be completed for the 2011-2019 fire seasons
Manpower Resourcing Data	• We were unable to identify a reliable and complete set of data that was representative of the manpower resourcing for any fire season	• No analyses on manpower resourcing were completed
Coverage Data	• Coverage data by region by day was provided for 2011-2019 • Coverage data by region was not available for many days between 2011-2019	• Wildfire analyses pertaining to coverage data excluded wildfires for which the coverage data was not available
IMAGIS Cost Data	• Cost data, which includes overall program costs by wildfire program type, was provided for fiscal year 2016-2020 • MNP had program cost data for fiscal 2011-2015 from the 2015 wildfire review which was comparable to the fiscal year 2016-2020 data at the	• Suppression costs analyses referenced the FIRES database which included data from 2011-2019 • Analyses of cost data for other programs activities (i.e. smoke patrol) was limited to fiscal 2016-2020 since the cost item descriptors differed from the fiscal year 2011-2015 data set • Analyses of total program cost data (i.e., detection, preparedness) included data from fiscal year 2011 – fiscal year 2020 since it was comparable across

Data Type	Description	Discussion / Impact
	program level but not at the activity level o I.e. total detection program spending was comparable across the fiscal year 2011-2015 and fiscal year 2016-2020 data; o Detection activities (i.e., lookout tower manpower) in the fiscal year 2011-2015 and fiscal year 2016-2020 data sets were not comparable due to different descriptors (labels)	datasets (fiscal year 2011-2015, fiscal year 2016-2020)
	• Activity Type (i.e., wildfire suppression, preparedness, etc.) was not provided with the IMAGIS cost data for fiscal year 2016-2020	• The fiscal year 2011-2015 cost dataset included Activity Type data and both datasets included an Activity Code for each line item. The Activity Type was imported to the fiscal year 2016-2020 IMAGIS data via the Activity Code columns in both datasets

6 | Appendices

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APPENDIX A – GLOSSARY

AAF – Alberta Agriculture and Forestry

Aerial Detection – A system for or the act of discovering, locating, and reporting wildfires from aircraft. May be planned or unplanned.

Air Attack – A fire suppression operation involving the use of aircraft to deliver suppressants or retardants to a wildfire.

Air Attack Officer – The person responsible for directing, coordinating, and supervising a fire suppression operation involving the use of aircraft to deliver retardants or suppressants on a wildfire.

Airtanker – A fixed-wing aircraft fitted with tanks and equipment for dropping suppressants or retardants on wildfires.

Airtanker Base – An operational base, either permanent or temporary, at which airtankers are held in readiness for action on wildfires. Includes dispatch facilities, crew day quarters, limited equipment storage, and administrative facilities. May also be equipped to provide fire retardant.

Alberta's First Responder Radio Communications System (AFRRCS) – The province-wide radio system is a two-way radio network for first responders in municipal, provincial and First Nations agencies across the province to coordinate joint emergency response and integrate inter-agency communications and operations.

All-hazard – Any incident, natural or human caused, which warrants action to protect life, property, environment, and public health and safety, and minimize disruption of government, social, and economic activities.

Available fuel – The quantity of fuel in a particular fuel type that would actually be consumed under specified burning conditions.

AWARE – Alberta Wildfire Anticipation Readiness Engine software utilized for preparedness planning in Alberta.

AWCC – Alberta Wildfire Coordination Centre

Backfiring – A form of indirect attack where extensive wildfire is set along the inner edge of a control line or natural barrier, usually some distance from the wildfire and taking advantage of indrafts, to consume fuels in the path of the wildfire, and thereby halt or retard the progress of the wildfire front.

Being Held – See Fire Status – Being Held

Birddog Aircraft – An aircraft carrying the person directing aerial operations on a wildfire. Also known as the Birddog.

Blow up – A somewhat sudden, and sometimes unexpected, major increase in rate of spread and Head Fire Intensity sufficient to upset overall wildfire suppression action or plans. Blowups can result from small or large wildfire situations.

Buildup Index (BUI) – A numerical rating of the total amount of fuel available for combustion that combines the Duff Moisture Code and Drought Code.

Burning Period – That part of each 24-hour day when wildfires are generally the most active. Typically, this is from mid-morning to sundown, although it varies with latitude and the time of year.

Chain of Command – A series of command, control executive or management positions in hierarchical order of authority.

Complex – Two or more individual incidents located in the same general area which are assigned to a single Incident Commander or to Unified Command.

Conflagration – A popular term for a large, fast-moving wildfire exhibiting many or all of the features associated with extreme fire behaviour.

Containment – Showing the percent of fireline contained or being held. For example, 40 percent of the line is contained with the use of mechanical, hose line or natural barriers. On Type 1 and Type 2 wildfires, the incident management team will submit the ICS209 form showing the percent of the fireline contained or being held. For example, 40 percent means that 40 percent of the line is contained with the use of mechanical, hose line or natural barriers.

Convection Column – The definable plume of hot gases, smoke, firebrands, and other combustion by-products produced by and rising above a wildfire.

Coverage Level – The volume per unit area of wildfire suppression chemical or water dispersed on a forest fuel described in US gallons per 100 square feet or litres per square metre.

Crew Leader – Type 1 – A wildfire crew leader is the primary supervisor in command of usually 2 to 20 crew members and responsible for their performance, safety, and welfare while maintaining the span of control. The CRWL may be responsible for overall management of the incident and reports to the Agency Administrator.

Crew Leader – Type 2 – A wildfire crew leader is the primary supervisor in command of usually 2 to 20 crew members and responsible for their performance, safety, and welfare while maintaining the span of control. The CRWL may be responsible for overall management of the incident and reports to the Agency Administrator.

Crew Leader – Type 3 – Generally made up of a temporary firefighter forces used for mop-up situations that have received some type of basic agency firefighting training.

Crowning – A wildfire ascending into the crowns of trees and spreading from crown to crown.

Daily Severity Rating – A numerical measure, based on the Fire Weather Index (FWI), specifically designed for averaging, either for any desired period of time (e.g. week, month, year) at a single fire weather station or spatially over a number of stations.

Demobilization Unit – Functional unit within the Planning Section responsible for assuring orderly, safe and efficient demobilization of an incident resources to the original location and status.

Detection Aircraft – An aircraft deployed for the express purpose of discovering, locating, and reporting wildfires.

Difficulty of Control – The amount of effort required to contain and mop-up a wildfire based on its behaviour and persistence as determined by the wildfire environment.

Direct Attack – A method whereby the wildfire is attacked on the burning fuel.

Discovery – Determination that a wildfire exists at a specific location; in contrast to action related to detection, reporting of the wildfire is not required.

Discovery Time – The period from start of a wildfire (estimated or known) until the time the wildfire was discovered.

Dispatch – The implementation of a command decision to move a resource or resources to an assigned operational mission or an administrative move from one location to another.

Dozer Line—Fireline constructed by the front blade of a dozer.

Drought – A period of relatively long duration with substantially less than normal precipitation, occurring usually over a wide area.

Drought Code (DC) – A numerical rating of the average moisture content of deep, compact organic layers. This code indicates seasonal drought effects on forest fuels and is a predictor of smouldering in deep duff layers and large logs.

Duff Moisture Code (DMC) – A numeric rating of the average moisture content of loosely compacted organic layers of moderate depth. This code gives an indication of fuel consumption in moderate duff layers and medium-size woody material.

Escaped Fire – A wildfire (or prescribed fire that has burned beyond its intended area) that remains not under control following initial attack.

Extinguished – See Fire Status – Extinguished

Extreme Fire Behaviour – A level of fire behaviour that precludes any wildfire suppression action. It usually involves one or more of the following characteristics: high rate of spread and Head Fire Intensity, crowning, prolific spotting, presence of large fire whirls, and a well-established convection column. Fires exhibiting such phenomena often behave in an erratic and dangerous manner.

Forest Fire Behaviour Prediction System (FBP) – A subsystem of the Forest Fire Danger Rating System. The FBP System provides quantitative outputs of fire behaviour characteristics for certain major Canadian fuel types and topographic situations.

Fine Fuel Moisture Code (FFMC) – A numerical rating of the moisture content of litter and other cured fine fuels. This code indicates the relative ease of ignition and flammability of fine fuel.

Fine Fuels – Fuels that dry quickly, ignite readily, and are consumed rapidly by wildfire. Examples include: cured grass, fallen leaves, needles, and small twigs.

Fingers of a Fire – The long narrow extensions of a wildfire projecting from the main body.

Fire Behaviour – The manner in which fuel ignites, flame develops, and wildfire spreads and exhibits other related phenomena as determined by the interaction of fuels, weather, and topography.

Fire Benefits – Any effect(s) of wildfire that are favourable or beneficial in terms of the attainment of forest management and other land use objectives.

Fire Cause – Human – Forest Industry – A wildfire caused by people or machines engaged in any activity associated with forest products production.

Fire Cause – Human – Human Other – A wildfire of known human cause that cannot be properly classified under any of the standard classes listed below.

Fire Cause - Human – Incendiary – A wildfire wilfully started for the purpose of mischief, grudge, or illegitimate gain.

Fire Cause - Human – Other Industry – A wildfire caused by industrial operations other than forest industry or railroads. Includes municipal, provincial, or federal works projects whether employees, agents, or contractors.

Fire Cause - Human – Railroads – A wildfire caused by any machine, employee, agent, or contractor performing work associated with a railway operation, or a passenger on a train.

Fire Cause - Human – Recreation – A wildfire caused by people or equipment engaged in a recreational activity (e.g. vacationing, off-highway vehicle use [e.g. ATVs] fishing, picnicking, non-commercial berry picking, hiking).

Fire Cause - Human – Resident – A wildfire resulting from activity performed by people or machines for the purpose of agriculture or an accidental wildfire caused by activity associated with normal living in a forested area.

Fire Cause - Human – Undetermined – A wildfire of undetermined cause, including a wildfire that is currently under investigation, as well as one where the investigation has been completed and a cause was not determined.

Fire Cause - Natural – Lightning – A wildfire caused directly or indirectly by lightning.

Fire Cause - Natural – Natural Other – A wildfire of known natural cause other than lightning.

Fire Danger – A general term used to express an assessment of both fixed and variable factors of the wildfire environment that determine the ease of ignition, rate of spread, difficulty of control, and wildfire impact.

Fire Danger Class – A segment of a fire danger index scale identified by a descriptive term (e.g. Low, Moderate, High, Extreme), and/or a colour code. The classification system may be based on one or more fire danger index (e.g. the Buildup Index is sometimes used in addition to the Fire Weather Index).

Fire Danger Index – A quantitative indicator of one of more facets of wildfire danger, expressed either in a relative sense or as an absolute measure; often used as a guide in a variety of wildfire management activities (e.g. to judge day-to-day preparedness and suppression requirements, as a basis for providing information on wildfire danger to the general public in wildfire prevention, as an aid to prescribed burning).

Fire Danger Rating – The process of systematically evaluating and integrating the individual and combined factors influencing wildfire danger represented in the form of wildfire danger indexes.

Fireguard – A strategically planned barrier, either manually or mechanically constructed, intended to stop or retard the rate of spread of a wildfire, and from which suppression action is carried out to control a wildfire. The constructed portion of a control line. Fireguards in the Forest Protection Area often exist pre-fire and are maintained around communities to protect a community from the risk of incoming wildfire.

Fireline – That portion of the wildfire upon which resources are deployed and are actively engaged in the incident. In a general sense, the working area around a wildfire.

Fire Load – The number and magnitude (i.e. wildfire size class and Head Fire Intensity) of all wildfires requiring suppression action during a given period within a specified area.

Fire Management – The activities concerned with the protection of people, property, and forest areas from wildfire and the use of prescribed burning for the attainment of forest management and other land use objectives, all conducted in a manner that considers environmental, social, and economic criteria. Wildfire management represents both a land management philosophy and a land management activity. It involves the strategic integration of such factors as knowledge of fire regimes, probable wildfire effects, values -at-risk, level of forest protection required, cost of wildfire-related activities, and prescribed wildfire technology into multiple-use planning, decision making, and day-to-day activities to accomplish stated resource management objectives. Successful wildfire management depends on effective wildfire prevention, detection, and presuppression, having an adequate wildfire suppression capability, and consideration of wildfire ecology relationships.

Fire Management Planning – The systematic, technological, and administrative management process of determining the organization, facilities, resources, and procedures required to protect people, property, and forest areas from wildfire and to use wildfire to accomplish forest management and other land use objectives.

Fire Occurrence – The number of wildfires started in a given area over a given period of time. See Fire Cycle, Fire Frequency.

Fire Perimeter – The entire outer edge boundary of a wildfire. Recommended units are metres or kilometres.

Fire Prevention – Activities directed at reducing wildfire occurrence; includes public education, law enforcement, personal contact, and reduction of wildfire hazards and risks.

Fire Progression Map – A map maintained to show at given times the location of the wildfire perimeter and spot wildfires, deployment of resources, and suppression activities (e.g. constructed fireguard).

Fire Season – The period(s) of the year during which wildfires are likely to start, spread, and do damage to values-at-risk sufficient to warrant organized wildfire suppression; a period of the year set out and commonly referred to in wildfire prevention legislation. The fire season is usually further divided on the basis of the seasonal flammability of fuel types (e.g. spring, summer, and fall). In Alberta, the legislated fire season is March 1 to October 31.

Fire Severity – Organic matter consumption from flaming and smouldering combustion.

Fire Size Class – A classification of wildfire area, independent of wildfire typing through the Incident Command System Type A less than 0.1 ha; Type B 0.11 to 1.0 ha; Type C 1.1 to 10 ha; Type D 10.1 to 100 ha; Type E 100.1 to 1,000 ha; Type F 1,000.1 to 10,000 ha; Type G 10,000.1 to 100,000 ha; Type H over 100,000 ha.

FireSmart – A program that helps communities and residents manage and reduce the threat of wildfire. The program supports communities in carrying out activities aimed at reducing the threat of wildfire.

Fire Status - Being Held (BH) – Indicates that with currently committed resources, sufficient suppression action has been taken that the wildfire is not likely to spread beyond existent or predetermined boundaries under prevailing and forecasted conditions.

Fire Status - Extinguished (EX)– Having been extinguished.

Fire Status - Out of Control (OC) – Describes a wildfire not responding or only responding on a limited basis to suppression action such that perimeter spread is not being contained.

Fire Status - Under Control (UC) – Having received sufficient suppression action to ensure no further spread of the wildfire.

Fire Suppression – All activities concerned with controlling and extinguishing a wildfire following its detection.

Fire Weather – Collectively, those weather parameters that influence fire occurrence and subsequent fire behaviour (e.g. dry-bulb temperature, relative humidity, wind speed and direction, precipitation, atmospheric stability, winds aloft).

Fire Weather Forecast – A prediction of the future state of the atmosphere prepared specifically to meet the needs of wildfire management in wildfire suppression and prescribed burning operations. Two types of forecasts are most common: The zone or area weather forecast is issued on a regular basis during the fire season for a particular geographical region and/or one or more fire weather stations. These regions are delineated on the basis of fire climate and/or administrative considerations. A spot weather forecast is issued to fit the time, topography, and weather of a specific campaign wildfire location or prescribed fire site. These forecasts are issued on request and are more detailed, timely, and specific than zone or area weather forecasts.

Fire Weather Index (FWI) – A numerical rating of fire intensity that combines the Initial Spread Index and Buildup Index. It is suitable as a general index of wildfire danger throughout the forested areas of Canada.

Forest Resource Improvement Association of Alberta (FRIAA) – A non-profit association that promotes, initiates, and delivers funding for projects that enhance Alberta's forest resources through the delivery of eight targeted programs.

Fuel Load – The dry weight of combustible materials per unit area. Recommended units are kilograms per square metre (kg/m2) or tonnes per hectare (t/ha). 1.0 kg/m2 is equivalent to 10 t/ha.

Fuel Management – The planned manipulation and/or reduction of living or dead forest fuels for forest management and other land use objectives (e.g. hazard reduction, silvicultural purposes, wildlife habitat improvement) by prescribed fire; mechanical, chemical, or biological means; and/or changing stand structure and species composition.

Fuel Type / Fuel Complex – An identifiable association of fuel elements of distinctive species, form, size, arrangement, and continuity that will exhibit characteristic fire behaviour under defined burning conditions.

Green Up – The appropriate time during the first half of the fire season in which deciduous trees and/or understory vegetation (e.g. grasses, herbs, shrubs) have more or less completed their flushing of new growth. This typically takes place in late spring/early summer.

Ground Fuels – All combustible materials below the litter layer of the forest floor that normally supports smouldering or glowing combustion associated with ground fires (e.g. duff, roots, buried punky wood, peat).

Head Fire – That portion of the wildfire perimeter having the greatest rate of spread and wildfire intensity which is generally on the downwind and/or upslope part of the wildfire.

Head Fire Intensity (HFI) – The rate of heat energy release per unit time per unit length of head of the wildfire. Flame size is its main visual manifestation. Head fire intensity is a major determinant of certain wildfire effects and difficulty of control. Numerically, it is equal to the product of the net heat of combustion, quantity of fuel consumed in the flaming front, and linear rate of spread. Recommended unit is kilowatts per metre (kW/m).

Heavy Fuels – Large diameter woody or deep organic materials that are difficult to ignite and burn more slowly than fine or medium fuels.

Heavy Helicopter – 15-plus passenger seats up to 25,000 lbs. external load (e.g. Bell 214, Sikorsky 61 and 64, Vertol 107 and 234, Kamov 32).

Helitack – Initial attack on wildfires involving the use of helicopters and trained crews, deployed as a complete unit.

Helitack Crew – An initial attack crew specially trained in the tactical and logistical use of helicopters for wildfire suppression.

Helitank – A specially designed tank fitted to a helicopter and used for transporting and dropping suppressants or retardants.

Helitanker – A helicopter equipped with a helitank or a bucket.

Hot Spotting – A method to check the spread and intensity of a wildfire at those points that exhibit the most rapid spread or that otherwise pose some special threat to control of the situation. This is in contrast to systematically working all parts of the wildfire at the same time, or progressively, in a step-by-step manner.

Incendiary Fires – Wildfires that are deliberately and maliciously set by people.

Incident – An occurrence, either caused by humans or natural phenomena that requires a response to prevent or minimize loss of life or damage to property and/or the environment.

Incident Action Plan (IAP) – An oral or written plan containing general objectives reflecting the overall strategy for managing an incident. It may include the identification of operational resources and assignments. It may also include attachments that provide direction and important information for management of the incident during one or more operational periods.

Incident Commander (IC) – The individual responsible for all incident activities, including the development of strategies and tactics and the ordering and release of resources. The IC has overall authority and responsibility for conducting incident operations and is responsible for the management of all incident operations at the incident site.

Incident Command Post (ICP) – The field location at which the primary tactical-level, on-scene incident command functions are performed. The ICP may be co-located with the Incident Base or other incident facilities and is sometimes identified by a green rotating or flashing light.

Incident Command System (ICS) – A standardized on-scene emergency management construct specifically designed to provide for the adoption of an integrated organizational structure that reflects the complexity and demands of single or multiple incidents, without being hindered by jurisdictional boundaries. ICS is the combination of facilities, equipment, personnel, procedures, and communications operating within a common organizational structure, designed to aid in the management of resources during incidents. It is used for all kinds of emergencies and is applicable to small as well as large and complex incidents. ICS is used by various jurisdictions and functional agencies, both public and private, to organize field-level incident management operations.

Incident Management Team – The Incident Commander and the appropriate Command and General Staff personnel assigned to an incident.

Incident Types – Categorization of incidents into different levels of extremity and complexity in order to effectively make decisions about resource requirements. Incidents Types are measured on a five-category scale, where a Type 5 incident is the least complex and resource-intensive and a Type 1 is the most complex and resource intensive. Incident Commanders are typically assigned accordingly.

Indigenous – The preferred term in Canada to include First Nations, Inuit, and Métis.

Indirect Attack – A method whereby the control line is strategically located to take advantage of favourable terrain and natural breaks in advance of the wildfire perimeter and the intervening strip is usually burned out or backfired.

Information Officer – A member of the Command Staff responsible for interfacing with the public and media or with other agencies requiring information directly from the incident. There is only one Information Officer per incident. The Information Officer may have assistants.

Initial Attack – The action taken to halt the spread or potential spread of a wildfire by the first firefighting force to arrive at the wildfire.

Initial Attack Crew – Personnel trained, equipped, and deployed to conduct suppression action to halt the spread or potential spread of a wildfire within the first burning period.

Initial Attack Resources – Firefighting resources funded and organized specifically for the prime objective of implementing initial attack on wildfires. See Airtanker, Initial Attack Crew.

Initial Spread Index (ISI) – A numerical rating related to the expected rate of wildfire spread. It combines the effects of wind and Fine Fuel Moisture Code on rate of spread but excludes the influence of variable quantities of fuel.

Intermediate Helicopter – 5 to 8 seats, up to approximately 2,500 lbs. external load. (e.g. Bell 206L, AS350, Bell 407, Bell 222, etc.).

Jurisdiction – A range or sphere of authority. Public agencies have jurisdiction at an incident related to their legal responsibilities and authority. Jurisdictional authority at an incident can be political or geographical (e.g., municipal, regional) or functional (e.g., law enforcement, public health).

Jurisdictional Agency – The agency having jurisdiction and responsibility for a specific geographical area, or a mandated function.

Light Helicopter – 1 to 4 passenger seats, up to approximately 1,500 lbs. external load (e.g. Robinson R22, Bell 47 and 206B, Hiller 12E/T, Hughes 500, etc.).

Lightning Locator System – A network of sensors to detect the location and polarity of cloud-to-ground lightning flashes in real-time.

Loaded Patrol – An aerial patrol where the aircraft is carrying an initial attack crew or fire retardants on board while conducting aerial detection flights.

Logistics Section – The Section responsible for providing facilities, services, and materials for the Incident.

Logistics Section Chief – This individual responsible for supervising the Logistic Section. Reports to the Incident Commander and is a member of the General Staff. This position may have one or more deputies assigned.

Lookout Observer – A competent and trusted person located in an advantageous position who has the responsibility of watching for potential wildfire problems and then relating them to their supervisor.

Medium Fuels – Fuels too large to be ignited until after the leading edge of the wildfire front passes, but small enough to be completely consumed.

Medium Helicopter – 9 to 14 passenger seats, up to approximately 6,000 lbs. external load. (e.g. Sikorsky S55T and 58T, Bell 204, 205, 212, K-Max, etc.).

Mitigation – The actions taken to reduce the impact of disasters in order to protect lives, property, the environment, and to reduce economic disruption.

Modified Response Fire – A wildfire that is managed using a combination of suppression techniques, including direct and indirect attack as well as monitoring to steer, contain or otherwise manage wildfire activity within a pre-determined perimeter such that costs and/or damage are minimized and/or benefits from the wildfire are maximized.

Mutual Aid Agreement – An agreement between and among jurisdictions that provides a mechanism to quickly obtain emergency assistance in the form of personnel, equipment, materials, and other services. The primary objective is to facilitate rapid, short-term deployment of emergency support prior to, during, and/or after an incident.

Operations Section – The Section responsible for all tactical operations at the incident. This section can include Branches, Divisions and/or Groups, Task Forces, Strike teams, Single Resources, and Staging Areas.

Operations Section Chief – The individual responsible for supervising the Operations Section. Reports to the Incident Commander and is a member of the General Staff. This position may have one or more deputies assigned.

Out of Control – See Fire Status – Out of Control

Preparedness – A continuous cycle of planning, organizing, training, equipping, exercising, evaluating, and taking corrective action in an effort to ensure effective coordination during incident response.

Prescribed Burning – The knowledgeable application of fire to a specific land area to accomplish pre-determined forest management or other land use objectives.

Prescribed Fire – Any fire utilized for prescribed burning; usually ignited according to agency policy and management objectives.

Presuppression – Those wildfire management activities in advance of wildfire occurrence concerned with the organization, training, and management of a firefighting force and the procurement, maintenance, and inspection of improvements, equipment, and supplies to ensure effective wildfire suppression.

Prevention – Actions taken to avoid the occurrence of negative consequences associated with a given threat; prevention activities may be included as part of mitigation.

Rappel Crew – An initial attack crew trained to descend from a specially equipped, hovering helicopter on a rope fitted with a mechanical device to control the rate of descent.

Rate of Spread (ROS) – The speed at which a wildfire extends its horizontal dimensions, expressed in terms of distance per unit of time. Generally thought of in terms of a wildfire's forward movement or head fire rate of spread, but also applicable to backfire and flank fire rates of spread. Recommended units are metres per minute (m/min) or kilometres/hour (km/h).

Resources – Personnel and major items of equipment, supplies, and facilities available or potentially available for assignment to incident operations and for which status is maintained. Resources are described by Kind and Type and may be used in operational support or supervisory capacities at an incident.

Response Time – The period from receipt of first report of a wildfire to start of actual firefighting.

Risk – Broadly, the effect of uncertainty on objectives. Risk is often expressed in terms of a combination of the consequences of an event and the associated likelihood of occurrence.

Risk Management Framework – Set of components that provide the foundations and organizational arrangements for designing, implementing, monitoring, reviewing and continually improving risk management throughout the organization.

Smoke – The visible products of combustion rising above a wildfire.

Smoke Column – Smoke and other gases that form a column-shaped mass above a wildfire, characterized by sharply defined, billowed edges.

Spatial Fire Management System – Software that produces daily to hourly maps of fire weather and potential fire behaviour based on the interpolation of weather observations and fuels maps.

Spot Fire – A wildfire ignited by firebrands that are carried outside the main wildfire perimeter by air currents, gravity, and/or fire whirls.

Spotting – A wildfire producing firebrands carried by the surface wind, a fire whirl, and/or convection column that fall beyond the main wildfire perimeter and result in spot wildfires.

Strategy – The general plan or direction selected to accomplish incident objectives.

Suppressant – An agent used to extinguish the flaming, smouldering, or glowing stages of combustion by direct application to burning fuels.

Surface Fire – A wildfire that burns in the surface fuel layer, excluding the crowns of the trees, as either ahead wildfire, flank fire, or backfire.

Surface Fuels – All combustible materials lying above the duff layer between the ground and ladder fuels that are responsible for propagating surface wildfires (e.g. litter, herbaceous vegetation, low and medium shrubs, tree seedlings, stumps, downed-dead roundwood).

Sustained Action Crew – Personnel trained, equipped, and deployed to conduct suppression action on a wildfire for an extended period of time.

Tactics, Fire Suppression – Determining exactly where to establish control lines, what to do along these lines, and how best to utilize each firefighting resource group to cope with site-specific conditions and fire behaviour at the moment.

Tanker – A specialized truck on which is mounted a tank, a fire pump, hose, and supplementary equipment. Can also be used as a short form for airtanker.

Under Control (UC) – See Fire Status – Under Control

Under Investigation – referring to the status of a wildfire with an unknown cause.

Unified Command – An application used when more than one agency has incident jurisdiction or when incidents cross political jurisdictions. Agencies work together through the designated members of the Unified Command (UC), often the senior persons from agencies and/or disciplines participating in the UC, to establish a common set of objectives and strategies and a single Incident Action Plan.

Unused Minimums – While the 'minimum guarantee' is an hourly guarantee agreed to by the contracting party, in this case the Government of Alberta, to secure availability of the Contractor's rotary wing aircraft. Unused minimum hours are the hours included in this agreement that were not expended during the contractual period but are entitled to payout at the unused minimum rate.

Values-at-Risk – The specific or collective set of natural resources and man-made improvements/ developments that have measurable or intrinsic worth and that may be destroyed or otherwise altered by wildfire in any given area.

Wildfire – An unplanned or unwanted natural or human-caused wildfire, as contrasted with a prescribed fire.

Wildland Urban Interface (WUI) – The area where homes and other human development meets or are inter-mixed with wildland fire fuels.

Wind Speed – The rate of horizontal motion of the air. In the Canadian Forest Fire Danger Rating System and in fire weather forecasts, wind speed is assumed to be measured or estimated at a standard height of 10 metres in the open on level terrain. Recommended unit is kilometres/hour (km/h).

APPENDIX B – 2019 WILDFIRE REVIEW: SITUATIONAL ANALYSIS OF ENVIRONMENTAL CONDITIONS

Introduction

Alberta Agriculture and Forestry (AAF) commissioned MNP to carry out an independent, external review of the 2019 spring wildfire activity in Alberta through an RFP process. The extreme fire behaviour associated with the wildfires in May and early June resulted in the evacuation of over 20 communities and approximately 15,000 people. This Situational Analysis focussed on understanding and describing the environmental conditions leading up to, and at the outset of, the 2019 spring wildfire events. The three major wildfire incidents that are being examined for this component of the review include:

- Battle complex (PWF052, PWF054) — detected May 11 in the Peace River Forest Area and grew to 52,606 hectares in size.
- Chuckegg Creek wildfire — detected May 12 in the High Level Forest Area and grew to 350,135 hectares in size.
- McMillan complex (SWP049, SWF050, SWF069, SWF078, SWF079, SWF090, SWF099)—detected May 18 in the Slave Lake Forest Area and grew to 273,045 hectares in size.

Setting the Context

Historically, Alberta has experienced frequent human- and lightning-caused wildfire ignitions in the month of May, some of which ultimately develop into catastrophic wildfire events. Recent notable / extreme spring fire seasons in Alberta include 1968, 1972, 1980, 2001, 2002, 2011, 2015 and 2016. Both the 2011 and 2016 wildfire events resulted in significant losses to community values. Independent program reviews in 2011, 2015 and 2016 provided short- and long-term recommendations for program enhancements relative to wildfire threat in the month of May.

There were several weather and fuel conditions in the winter / spring months of 2019 that signaled an early and potentially severe spring fire season. Figures 1 and 2 illustrate abnormally dry and moderate to severe drought conditions in northwestern Alberta in April and May based on the North American Drought Monitoring System provided by the National Oceanic and Atmospheric Administration (NOAA)[1]. Figures 3 and 4 provide further evidence of the developing 2018/2019 drought situation in northwestern Alberta, showing quarterly temperature and precipitation anomalies for Environment Canada weather stations for March-May 2019.

Appendix B1 illustrates that NOAA derived drought conditions were apparent for northwestern Alberta as early as September of 2016, 2017 and 2018. Figure 5 is an example of the longer-term drought impact in the High Level Forest Area.

The three-year drought in the High Level Forest Area was further exacerbated in 2019 by the lack of precipitation and warm temperatures during the months of March, April and May. Figures 6 and 7 clearly illustrate these intensified conditions by comparing monthly precipitation amounts and average temperatures in 2018/2019 with the 30-year historical average for High Level. Along with an early snow melt by mid-April in northern Alberta, these

[1] The NOAA North American Drought Monitoring System is recognized as useful for monitoring broad scale drought conditions that develop in the western US and Canada on an annual basis.

weather patterns combined to signal an early fire season. Consistent with several previous spring wildfire experiences in Alberta, the month of May 2019 was set up for potential catastrophic wildfire events.

Figure 1: North American Drought Monitor for April 30, 2019[2]

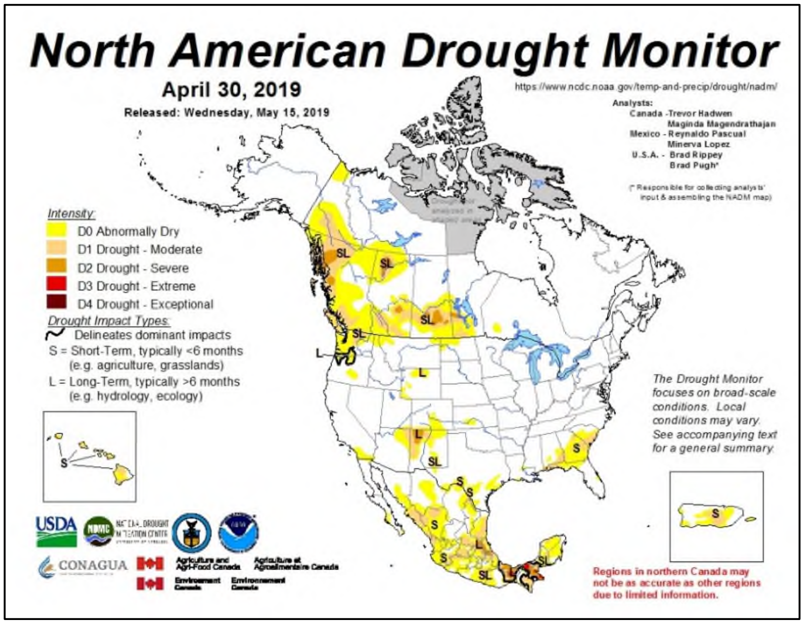

Figure 2: North American Drought Monitor for May 31, 2019[3]

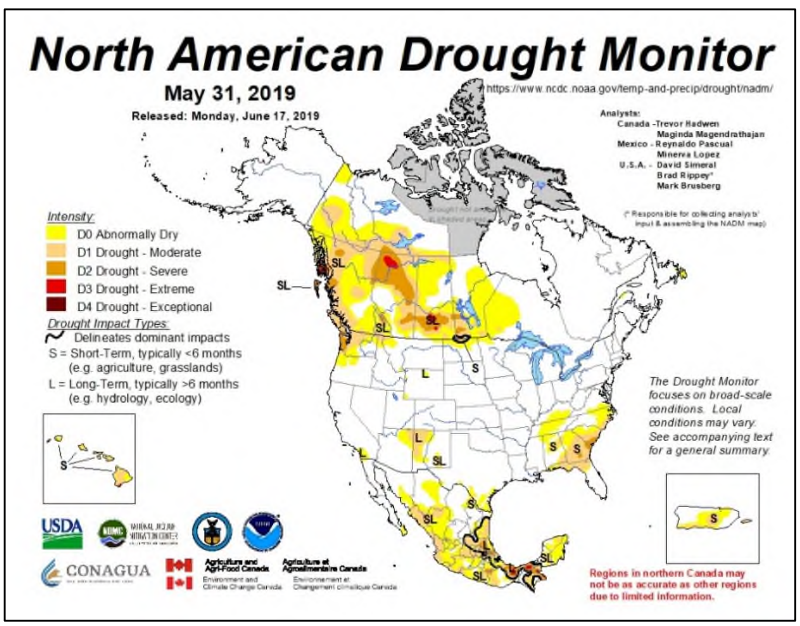

Figure 3: Quarterly Temperature Anomaly for Canada March - May 2019[4]

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[2] Source: Retrieved from https://www.ncdc.noaa.gov/temp-and-precip/drought/nadm/maps/en/201904

[3] Source: Retrieved from https://www.ncdc.noaa.gov/temp-and-precip/drought/nadm/maps/en/201905

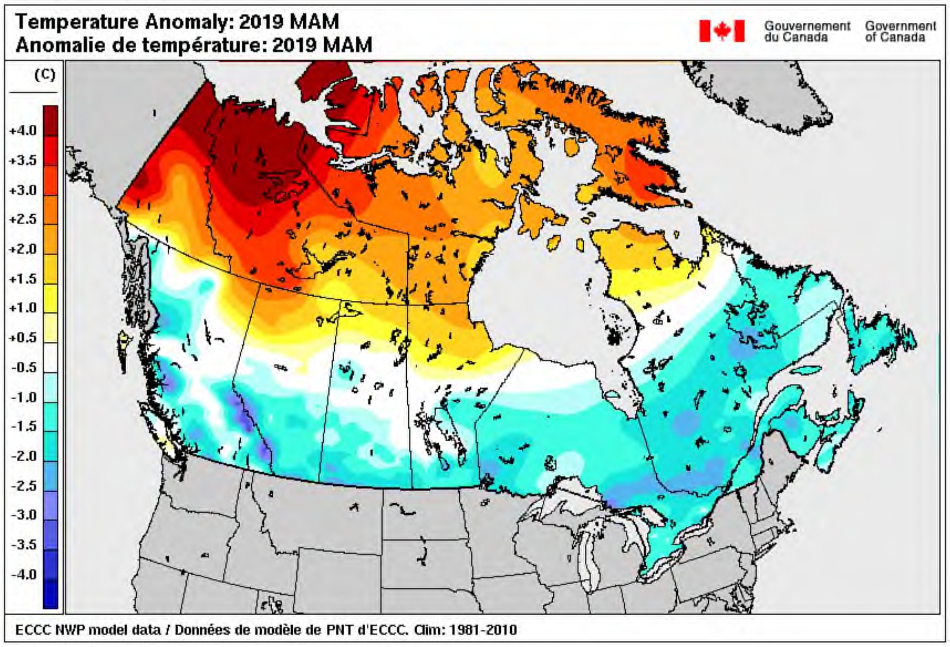


Figure 4: Quarterly Precipitation Anomaly for Canada March - May 2019[4]

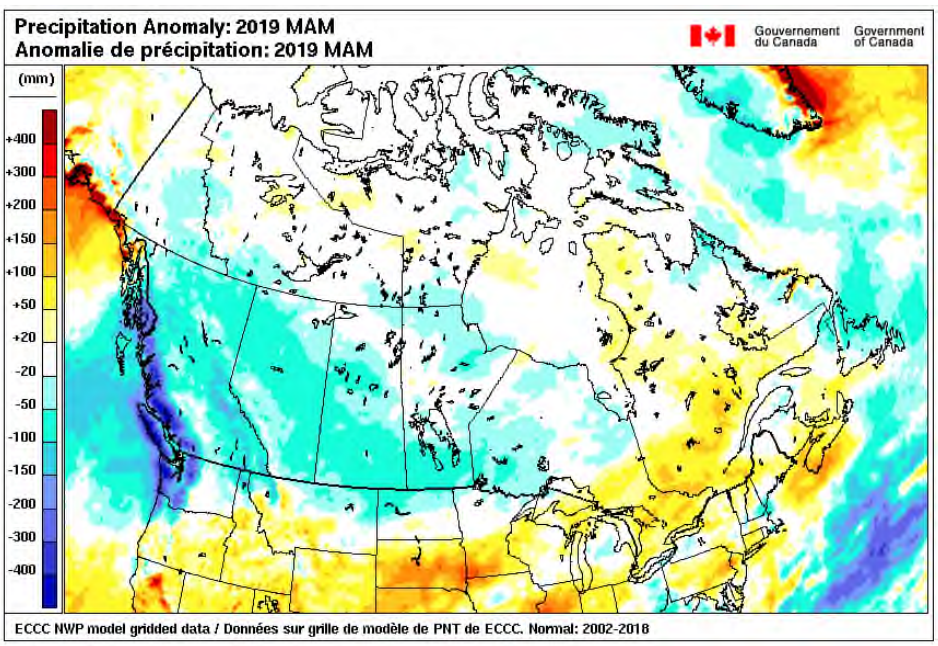


Figure 5: Illustration of the Effects of Long-Term Drought Conditions That Decreased the Water Table and Dried Up Lakes in The General Area of High Level

[4] Source: Real-Time Weather Statistics Maps, Environment and Climate Change Canada, accessed on October 28, 2019. http://collaboration.cmc.ec.gc.ca/cmc/wtoftpa/www/

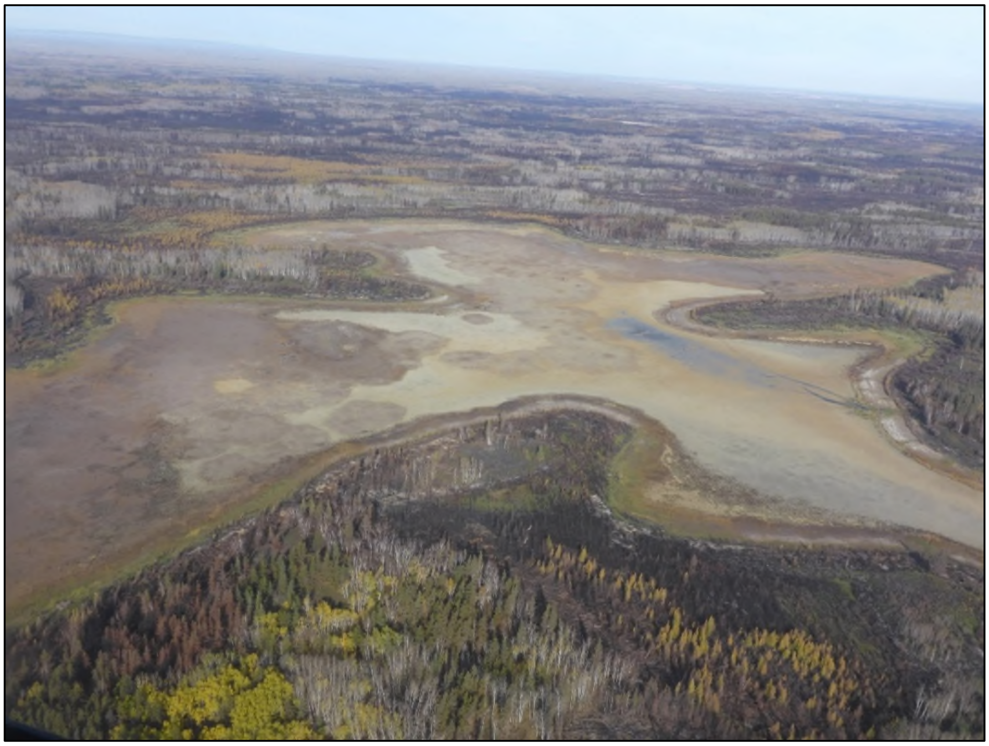


Figure 6: 2018/2019 Monthly Precipitation Anomalies for High Level Environment Canada Airport Station

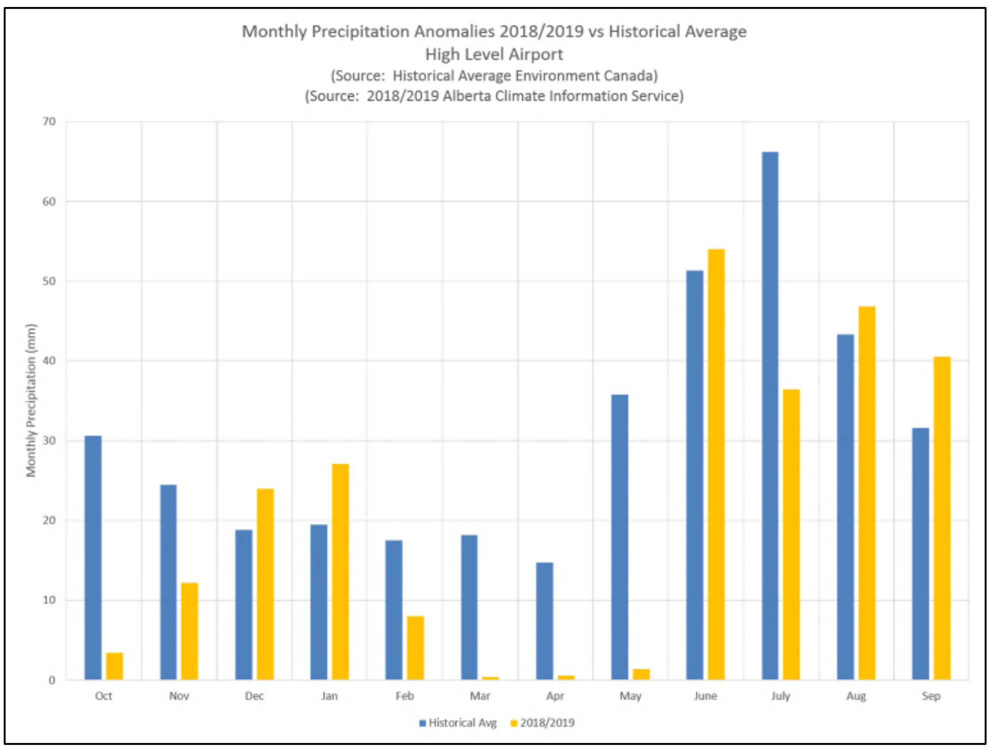
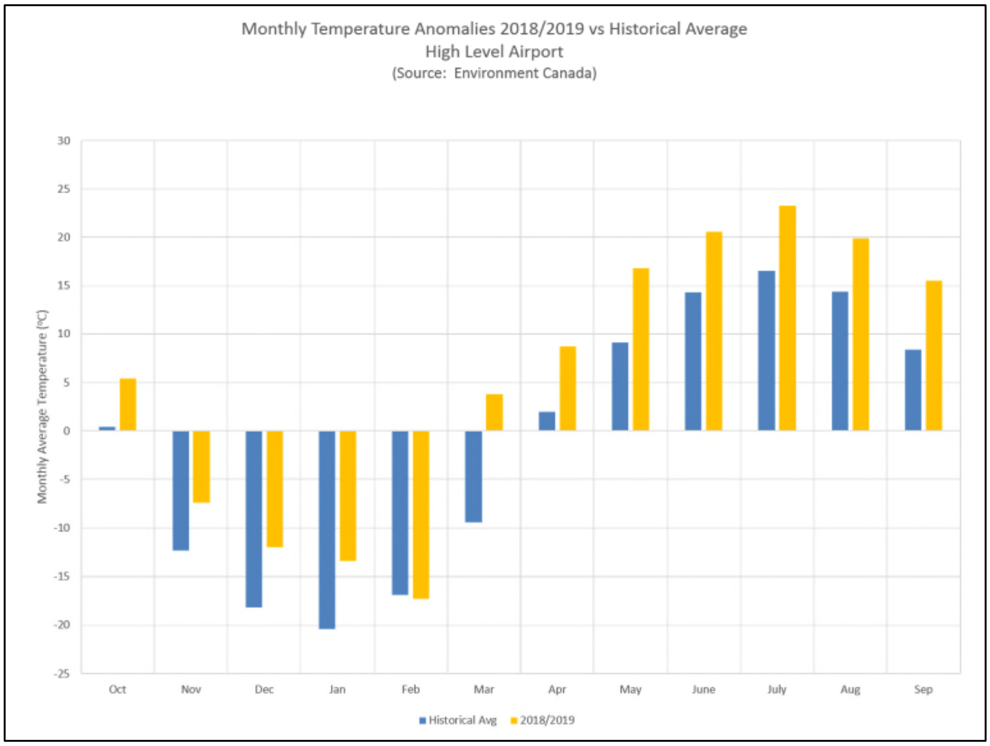


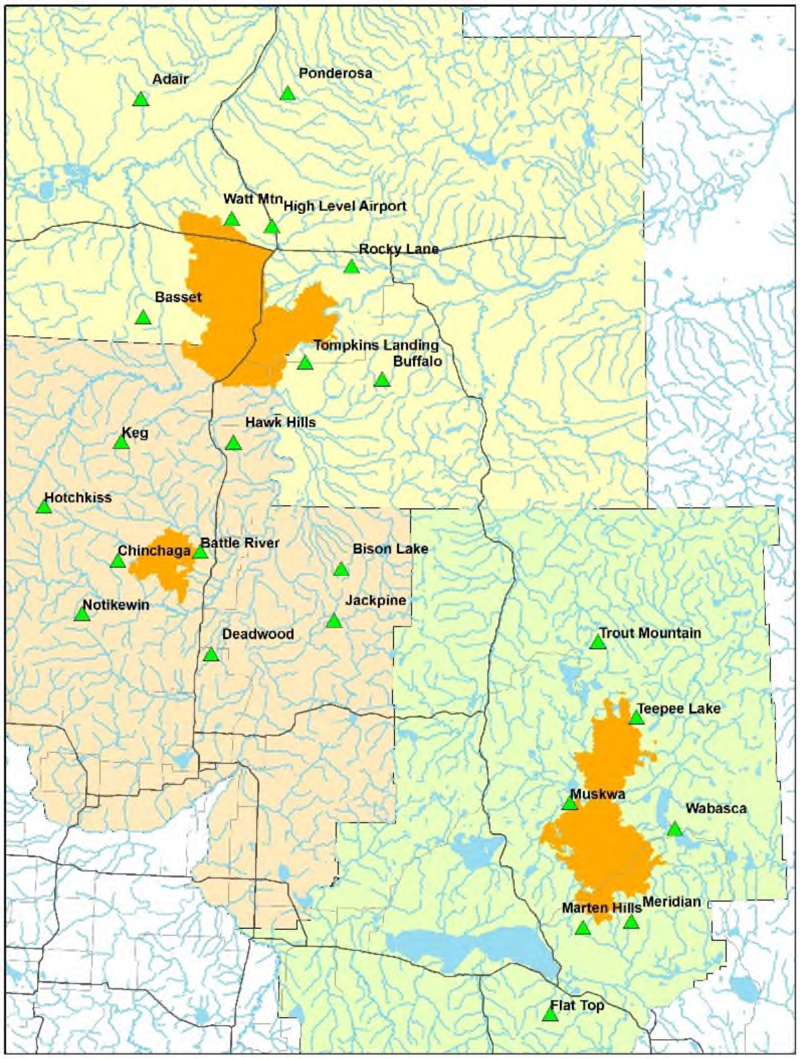
Figure 7: 2018/2019 Monthly Temperature Anomalies for High Level Environment Canada Airport Station



Wildfire ignitions that occurred May 11 (PWF052, "Battle River"), May 12 (HWF042, "Chuckegg Creek") and May 18 (SWF049, "McMillan") quickly developed into major conflagrations (Figure 8). These wildfires exhibited erratic fire behaviour including prolific long-range spotting, pyrocumulonimbus (pyrocb) development that caused downwind lightning fires and wildfire spread rates at times exceeding Fire Behaviour Prediction (FBP) System projections. The following section documents the inputs and outputs of the Canadian Forest Fire Weather Index (FWI) System from early 2019.

Note: SWF050 and SWF069 were overrun by SWF049 on June 1 and June 2 respectively.

Figure 8: Weather Stations Associated with The Three Wildfire Complexes in The High Level, Peace River and Slave Lake Forest Areas During May 2019



Provincial Fire Weather Index System Components

The FWI System is a component of the Canadian Forest Fire Danger Rating System (CFFDRS) and was first issued in 1970. It is used for daily wildfire management planning during the annual fire season. The FWI System, which depends solely on weather readings, provides a general measure of fire danger throughout forested and rural areas. The FWI System has also been fully implemented in parts of the US and in New Zealand. Components of it have been used in many countries including Spain, Portugal, Sweden, Argentina, Mexico, Fiji, Indonesia and Malaysia. This empirical approach to developing a danger rating system in wildfire prone environments has achieved international credibility. Much of the early empirical data was collected in Alberta and the Northern Forestry Centre in Edmonton continues to provide science-based updates.

The FWI System consists of three codes and three indices that account for the effects of fuel moisture and wind on fire behaviour (Table 1). The first three components are fuel moisture codes (FFMC, DMC and DC) and the final three are fire behaviour indices (ISI, BUI and FWI). In general, the values of these indices increase as fire danger increases.

An often-under-utilized component / extension of the FWI System is a method of calculating daily, monthly or seasonal severity rating (SSR). Developed by D.E. Williams in 1959 and modified for use with the current FWI System by C.E. Van Wagner in 1970, this severity rating permits the comparison of fire seasons, or portions of fire seasons at a local, regional and national scale across Canada. The SSR is a weighted average of daily fire danger, calculated from daily measurements of temperature, wind speed, relative humidity and precipitation. The weighting factors used by Williams were developed from experimental test fires and are based on wildfire perimeter and drought to represent severity. In this way, each day can be assumed to have its individual Daily Severity Rating (DSR), and these can be summed and averaged over any time period (e.g. monthly or seasonally), unlike components in the FWI System.

Indices that represent rate of spread, the Initial Spread Index (ISI) and fuel consumption, the Buildup Index (BUI) are combined within the FWI System to form the Fire Weather Index (FWI), which represents overall fire intensity or resistance to control. The Daily Severity Rating (DSR) is a transformation of the daily FWI value, calculated as follows:

$$DSR = 0.0272\, FWI^{1.77}$$

Higher FWI values receive more weight in the calculation of DSR, emphasizing the increasing contribution of high to extreme FWI values to overall fire severity. The DSR is therefore a simple power function of the FWI that gives greater weight to higher values than lower ones, and is intended to reflect the amount of effort required to suppress a wildfire. Daily values of the DSR can be summed to obtain a cumulative value (CDSR) and averaged over any desired period (i.e., week, month, or season). CDSR values can be graphed daily and compared to historical CDSR levels (or 90th percentile values, for example) to give wildfire managers a sense of how a fire season is developing in comparison to recent seasons. In turn, this trend would help in anticipating developing problems and planning accordingly.

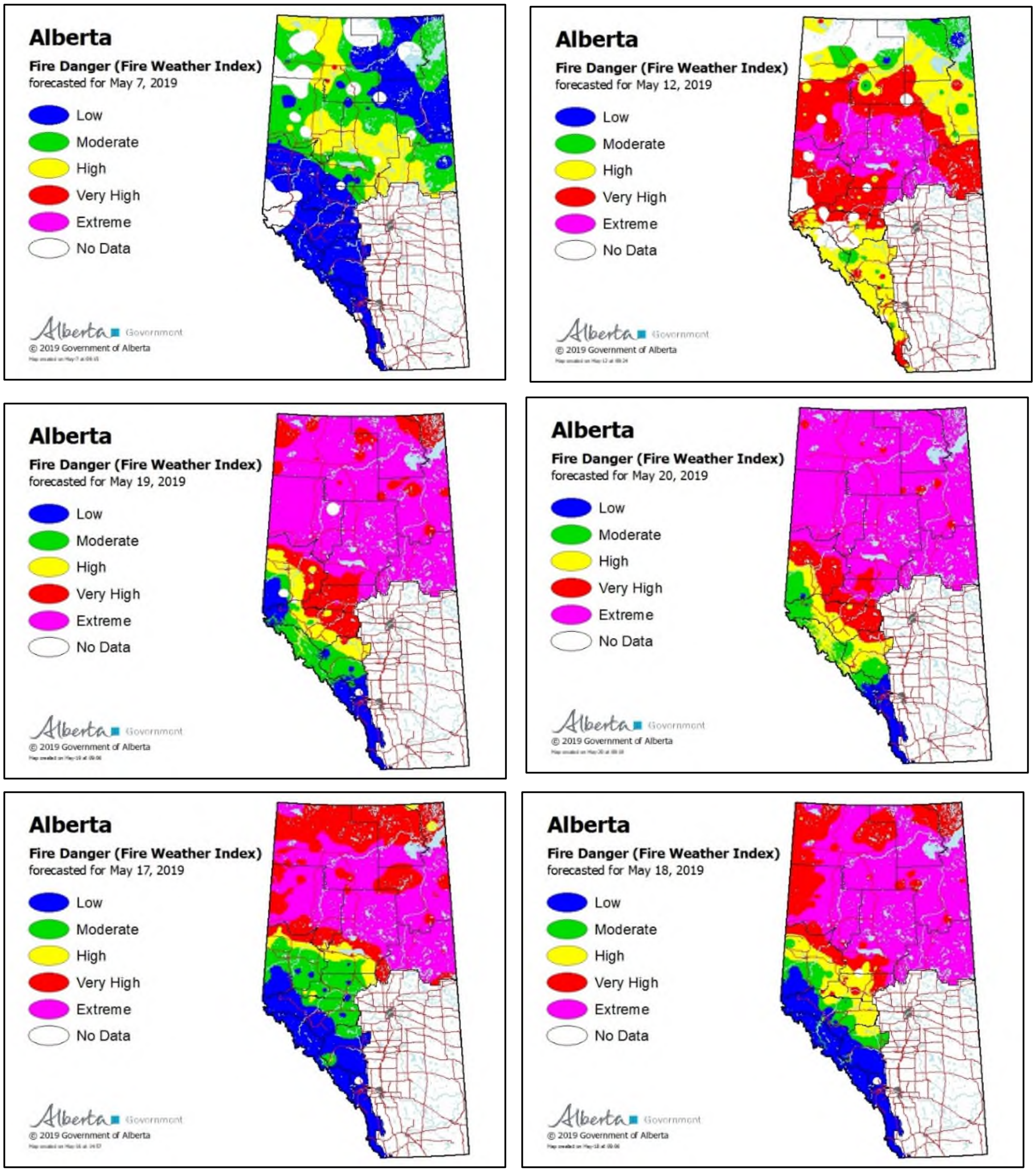
Table 1: FWI Values in Relation to Low, Moderate, High, Very High and Extreme Fire Danger Ratings

Fire Danger Rating	FFMC Fine Fuel Moisture Code	DMC Duff Moisture Code	DC Drought Code	ISI Initial Spread Index	BUI Build Up Index	FWI Fire Weather Index
Low	0-76	0-21	0-79	0-1.5	0-24	0-4.5
Moderate	77-84	22-27	80-189	2-4	25-40	4.5-10.5
High	85-88	28-40	190-299	5-8	41-60	10.5-18.5
Very High	89-91	41-60	300-424	9-15	61-89	18.5-29.5
Extreme	92+	61+	425+	16+	90+	29.5+

Provincial Fire Weather Index System Conditions Early 2019

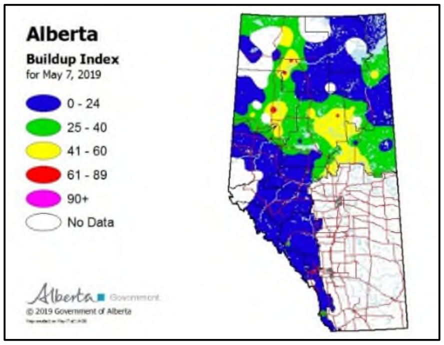
Maps showing the spatial distribution of fire danger conditions across Alberta, expressed through the component codes and indices of the Canadian FWI System, are developed and distributed daily. Duty Officers have forecasted values from the previous day, followed by AM revisions based on weather updates, followed by the actual values at 13h00. These maps are intended to illustrate trends in fire danger conditions for information and pre-suppression planning purposes. A series of selected maps showing trends in the Fire Weather Index (FWI), the Buildup Index (BUI), and the Drought Code (DC) are presented in Figures 9, 10 and 11. The FWI and BUI maps illustrate the rapid development of escalating dry conditions and fire danger from relatively benign values at the beginning of May to widespread extreme values across northern Alberta by the middle of the month. These conditions prevailed throughout May and into early June.

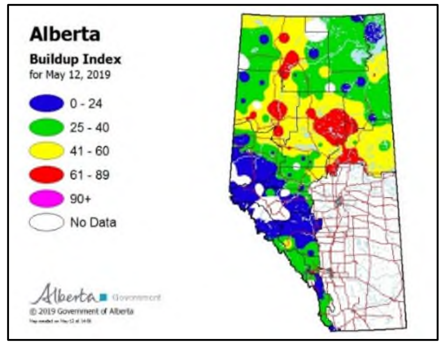
Figure 9: Provincial Fire Danger (Fire Weather Index) Maps for Selected Dates Related to The High Level, Peace River and Slave Lake Wildfire Events[5]

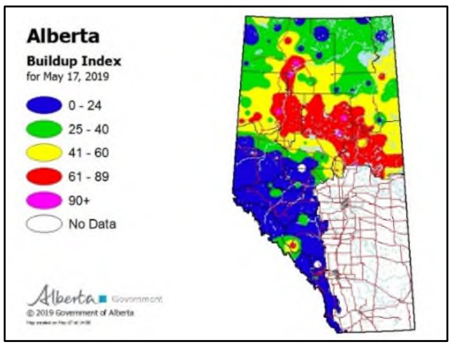


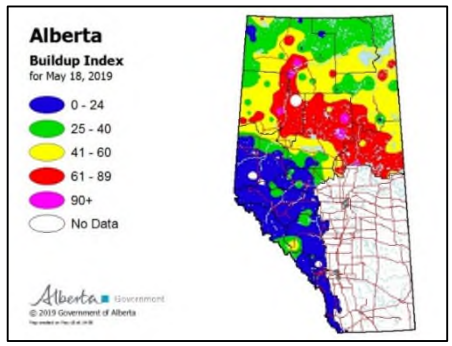
5 Source: Alberta Agriculture and Forestry

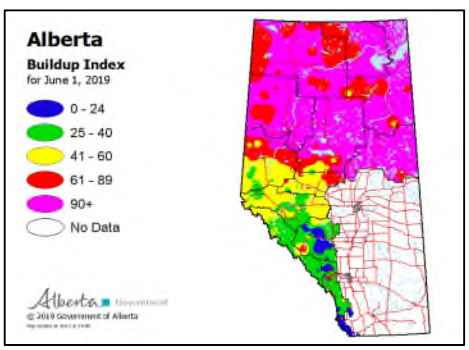
Figure 10: Provincial BUI Maps for Selected Dates Related to The High Level, Peace River and Slave Lake Wildfire Events

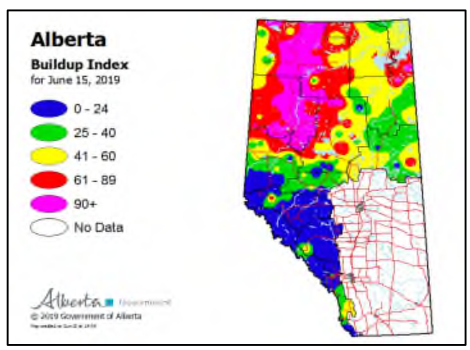


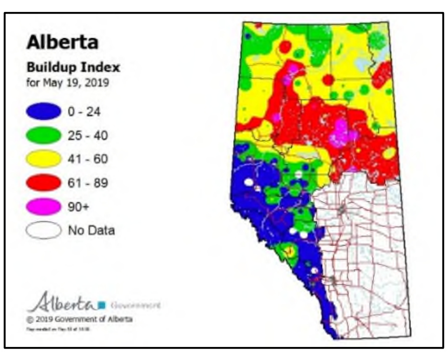












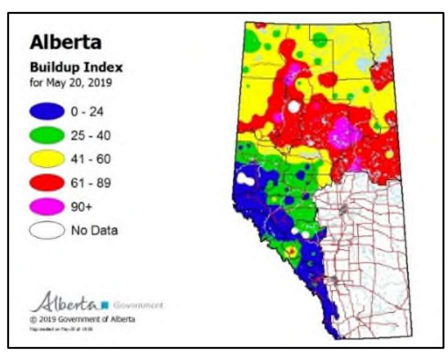
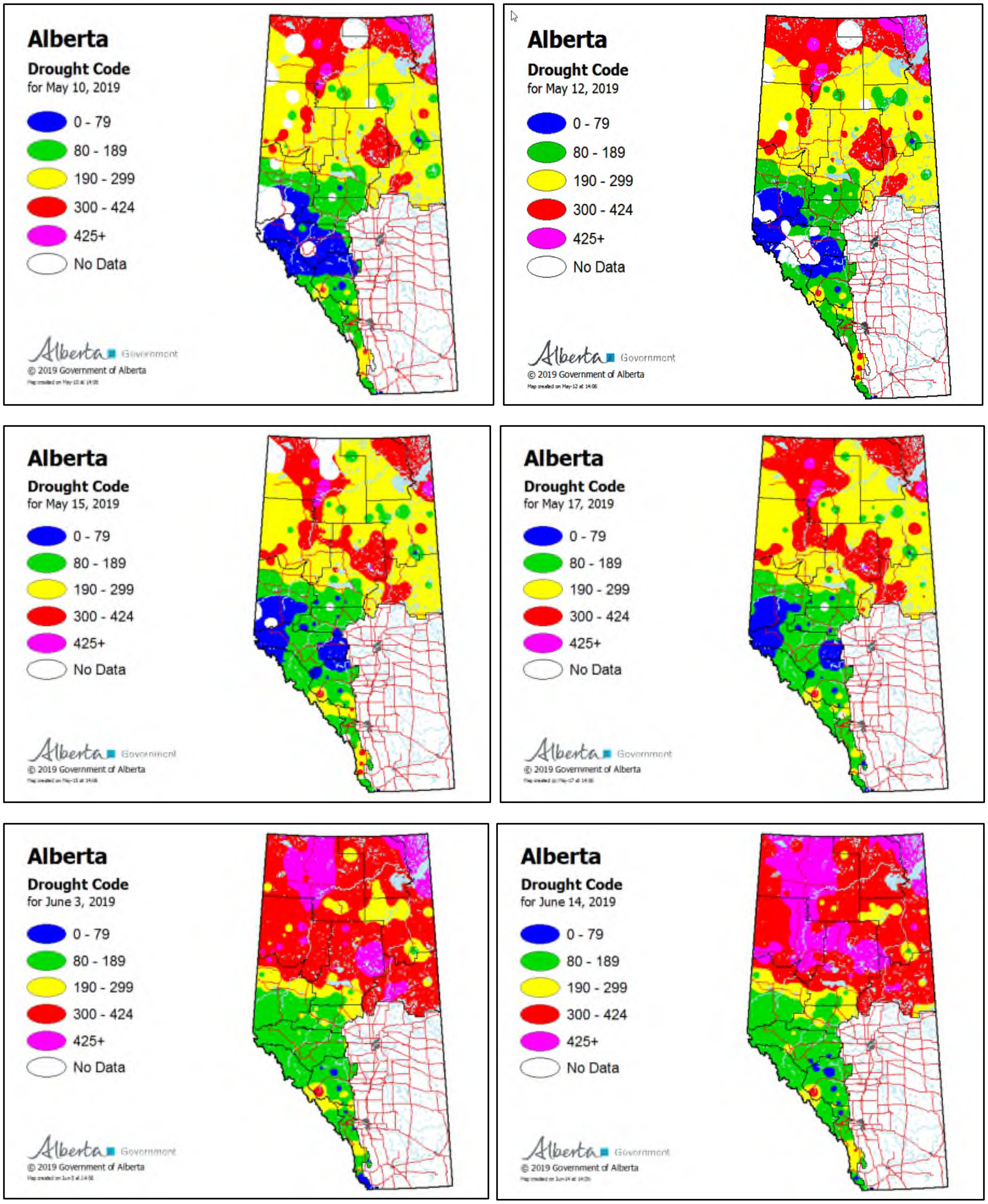


Figure 11: Provincial DC Maps for Selected Dates Related to The High Level, Peace River and Slave Lake Wildfire Events[6]



6 Source: Alberta Agriculture and Forestry

Regional Fire Weather Index System Conditions

Fire Weather Index (FWI) System recordings are archived for each fire season, and these historic records can be used to summarize the frequency distribution of individual elements of the FWI System. Fire weather station records associated with the wildfire complexes in High Level, Peace River and Slave Lake (Figure 8) were reviewed to determine the variance of weather inputs to the FWI System. One prerequisite to selection of a weather station for a historic analysis was number of years that the weather station has been in use. A number of the recently installed automatic weather stations were excluded from the historical analysis on that basis. Tables 2, 3 and 4 present the historic percentile values of both weather inputs and FWI outputs for the Ponderosa Automatic (1983-2019), Battle River Lookout (1974-2019) and Wabasca Automatic (1994-2019) weather stations; including the maximum values experienced during this period. Drought Code values for early ignition dates at High Level (Ponderosa Auto), Peace River (Battle River Lookout) and Slave Lake (Wabasca Auto) were 451, 368 and 476, respectively. All three of these values were above the 90th percentile based on historic weather analysis for the three recording stations.

Note: A percentile is a measure used in statistics indicating the value below which a given percentage of observations in a group of observations falls. For example, the 90th percentile is the value below which 90 percent of the observations may be found.

Table 2: Seasonal Historic Weather Analysis for the Ponderosa Automatic Weather Station

Ponderosa Automatic – Spring (1983 – 2019)									
PERCENTILE	TEMP	RH	WIND SPEED	FFMC	DMC	DC	ISI	BUI	FWI
80	20	25	13	92	40	353	9.5	59	22
90	23	22	15	93	51	418	11.5	72	27
95	25	19	16	94	62	454	13.4	89	33
98	27	16	18	95	80	483	15.2	110	39
Max	32	9	22	97	113	551	18.5	136	46
HWF042 Start Date May 12	16	22	16G39	79	40	451	2.4	65	8.4

Table 3: Seasonal Historic Weather Analysis for the Battle River Lookout Weather Station

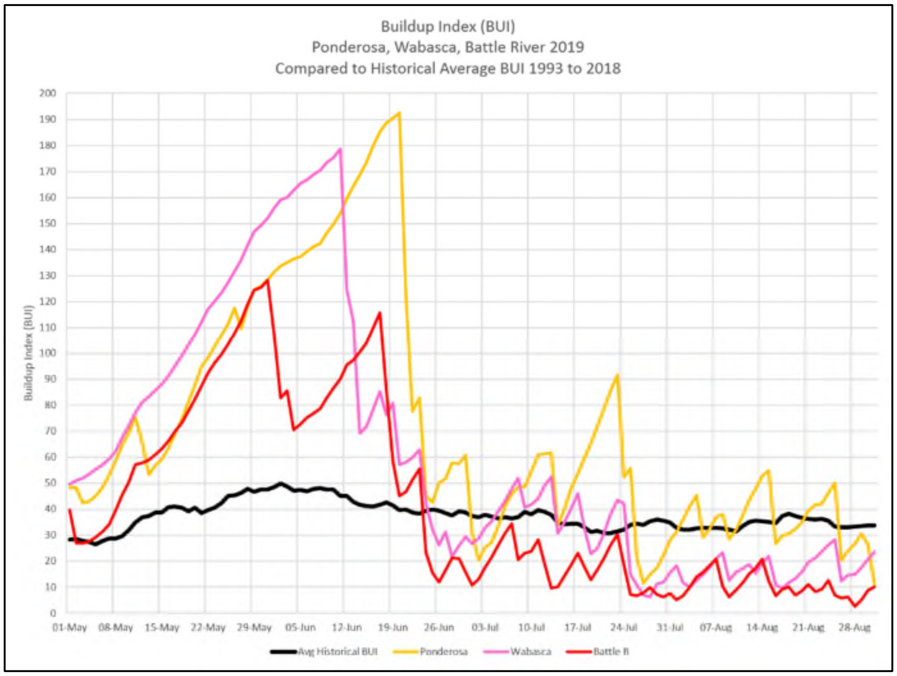
Battle River Lookout – Spring (1974 – 2019)									
PERCENTILE	**TEMP**	**RH**	**WIND SPEED**	**FFMC**	**DMC**	**DC**	**ISI**	**BUI**	**FWI**
80	18	36	16	89	35	295	7.3	50	17
90	20	31	20	90	47	346	9.2	64	22
95	22	27	22	91	60	391	11.0	75	24
98	23	25	26	92	75	456	14.0	95	29
Max	29	17	50	94	105	533	94.0	135	67
PWF052 Start Date May 11	23	23	11	93	35	368	11.4	57	26

Table 4: Seasonal Historic Weather Analysis for the Wabasca Automatic Weather Station

Wabasca Automatic – Spring (1994 – 2019)									
PERCENTILE	**TEMP**	**RH**	**WIND SPEED**	**FFMC**	**DMC**	**DC**	**ISI**	**BUI**	**FWI**
80	18	34	19	89	38	324	7.9	54	17
90	20	28	23	91	54	368	10.7	71	24
95	22	25	27	92	70	397	13.4	88	30
98	24	23	33	93	82	457	17.3	103	39
Max	30	18	50	95	116	553	46.8	152	64
SWF049 Start Date May 18	17	28	23G39	91	67	476	15.8	99	42

Figure 12 illustrates the 2019 Buildup Index (BUI) for Ponderosa Auto, Wabasca Auto and Battle River Lookout weather stations plotted against the combined average for 1993 to 2018. Of interest is the steep climb of the BUIs above the historic average at all three weather stations, beginning in early May.

Figure 12: 2019 Daily BUI values for Ponderosa, Wabasca and Battle River Stations in Comparison to the Combined Historical Average for These Stations



Fire danger ratings for the month of May varied across northern portions of the province, however, by mid-May extreme fire danger conditions existed throughout the High Level, Peace River and Slave Lake Forest Areas. Wildfire ignitions in High Level, Peace River and Slave Lake developed into the three major complexes and by June 15, 704,929 hectares had burned in northern Alberta. FWI conditions associated with each complex are summarized in the following pages.

High Level Forest Area

The Chuckegg Creek wildfire (HWF042) ignited on May 12 and grew to 237,000 hectares by the end of July. Several environmental factors indicated drought conditions throughout the High Level Forest Area in early 2019. A significant drop in the water table resulted in dry, low-lying peat and lake systems, which exposed additional fuels that normally are classed as non-fuel. At the same time the continuity of flammable fuels, which was already high, increased substantially across the landscape. The effect of additional fuel loading and continuity on fire behaviour is addressed later in this report.

In terms of FWI System outputs, the rapid change from normal to extreme conditions in the High Level Forest Area during the month of May is clearly evident. The exception is high drought code carry over from 2018. This section of the report presents the chronology of FWI System components as the spring fire season developed in the High Level Forest Area.

FIRE DANGER CONDITIONS IN MAY AND JUNE 2019

Daily FWI System outputs for the Ponderosa Automatic weather station are shown in Figure 13. While moderate conditions prevailed during the first few days of May, the impact of negligible precipitation over the remainder of that month and the first half of June resulted in a dramatic and consistent rise in the BUI to extreme levels. During this period, high winds and low relative humidity levels often resulted in ISI and FWI values (also shown in Figure

13) that were frequently quite extreme, particularly between May 17 and May 20. These FWI System outputs can be interpreted as a strong indication that many wildfires would be fast-moving and intense, exhibiting strong resistance to control.

High to extreme wind speeds were observed almost daily during May 2019 in the High Level Forest Area. In addition to frequent high wind speed values, it is also evident that these winds were often sustained over multi-day periods (Figure 14), which would result in continued high rates of wildfire growth, while also contributing to accelerated fuel drying. Figure 15 illustrates the landscape features of the Chuckegg Creek wildfire that burned on May 17 and 18. Note the continuity of fine fuels and the intensity of the burn in the aspen stands. Figure 16 illustrates the weather stations associated with the Chuckegg Creek wildfire.

Figure 13: 2019 BUI plotted with ISI and FWI Values for The Ponderosa Auto Weather Station. The Start Date, 13h00 Values and Major Wildfire Runs Are Noted on The Graph.

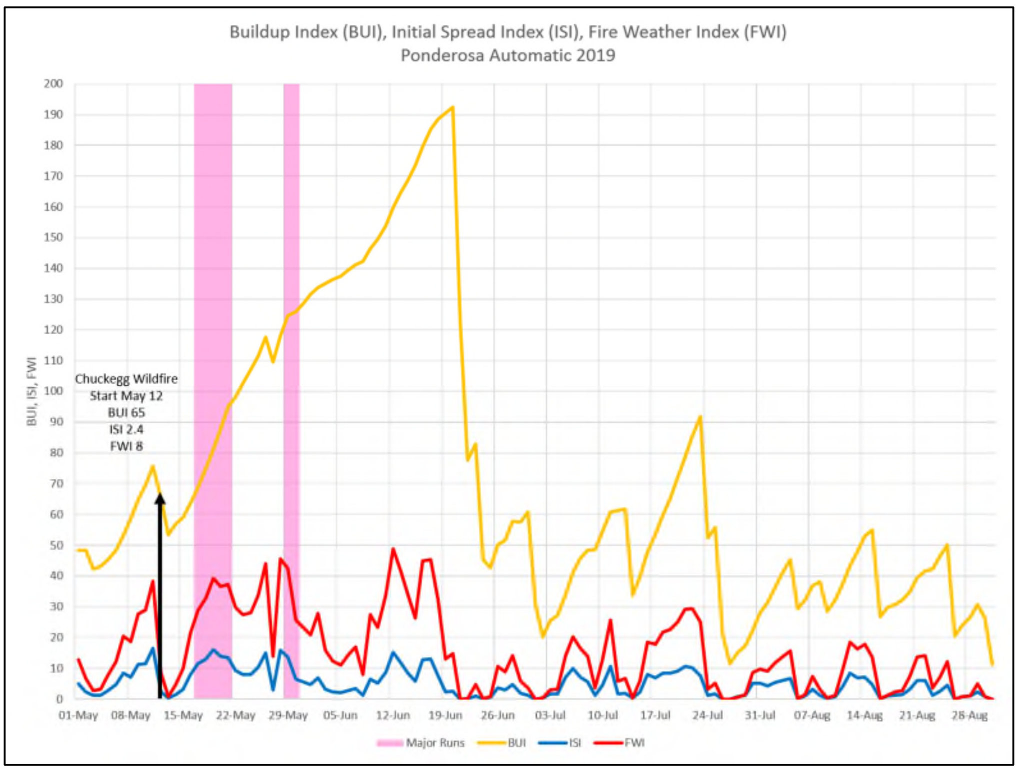


Figure 14: Sustained 13h00 Wind Speeds for May 2019

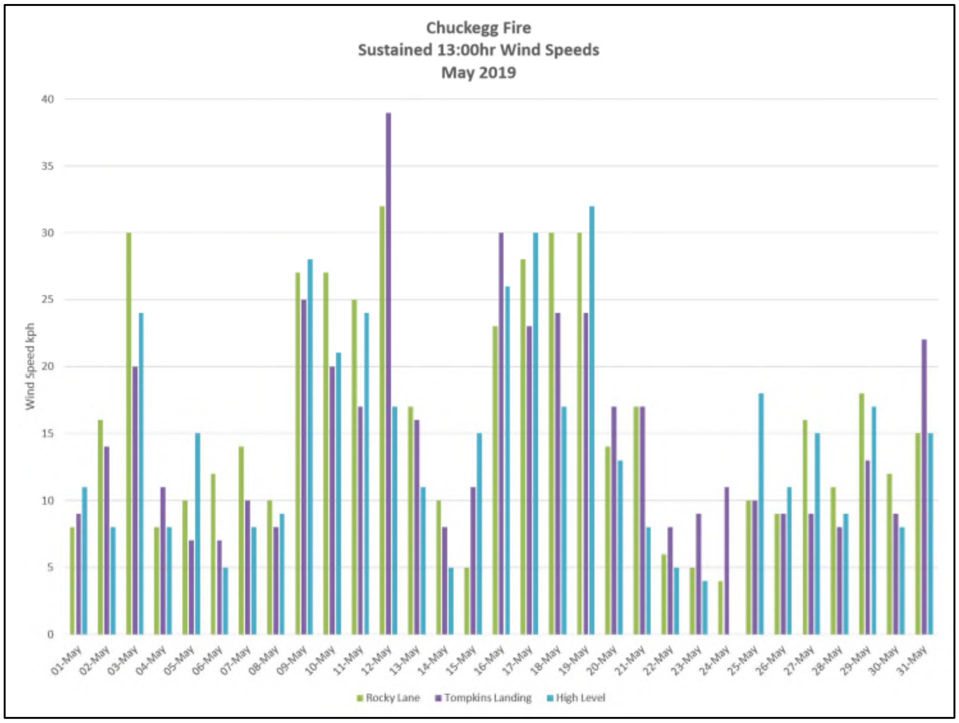
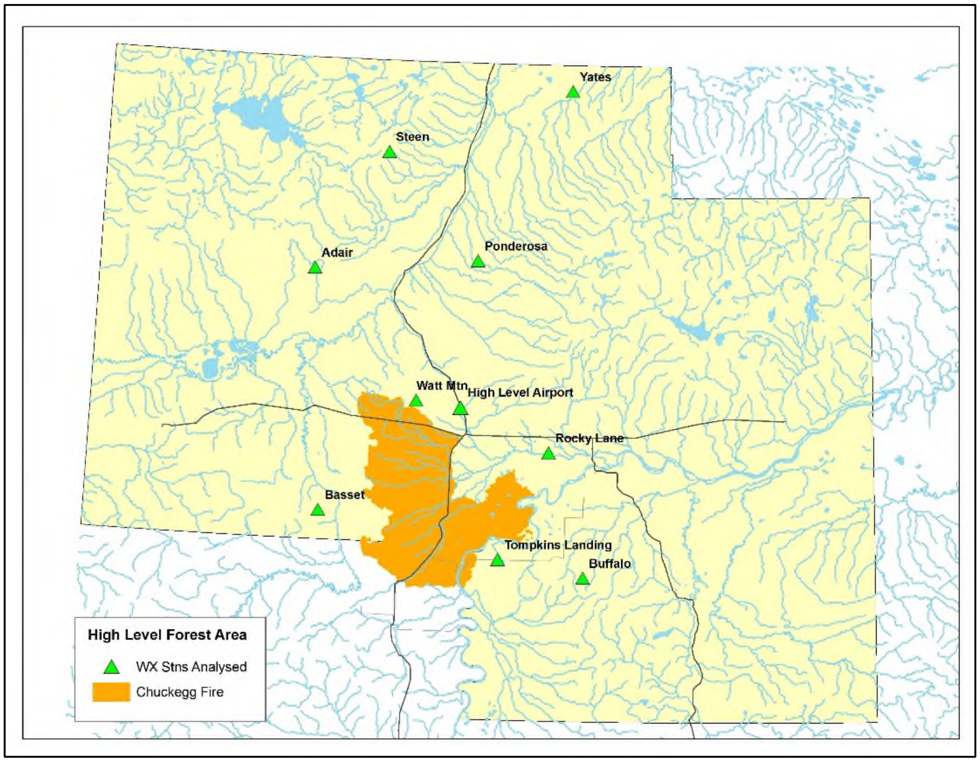


Figure 15: Illustration of Area Burned on May 17 and May 18 by the Chuckegg Creek Wildfire

Figure 16: High Level Forest Area Weather Stations in Relation to the Chuckegg Creek Wildfire



DROUGHT CODE CONDITIONS

Early indicators of drought conditions in the High Level Forest Area in Alberta are shown in Table 5, that summarizes the closing Drought Code (DC) values for local weather stations in the fall of 2018. Both Rocky Lane and Tompkins Landing automatic weather stations closed on October 31 with extreme DC values. Based on overwinter snow conditions, new 2019 starting values for the DC are also included in Table 5. The same stations' starting values are over 400, which is the equivalent of DC values of mid-summer in a severe fire season. Figures 17 to 18 illustrate the impact of the drought conditions that lowered the water table substantially and dried up lakes in the general area of High Level. The addition of deep organic fuels associated with the dried-up lakes has significant impact on the ability to model and predict fire behaviour (Waddington et al, 2012[7]).

[7] Reference: Examining the utility of the Canadian Forest Fire Weather Index System in boreal peatlands. J.M. Waddington, D.K. Thompson, M. Wotton, W.L. Quinton, M.D. Flannigan, B.W. Benscoter, S.A. Baisley, and M.R. Turetsky. Can. J. For. Res. Vol 42:47-58 (2012). doi: 10.1139/X11-162

Table 5: High Level Forest Area Weather Station Open / Close Dates and FWI

STATION	YEAR	FWI END DATE	FWI START DATE	DROUGHT CODE
Ponderosa Auto	2018	October 31		613
	2019		April 2019	371
Watt Mtn	2018	October 22		321
	2019		April 29	232
Basset	2018	August 30		325
	2019		May 9	241
Rocky Lane Auto	2018	October 31		681
	2019		April 17	451
Tompkins Landing Auto	2018	October 31		702
	2019		April 17	424

Figure 17: Spring 2019 Drought Code Conditions Near High Level (Photo of Devils Lake)

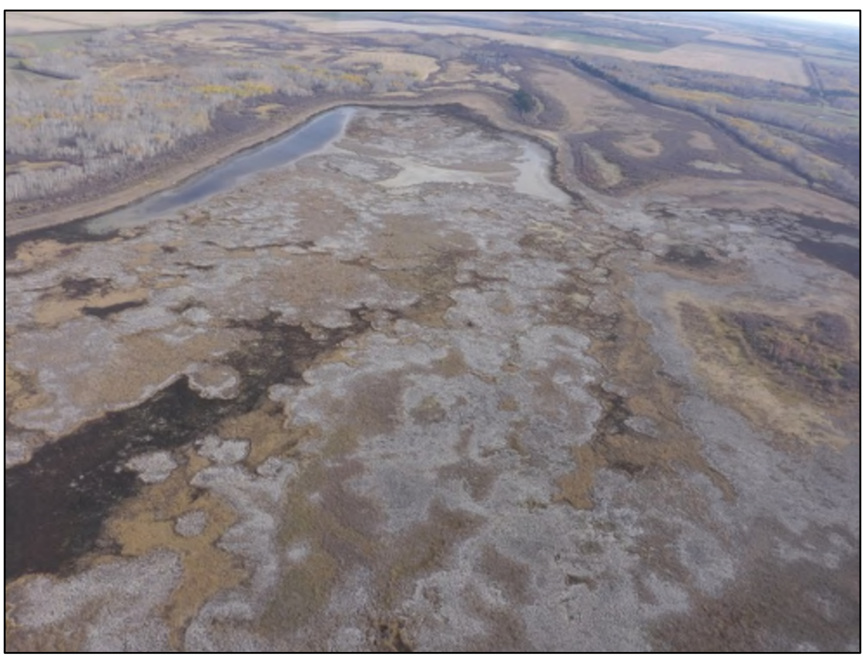
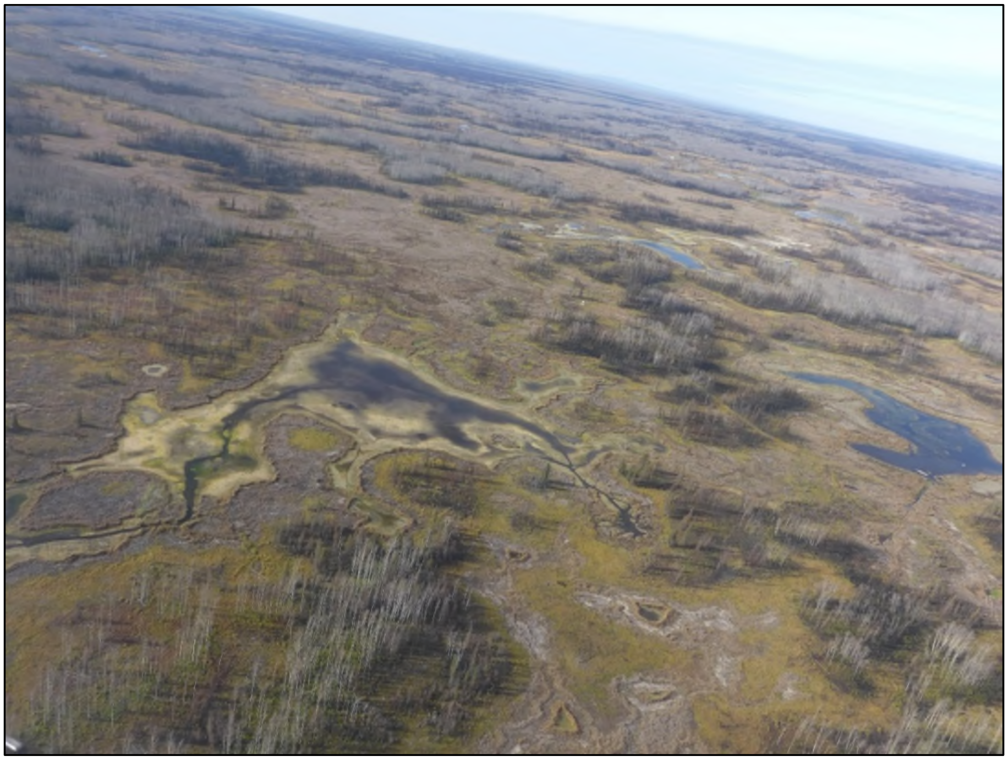


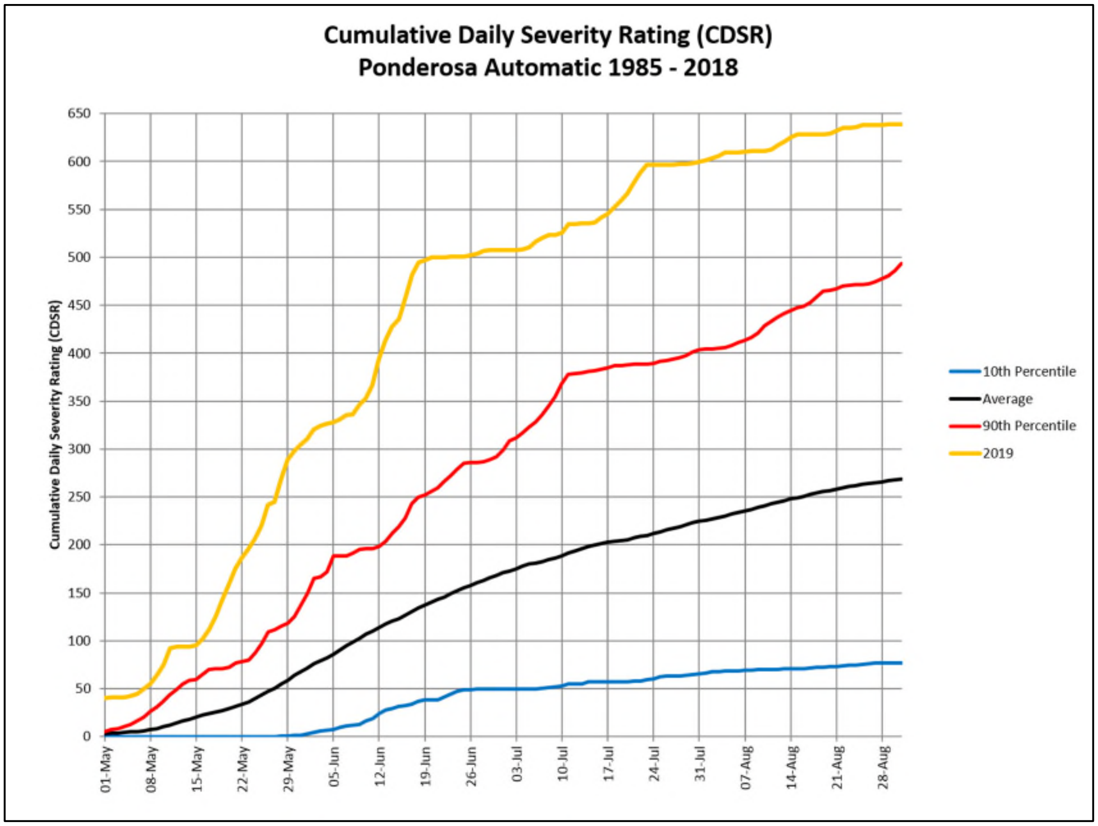
Figure 18: Spring 2019 Drought Conditions Near High Level



CUMULATIVE DAILY SEVERITY RATING

The Cumulative Daily Severity Rating (CDSR) component of the FWI System is referenced earlier in this report. Figure 19 illustrates the 2019 CDRS graph plotted against the historic average (black line), the 10th percentile (blue line) and the 90th percentile (red line) for the Ponderosa Automatic weather station. The 2019 CDRS line (yellow) tracks above the 90th percentile prior to ignition of the Chuckegg Creek wildfire on May 12 and on May 15 begins a steep climb through to June 19. During the period of May 17 to May 31 the area burned increases from 271 hectares to 237,000 hectares, confirming the utility of the CDSR values as an indicator of resistance to control.

Figure 19: Cumulative Daily Severity Rating for The Ponderosa Automatic Weather Station



Peace River Forest Area

As in High Level, fire danger conditions associated with the Battle complex escalated quickly late in the first week in May, driven by high wind speeds, low relative humidity levels and no precipitation. Build Up Index (BUI) levels rose dramatically through late May while Fire Weather Index (FWI) values were frequently very high to extreme (Figure 20). During this period, sustained high winds were also common. This combination resulted in extreme fire behaviour, with increasing levels of fuel consumption, fire intensity and resistance to control.

PWF052 was detected at 21h10 on May 11 and both the DC and FWI values were above the historic 90th percentile. Although the wildfire was assessed just before dark, no initial attack occurred until the following morning and wildfire size was estimated at 779 hectares by 08h36. A slight drop in the FWI values resulted in a Being Held (BH) declaration at 08h00 on May 16, however FWI values began to rapidly accelerate during the rest of May.

The FWI, BUI and ISI increased steadily during the first week of May in a similar pattern to the High Level Forest Area (Figure 20). The FWI values decreased on May 14 to 10 but rapidly increased to 34 through to May 21 and the BUI continued to climb very steeply. Strong sustained winds occurred in the Battle complex area prior to ignition of PWF052 and continued from May 16 through to May 21 (Figure 21). Figure 22 illustrates the location of weather stations in the Battle complex area. The Battle River Lookout was the primary station for this analysis.

Note: ISI values plotted in Figure 20 are based on a 10-minute wind average at 13h00 and do not represent the sustained wind values in Figure 21.

Figure 20: 2019 BUI Plotted with ISI and FWI for the Battle River Weather Station. The Start Date and 13h00 Values Are Noted on The Graph.

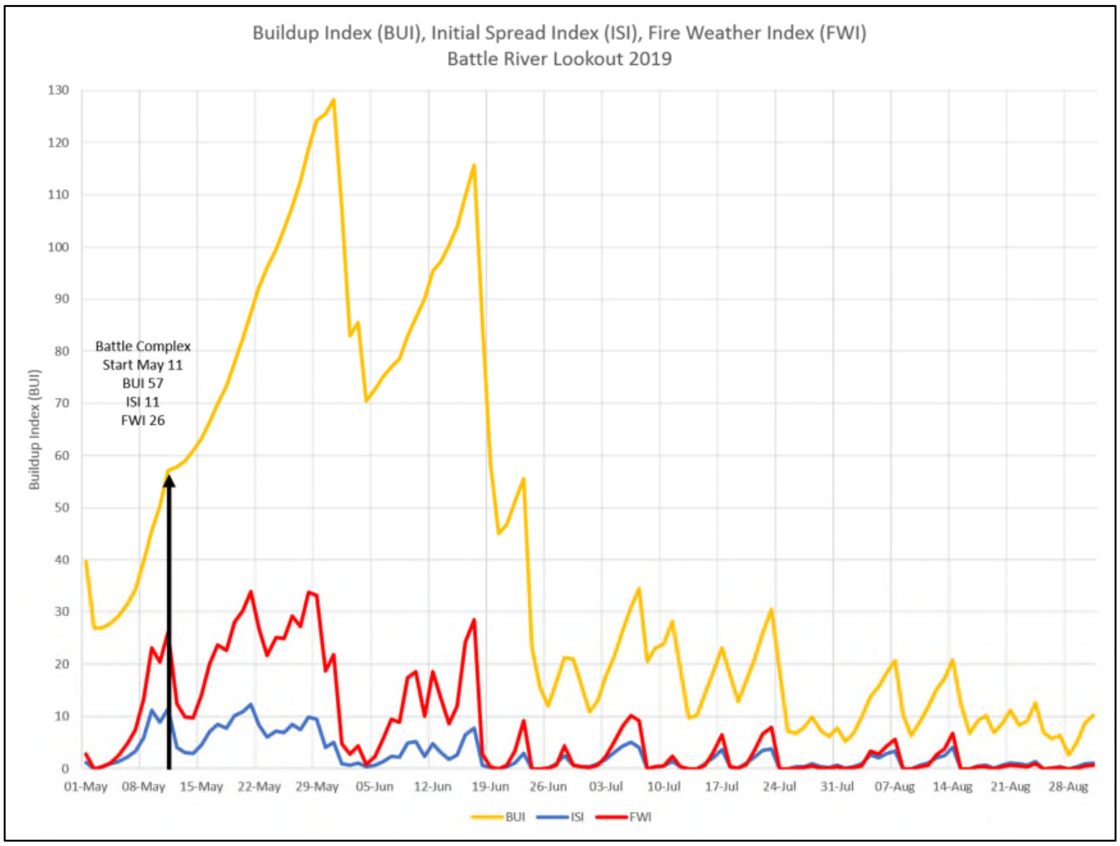


Figure 21: Sustained 13h00 Wind Speeds for May 2019

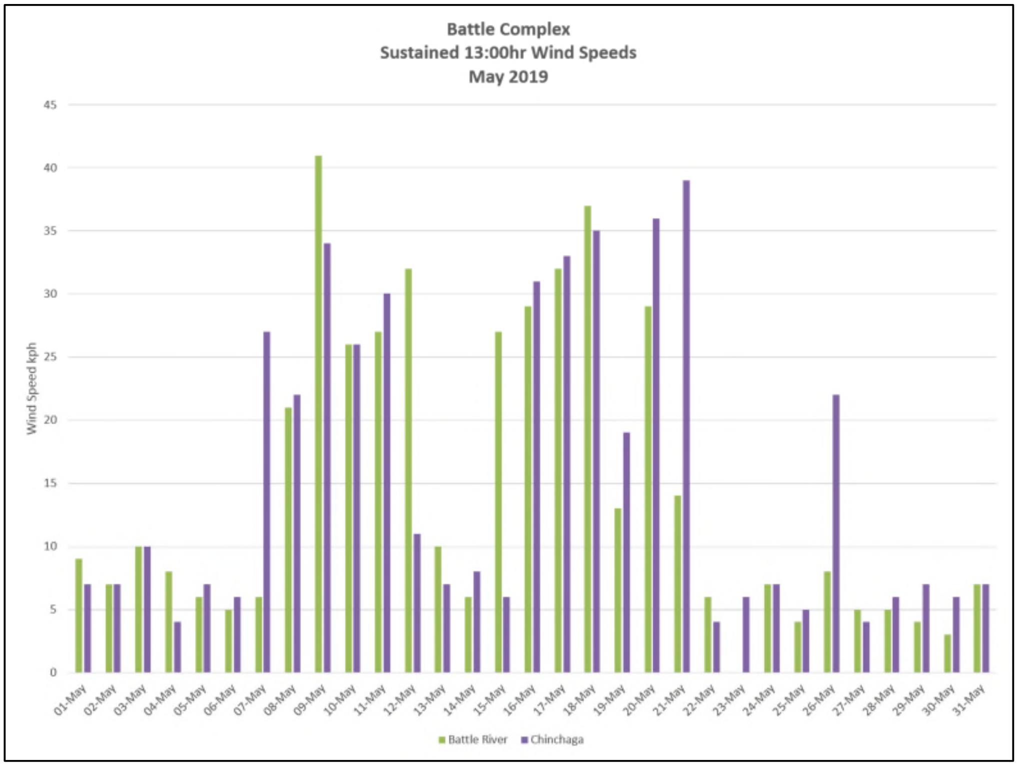
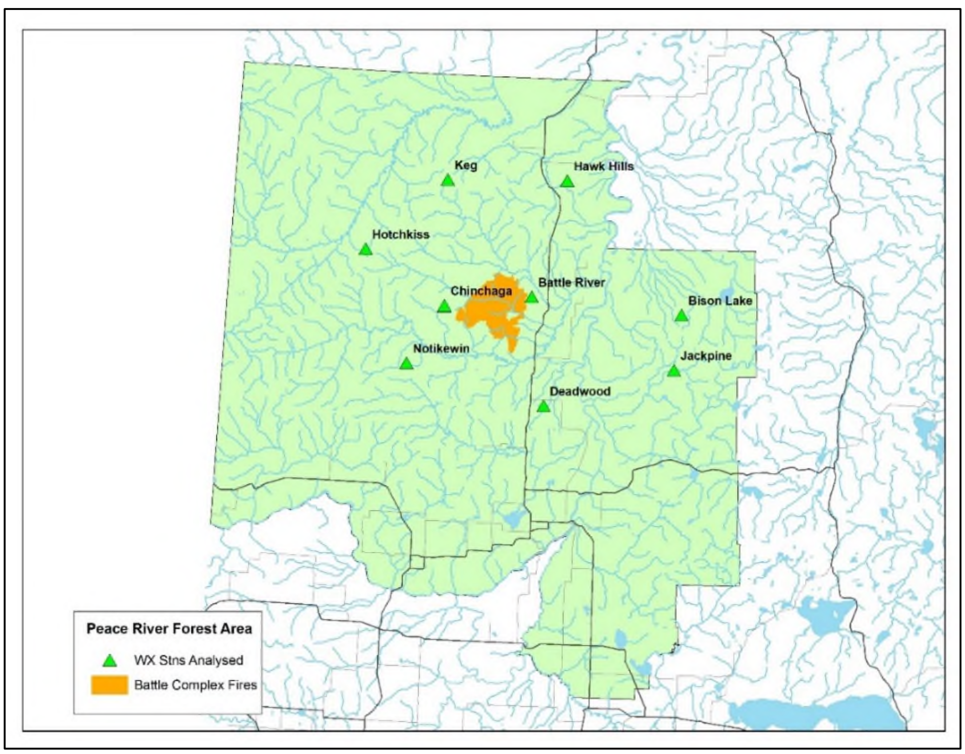


Figure 22: Peace River Forest Area Weather Stations in Relation to the Battle Complex



DROUGHT CODE CONDITIONS

Early snow melt in the Peace River Forest Area was consistent with the general pattern in northern Alberta and consequently FWI calculations began mid-April. Table 6 summarizes the closing Drought Codes in 2018 and April start-up values for the 2019 Drought Codes. Note that FWI calculations commence three days following snow-gone in the area. The Battle River automatic weather station starting value is significantly higher than other local stations in the area.

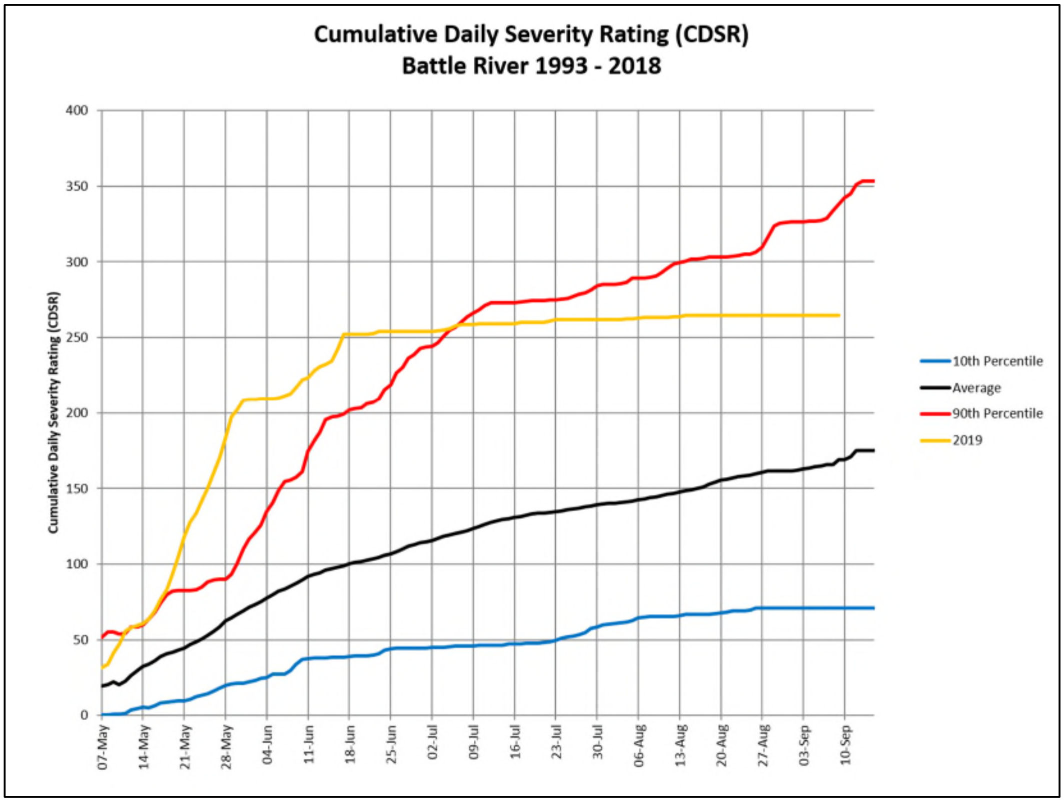
Table 6: Peace River Forest Area Weather Station Open / Close Dates and FWI

STATION	YEAR	FWI END DATE	FWI START DATE	DROUGHT CODE
Battle River Auto	2018	October 31		444
	2019		April 18	306
Deadwood Auto	2018	October 31		306
	2019		April 11	229
Notikewan Auto	2018	August 30		295
	2019		April 28	143
Hotchkiss Auto	2018	October 31		348
	2019		April 18	227
Hawk Hills Auto	2018	September 13		196
	2019		April 18	141
Chinchaga Auto	2018	October 31		176
	2019		April 18	79

CUMULATIVE DAILY SEVERITY RATING

Similar to the Ponderosa Auto Cumulative Daily Severity Rating (CDSR) trend, the Battle River 2019 trend reached the 90th percentile average prior to PWF052 ignition on May 11 (Figure 23). The 2019 trend then climbed steeply above the 90th percentile average until June 18 during which time PWF052 burned a total of 55,179 hectares. Again, the 2019 CDSR trend is a strong indicator of resistance of control during the month of May.

Figure 23: Cumulative Daily Severity Rating for the Battle River Weather Station



Slave Lake Forest Area

The wildfire events in High Level and Peace River Forest Areas preceded the ignition of SWF049 on May 18 and fire danger conditions had continued to worsen from early May. As in High Level and Peace River, early snow melt and high carry-over Drought Codes from 2018 were indicators of an early and potentially severe fire season. Several lookouts adjacent to communities were opened on April 1 and wildfire operations were all up and running by the end of April.

FIRE DANGER CONDITIONS IN MAY AND JUNE 2019

FWI System components on the day of ignition (May 18) of SWF049 were increasing steadily with the Drought Code at the 90th percentile and the FFMC and ISI at the 95th percentile. The FWI, BUI and ISI values were all extreme prior to May 30 (Figure 24) when SFW049 increased by more than 80,000 hectares.

Figure 25 illustrates the presence of strong sustained winds during the most active burning periods associated with SWF049. Figure 26 identifies the location of the Wabasca weather station used in this analysis.

Figure 24: 2019 BUI Plotted with ISI and FWI for the Wabasca Automatic Weather Station. The Start Date, 13h00 Values and Major Run is Noted on the Graph.

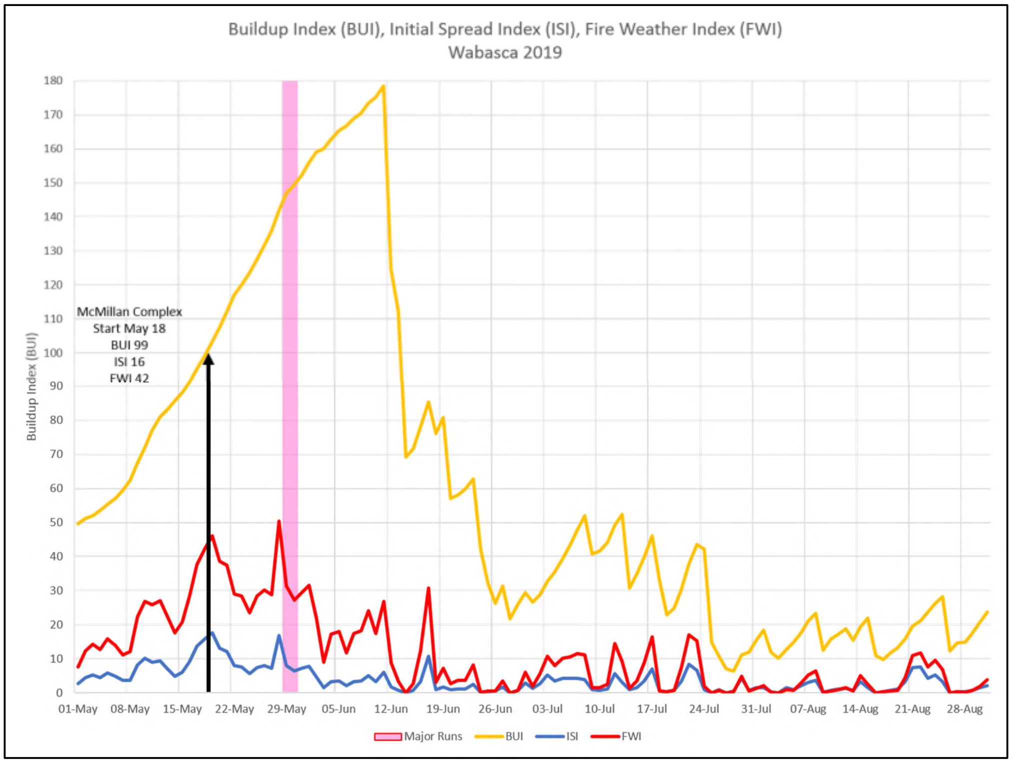


Figure 25: Sustained 13h00 Wind Speeds for May 2019

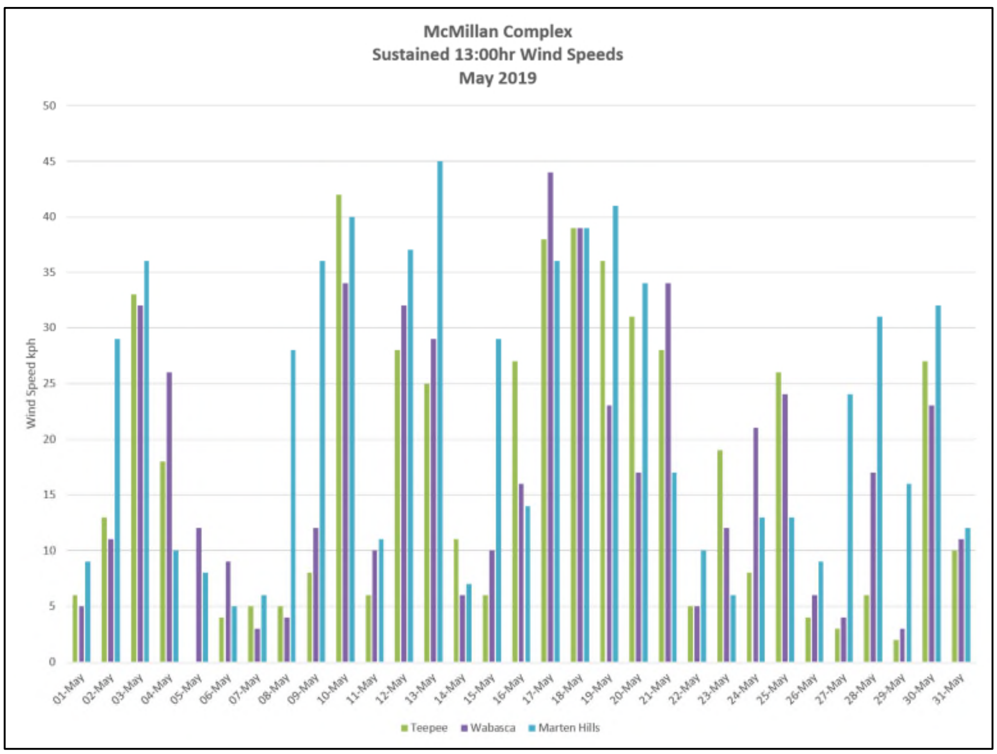
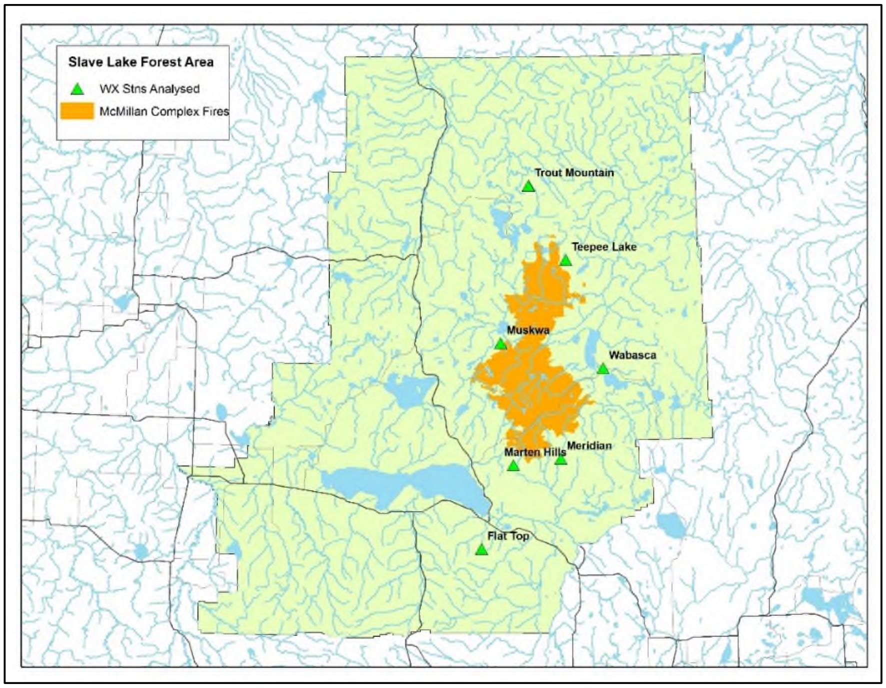


Figure 26: Slave Lake Forest Area Weather Stations



DROUGHT CODE CONDITIONS

Table 7 summarizes the closing Drought Codes in 2018 and April start up values for the 2019 Drought Codes for stations in the McMillan complex area. Drought conditions were similar to the Battle complex but lower than the Chuckegg Creek wildfire.

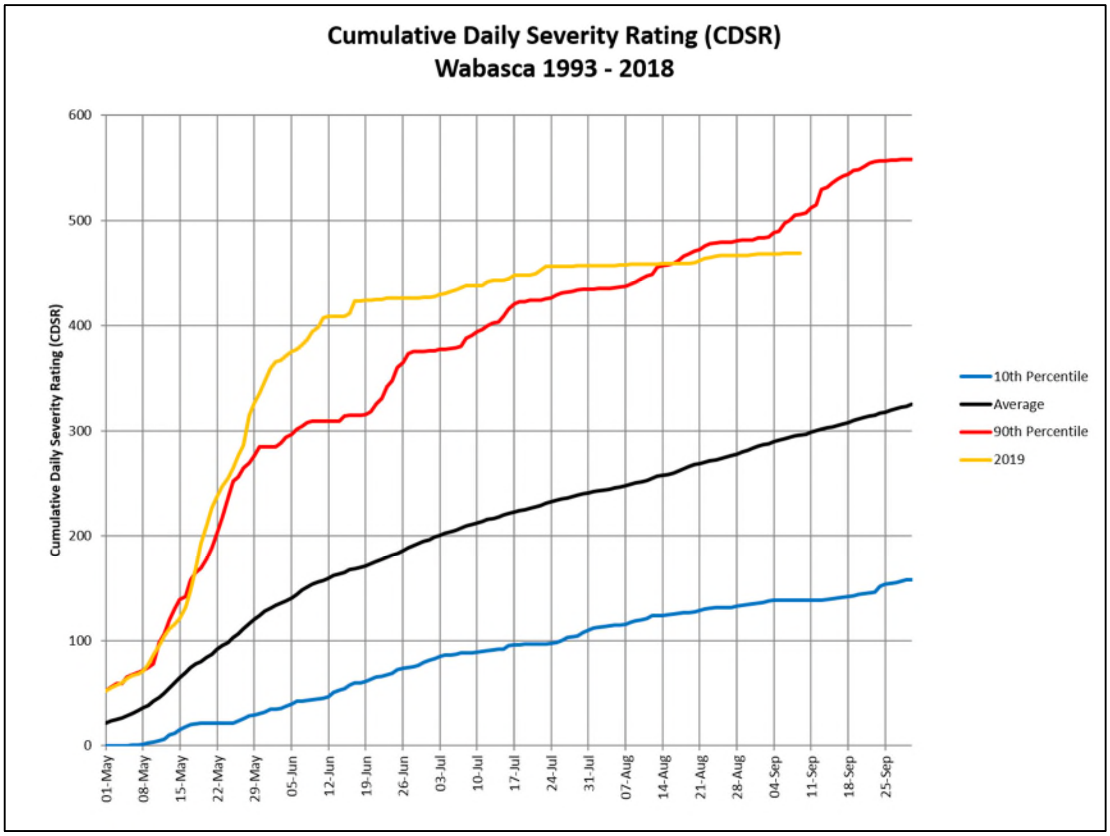
Table 7: Slave Lake Forest Area Weather Station Open / Close Dates and FWI

STATION	YEAR	FWI END DATE	FWI START DATE	DROUGHT CODE
Teepee Auto	2018	October 31		341
	2019		April 16	253
Muskwa Auto	2018	October 31		370
	2019		April 20	239
Marten Hills Auto	2018	October 31		207
	2019		April 30	76
Wabasca Auto	2018	October 31		465
	2019		April 16	360

CUMULATIVE DAILY SEVERITY RATING

Consistent with the 2019 CDSR trends in High Level and Peace River, the Wabasca trend exceeded the 95th percentile well ahead of the major fire runs on SWF069. Again, the steep climb of the 2019 CDSR trend in early May signals significant increase in difficulty of control on active wildfires (Figure 27). Note the position of the 2019 trend on May 29/30 when SWF069 over-ran SWF049 and area burned increase is approximately 100,000 hectares.

Figure 27: Cumulative Daily Severity Rating for the Wabasca Automatic Weather Station



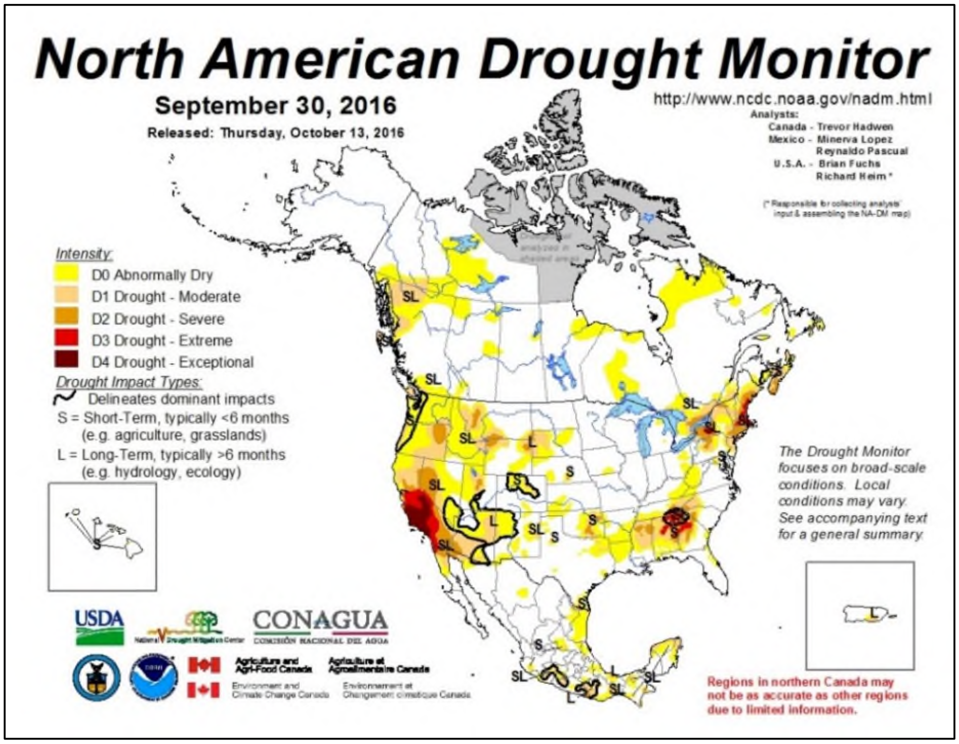
Summary

Early indications of a potentially severe fire season in northern Alberta were the extreme closing Drought Code values in October 2018 for several weather stations in High Level, Peace River and Slave Lake Forest Areas. Temperature and precipitation anomalies in April and May of 2019 contributed to early snow melt and subsequent early initiation of the FWI System calculations at a number of weather stations. The month of May was characterized by a rapid increase of fire danger conditions throughout northern Alberta, and ultimately more than 528,460 hectares burned during that month in three wildfire complexes in the High Level, Peace River and Slave Lake Forest Areas. A chronology of the findings from the Situational Analysis follows:

- Drought conditions preceded the fire season in northern Alberta late 2018 and early 2019.
- Temperature and precipitation anomalies during March/April 2019 contributed to early snow melt and very dry fine fuels by May.
- Strong sustained winds in March and April also contributed to early snow melt and drying conditions.
- Fire Weather Index System values increased at an unusually rapid rate during May 2019.
- The Buildup Index exceeded the historic average (1993-2018) from early May through to June 25.
- Strong sustained winds were associated with periods of significant wildfire growth at all three wildfire incidents.
- Very High Fire Weather Index values were associated with periods of significant wildfire growth at all three wildfire incidents.
- The Cumulative Daily Severity Rating exceeded the 90th percentile level prior to wildfire ignitions in all three wildfire incidents.

Appendix B1 – North American Drought Monitor Maps for September 2016 – 2018

North American Drought Monitor for September 30, 2016[8]



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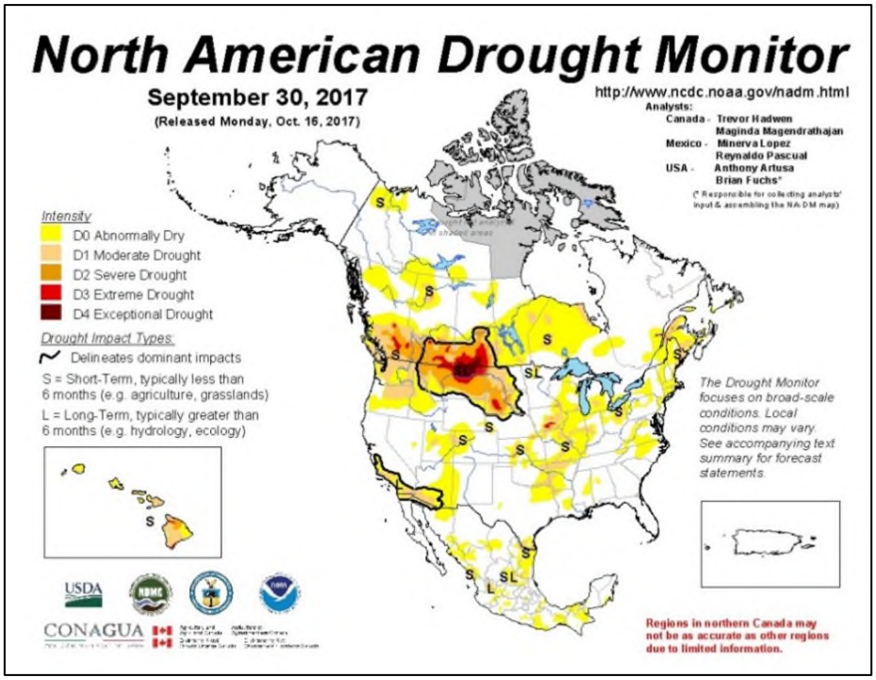
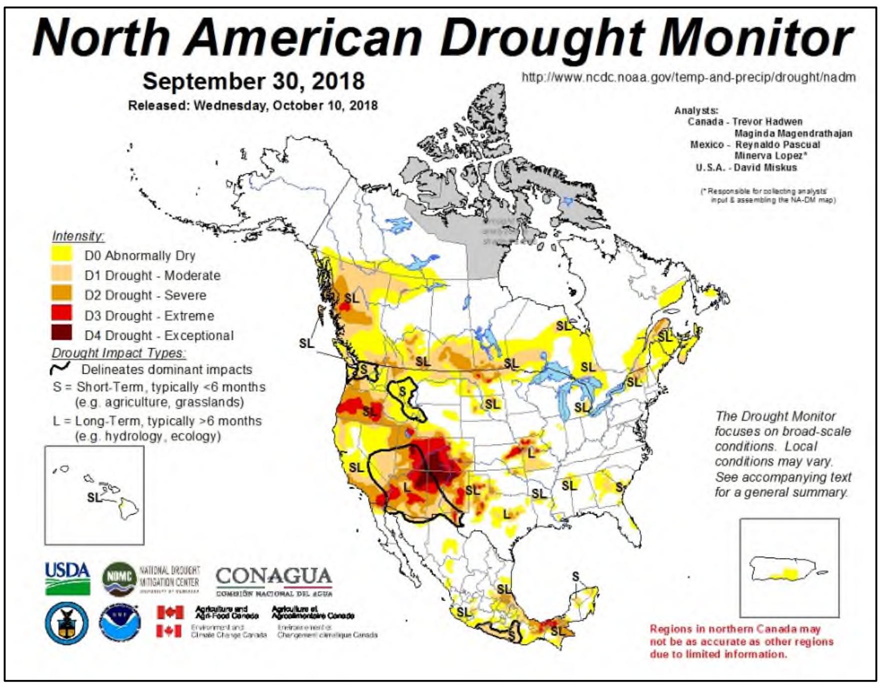
8 Source: Retrieved from: https://www.ncdc.noaa.gov/temp-and-precip/drought/nadm/maps/en/201609

North American Drought Monitor for September 30, 2017[9]



North American Drought Monitor for September 30, 2018[10]



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[9] Source: Retrieved from: https://www.ncdc.noaa.gov/temp-and-precip/drought/nadm/maps/en/201709

[10] Source: Retrieved from: https://www.ncdc.noaa.gov/temp-and-precip/drought/nadm/maps/en/201809

APPENDIX C – HFI CLASSES

Head Fire Intensity (HFI) Class Chart		
Fire Intensity Class	**Description of Probable Fire Potential and Implications for Wildfire Suppression**	**HFI Value (kW/m)**
1	• New fire starts are **unlikely to sustain** themselves due to moist surface fuel conditions • New ignitions may still take place from lightning strikes or near large and prolonged heat sources (e.g. campfires) • Resulting wildfires generally do not spread much beyond point of origin; if they do, **control is very easily achieved** • Complete extinguishment of wildfires that are already burning may still be required provided there is sufficient fuel and it is dry enough to support smouldering combustion	**< 10**
2	• From the standpoint of moisture content, surface fuels are considered sufficiently receptive to sustain ignition and combustion from both flaming and glowing firebrands • **Fire activity is limited to gentle surface burning with maximum flame heights of < 1.3m** • **Control of wildfires is fairly easy** but can become troublesome as adverse fire impacts can still result • Wildfires can become costly to suppress if not attended to immediately • Direct manual attack by "hot spotting" around the entire fire perimeter with only hand tools and water from backpack pumps; a "light" helicopter with bucket is also effective	**10 - 500**
3	• Both moderately and highly vigorous surface wildfires with flames up to just over 1.5m high or intermittent crowning (i.e. torching) can occur • As a result, wildfires can be moderately difficult to control • Hand-constructed fireguards are likely to be challenged and the opportunity to "hotspot" the perimeter gradually diminishes • Water under pressure (e.g. wildfire pumps with hose lays) and heavy machinery (e.g. bulldozer and "intermediate" helicopter) are generally required for effective action at the wildfire's head	**500 - 2000**

Head Fire Intensity (HFI) Class Chart		
Fire Intensity Class	**Description of Probable Fire Potential and Implications for Wildfire Suppression**	**HFI Value (kW/m)**
4	• **Burning conditions have become critical** as intermittent crowning and short-range spotting is commonplace and as a result **control is very difficult** • Direct attack on the head of a wildfire by ground forces is feasible for only the first few minutes after ignition has occurred • Otherwise, any attempt to attack the wildfire's head should be limited to "medium" or "heavy" helicopters • Until the wildfire severity abates, resulting in the subsidence of a wildfire run, the uncertainty of successful control exists	**2000 - 4000**
5	• **Intermittent crown wildfires are prevalent** and continuous crowning is also possible as well in the lower end of the spectrum • **Control is extremely difficult and all efforts at direct control are likely to fail** • Direct control is rarely possible given the wildfire's probably ferocity except immediately after ignition and should only be attempted with the utmost caution • Any suppression action must be restricted to the flanks and back of the wildfire, depending on the wildfire's forward role of advance	**4000 - 10,000**
6	• The situation should be considered as **"explosive" or extremely critical** in this class • The characteristics commonly associated with extreme fire behaviour (e.g. rapid spread rates, continuous crown wildfire development, medium-to-long range spotting, firewhirls, massive convection columns, great walls of flame) is a certainty • Wildfires present **serious control problems** as they are **virtually impossible to contain** until burning conditions emeliorate • Direct attack is rarely possible given the wildfire's probable ferocity except immediately after ignition and should only be attempted with the utmost caution • The only effective and safe control action that can be taken until the wildfire run expires is at the back and up along the flanks	**> 10,000**

APPENDIX D – OVERVIEW OF THE 2019 FIRE SEASON

Summary of Events

The 2019 fire season experienced three major incidents: the Chuckegg Creek wildfire ("Chuckegg"), Battle complex ("Battle"), and McMillan complex ("McMillan"). Each of these incidents had their own unique challenges that were compounded by underlying drought, prolonged spring season drying, windy conditions and concurrent timelines. Despite these challenges, the Wildfire Management Branch (WMB) and its partners were able to protect public safety throughout the course of these events. However, because of extreme hazard conditions and aggressive fire behaviour WMB was challenged to effectively contain the duration and severity of these major wildfire incidents. Outcomes were significant; in addition to over 883,000 hectares of total area burned and 17 structures lost, this fire season was also the costliest, incurring a direct government wildfire suppression expenditure of approximately $438.6 million.[11]

This document is a summary of the events that took place leading up to, during, and following the three major wildfire incidents of 2019.

2019 Pre-Season

Early Season Conditions

A contributing factor to the severity and intensity of the three major wildfire incidents was the hazardous conditions leading up to the 2019 spring fire season. In October 2018, several weather stations in High Level, Peace River and Slave Lake Forest Areas recorded extreme Drought Code values followed by winter precipitation that was below normal. The three-year drought in the High Level Forest Area was further exacerbated in 2019 by the lack of precipitation and warm temperatures during the months of March, April and May. Along with an early snow melt by mid-April in northern Alberta, these weather patterns combined to signal an early fire season.

These wildfire incidents occurred during a long drought, prior to green-up, and continued through May with hot, dry and windy conditions. Spring wildfires are particularly susceptible to wind and have an abundance of dry fine fuels, which present a challenge to firefighters because of their quick ignition and potential for spotting. Spring wildfires do not typically fully involve the heavier fuels under light wind, and this typically reduces the amount of suppression effort required to extinguish them. This advantage, however, was not experienced during drought conditions seen in 2019. Consistent with several previous spring wildfire experiences in Alberta, May 2019 was set up for potentially catastrophic wildfire events.

Pre-Season Activities

WMB is expected to be ready for fire season by May 1 or two weeks after snow melt. This means that preparedness activities such as training for WMB staff, readiness of equipment and ensuring contract resources such as airtankers are completed in the weeks leading up to the start of May. In addition, communications and

[11] The expenditures for fiscal year 2019-20 (April 1, 2019 to March 31, 2020) used in this section were based on preliminary information (actual expenditures and estimated commitments) AAF provided to MNP in November 2019. WMB's total expenditures for the 2019-20 fiscal year were approximately $570 million. This includes approximately $109 million base budget expenditures, and $461 million contingency funding expenditures for wildfire presuppression and response.

prevention activities with key stakeholders such as communities, industries and the public are a major priority at this time of year. These pre-season activities are critical inputs to ensure an effective response during the fire season.

Given that human-caused wildfires in Alberta have a history of leading to large and damaging wildfires in the first weeks of May, a spring focus on increased prevention activities, which relies heavily on effective communication with the public, is particularly important. One of the complicating factors of the 2019 fire season was the timing of the provincial election in April. Pre-fire season communication activities were slowed and the traditional advertising for prevention went unspent as Forest Area Information Officers (IOs) and the wildfire communications team was required to follow the direction of the Office of Communication and Public Engagement in enforcing the *Alberta Election Communication Policy*. The *Alberta Election Communication Policy* ensures that government communication during the writ period does not influence the election. Unfortunately, Alberta's fixed election period is legislatively set for March 1 through to May 31, which coincides with the start of a fire season. While there are exemptions for issues of public health and safety, wildfire prevention did not appear to receive that exemption in early 2019. It is not possible to determine what, if any, impact this had, given WMB does not have data to correlate the effectiveness of their communications and advertising with wildfire activity. However, the amount of earned media coverage (e.g., interviews by radio stations) was reduced given that IOs were not advertising key messages.

For the first time in four years, WMB had a Wildfire Information Unit Lead position in place. This role had remained unfilled for a number of years and was only in place for a short time before the fire season started. The position was a crucial advocate, alongside the Director of Communications for Alberta Agriculture and Forestry, to ensure IOs were empowered to speak to wildfire related media queries.

Past experience in Alberta (Chisholm, Slave Lake, Fort McMurray) shows how these fast-moving spring wildfires can become a major concern to communities. While municipal elected officials, Directors of Emergency Management (DEMs), and other emergency-related staff may have some Incident Command Structure (ICS[12]) training, many do not. A lack of experience with wildfires makes it even more difficult to adequately prepare staff and local resources to play their part in managing large scale incidents impacting their community. Experience also shows that the best way to prepare for such events is through multi-stakeholder tabletop and functional exercises, such as those recommended following the Horse River wildfire in 2016. These exercises are critical in providing a better understanding of roles and responsibilities, and for forming relationships among local authorities[13], government agencies, and WMB that are vital during emergency response. To improve upon Unified Command execution and operations and build these relationships, a Unified Command all-hazard incident management workshop ("Wildland-Urban Interface Unified Command Workshop") was conducted in Hinton in January 2019. Results of this workshop were published by Alberta Emergency Management Agency (AEMA) in *a Best Practices of Unified Command* document that was circulated with local authorities prior to the 2019 fire season.

[12] Incident Command System (ICS) is a standardized on-scene incident management concept designed specifically to allow responders to adopt an integrated organizational structure equal to the complexity and demands of any single incident or multiple incidents without being hindered by jurisdictional boundaries (US National Response Team). The ICS structure is used throughout Canada and other jurisdictions to act as a "common language" between agencies during emergency incidents. ICS is used throughout Alberta.

[13] Local Authorities are areas in Alberta that provide local government (Government of Alberta). This includes bodies such as municipalities and Indigenous communities.

While the level and frequency of training of local authorities and other WMB partners was not centrally tracked leading into 2019, new legislation will require this metric to be monitored in future seasons. As of January 1, 2020, the *Alberta Emergency Management Act* has mandated that these types of emergency preparation activities take place across the province. Under the Local Authority Emergency Management Regulation, local authorities are required to complete an annual tabletop exercise as well as a functional exercise every four years.[14] These requirements will help ensure a better level of training and preparedness across communities in Alberta.

Labour Regulation Implications in 2019

The Detection Program of WMB faced an unexpected challenge leading in to the 2019 fire season due to the expiration of a legislative exemption that permits wildfire lookout observers to work longer hours in a day than other workers in the province. The effectiveness of the lookout network relies on trained staff to maintain constant observation of the surrounding area in order to maintain primary coverage of the detection network during fire season. Under a past exemption under Section 1 of the Alberta Employment Standards Regulation, lookout observers were able to work longer hours than prescribed because of the nature and location of the work. However, in November 2018, this exemption expired and was not restored before the start of the season (restored in July 2019), causing uncertainty and disruption for returning staff and forcing changes to schedules for a critical early period of the 2019 fire season.[15] As a result, lookouts did not have the same staffing as past fire seasons, leaving some lookouts unmanned during mandatory days off, increasing reliance on other fire detection strategies. During these imposed days off, 23 new wildfires were detected in the immediate area of unmanned lookouts by secondary methods. Some might indicate that detection of these wildfires may have been slower than if the lookouts were manned when these wildfires started. However, with the data available, no correlation was possible between staffing of lookouts and any avoidable or unavoidable outcome. None of these 23 wildfires were the ignition source of any of the three major wildfire incidents of 2019. Nonetheless, this gap in the lookout observer exemption from the Employment Standards Regulation may have had a material impact on the overall efficacy of the detection network in 2019.

Preparedness

Snow melt occurred in northern Alberta early in 2019 and by mid-April, WMB had activated firefighters, aircraft, and contracts. The organization moved into operating season by end of April, with weather stations operating, staff in lookouts, and the Preparedness Planning System (PPS) operating at Forest Areas (FAs) and at Alberta Wildfire Coordination Centre (AWCC) in Edmonton. By early May, nearly all contract aircraft and overhead staff were working. Some firefighters and seasonal staff remained in training with a goal of shifting to full capacity and regular shifts by May 15. Efforts have been made over the last few years to have fire crew resources fully prepared by May 1 at the latest, but challenges remain to meet this target timeframe.

WMB has a formalized PPS that is designed to adjust the number and positioning of firefighters, helicopters, airtankers, and heavy equipment daily as the wildfire hazard changes. This system uses a "coverage assessment" based on a calculation of the time for a crew in a helicopter to dispatch from their base and reach any point in a FA. If a crew is calculated to arrive at a wildfire location before the wildfire reaches two hectares in size (a key

[14] *Local Authority Emergency Management Regulation – Summary* (2018). Government of Alberta.

[15] Phone correspondence. *Employment Standards Regulation*. January 7, 2020.

initial attack target), that part of the FA is estimated to be “covered". In 2019, an older GIS-based software for this calculation was replaced with Alberta Wildfire Anticipation and Readiness Engine (AWARE) software.

The PPS is used by FAs and resources, such as fire crews and helicopters, are added and dispersed among bases as the fire danger increases. There were few examples in the spring of 2019, if any, where wildfires occurred, and crews and helicopters were not available for initial attack. By the time critical wildfires were detected on May 11, all contracted airtankers were on alert. The PPS system was challenged when conditions became extreme in May 2019. WMB Duty Officers are expected to keep coverage above 80 percent under these conditions. One problem with this approach is that it does not adequately address scenarios where resources become scarce and prioritization issues developed between manning up existing wildfires and meeting the preparedness PPS requirements. As well, airtankers, which are a critical resource when several wildfires are exhibiting extreme fire behaviour, became stretched on critical days. Overall, access to resources and limitations to organizational capacity increased the level of risk associated with the extreme conditions faced in 2019.

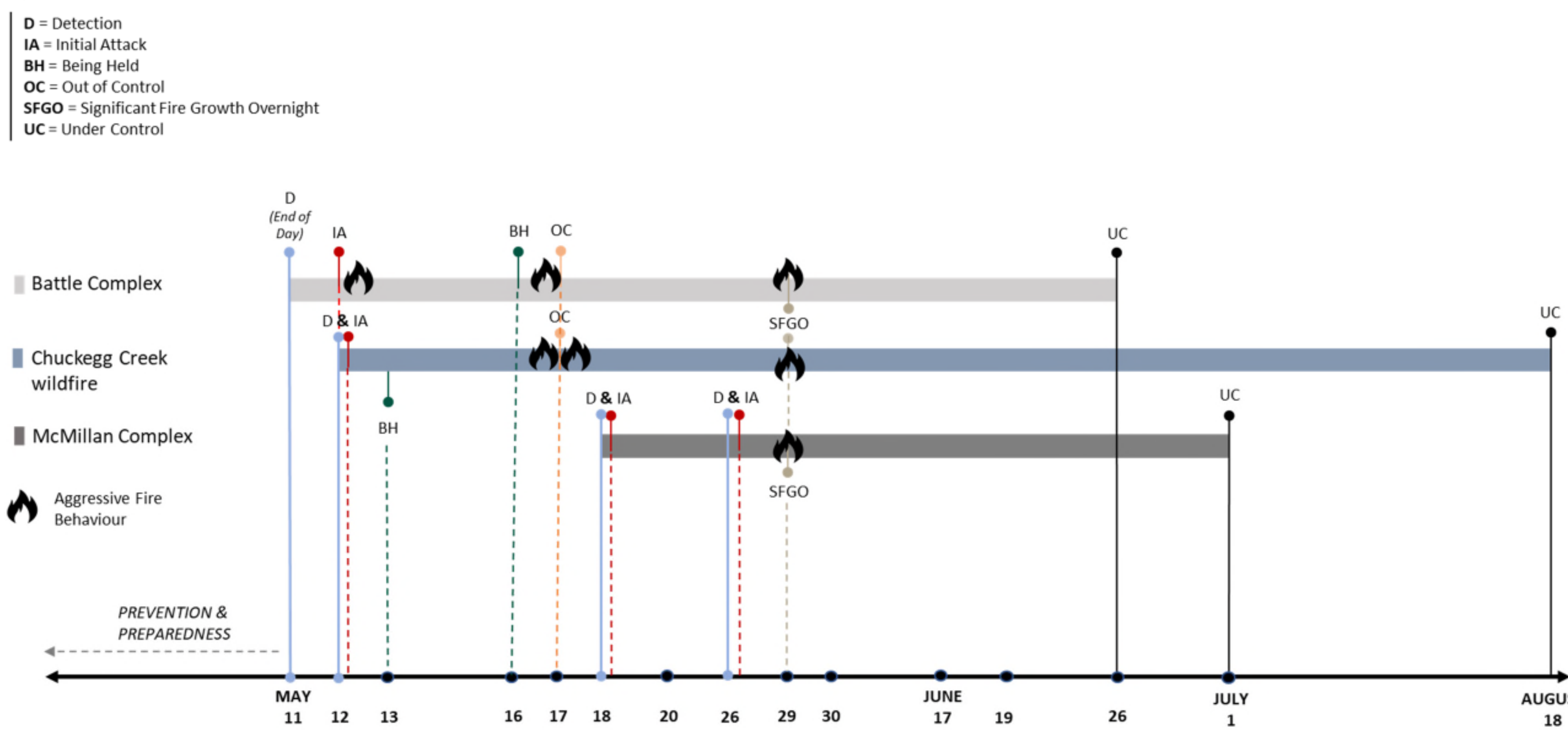
Summary of 2019 Major Incidents

Overview

Extreme hazard conditions in northern Alberta were well understood by WMB staff going into the month of May. Early season wildfires are expected to be very fast moving whenever pushed by winds, and typically are active under moderate winds because of the amount of fine fuel available before deciduous plants "green up". These extreme weather conditions came to a head in the northwest section of the province the weekend of May 11 and 12, beginning a month of aggressive fire behaviour that challenged WMB staff and resources.

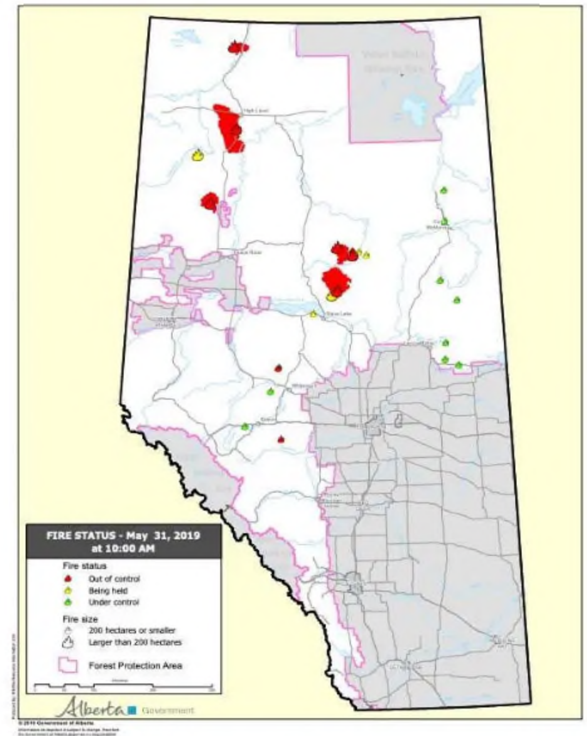
The figure below depicts the timeline in May for the three major wildfire incidents included in the scope of this review.

Figure 28: Timeline of 2019 Major Incidents



Despite the three major incidents that occurred in 2019, WMB was very successful in controlling the majority of wildfires that occurred during the same time period. In addition to Chuckegg Creek wildfire, Battle and McMillan complexes, there were 301 other wildfires that occurred in the month of May, 285 of which were held. Figure 29 illustrates those wildfires that grew to more than 200 hectares in size during the month of May.

Figure 29: Map of Alberta Fire Status--May 31, 2019



Four[16] Out of Control[17] incidents, including the northernmost Jackpot Creek wildfire, required sustained action at the same time, and thus caused the majority of operational concerns. The simultaneous nature of these incidents and weather conditions experienced at the time, made resourcing sustained action while maintaining capacity for IA in the province extremely challenging.

Initial Response

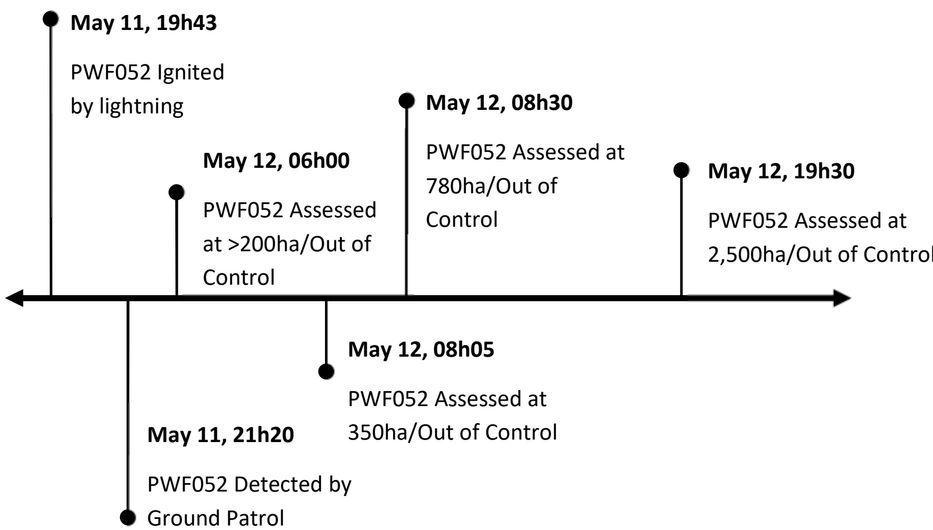
The first major wildfire incident, PWF052 (Battle), was detected late on May 11. This wildfire would eventually become part of the Battle complex. Lightning, likely from earlier in the evening at 19h43, caused this wildfire. The wildfire was detected at 21h10 by ground patrol staff in Manning. Approximately 25 minutes later, a second smoke report, PWF054 (Battle), was reported by Deadwood lookout just north of PWF052. Due to the late time of day that both wildfires were detected, only a quick aerial reconnaissance was possible before aircraft reached grounding time for the night. IA forces were mobilized but lack of access and approaching nightfall prevented their ability to deploy. A heavy equipment group was mobilized closer to the area that evening to improve access for IA the following morning.

[16] Note SWF049 and SWF069 were just joining at the time the map was made.

[17] A wildfire is defined as Out of Control (OC) when the wildfire is not responding to suppression action such that the perimeter spread is not being contained.

Early the following morning, an Incident Commander (IC), Unit Crew and supporting aircraft and heavy equipment were assigned to PWF052 and PWF054. The initial reconnaissance at 06h00 determined that PWF052 was beyond resources immediately on hand and assessed at over 200 hectares in size. Just north of PWF052, PWF054 was estimated to be between 50 and 75 hectares with containment considered achievable. As a result, priority for ground crews was assigned to PWF054 as a new strategy was being developed for PWF052.

Figure 30: Initial Progression of PWF052 (Battle Complex)



The Head Fire Intensity (HFI)[18] of PWF052 in the morning of May 12 was assessed as HFI 5, meaning there were extreme fire behaviour conditions present at the time. Unusually dry overnight conditions coupled with high winds early in the day caused PWF052 to grow exponentially in the hours to come.

Airtanker operations on PWF052 commenced at 08h50 with multiple groups and continued action until 13h45, when air attack was suspended because the action was proving ineffective given the extreme fire behaviour. By 19h30 on May 12, PWF052 was estimated at 2,500 hectares. A Type 1 Incident Management Team (IMT) arrived during the day on May 13, effectively taking over the incident by that evening. Aside from some hand ignition work undertaken late in the day on May 12 to help protect a grazing lease to the south, no ground crews were deployed on PWF052 until May 14. Dozer guard construction commenced the morning of May 12 and continued throughout the first days. Aerial suppression using helicopter buckets continued throughout the period with additional airtanker support provided periodically where achievable objectives could be determined. Once the IMT assumed command of the incident, concentrated ground resources commenced on May 14. By May 15, 121 firefighters were resourced to PWF052.

On the same day that IA on PWF052 and PWF054 was underway, HWF042, known later as the Chuckegg Creek wildfire, was detected at 13h22, and assessed to be 20 hectares in size. While detected on May 12, HWF042 was likely started at 18h08 the previous evening following a lightning strike, which held over and popped up during the

[18] Head Fire Intensity (HFI) is a fire weather index used to indicate the dryness of forest fuels and give relative measure of the burning conditions that can be expected by a "standard" fuel type (Alberta Wildfire – Understanding Fire Weather). HFI is measured on a six-point scale, with 1-2 indicating a low hazard rating through to 6, indicating an extreme hazard rating.

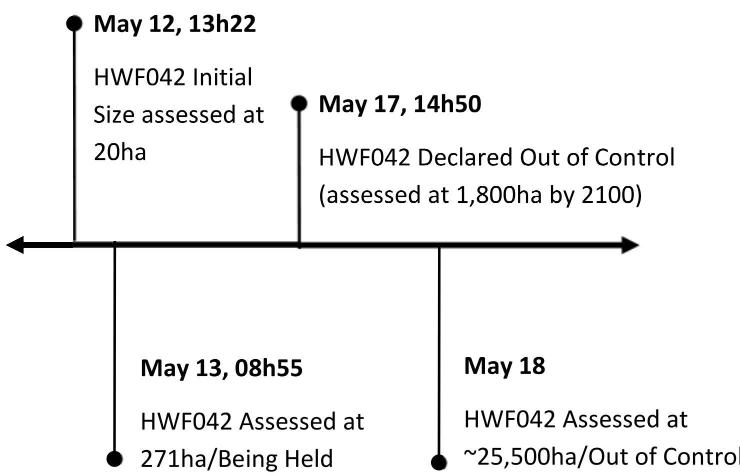
daytime heating. The IA was immediate upon detection and included two Helitack (HAC) crews and one Firetack (FTAC) crew along with wildfire officers, heavy equipment and helicopter support. Airtankers were requested but were delayed because of other wildfire priorities. Eventually airtankers were diverted from the Jackpot Creek wildfire, HWF041, which had been reported earlier the same day. The first airtanker arrived at 15h15, three hours and 43 minutes after detection.

HWF042 grew overnight to an estimated 271 hectares by the morning of May 13 and was declared Being Held (BH) at 08h55. For the next four days of HWF042, under modest winds and because of suppression efforts, the wildfire burned within the recognized perimeter and over the next four days did not grow.

Categorizing the wildfire as BH on the morning of May 13 caused confusion for many stakeholders. This was likely due to the terminology that defines BH[19], which is based on a low likelihood of wildfire spread given the prevailing and forecasted weather and resourcing. Because this definition is based on likelihood, it is subject to changing conditions; however, it was interpreted by many to mean HWF042 was UC. Consequently, the wildfire spread that occurred in the days to follow was unexpected by many members of the public.

Late afternoon on May 17 forecasted winds caused the HWF042 to escape; it was declared OC at 14h50 on May 17. It spread rapidly and grew to 1,800 hectares by 21h00. By 21h00 the following day, it had reached a size of over 25,000 hectares.

Figure 31: Initial Progression of HWF042 (Chuckegg Creek)



By May 18, extremely dry conditions were well established in northern Alberta and new and existing wildfires were challenging suppression resources – particularly whenever the winds picked up. The existing Battle complex and Chuckegg Creek wildfire grew considerably on May 17 and were burning OC. The forecast for May 18 included a Red Flag Watch for the Red Earth weather zone with forecasted southeast winds of 25 kilometres/hour gusting to 45 kilometres/hour. With WMB already challenged by the wildfires in High Level and Peace River, resources

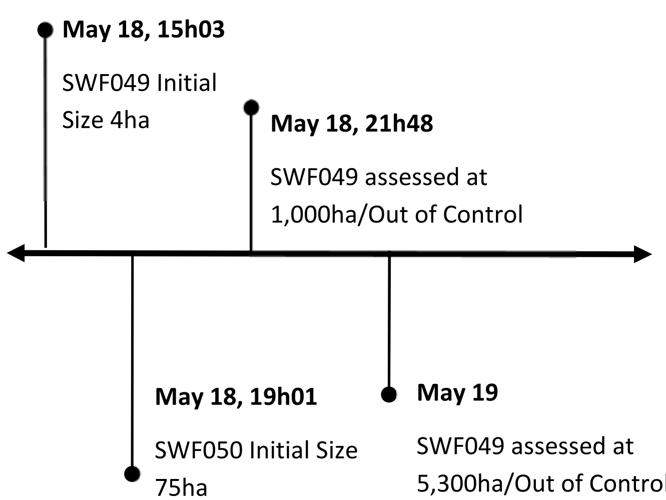
[19] BH is defined by WMB Standard Operating Procedures as "a wildfire that is identified as "being held" is when sufficient resources are currently committed and sufficient action has been taken, such that the wildfire is not likely to spread beyond existent or predetermined boundaries under prevailing and forecasted weather and fire behaviour conditions." This definition is consistent with other wildland fire agencies in Canada.

became further stretched with the ignition of new wildfires northeast of Slave Lake, which ultimately became the McMillan complex.

While SWF049 and SWF050 remain under investigation, at approximately 14h00 on May 18, a person ignited grass in several places along the north side of Highway 754 that runs between Marten Beach and Wabasca.[20] Other members of the public who were travelling the same highway quickly spotted the wildfires; SWF049 and SWF050 were reported via the 310-FIRE reporting line by 14h14. The HFI forecast for the area was 6 at the time of detection. Teepee Lake lookout confirmed the location and staff on route to SWF048 (a power line caused wildfire reported an hour earlier) reported "two good columns" suggesting the wildfires were getting a good push from the steady winds in extremely dry conditions.

IA was dispatched from Wabasca and air attack was requested and dispatched from Fort McMurray to respond to SWF049 and SWF050. The CL215T group positioned in Slave Lake for the day, like other groups across the province, was working other wildfires when SWF049 and SWF050 were reported. Ground crews, air attack and heavy equipment were well coordinated in the first 36 hours. A decision was made to focus on SWF050 because it was determined to be more likely to hold – this determination was valid. With heavy equipment supported by ground crews and helicopter buckets, SWF050 was held over the following two days growing to 1,540 hectares - it's final size - by the end of day on May 19 and declared BH on May 27. SWF049 was much more challenging; by the end of day on May 18, SWF049 was estimated to be 1,000 hectares in size. Ground forces were working at the rear, while airtankers and helicopters tried to hold the wildfire against McMillan Lake. On May 19, when winds continued to push the wildfire, SWF049 spread around McMillan Lake and grew to 5,300 hectares by the end of the day, setting the stage for the large complex that would persist for several weeks.

Figure 32: Initial Progression of SWF049 and SWF050 (McMillan Complex)



In the case of SWF049, appropriate Operations Section staff were assigned and provided continuity as an IMT arrived days later. However, the Forest Area was unable to resource support positions for Logistics, Finance and

[20] Note that the cause of SWF049 and 050 was determined to be arson. However, these wildfires remain under investigation, as the responsible person(s) have not yet been identified.

Administration and Plans Sections – both in the Forest Area office and at the incident itself. Interviews indicated the shortage of skilled and able staff to support Alberta IMTs was chronic in 2019; IMTs from other provinces arrived with support staff – a total of 19 people – yet Alberta teams were dispatched with eight people, assuming resource positions would be sourced as needed.

Sustained Action

Chuckegg Creek (HWF042)

On May 17, 2019 the Chuckegg Creek wildfire was declared OC and an IMT assumed command on May 20. A total of eight IMT teams were deployed in successive tours on Chuckegg Creek, with a total of 5,333 deployed to action the wildfire to bring it under control.

This wildfire was extremely active throughout the month of May and into June, presenting significant challenges for wildfire and emergency response organizations. There were, however, two extreme periods of fire behaviour that stand out. The first occurred between May 17 and 20, when the wildfire grew and took a 25-kilometre run, growing from approximately 2,300 hectares to over 71,400 hectares. Evacuation Orders were issued by Mackenzie County, the Town of High Level and the Dene Tha' First Nation, displacing over 3,000 residents from their homes.

These evacuations triggered the establishment of Unified Command for the Chuckegg Creek incident, which was enacted on May 21 with an Incident Command Post (ICP) in the Town of High Level. This first period of Unified Command was terminated on May 29. The timing of this termination proved extremely challenging due to aggressive fire behaviour that same day.

The initial set-up of Unified Command came with challenges as partners formed relationships and familiarized themselves with Unified Command protocol. Municipalities, admittedly, "possessed limited Incident Command System (ICS) knowledge and experience", particularly in the context of ICS protocol, which impacted efficiency when setting priorities and making decisions.[21] However, the first execution of Unified Command was reported to be effective and well received. A clear example of the effectiveness of Unified Command was illustrated during the 6,000 hectares burn out operation that was conducted on the northern flank of the wildfire. This exemplified the product of all jurisdictions working together and was instrumental in protecting the Town of High Level. The residents evacuated from Chuckegg Creek in May — Mackenzie County, the Town of High Level, Dene Tha' First Nation, Keg River and Carcajou areas — returned to their communities between June 2 and 5 following weeks of evacuation.

The second major run occurred on May 29, when Chuckegg Creek ran 30 kilometres overnight. These conditions were extreme — wildfire growth of this extent overnight is very uncommon. One area that presented a significant challenge to firefighters was a horseshoe-shaped area immediately adjacent the Peace River. This was an area of approximately 80,000 to 90,000 hectares in size of contiguous fuel, without any access points and little available water except the river itself. Different strategies were deployed to deal with this situation, but ultimately the emphasis on aerial ignition proved to be the most successful given the options available. This technique raised many concerns with local stakeholders given the increased risk and smoke concerns associated with aerial ignition, but was ultimately implemented with some success. Despite the firefighting efforts, the wildfire spread beyond control lines before the horseshoe area could be adequately addressed.

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[21] *Unified Command Observations & Recommendations* (2019), Alberta Emergency Management Agency.

Unified Command was established again between Mackenzie County and WMB on June 18. Rapid wildfire growth forced additional communities to evacuate between June 17 and 19, including the Hamlet of La Crete, Beaver First Nation and the community of Blue Hills. These were the last evacuations of the 2019 major incidents.

Chuckegg Creek, however, continued to burn OC until it was held on July 25 and eventually declared Under Control (UC) on August 18 — 98 days after detection. Chuckegg Creek burned a total area of 350,135 hectares with structures lost on the Paddle Prairie Métis Settlement and Mackenzie County in the area around Thompkins/Blue Hills.

PADDLE PRAIRIE MÉTIS SETTLEMENT

The Paddle Prairie Métis Settlement (PPMS) suffered significant loss as a result of the Chuckegg Creek wildfire that devastated their community.

Community Profile

The Paddle Prairie Métis Settlement is a Métis settlement in northern Alberta along the northern boundary of the County of Northern Lights and is home to nearly 800 members. It is located along the Mackenzie Highway (Highway 35), approximately 72 kilometres south of the Town of High Level and is the largest and most northerly of eight Métis Settlements in the province. The Settlement consists of approximately seventeen townships or nearly 175,000 hectares. It is bounded by the Peace River on its eastern border, with access across the river provided by the La Crete ferry. The land of the community is rich in wildlife, boreal timber, natural gas production and has multiple agricultural uses. Hunting is a primary source of food and a way of life for many community families, supplemented by fishing and trapping.

Impacts of the 2019 Fire Season

Overall, PPMS felt that they "fell through the cracks" during the 2019 fire season. As a Métis Settlement, they are not connected to Indigenous Services Canada as a First Nations Reserve would be, nor are they governed by the *Municipal Government Act,* as a municipality would be. Métis Settlements are unique communities within the province, by virtue of the *Métis Settlements Act*, with distinct status, rights, and jurisdiction. However, due to this legislative distinction, Métis Settlements, like Paddle Prairie, are left without direction or support in many cases, including during natural disasters. Consequently, during the wildfire events of the 2019 season, the roles, responsibilities and communication between PPMS and WMB were unclear at times. While PPMS declined to join the Unified Command established between the Town of High Level, Mackenzie County and the WMB, the community had a minimum of once-daily communication with Unified Command to maintain a level of situational awareness as it related to Chuckegg Creek.

On May 21, the community made the decision to evacuate a portion of community members due to air quality concerns for seniors and persons with disabilities. On May 26, the remainder of the community's 800 residents were evacuated. Community members were unable to return for 26 days, the longest evacuation period in the 2019 fire season.

Despite the efforts of neighbouring Town of High Level and of WMB, PPMS suffered serious loss and struggled with lack of resources to deal with the trauma it faced. Out of approximately 250 homes in the community, 16 were destroyed. Nine homes suffered some sort of damage and several outbuildings were lost. Impacts of the devastation included the loss of several traditional medicine gathering sites and worries of significant reduction in wildlife activity and harvestable timber.

Overall, Paddle Prairie Métis Settlement was uniquely and adversely affected by the 2019 fire season. The community, like many affected by wildfire in 2019, continues to heal from the impacts of the 2019 season.

Battle Complex (PWF052)

The first IMT took command of the Battle complex on May 13, 2019. A total of five IMTs were deployed on this wildfire in succession and, at its peak, over 490 personnel, 23 helicopters and 60 pieces of heavy equipment were deployed to fight the Battle complex.

Like the Chuckegg Creek wildfire, the Battle complex was initially declared BH at 08h00 on May 16 at 2,271 hectares. When the unanticipated challenges of the wind event occurred on May 17, it returned to OC at 15h30 that day, spreading northwest to an estimated size of 5,271 hectares. This change of the wildfire's control status from BH back to OC in such a short timeframe reduced confidence of the stakeholders immediately involved in WMB and the suppression actions being taken.

The second major run Battle took was on May 29 as a result of a frontal passage - the same weather pattern which affected all three major incidents. Once again, firefighters were caught off guard and the wildfire size increased by more than 12,500 hectares overnight. The spread was so unexpected that it caused the immediate evacuation of the main wildfire camp as a precautionary measure. Although specific communities were not immediately threatened by Battle, evacuation orders were issued for the more rural areas of the Keg River and Carcajou. There were also significant timber values in the immediate area along with several specific industry assets, such as the Trans Canada camp, which self-evacuated for precautionary measures.

Initially, wildfire suppression tactics on the Battle complex focused on a direct attack approach, but this eventually shifted to an indirect attack approach and the aggressive use of aerial ignition. This created major concerns with several stakeholders, especially the forest industry in the immediate area, given their concerns around further loss of timber supply from the ignition process. Given the fire behaviour and conditions on the ground, the decision to use indirect attack proved successful.

Another significant concern occurred on the east flank of the wildfire, where several farms and a concentration of agriculture values existed. Dozer guards were constructed along this flank to provide a contingency containment line in case the wildfire was to run in that direction. However, communications with the stakeholders affected were limited and concerns were raised around the level and necessity of damage to their assets.

Ultimately, the Battle complex was declared BH for the final time on June 13 and declared UC on June 26 (46 days until UC with a total burned area of over 55,000 hectares).

McMillan Complex (SWF049 [including SWF050 and SWF069], SWF078, SWF079, SWF090, SWF099)

On May 26, a lightning fire (SWF069) was reported directly north of SWF049 and west of Teepee Lake lookout (southeast of the community of Trout Lake) at 17h36 – the peak of the burning period. Because of burning conditions, this new wildfire escaped IA. SWF069 was given lower priority for firefighting resources because of the unmet demands of the higher priority wildfires already underway (Battle, Chuckegg Creek). The IMT dispatched to the wildfire was given a priority to protect values immediately at risk, including any communities nearby.

A second significant event occurred on McMillan the afternoon of May 29 and into May 30. Good progress had been made on sections of SWF049 with heavy equipment, but a cold front – the same frontal passage that affected Battle and Chuckegg Creek– passed in the afternoon of May 29 bringing a significant shift in wind speed and direction. By the morning of May 30, SWF049 and SWF069 had, together, added about 100,000 hectares of burned area. Subsequently, SW069 and SWF049 were combined into one wildfire. McMillan would grow to over 273,000 hectares with almost 900 kilometres of perimeter in the days to follow.

The fire growth that challenged both the McMillan and Battle complexes on May 29 and 30 warranted separate analysis that is presented in Appendix B. To summarize, a shift in wind direction related to a frontal passage was forecasted for May 29. The significance of this event may have been underestimated by some, even using available fire behaviour prediction tools. Nonetheless, the unexpected overnight growth in area burned placed stress on incident management staff and caused a shift in priorities and thinking on May 30.

This rapid wildfire growth quickly endangered more communities, forcing numerous evacuations on May 30, including the Hamlet of Wabasca and Chipewyan Lake Village in the Municipal District of Opportunity, the Hamlet of Marten Beach in the Municipal District of Lesser Slave River, and Trout Lake of the Peerless Trout First Nation, a total of over 6,000 people.

McMillan complex would be declared UC on July 1, having burned for 44 days before UC with an area burned of over 273,000 hectares.

Post-Wildfire

Returning Home

Evacuees returned home throughout the month of June following one of the most extreme spring fire seasons in recent history. Returning home after the evacuations was difficult for those displaced not only as residents, but as business owners, local government and administration, farmers, and other identities that were put on hold during the months of May and June.

A NOTE ON THE 2019 EVACUATIONS

While not within the scope of the 2019 Spring Wildfire Review, the number and length of evacuations related to the three incidents is grounds for discussion. In total, approximately 15,000 Albertans were displaced from their homes due to threat of wildfire from Chuckegg Creek, Battle, and/or McMillan. For some, this threat is a seasonal reality of living in the Wildland Urban Interface. For others, the events of the 2019 fire season had a lasting impact on those who were forced to leave, as well as those who stayed behind.

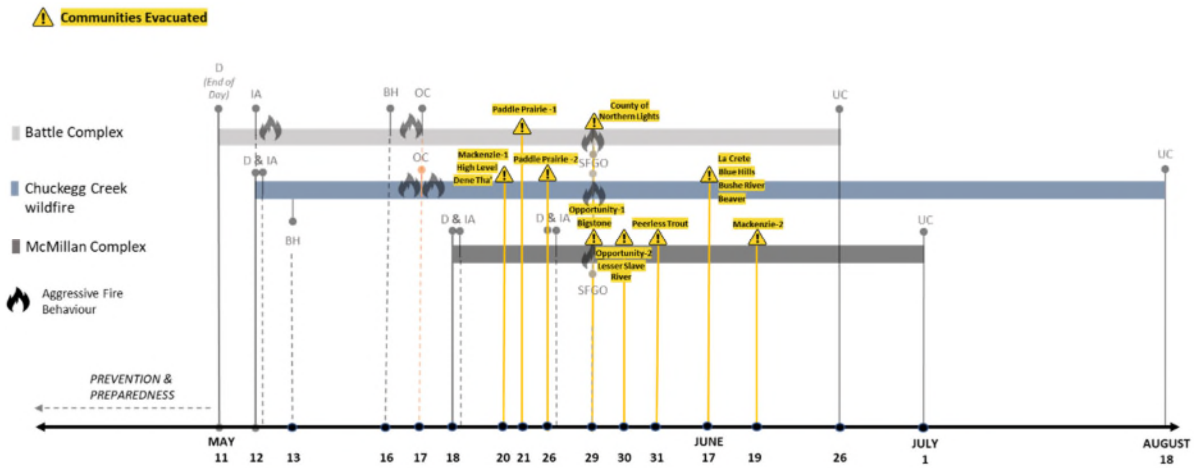
In order to understand the experiences of communities affected by wildfire it is important to expand the scope of what constitutes "affected". Those facing imminent danger were forced to leave their homes and seek refuge, an experience that is undeniably traumatic. Because of the degree of impact and uncertainty an evacuation can have on an individual, there are several government and agency supports and existing protocols in place to manage this process. While these supports cannot eliminate the mental, emotional, and physical toll on evacuees, they recognize and address the immediate needs of a displaced population.

However, and perhaps unique to the remote communities of Alberta's north, evacuations have a ripple effect on residents in the surrounding areas of evacuated communities. Many smaller communities within a large radius of the limited number of major centres in the northwest region depend on these centres for access to water, fuel, and food.

While these populations may be beyond the evacuation line, they become "refugees in [their] own homes", stranded without access to basic needs. This challenge is often exacerbated by road closures that severely limit access to and from remote communities, posing a risk to residents' basic needs and means of escape in the event of elevated wildfire threat.

These circumstances question the current standard for evacuated populations. While a population may not be within immediate danger of wildfire, they may still be adversely affected by it. The scope of influence of an evacuation is critical to the basic needs of many populations in Alberta's north and therefore can be considered an equally important component of local and provincial disaster planning.

Figure 33: 2019 Evacuation Timeline*



**Note that in addition to those communities listed above, evacuees that did not declare a home address registered in Slave Lake, Fort Vermilion, and Grande Prairie.*

A NOTE ON LOCAL RESOURCES

A pain point following the 2019 fire season was the experiences of local incident management resources. Unlike imported resources, local resources (including local administrations) are presented with a confluence of additional challenges; they may have suffered loss themselves, their friends and neighbours are looking to them for information and leadership, and they shoulder responsibility for the event as well as the continued administration of the community and the requirement to complete disaster recovery applications. This puts a burden on individuals and organizations. Mental health and organizational supports are limited, especially post-event. This can have profound impact on those individuals, and supports ought to be explored following the event. The experiences of these individuals during the 2019 fire season affirm this challenging reality, having expressed difficulty with returning to their personal and professional lives following the incidents.

Addressing these concerns is outside of the WMB mandate, however, indicates the importance of wildfire partner relationships.

Looking Ahead

The number, concurrency, and duration of the major wildfire incidents in 2019 made this fire season particularly challenging for WMB and its partners and stakeholders. However, the challenges faced in the 2019 are not expected to be unusual in coming seasons. In fact, due to the impacts of climate change, experts predict that these extreme hazard conditions will increase in years to come, with longer and more extensive periods of drought in Alberta. This, combined with an extensive and growing network of values-at-risk located across Alberta, calls for a commitment to better prepare and adapt to increased risk of wildfire. Perhaps most importantly, to better plan, educate, and manage wildfire in and around Alberta's wildland communities. By understanding the experiences of 2019 through the Spring Wildfire Review, stakeholders, including WMB, can better understand the realities and impacts of wildfire in Alberta. This understanding ultimately serves to equip WMB with the ability to manage increasingly challenging and complex conditions in the years to come.

APPENDIX E – 2019 WILDFIRE REVIEW: SATELLITE FIRE BEHAVIOUR OBSERVATIONS ASSOCIATED WITH FWI SYSTEM COMPONENTS

Introduction

The 2019 FWI components have been described in the Appendix B: 2019 Wildfire Review: Situational Analysis Of Environmental Conditions. It is clear that the FWI System indicated the potential for extreme fire behaviour following ignition of a wildfire in the High Level, Peace River or Slave Lake Forest Areas. This section of the review report describes the fire behaviour observations in each of the three wildfire incidents through interpretation of satellite imagery.

Fire behaviour is a function of three fire environment factors: weather, topography and available fuels. Weather and fuel availability were determined to be the principal drivers of extreme fire behaviour associated with the three wildfire incidents. Of interest are the fire behaviour observations during the month of May that were associated with the rapid rate of area burned in each of the wildfire incidents as provided through satellite imagery. Early indications of a potentially severe fire season in northern Alberta were the extreme closing Drought Code values in October 2018 for several weather stations in High Level, Peace River and Slave Lake Forest Areas. Temperature and precipitation anomalies in April and May of 2019 contributed to early snow melt and subsequent early initiation of the FWI System calculations (13h00 MDT) at a number of weather stations. The month of May was characterized by a rapid increase of fire danger conditions throughout northern Alberta, and ultimately more than 528,460 hectares burned during that month in the three wildfire incidents in the High Level, Peace River and Slave Lake Forest Areas (see Table 8).

Table 8: Estimates of Significant Area Burned Days Associated with the Three Wildfire Incidents

Wildfire	Timeframe	Estimated Area Burned[22]
Chuckegg Creek wildfire (HWF042)	May 12 – May 31	237,000 hectares (Total within timeframe)
	May 17 – May 20	68,729 hectares (Increase)
	May 29 – May 30	80,000 hectares (Increase)
Battle complex (PWF052)	May 11 – May 30	52,606 hectares (Total within timeframe)
	May 29 – May 30	12,052 hectares (Increase)
McMillan complex (SWF049)	May 20 – May 31	155,600 hectares (Total within timeframe)
	May 29 – May 30	59,446 hectares (Increase)
McMillan complex (SWF069)	May 29 – May 30	40,345 hectares (Increase)

Note: *SWF050 and SWF069 were overrun by SWF049 on June 1 and June 2 respectively.*

[22] Source: Agriculture and Forestry FIRES program

Satellite Imagery of Significant Fire Behaviour Events

Overview of Satellite Technology and Image Interpretation

Instruments onboard satellite platforms provide daily images that can be used to observe fire behaviour and smoke plume dynamics. Spread rate and burned area estimates can also be measured, although instrument resolution can be a limiting factor. The Advanced Very High-Resolution Radiometer (AVHRR) instrument onboard the NOAA Polar Operational Environmental Satellites (POES) has a spatial resolution close to one kilometre and was used to measure wildfire spread and size on the 2019 northwestern Alberta wildfires.

***Note**: These satellite estimates will be close to airborne measurements taken over the wildfires but will not match exactly.*

Data from instruments on five different satellite platforms was collected and analyzed for the period of significant wildfire activity in northern Alberta during the month of May. Four of these systems are polar-orbiting, while one is geostationary over the equator with its movement synchronized with the earth's rotation. The instruments onboard these satellites have varying degrees of spatial resolution (pixel size) from coarse (approximately four kilometre) to fine (30 metres). The satellite platforms used included:

- The newest Geostationary Operational Environmental Satellite (GOES) operated by NOAA with a four kilometre resolution, gathers data every 15 minutes in one visible and four infrared channels.
- Landsat polar-orbiting satellite imaging systems (Landsat 7 and 8) with a high spatial resolution (30 metres) and return intervals of 16 days.
- The NOAA POES with AVHRR instruments provide daily coverage (higher at northern latitudes) with many channels at a resolution of approximately 1.1 kilometres.
- The Moderate Resolution Imaging Spectroradiometer (MODIS) onboard the Terra and Aqua polar-orbiting satellites permit observation of a given point two to four times every 24 hours at a spatial resolution from 250-500 metres in the spectral bands.
- The Visible Infrared Imaging Radiometer Suite (VIIRS) onboard the Suomi National Polar-orbiting Partnership (NPP) satellite designed to provide improved resolution to MODIS and AVHRR products, with a peak resolution of approximately 375 metres.

On past wildfire reviews in Alberta (e.g. Slave Lake 2011 and Horse River 2016), satellite analyses have proven very reliable in buttressing on-ground or airborne fire behaviour observations. This has included measurements of wildfire growth, rates of spread and downwind spotting distances, along with convection column dynamics and the development of pyrocbs (pyrocumulonimbus).

Spread rates can be estimated from satellite imagery during major wildfire runs by comparing images from consecutive satellite overpasses. The accuracy of the estimate depends on the resolution of the satellite instrument being used, which is approximately 1.1 kilometres for AVHRR. Measuring the distance covered by a wildfire between overpasses gives an estimate of rate of spread. This works best if the overpass interval is relatively short and, from a fire behaviour perspective, if the consecutive overpasses occur between mid-morning and evening local time. This method was used to measure the spread rates on the Chuckegg Creek wildfire and the McMillan complex wildfires in this review report.

Wildfire spread rates can also be predicted using the Canadian Forest Fire Prediction (FBP) System, a subsystem of the Canadian Forest Fire Danger Rating System (CFFDRS). The FBP System provides quantitative estimates of rate of spread, fuel consumption and overall frontal fire intensity for common fuel types, including boreal conifer, deciduous and mixed wood types, along with grass and logging slash. The FBP System is based on numerous well-documented experimental burns, along with wildfire measurements. These data were correlated with on-site or nearby weather observations to predict fire behaviour relative to the codes and indices of the Canadian Forest Fire Weather Index (FWI) System. In this section of the review, observed wildfire spread rates were compared with those predicted for the C2 (boreal spruce) fuel type using local hourly weather and FBP System values.

Pyrocumulonimbus Development During Major Wildfire Runs

Pyrocumulonimbus (pyrocbs) are wildfire-related convective storms that have similarities to thunderstorms (cumulonimbus). The pyrocb is typically anchored to a flaming wildfire and persists as long as the heat energy release of the wildfire is sufficient to maintain the high convection column. Scientific investigations into forecasting and understanding the dynamics of pyrocbs has only begun recently, but they are intense storms with strong indrafts and downdrafts, suppressed precipitation and major lightning activity, which can drastically intensify fire behaviour at surface levels[23,24, 25].

A number of pycrobs were documented through satellite imagery during major runs of the Chuckegg Creek wildfire and McMillan complex. The relevance of pyrocbs, in relation to wildfire spread rates that significantly exceed the Fire Behaviour Prediction (FBP) System predictions, will be discussed with respect to a major pyrocb that developed over SWF069 (McMillan complex) in this section of the review report. Figures 34 and 35 illustrate examples of pyrocbs associated with extreme fire behaviour in Alberta and the Northwest Territories.

Figure 34: Chisholm Wildfire Pyrocb With Convection Column To 45,000 Feet. Edmonton Radar 19h30 on May 28, 2001[26]

[23] Reference: Rosenfeld, D., Fromm, M., Trentmann, J., Luderer, G., Andrea, M.O., and Servranckx, R. 2007. The Chisholm firestorm: observed microstructure, precipitation and lightning activity of a pyro-cumulonimbus. Atmos. Chem. Phys., 7,645-659.

[24] Reference: Fromm, M.J., and Stocks, B.J. 2010. Pyrocumulonimbus. McGraw-Hill Yearbook of Science and Technology 320-324.

[25] Reference: Peterson, D.A., Campbell, J.R., Hyer, E.J., Fromm, M.D., Kablick III, G.P., Cossuth, J.H., DeLand, M.T. 2018. Wildfire-driven thunderstorms cause a volcano-like atmospheric injection of smoke. Npg Ckimate and Atmospheric Science 1:30; do1:10.1038/s41612-018-0039-3.

[26] Photo Source: Chisholm Fire Review Committee Final Report, October 2001. https://open.alberta.ca/dataset/5ce6f474-6be3-420b-bc0a-626a326ca015/resource/79b600b8-9339-47f4-a88f-85b9a374ec02/download/2001-chisholmfire-reviewcommitteefinalreport-oct2001.pdf

Figure 35: Northwest Territories Wildfire ZF020-14 Developing A Pyrocb On July 14, 2014 at 21h16. Note Strong Winds Aloft Indicating A Low-Level Jet That Is Interacting with Convection Dynamics and Producing Extreme Fire Behaviour.

McMillan Complex - May 29

SATELLITE IMAGERY DURING EXTREME FIRE BEHAVIOUR CONDITIONS

Forecast conditions for the McMillan complex for May 29 indicated that a dry cold front would pass over the wildfire around 18h00, with a tightening gradient causing winds to strengthen from the northwest. Windspeeds of 15 kilometres/hour (gusting to 25 kilometres/hour), along with temperatures of 28 to 30^{0}C and relative humidity values down to 15 percent were forecasted. This would translate into predicted forward spread rates approaching 2 kilometres/hour using the FBP System.

This fire behaviour forecast was largely accurate for the SWF049 wildfire, compared to spread rates measured between satellite overpasses using the Advanced Very High-Resolution Radiometer (AVHRR) instrumentation on the NOAA Polar Orbiting Satellites (POES). Spread rates between 1.2 and 2.1 kilometres/hour were measured between 18h07 and 21h59. However, the SWF069 wildfire just north of SWF049 grew substantially during this period, in an explosive manner that was not forecasted or anticipated. AVHRR measurements between 18h07 and 23h39 show a large increase in area burned and spread rates on SWF069 during this period. Five separate spread measurements were obtained, ranging from 2.4 kilometres/hour before 20h19 up to 6.0 kilometres/hour for the 20h19 to 23h39. This unexpected fire behaviour was due to the effects of a pyrocb storm that formed directly over SWF069, beginning at 19h40. By 22h00, the convection column over SWF069 was 12.1 kilometres in height, due to the strong vertical development associated with a pyrocb.

***Note**: Severe turbulence due to strong indrafts and downdrafts are associated with pyrocb development, resulting in explosive fire behaviour that is generally unpredictable. Dry lightning is also associated with pyrocb formation.*

The AVHRR imagery panels in Figure 36 show the growth of SWF069 between 18h07 and 22h39 on May 29. The pyrocb is forming at 20h19 and is quite well-developed in the panels at 22h00 and 22h26. The AVHRR imagery shows the wildfire perimeter growing rapidly, with the estimated wildfire area growing from 13,830 hectares at 18h07 to 47,634 hectares at 23h39. A smaller pyrocb can be seen forming over SWF049 on the 23h39 satellite overpass.

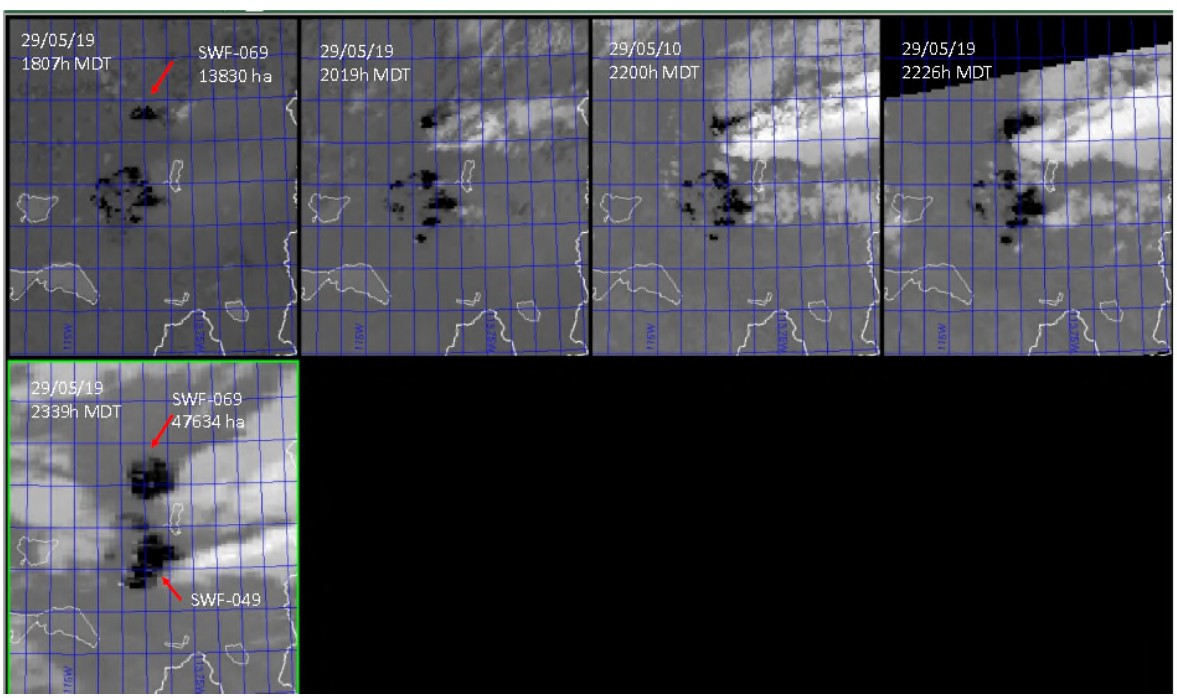
Predicted and observed spread rates for SWF049 and SWF069 are summarized in Table 9, and the hourly FWI System component values used for predictions are shown in Appendix E1.

Table 9: Observed and Predicted Spread Rates On SWF049 And SWF069 on May 29, 2019

Wildfire No.	Satellite Date	Satellite Time Frame	Observed ROS	Predicted ROS*	Fuel Type	Interval Hourly ISI	Daily BUI
SWF049	May 29	18h07 – 21h59	1.2 – 2.1 kph	0.1 – 1.4 kph Avg 0.3 kph	C2	2.7 – 6.4 Avg 5.0	147
SWF069	May 29	18h07 – 23h39	2.4 – 6.0 kph	0.1 – 1.4 kph Avg 0.3 kph	C2	2.7 – 6.4 Avg 5.0	147

***Note**: *Predicted ROS range calculated using lowest hourly wind speed and FFMC, and highest hourly wind speed and FFMC during the satellite time frame interval. Average predicted ROS calculated using average hourly wind speed and FFMC during the satellite time frame interval. Predicted ROS calculations made using: REDapp version 6.2.4 – The Universal Fire Behaviour Calculator.*

Figure 36: NOAA AVHRR Imagery Sequence Showing Pyrocb Development Over SWF-069 on May 29, 2019



Figures 37 and 38 provide a NOAA AVHRR multi-channel view of the pyrocb at 20h19 and 22h00. The colours represent cloud temperatures that can be used to determine the height of the pyrocb convection column.

Figure 37: Multi-Channel AVHRR View OF SWF069 at 20h19 MDT

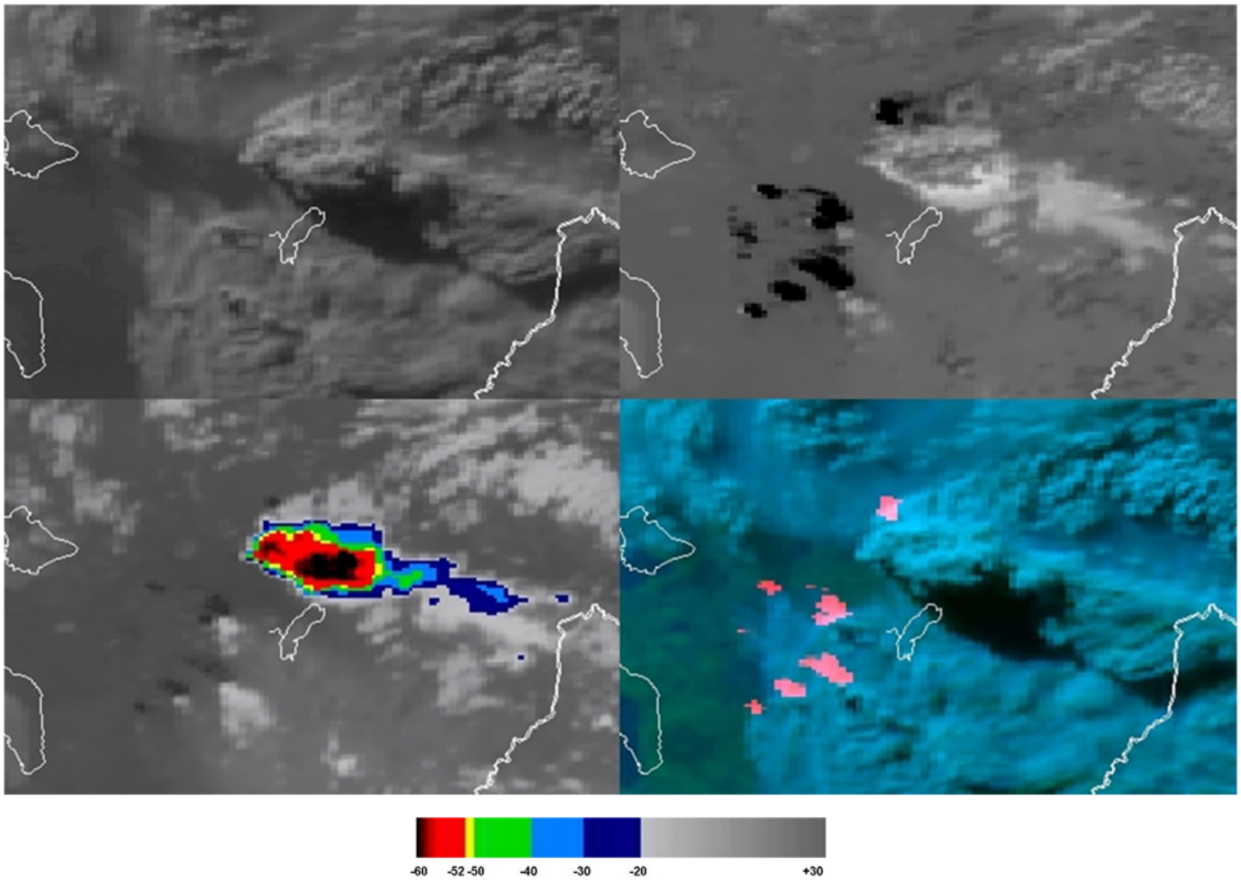


Figure 38: AVHRR Image of SWF069 at 22h00 On May 29, 2019

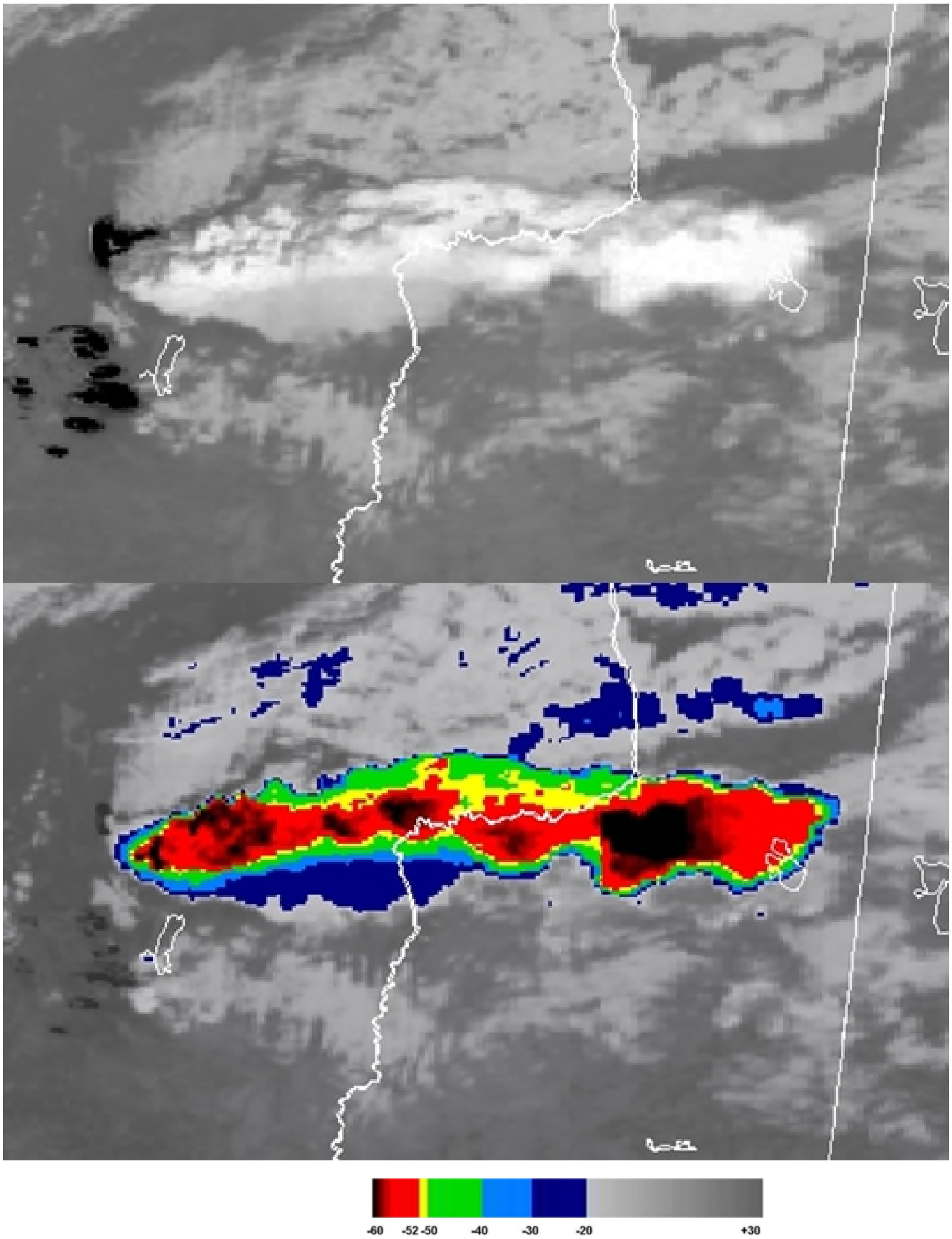
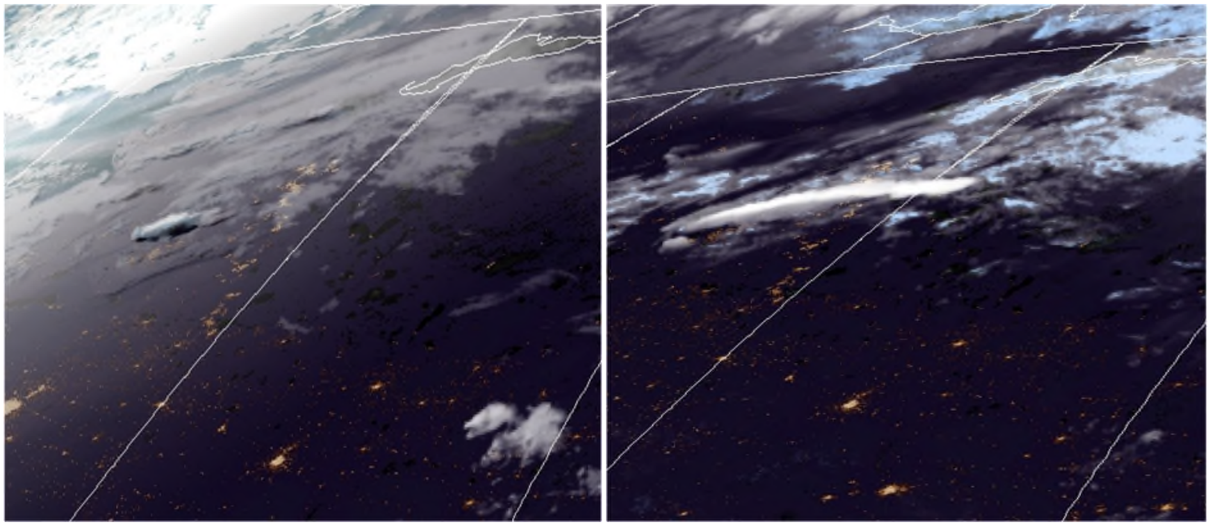


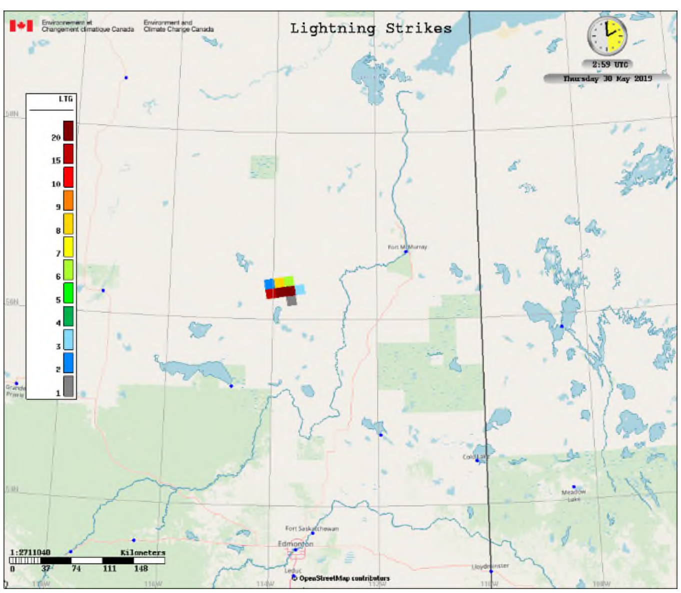
Figure 39: -GOES Images OF SWF069 Pyrocb at 20h30 (Left) and 22h50 (Right)



A longer-range view of the SWF069 pyrocb is provided in Figure 39, which shows NOAA GOES (Geostationary Operational Environmental Satellite System) imagery at 20h30 and 22h50, and the distance covered by the downwind smoke plume during this period.

This was clearly an intense pyrocb that influenced the area growth and spread of SWF069. Note the circular wildfire shape, which indicates the ambient wind speed and direction had little influence, and the wildfire was column-dominated. Dry lightning associated with the pyrocb was observed in the immediate area around SWF069 between 20h19 and 23h39, the same period when the pyrocb was most active. Figure 40 shows the location and density of lightning strikes near the wildfire in the 20-minute period before 20h59. Lightning from the SWF069 column resulted in numerous new wildfire starts downwind.

Figure 40: Location and Density of Lightning Strikes Downwind of SWF069[27]



[27] Credit: Environmental Emergency Response Section, Meteorological Service of Canada, Environment and Climate Change Canada

AGRICULTURE AND FORESTRY WILDFIRE MODELLING EXAMPLE FOR WILDFIRE SWF069

A unique case study of the extreme rate of spread on SWF069 was provided by Neal McLoughlin, Wildfire Management Branch (WMB), based on aerial GPS perimeters, and MODIS and VIIRS I-Band satellite data. Area burned on SWF069 for May 29 and 30 exceeded 50,000 hectares, and the most extreme fire behaviour was associated with a pyrocb at 21h20 to 22h55 on May 29. The strong vertical development of convection columns leading to pyrocumulonimbus storm development results in winds aloft being transferred to the surface, in addition to strong indrafts, gustiness, downdrafts and lightning. This is an unpredictable development not captured directly in weather and fire behaviour forecasts.

Of particular interest is the 21h20 to 22h55 spread rate of 10.7 kilometres/hour, when surface winds from three surrounding weather stations ranged from five to 15 kilometres/hour. In contrast to the surface winds, mean upper level winds from zero to six kilometres were considerably higher at the Stony Plain Upper Air Weather Station indicating development of a pyrocb (Appendix E2). A Prometheus wildfire modelling scenario using the mean upper wind velocities reconciles the satellite measured rate of spread with the Prometheus prediction (Figure 41). This case study suggests that a two-dimensional FBP system is limited in predicting wildfire spread rates when fire behaviour is driven by third dimension factors such as convection column thermal physics, upper level winds and atmospheric instability.

Following the unexpected significant growth of SWF069 overnight on May 29, WMB fire behaviour modellers began to investigate potential factors that may have influenced this event. They determined elapsed times and spread rates from satellite hotspot detections, and noted an extreme wildfire spread rate between 21h20 and 22h55 (Table 10). During this short period the wildfire appeared to spread at a rate of 10.7 kilometres/hour, which is a spread rate very rarely observed on wildland fires. This time interval coincides with the development of the strong and violent pyrocumulonimbus storm and increasing spread rates observed in the AVHRR satellite imagery described earlier.

WMB fire behaviour modellers are now planning to use upper level winds to forecast fire behaviour when they expect convection column interactions with the upper atmosphere, which may result in stronger winds at the surface.

Figure 41:Wildfire Spread Documentation on SWF069 Including 10.7 Km/Hr Run At 21h20 To 22h55 on May 29, 2019. Credit: Neal Mcloughlin, Wildfire Management Branch

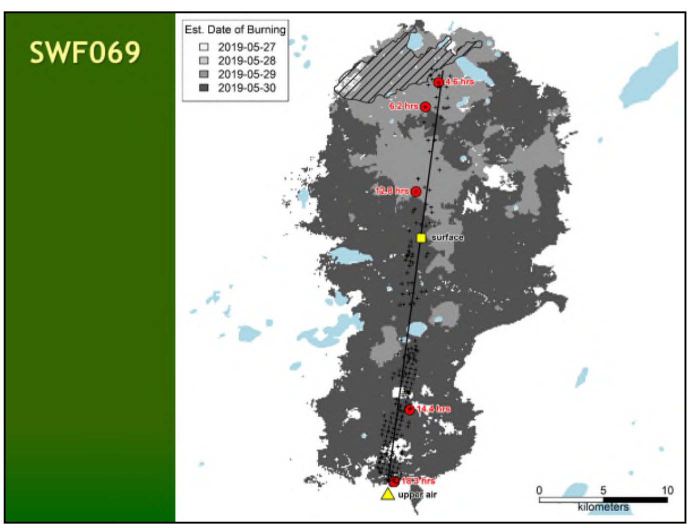


Table 10: Comparison of Satellite Observed ROS and FBP Predicted ROS for SWF069 on May 29 and May 30, 2019

Wildfire No.	Satellite Date	Satellite Time Frame	Observed ROS	Predicted ROS*	Fuel Type	Interval Hourly ISI	Daily BUI
SWF069	May 29	08h30 – 13h06	0.22 kph	0.1 – 0.7 kph Avg 0.2 kph	C2	1.6 – 5.9 Avg 4.1	142
	May 29	13hh06 – 1442	1.23 kph	0.4 – 0.9 kph Avg 0.5 kph	C2	5.9 – 6.7 Avg 6.2	147
	May 29	14h42 – 21h18	1.01 kph	0.1 – 0.7 kph Avg 0.5 kph	C2	4.4 – 7.3 Avg 6.2	147
	May 29	21h20 – 22h55	10.66 kph	0.2 – 0.6 kph Avg 0.3 kph	C-2	4.4 – 5.4 Avg 4.7	147
	May 29 May 30	22h45 02h48	1.47 kph	0.1 – 0.4 kph Avg 0.2 kph	C-2	2.1 – 5.4 Avg 3.0	147

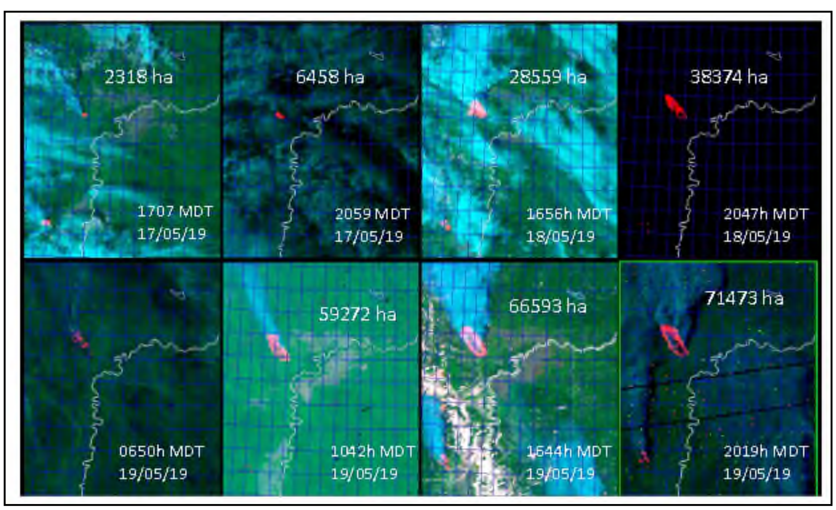
***Note**: *Predicted ROS range calculated using lowest hourly wind speed and FFMC, and highest hourly wind speed and FFMC during the satellite time frame interval. Average predicted ROS calculated using average hourly wind speed and FFMC during the satellite time frame interval. Predicted ROS calculations made using: REDapp version 6.2.4 – The Universal Fire Behaviour Calculator.*

Chuckegg Creek Wildfire - May 17 to 19 and May 29

SATELLITE IMAGERY DURING EXTREME FIRE BEHAVIOUR CONDITIONS

The Chuckegg Creek wildfire (HWF042) ignited on May 12 under very high fire danger conditions, but wildfire spread did not accelerate until late on May 17. On May 20, the wildfire size reached approximately 69,000 hectares and the Town of High Level and the communities of La Crete and Paddle Prairie were evacuated.

Figure 42: Composite May 17 – May 19, 2019 Chuckegg Creek Wildfire



Satellite images from NOAA AVHRR (POES) from May 17 (17h07 MDT) to May 19, 2019 illustrate the increase in the satellite-estimated wildfire size from 2,318 hectares on May 17 to 71,473 hectares on May 19 (Figure 42). Satellite data was used to calculate forward rate of spread at selected intervals on May 17, 18 and 19, and these were compared to FBP System predictions using hourly weather data from the High Level Airport (Table 11).

An additional observation on May 29, as the Chuckegg Creek wildfire was spreading to the southeast, was also consistent with predicted spread. Although rate of spread comparisons vary, in general, the FBP System predictions are lower than satellite measured rate of spread.

Table 11: Observed and Predicted Spread Rates on the Chuckegg Creek Wildfire on May 17-19 and May 29, 2019

Wildfire No.	Satellite Date	Satellite Time Frame	Observed ROS	Predicted ROS*	Fuel Type	Interval Hourly ISI	Daily BUI
HWF042	May 17	17h07 – 20h59	1.4 kph	0.2 – 2.4 kph Avg 0.9 kph	C2	5.8 – 22.0 Avg 12.7	64
	May 18	16h56 – 20h47	2.0 kph	0.4 – 2.4 kph Avg 1.2 kph	C2	6.3 – 23.7 Avg 14.3	69
	May 19	10h42 – 20h19	1.35 kph	0.7 – 3.7 kph Avg 2.2 kph	C2	11.2 – 40.0 Avg 23.1	75
	May 29	09h39 – 18h07	1.2 kph	0.1 – 3.1 kph Avg 0.9 kph	C-2	1.9 – 27.1 Avg 12.4	96

Note*: *Predicted ROS range calculated using lowest hourly wind speed and FFMC, and highest hourly wind speed and FFMC during the satellite time frame interval. Average predicted ROS calculated using average hourly wind speed and FFMC during the satellite time frame interval. Predicted ROS calculations made using: REDapp version 6.2.4 – The Universal Fire Behaviour Calculator.*

SMOKE DISPERSION MODELLING

Smoke dispersion across northern Alberta during the May 29 to 30 period is illustrated in Figures 43 and 44. Projected smoke drift using the Environment Canada Atmospheric Transport and Dispersion Model (ATDM) compares well with the actual smoke distribution shown in the MODIS satellite image, and illustrates the significant and widespread downwind smoke impact on wildfire suppression operations. As discussed previously, the occurrence of pyrocbs in the Chuckegg Creek wildfire and McMillan complex contributed to extreme fire behaviour and also to significant smoke impact on firefighter safety and aerial suppression operations.

Figure 43: MODIS Imagery (Terra and Aqua) Illustrating Both Active Wildfires and Smoke Drift on May 30.[28]

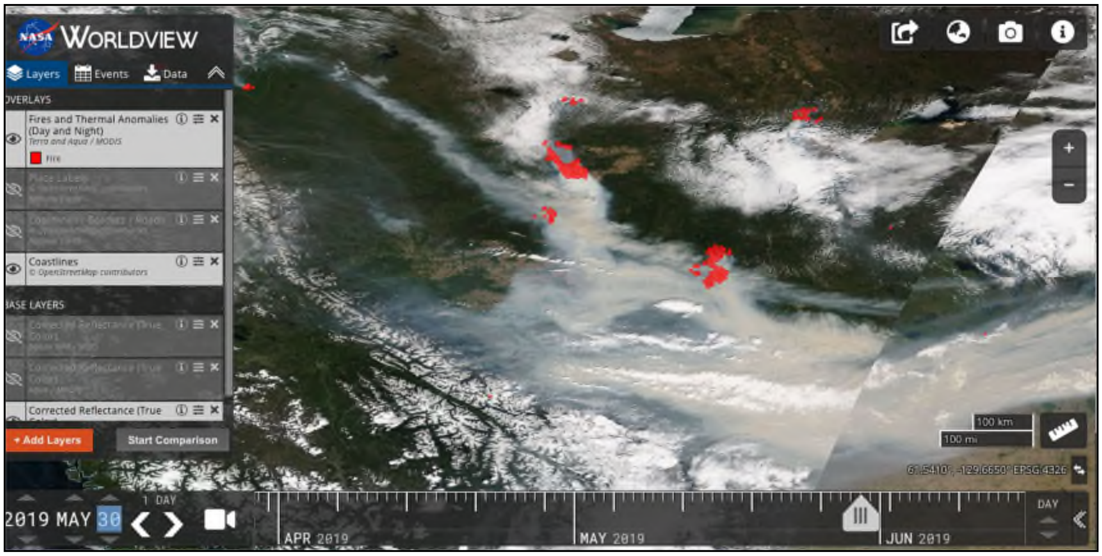
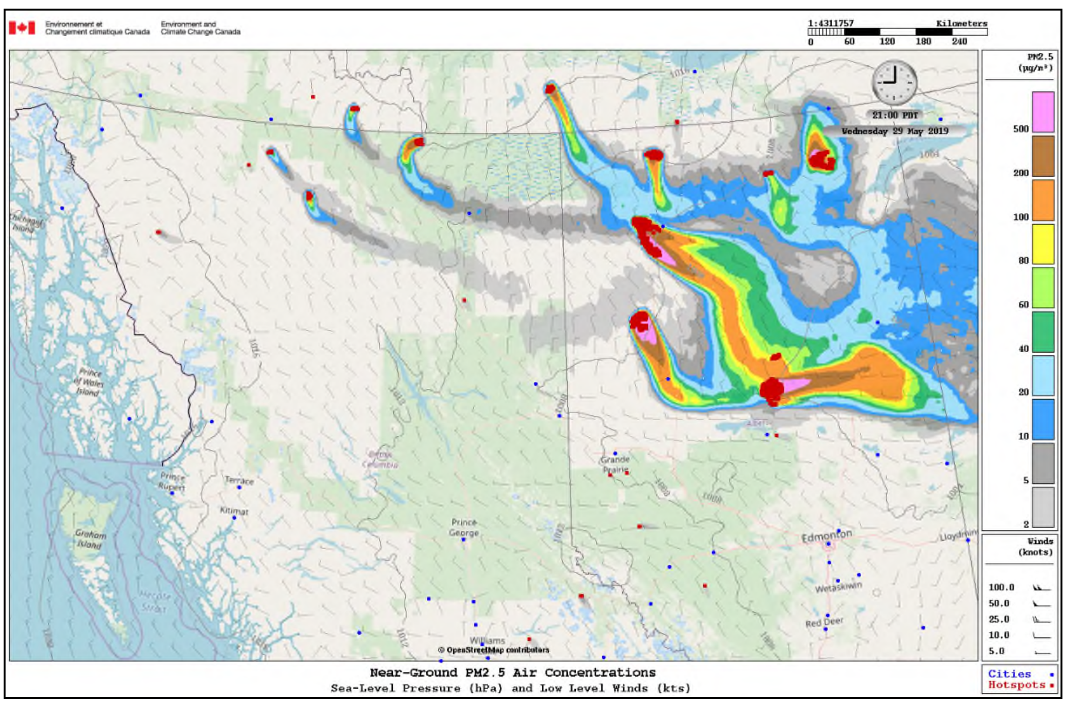


Figure 44: Automatic ATDM (Atmospheric Transport and Dispersion Model) Image Illustrating Smoke Dispersion Across Northern Alberta at 22h00 MDT On May 29, 2019.[29]



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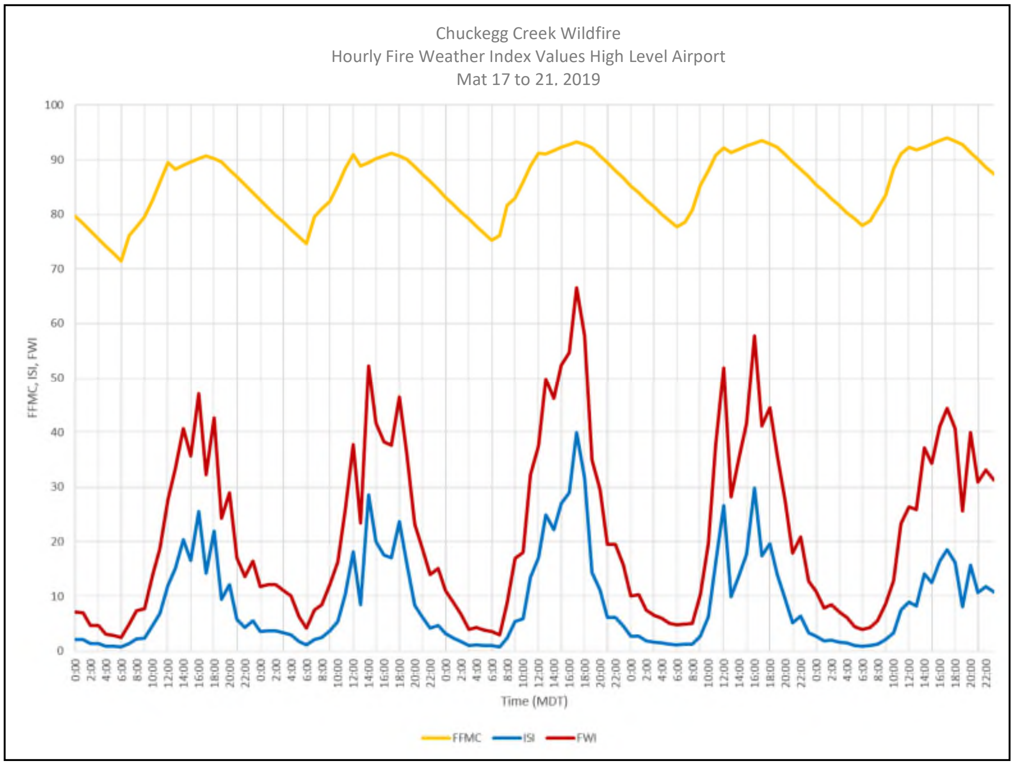
[28] Source: https://worldview.earthdata.nasa.gov

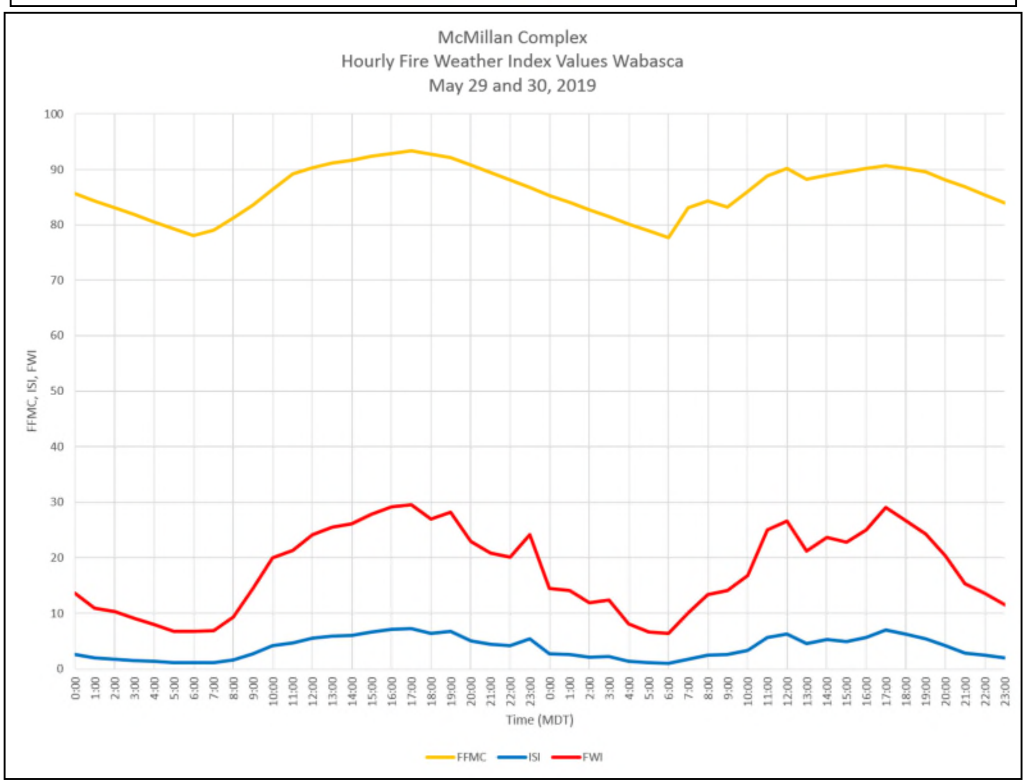
[29] Credit: Environmental Emergency Response Section, Meteorological Service of Canada, Environment and Climate Change Canada

Summary of Satellite Fire Behaviour Observations Associated with FWI System Components

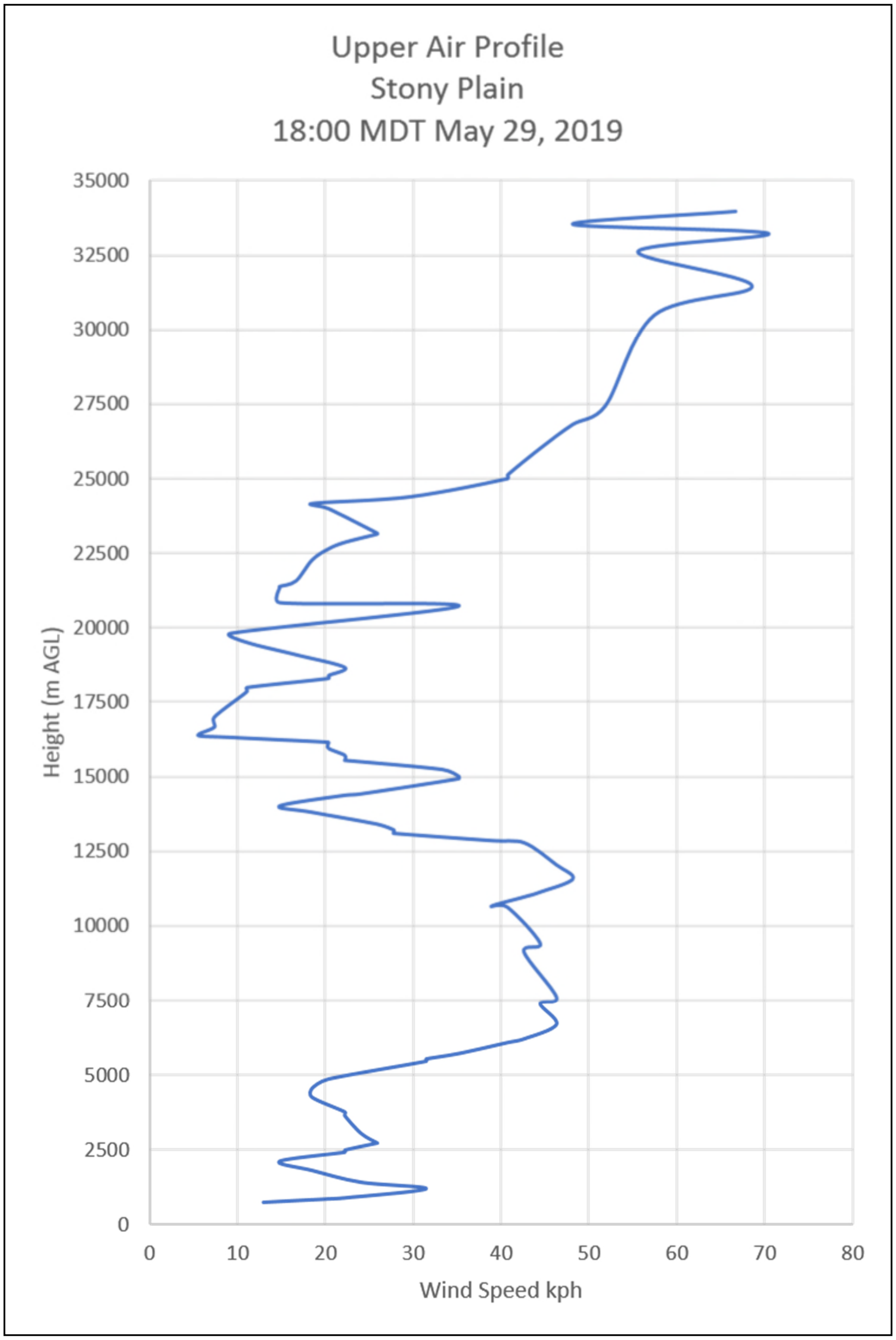
- On past wildfire reviews in Alberta (e.g. Slave Lake 2011 and Horse River 2016) satellite analyses have proven very reliable in buttressing on-ground or airborne fire behaviour observations. This has included measurements of wildfire growth, rates of spread, and downwind spotting distances, along with convection column dynamics and the development of pyrocbs.
- Satellite imagery confirms that Canadian Forest Fire Behaviour Prediction (FBP) System forecasts for wildfire spread rates were reasonably accurate for the Chuckegg Creek wildfire and McMillan complex during late May 2019.
- The unexpected large growth on SWF069 was due to the development of a strong pyrocumulonimbus storm directly over the wildfire late on May 29, which resulted in localized strong gusty winds and erratic fire behaviour.
- Pyrocumulonimbus are wildfire-related convective storms that have similarities to thunderstorms (cumulonimbus). The pyrocb is typically anchored to a flaming fire and persists as long as the heat energy release of the wildfire is sufficient to maintain the high convection column. Scientific investigations into forecasting and understanding the dynamics of pyrocbs has only begun recently. Pyrocbs are intense storms with strong indrafts and downdrafts, suppressed precipitation and major lightning activity, which can drastically intensify fire behaviour at surface levels.
- A number of pyrocbs were documented through satellite imagery during major runs of the Chuckegg Creek and McMillan complex wildfires. The relevance of pyrocbs, in relation to wildfire spread rates that significantly exceed the FBP System predictions, is discussed with respect to a major pyrocb that developed over SWF069 (McMillan complex).
- A unique case study of the extreme rate of spread on SWF069 was provided by Neal McLoughlin, Wildfire Management Branch, based on aerial GPS perimeters, and MODIS and VIIRS I-Band satellite data. Area burned on SWF069 for May 29 and 30 exceeded 50,000 hectares, and the most extreme fire behaviour was associated with a pyrocb at 21h20 to 22h55, on May 29.
- This case study suggests that a two-dimensional FBP System is limited in predicting wildfire spread rates when fire behaviour is driven by third-dimension factors, such as convection column thermal physics, upper level winds and atmospheric instability.

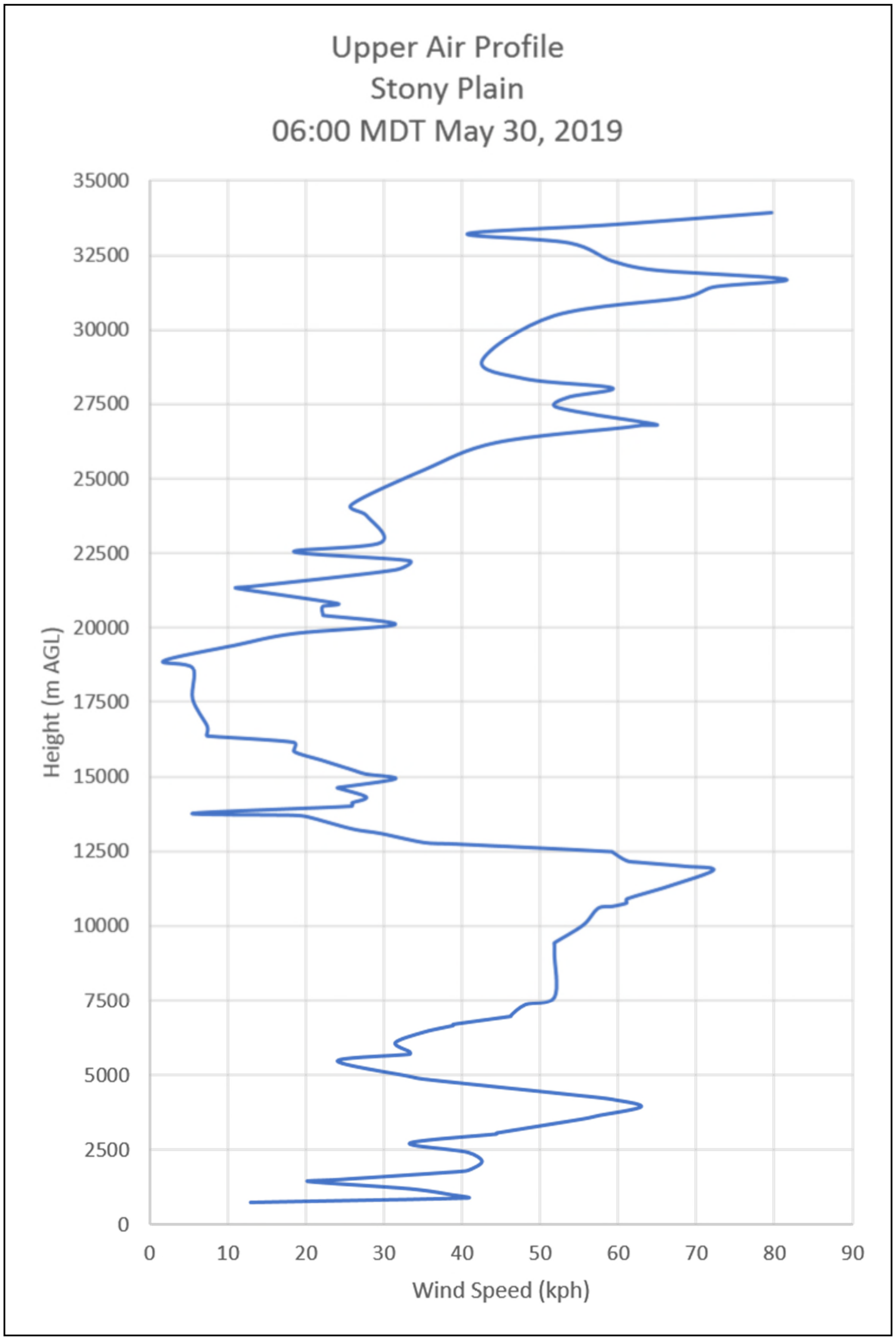
Appendix E1 – Hourly Fire Weather Indices for Satellite Imagery Reconciliation





Appendix E2 – Upper Air Wind Profiles from the Stony Plain Upper Air Station





Upper Air Profile
Stony Plain
06:00 MDT May 30, 2019
Height (m AGL)
35000
32500
30000
27500
25000
22500
20000
17500
15000
12500
10000
7500
5000
2500
0
0
10
20
30
40
50
60
70
80
90
Wind Speed (kph)

APPENDIX F – SUMMARY OF STAKEHOLDER FEEDBACK

Minister Sessions

Summary

As part of the 2019 Spring Wildfire Review, MNP and the Minister of Agriculture and Forestry travelled to communities affected by the 2019 fire season. There were three stakeholder sessions in total, two in December 2019 in High Level and La Crete and one in January 2020 in Slave Lake. These sessions served to give the residents, industry representatives, business owners, administration, and elected officials of these communities a chance to have their perspectives heard and understood by the Minister. Hosted in a townhall structure, the three sessions saw more than 175 stakeholders come out to have a say in wildfire management in their community.

The results of these sessions, summarized below, were combined with individual stakeholder interviews conducted throughout the course of the 2019 Spring Wildfire Review to inform communications, operations, and strategic opportunities for Wildfire Management Branch (WMB) and its partners.

High Level

Overall, the Town of High Level was thankful for the efforts of local leadership and the two-way communication that occurred between WMB and the municipality. While stakeholders acknowledged initial "hiccups" in setting up Unified Command and working with the IC structure, perceptions were, at-large, that Unified Command was effective and improved communication. Stakeholders emphasized the importance of communication coming from their local leaders, rather than from WMB, so it was important to have the municipalities at the table with Unified Command in order to provide sufficient information to their residents. However, at times, controls around messaging from other Government of Alberta branches (primarily AEMA) burdened the communications process. An excess of planning and caution resulted in delayed, "scripted" messaging. Social media was acknowledged as an excellent resource to reach the public during the course of the wildfire and the evacuation; however, social media was not able to reach all residents due to lack of internet access, difference in demographic groups, and other access issues.

PHOTO: @DEVINDVOTE

Additional concerns were primarily related to evacuation preparedness and impacts. When the town made the decision to evacuate, all residents, evacuated, shutting down key services like water and gas lines before leaving. Being evacuated also meant that there were no staff left behind to man accommodation and other services for emergency crews and first responders. This meant that many people had to be recalled to the evacuation zone to support those working in the area. It was suggested that in the future, the town maintain an inventory of local resources to be called upon in the instance of emergency. This inventory would help address local frustration over underuse of local resources, providing contact information and credentials of residents. In addition to direct wildfire services, this inventory would incorporate other key supports and services needed during wildfire events, such as hospitality, industry representatives, water and fuel trucks, grocers, and any other services deemed necessary to support first responders.

A consideration that had gone overlooked during evacuation was the displaced population that did not leave the area, rather moving to a location just outside the evacuation zone. These people, and other communities dependant on High Level as a critical service centre for food, fuel, water, prescriptions, and other necessities, lost access to basic needs with the closure of High Level (*note: certain communities in the region were not evacuated, but due to the closure of access roads their communities experienced the same conditions as those who had moved outside of the evacuation zone*). With limited alternative service centres due to the remoteness of the region, these populations were left as “refugees” outside of their own communities. This informed a potential recommendation to change the scope of what constitutes “critical infrastructure” to include the infrastructure and services needed to support both directly and indirectly affected populations during a disaster.

Stakeholders also brought forward concerns around the detection and initial attack efforts of fire crews, particularly relating to the perception that wildfires may have been started / lengthened due to economic incentive. This concern was echoed with frustration about firefighters working “10 to 3” and “coming home after 8 hours” and crews not working at night. Budget reductions to lookout resources were also concerning to stakeholders.

La Crete

The majority of concerns were centred around evacuation. In particular, residents expressed frustration with being forced to leave their property, rather than have the opportunity to support structural protection. There was a general sentiment that communications and decision making was done via “direction” rather than “facilitation” (“we were pushed from one place to the next”). Combined with a lack of visibility and confusion about when and why evacuations were occurring, this indicates that there is a lack of understanding as to the scope and role of WMB and the municipality.

Paddle Prairie expressed frustration with cost recovery following a lack of accessible insurance and inquired with the province as to how they may recover costs.

(PHOTO: @DEVINDVOTE)

As with High Level, stakeholders brought forward concerns around the detection and initial attack efforts of fire crews, particularly relating to the perception that wildfires may have been started / lengthened due to economic incentive. Some residents held the opinion that wildfire was an opportunity to assert authority on the community. There was a general perception that the shift from “firefighting” to “fire management” has had negative impacts on the size and length of wildfire burns. Relatedly, prescribed burns were not popularly supported by stakeholders.

For industry, collaboration between mills was supported and asked to be further in order to optimize salvage yield. Stakeholders suggested the potential for salvaged land to be re-zoned and used for farming to reduce the fuel load and act as a fuel break to protect against future wildfires. This re-zoning would also allow sooner capture of economic benefits for the ~360,000 ha burned. Another related opportunity was brought forward surrounding fuel breaks, suggested cattle and bison grazing leasing be issued to better protect the community against wildfire.

Slave Lake

Stakeholders within the Slake Lake Forest Area were unique in their experience and history with wildfire. Because of this, the group was, at large, focused on better preparation and ongoing management of wildfire on the landscape. Stakeholders emphasized the importance of a practiced, multi-stakeholder disaster and disaster recovery plans that address not only the preservation of human life, but other key values at risk, such as livestock and equipment. Moreover, the involvement of key stakeholders outside of the immediate wildfire management partners, such as industry and school boards, were suggested to be included in the planning process.

Most interestingly, stakeholders posed the possibility of wildfire education as part of the school curriculum, looking to target a wide, captivated audience in the risks and best practices of living in the Wildland-Urban Interface. Further to this, education on disaster planning and preparedness was voiced as a key need for many stakeholders. Practical education, such as wildland firefighter training for locals, was also sought after. The lack of training and use of local resources, like in other jurisdictions, was frustrating for stakeholders who saw “foreign” resources brought in.

As the McMillan complex was reportedly caused by arson, this was an obvious pain point for many. Stakeholders called for better incentive and methods for reporting suspicious activity to deter arson behaviour. It was the opinion of stakeholders that increased public awareness and vigilance would be meaningful to wildfire outcomes in the area. Stakeholders also called for increased dedicated resources and leverage existing government employees, such as Fish & Wildlife Officers, to support with surveillance and enforcement.

Related to inter-Ministry resourcing efforts, stakeholders indicated that the use of government employees, such as those working at weigh-in stations, could help to support traffic management and evacuation zone coverage during evacuations, which would greatly reduce the capacity burden on local RCMP. In fact, evacuations in general continue to be a challenge for many stakeholders who lack the resources to move residents, including vulnerable population, on short notice. Communities indicated that educating residents on 72-hour emergency kits is paramount in making evacuations as seamless as possible.

PHOTO: @DEVINDVOTE

The Slave Lake session also brought forward some themes similar to that of other wildfires. First, frustration around the perceived "10 to 3" firefighting of WMB. It was widely accepted that further overnight action could have prevented McMillan and past wildfires from growing to what they became. Additionally, the use of agricultural buffers to protect at-risk communities was viewed as a highly viable preventative option. Lastly, and perhaps confirming it as a theme across wildfires, was the clear disconnect in communication and understanding of roles and responsibilities between residents, municipalities, and elected officials. Opinions and perceptions between these parties was an area of frustration between all three groups, who each held different accounts from the 2019 fire season. It is clear that local stakeholders do not fully understand their scope and roles in wildfire management and that this uncertainty results in a perception of failure from WMB to effectively communicate and engage its stakeholders, despite the issue residing at the community level.

APPENDIX G – STAKEHOLDER ENGAGEMENT – WHAT WE HEARD

Objectives and Approach

The stakeholder engagement component of the 2019 Spring Wildfire Review was carried out with the following two main objectives:

- To engage with communities, including First Nations and Métis, and industry representatives for forestry, oil and gas, power and rail, who were severely impacted by the 2019 spring wildfire activity; and,
- To better understand the effectiveness of WMB's role in the ensuring public readiness for wildfire events, public communication of fire behaviour and in the communication of recommendations for evacuation alerts and evacuations.

The focus of the interviews was to collect feedback, key findings, and recurring themes related to the activities undertaken by WMB. Stakeholders were encouraged to share their stories, including the highlights and challenges of their experiences. The interview data was then aggregated and synthesized to produce the findings, summarized and detailed by wildfire event, in the following sections.

The communities engaged for this review were significantly impacted by wildfire events that are widely understood as highly stressful and possibly even traumatic for those affected. The findings captured in this document are a compilation of the perspectives, concerns, and commentary expressed by these communities, and can be directly attributed to their experiences and reflections during and after the 2019 fire season.

Stakeholder Participants

In October, November, and December of 2019 and January 2020, a review team travelled to the High Level, Peace River and Slave Lake Forest Areas to conduct interviews and focus groups with individuals and communities identified by WMB as being adversely affected by wildfire over the 2019 fire season. These interviews were a series of one-on-one, group, and townhall sessions that served to gather information and understand the experience of these stakeholders. In addition to face-to-face engagement, some interviews and discussions were done by telephone in order to accommodate schedules and availability.

Stakeholder engagement focused on discussions with community administration, elected officials, industry representatives, and residents of the High Level, Peace River, and Slake Lake Forest Areas who were impacted by the 2019 spring wildfires to better understand how wildfire information, in the pre-event, during the event and post event periods was communicated to the public and how this relates to stakeholder expectations. Interview questions were centered around the activities of WMB as they relate to the 2019 spring wildfires, looking at stakeholder engagement leading up to, during, and after the Battle, Chuckegg Creek, and McMillan wildfires.

In total, approximately 300[30] individuals had the opportunity to participate in the process. In the case of the townhall sessions[31], the Minister of Agriculture and Forestry and the local MLA's participated in the dialogue. This document recounts "what we heard" from stakeholders affected by wildfires in 2019.

[30] Approximately 175 individuals attended the townhall sessions with MNP and the Minister of Agriculture and Forestry, with the remaining 125 participating in one-on-one or group interviews with MNP.

[31] A total of three townhall sessions were hosted in High Level, La Crete, and Slave Lake.

An overview of the stakeholders and communities engaged is provided below in Table 12.

Table 12: Summary of Stakeholders and Communities Engaged

Chuckegg Creek Wildfire Community Stakeholders[32]	Battle Complex Community Stakeholders	McMillan Complex Community Stakeholders[33]
Beaver First Nation	County of Northern Lights	M.D. Lesser Slave River
Dene Tha' First Nation	Manning Grazing Association	M.D. Opportunity
Little Red River First Nation	Paddle Prairie Métis Settlement	Bigstone Cree Nation
Paddle Prairie Métis Settlement	Trans Canada Energy	Peerless Trout First Nation
Town of High Level	NG Contracting	
Mackenzie County		
Hamlet of La Crete		
Blue Hills Community		
Blue Hills School District		
Tolko Industries		
Norbord Inc.		
La Crete Sawmills		
Total Stakeholder Engagement Sessions: 28		

Summary of Findings

Stakeholder findings present overall highlights and opportunities as described by affected communities.

Key Highlights

- The highest prioritized value at risk within WMB is human life. The 2019 fire season resulted in no direct loss of life. Many stakeholders acknowledged this outcome and expressed gratitude for the efforts of WMB, the many firefighters and partners involved in the season.
- WMB was perceived by many stakeholders to be effective overall throughout the 2019 season and was generally respected for the work related to the Chuckegg Creek wildfire, Battle and McMillan complexes.

[32] Tall Cree First Nation declined to participate in stakeholder engagement interviews.

[33] MNP attempted to engage Loon River First Nation on multiple occasions but was unsuccessful in contacting a representative from the community.

- Many stakeholders pointed to the learnings and experiences of past wildfire seasons – especially 2011 (Slave Lake wildfire) and 2016 (Horse River/Fort McMurray wildfire) as significantly contributing to the increased preparedness of communities and their reception of wildfire management and evacuation protocols this past wildfire season.
- In general, industry with which WMB engaged reported that they received effective communication and appropriate involvement in the decision-making process.

Key Challenges

- The public has a limited understanding of wildland firefighting. Details about what firefighting constitutes, how it is operationalized, and what successful wildfire management looks like is not clear to most stakeholders. This creates a high demand for communication of information and context.
- Some stakeholders did not feel that WMB was effective or efficient and questioned their decision-making and ability to organize resources effectively.
  - There was a strongly held perception among a few individuals that there is an inherent disincentive for firefighters and contractors to efficiently control and extinguish wildfires. They feel there is financial gain to prolong wildfires and that this affected performance.
- Most concerns expressed by stakeholders were related to the impact of evacuation decisions and procedures on the public, including those who were forced out of their homes, hospitals and care facilities and those who were outside of the evacuation areas, but dependent on the evacuated centre for food, fuel and supplies.

Key Themes

1. **Relationships between stakeholders were integral to effective communication and operations during the wildfire. Multi-stakeholder emergency response planning resulted in cohesive regional action.**

   a. Conducting emergency planning in advance of the fire season with key stakeholders (such as fire departments, police services, Alberta Emergency Management (AEMA), industry, utilities, WMB, and bordering communities) developed relationships and established accountabilities that expedited communities' abilities to access and act upon accurate, timely information.

      i. Generally, most stakeholders consider all government departments and agencies to be "one government", rather than individual entities. As a result, positive or negative perspectives simply relate to that of "the government" in general. WMB usually takes on the role of "government" in people's minds.

   b. Partnerships with neighbouring municipalities allowed for sharing of information, resources, and expertise that improved the effectiveness and preparation of communities during the wildfire event and evacuation procedures.

   c. Communication was challenging for stakeholders without established relationships or without involvement in regional emergency response planning. The more remote the community was the wider the communication gap was, leaving these stakeholders feeling disconnected and disregarded by the WMB and other provincial bodies.

d. ICS[34] training enabled more effective communication with Incident Command (IC). However, having sufficient, trained resources on a consistent basis was challenging for many communities.

i. Additionally, because the ICS structure does not clearly recognize the role of elected officials in an Incident or Unified Command event (beyond that they should not be included in operational decision-making), administration, residents, and elected officials often felt like they "were getting different information from different places".

- Elected officials expressed frustration with the limitations of their abilities to support and lead their communities throughout the wildfire events.
- Without a defined role, involvement of elected officials was often ad-hoc, complicating relationships and information sharing between IC and community stakeholders.
  - Even after the fire season, stakeholders from within the same community have different understandings of how effective communication was and where communication breakdowns occurred.
  - While attributed to several variables, it was generally perceived that communication failures were a result of poor government communication with communities.

2. Lack of consistent WMB resources, approaches, and decision-making made forming relationships, maintaining knowledge continuity, and establishing trust between stakeholders difficult.

a. It was consistently reported that communication with WMB was impeded by a lack of knowledge and relationship continuity throughout the wildfires.

ii. Information about previous decisions and circumstances from both the community and the Incident Management Team (IMT) personnel was occasionally not relayed from one IMT team to another, often making information and support for the community inconsistent.

iii. Knowledge gaps were further impacted by the use of out-of-province resources with different protocols and procedures, providing local decision makers with conflicting information. For example, a community located near the Battle complex reported that the change-over between Alberta-based and British Columbia (B.C.) IMT teams was "clunky", due to different procedures for structural protection. Both the B.C. IMT team and the community struggled with understanding whether Structural Protection Units were to be sub-contracted (as they are in Alberta) or operated as part of the IMT team (as in B.C.), causing confusion and inefficient operations.

b. Discrepancies were reported most commonly during team changes, with communities citing that WMB contact persons changed regularly, often communicating with an individual new to the

[34] The Incident Command System (ICS) is a standardized on-site management system designed to enable effective, efficient incident management by integrating a combination of facilities, equipment, personnel, procedures, and communications operating within a common organizational structure. (Government of Alberta). ICS training is required for all Directors of Emergency Management.

community and/or situation who did not have knowledge of the information and direction that has been provided to date.

3. **Jurisdictional accountabilities and expectations between communities, WMB, and other governmental bodies was described as unclear.**
    a. Points of crossover between provincial bodies (e.g., AEMA / Provincial Operations Centre [POC], other divisions of AAF, Community & Social Services, etc.) resulted in "back and forth" between communities and government, impacting timely communication and service provision during and after the wildfires.
    b. Lack of clarity between provincial and federal jurisdictions impacted support for First Nations and Métis communities. It was unclear to many communities which governmental body they should look to for service provision and financial support.
    c. Direction and protocols to provide for the continuity and maintenance of essential services, such as hospitals, during evacuation was unclear and occurred on an ad-hoc basis.
4. **Due to narrow WMB credential requirements, local resources, knowledge, and critical infrastructure were underutilized by WMB, despite experience and expertise. If leveraged, locals were often an afterthought to operations.**
    a. Stakeholders felt that the approach of WMB to only use approved and credentialed operators for wildfire equipment and services was excessively narrow in scope (very specific qualifications / certifications required) and discounted those who are otherwise qualified to complete the job.
        i. This approach frustrated stakeholders who were not only willing to offer up services and manpower to wildfire management operations, but also had experience in doing so.
        ii. Frustrations were further aggravated when people from outside the local area were brought in to perform work with equipment and skillsets similar or identical to those that could be found within the community.
    b. Stakeholders were not included in planning discussions that would help them better prepare for and manage operational needs. IC, in general, did not consider the impacts to stakeholder's critical infrastructure.
        i. For example, while not directly fighting the wildfire, hotel and accommodation staff, catering, and facilities were required to host firefighters. Rather than being part of IC discussion, stakeholders were called back from evacuation to restart operations and support wildfire crews with accommodation.
    c. Local knowledge of operating on the challenging northern landscape was perceived as being dismissed. With all things equal, local stakeholders expressed the importance and potential for efficiency of understanding the conditions, access points, landscapes, and other key aspects of fighting wildfire around their communities.
        i. Commentary from stakeholders identified that the system used to identify and approve resources for wildfire management is different from the qualifications of locals, but this does not make local resources less valuable in many instances.
5. **Evacuations in rural and remote areas have different immediate needs and require consideration of a larger scope of influence than evacuation in more populated or urban areas.**

a. For many communities in northern Alberta, there is a reliance on a limited number of larger centres for ongoing service of basic needs. Beyond access roads, of which there are typically one to three, communities require access to larger centres for gas, trucked water, food, pharmaceuticals, and other key life sustaining resources.

b. During the evacuation, stakeholders recounted that those outside of the "official" evacuation line (even if only by a short distance), who may not be threatened by wildfire, were immediately at risk due to lack of access to these basic needs. Many stakeholders described the experience as being "refugees in [their] own homes".

6. **Wildfire and wildfire management have a significant impact on agricultural infrastructure and operations that requires advance planning and strategic and operational consideration during wildfire events.**

    a. Stakeholders shared challenges with protecting, caring for, and moving livestock threatened by wildfire.

    b. While IC operations considered residents, livestock was often forgotten or dismissed. Owners were generally not permitted into the evacuation zone to monitor and care for the livestock they left behind.

    c. Grazing, ranch, and farmland were often used during WMB operations, damaging the lands and infrastructure (e.g. fences) without considering the implications (e.g. escaped cattle). Stakeholders expressed frustration with the extent of damage to the property that may have been mitigated if ranchers and farmers were consulted.

    d. Remediation and compensation efforts for the damage sustained to these areas often fell through the cracks of different government agencies, and for many, have not been completed to date.

Detailed Findings

Chuckegg Creek Wildfire (May 12, 2019 – August 18, 2019)

HIGHLIGHTS

- The initial Unified Command put in place to evacuate the High Level area was described as highly effective. Numerous provincial (WMB, AEMA, Alberta Health Service [AHS]) and local bodies worked together to protect the community and its residents.
- Pre-existing relationships between WMB and local wildfire management stakeholders contributed to a strong, integrated working relationship with local administration and wildfire efforts in some communities.
- Where collaborative partnerships with WMB were in place, communication around the strategies and operational decision-making of IC were better understood and, in some cases, even supported and resourced by the local community.
- Public meetings with key community stakeholders throughout the Chuckegg Creek wildfire led to better communication, engagement, and management efforts between WMB and communities.

Chuckegg Creek Community Stakeholders:

- Beaver First Nation
- Dene Tha' First Nation
- Little Red River First Nation
- Blue Hills Community
- Town of High Level
- Mackenzie County
- Hamlet of La Crete
- Paddle Prairie Métis Settlement
- Tolko Industries
- Norbord Inc.
- La Crete Sawmills

CHALLENGES & FEEDBACK:

- WMB's focus on urban centres and inattention to more remote communities resulted in feelings of neglect, "disconnect" and "afterthought" for many rural and Indigenous stakeholders.
- There was a consistent perception that lack of engagement with Indigenous communities in advance of and during the fire season, overlooked potential resource use and local expertise that may have been leveraged by WMB operations.
    - In particular, a lack of discussion and collaboration limited the ability of Indigenous communities to share land-based knowledge and engage in the conversation and planning related to protecting their communities.
    - In general, stakeholders also found that local perspectives were not considered in deciding priority values at risk, such as traditional lands and areas with cultural importance.
- Lack of communication and inclusion in the decision-making process impeded the communities' ability to proactively make operational decisions or share information to members.

  - For example, due to the high level of concern and vulnerability of children, the evacuation of schools requires advance planning and significantly more time, as experienced in Blue Hills.
- There was significant concern around some of the chosen wildfire management tactics including proposed back-burning.
  - This concern relates to the perception that wildland firefighters often have little understanding of the "value" of a forest (timber, trapping, etc.).
- Some stakeholders indicated that local resources, such as firefighters, were "shut out" of decision-making and when used, were not utilized effectively (e.g., the policies in place limited their hours of work and when used, or resources were placed in areas with which they were not familiar).
- Some reported that there was disagreement over the decision to evacuate communities. At times evacuation orders were described as "unnecessary".
  - For example, there was a concern that "we don't evacuate for smoke" which may have reduced available time for residents to evacuate a particular area.
- Terminology and language surrounding wildfire conditions, in particular, the wildfire status of "being held", was misleading to stakeholders.
  - Lack of understanding around the connotation and highly contingent nature of "being held" led to communities feeling that WMB misrepresented the risk and urgency of the wildfire.
    - In many cases, this misunderstanding contributed to the public perception that the Chuckegg Creek wildfire should not have become out of control, and that WMB may not have had adequate resources on the wildfire at the stage when it was initially "being held", causing the wildfire to become out of control.
- Initial operations and communication from WMB were challenging; decision-making, quality of information, and timeliness of information were often insufficient for the needs of the communities.
  - Quality and depth of information from WMB (in some cases) was described as "limited", impacting the communities' ability to provide credible, timely information to the public.
- County administration struggled with misinformation amongst the public, but did not have the information needed to proactively address public concerns and questions due to restrictions from WMB.
- Lack of role clarity and responsibilities between local administration, provincial bodies, IC, and elected officials caused inefficiencies and impeded effective wildfire management practices in some cases.

Battle Complex (May 11, 2019 – June 26, 2019)

HIGHLIGHTS:

- Municipalities in the region received communications from WMB that, in general, effectively informed operational decision-making and messaging for residents.
- Stakeholders from municipalities in the region felt confident that the ICS structure ran smoothly and that, on the whole, it improved their ability to be heard as a community.

Battle Community Stakeholders:

- County of Northern Lights
- Manning Grazing Association
- Paddle Prairie Métis Settlement

CHALLENGES & FEEDBACK:

- Stakeholders that do not have municipal status expressed frustration with a lack of discussion and collaboration that resulted in rushed, reactionary action from WMB and the community.
- Relaying information from WMB to community members was hindered by a lack of capacity and experience at the local level and a lack of guidance from provincial bodies (WMB, AEMA).
- Messaging and delivery modes were required to be adapted based on highly varied levels of resident access to online communication platforms (emergency alerts, social media, etc.) in rural areas.
- Ranching and livestock considerations were treated as outside of the WMB jurisdiction, leaving the farming community without important logistical information leading up to and during the wildfire.
    - It was expressed that engagement in advance of the fire season may allow stakeholders to better prepare and contribute expertise to inform more effective and less damaging WMB practices on ranch lands.

McMillan Complex (May 18, 2019 – July 1, 2019)

HIGHLIGHTS:

McMillan Community Stakeholders:

- M.D. Lesser Slave River
- M.D. Opportunity
- Peerless Trout First Nation
- Bigstone Cree Nation

- As a region affected by wildfire in previous years, the communities interviewed expressed confidence and knowledge in the planning, emergency management, and evacuation experiences during the 2019 fire season.
- Communities universally expressed that performance and communication efforts from WMB were sufficient.
- Joint emergency planning occurred in all communities interviewed, resulting in collaborative operational efforts from WMB, participating communities, and other involved parties.
- Established relationships and familiarity with the operations structure of the ICS made communication with WMB timely and informative, and enabled administration to frame decision-making and public messaging around accurate and regularly provided information:
    - Receiving consistent updates at regular times from WMB provided clarity and certainty to community operations and decision-making.
    - Providing consistent updates at regular times from the administration to the public helped to set expectations and prevent mis-messaging.
    - Municipalities cited the importance of having designated and limited people responsible for communications. This ensures a single, reliable information source for both IC contacts and Public Information Officers at the community level.
- Having administration staff trained in multiple ICS functions helped provide contingency coverage and mitigate knowledge gaps if the primary designate for that function is unavailable.
    - This practice reduced knowledge loss year over year as administration staff change from one role to another.

CHALLENGES & FEEDBACK:

- Integration and communication between provincial bodies was identified as poor, negatively affecting stakeholders.
    - Specifically, working with the POC was challenging due to lack of representatives "on the ground".
    - Inconsistent information and misunderstandings resulted from a lack of visibility into the real-time events and operations occurring within the community.
- The management, service provision, and funding of evacuated persons complicated communities' ability to respond effectively to the wildfire event.
    - Stakeholders indicated that there is limited direction for communicating with, supporting, and potentially evacuating a displaced population within their borders, in addition to that of their own residents.
- Some communities indicated that they did not have visibility into the "why" behind certain wildfire management protocols, raising questions around "lengthy" evacuations and what was perceived to be "excessive" structural protection techniques.
- Stakeholders called for further integration and collaboration with school curriculum and regional school boards to address gaps in prevention and wildfire management knowledge and maximize public engagement touchpoints.
    - Furthermore, like the concerns expressed regarding the Chuckegg Creek widlfire, the vulnerability of school children was raised, calling for better planning and involvement with regional emergency response planning to mitigate logistical complications in the event of a wildfire evacuation.

Additional Options for Consideration

In addition to the summary and detailed findings above, community engagement brought forward additional themes and challenges expressed by stakeholders that are not directly related to the operations and communications of WMB. However, this section discusses topics that are inherently integrated into the actual and perceived operations of WMB. As such, these topics have been aggregated to detail what we heard and why they may be considered for further exploration in this review.

Public Understanding of Provincial Organizations Involved in Wildfire

- A reoccurring theme throughout the stakeholder engagement process was the lack of visibility communities and their members have into "who does what" leading up to, during, and following a wildfire. Public understanding of the roles, jurisdictions and scope complexities of the government bodies involved in wildfire management is not clear.
- It was heard that public perception of provincial functions, operations, and services are generally perceived to be that of "government".
- Frustration and confusion were expressed by stakeholders looking to multiple arms of government to service their needs with no clear answers or direction.
- Stakeholders used varying, and at times outdated, terminology to refer to the same provincial bodies involved in wildfire management.
    - E.g. often referring to WMB as SRD (Sustainable Resource Development) and "Alberta Forestry."

- Community leaders experienced significant challenges attempting to explain the boundaries of authority between the municipality, WMB and the numerous bodies working in the wildfire management space.
- The experiences shared by stakeholders identify communication concerns that reach beyond that of WMB. These concerns link to the broader scope of wildfire communications and performance as a collective government function.

Bearing the Cost of Wildfire

While logistics and communications played an integral role to the successful management of wildfire throughout communities in the Chuckegg Creek, Battle, and McMillan in the 2019 fire season, a common challenge for communities affected by wildfires was understanding the expectations, process, and controls associated with funding and recovering costs attributable to wildfire management and evacuation.

- Cost accounting and recovery was a challenge for most communities interviewed:
  - There is varying visibility on and control over wildfire spend at the community level.
  - Many stakeholders were unclear on the processes for recording and approving operational costs during the wildfires.
  - A lack of direction as to how and from who to recover costs left many municipalities carrying significant, yet to be recovered expenses that have affected municipal cash flow.
  - Inconsistent expectations from evacuees and unconfirmed reports of opportunistic local businesses made delivery of evacuee services difficult and costly.
  - Lack of clarity surrounding the roles and expectations of local administration in managing and providing services to a displaced population caused uncertainty around the standard of service to be provided, and by which body (provincial government, local government, and/or not-for-profit) these services would be provided.

In addition, there were several cost considerations related to evacuations:

- For those who are evacuated, many communities reported challenges with evacuation payments. These sudden income increases for many evacuees, in particular those struggling with addictions or mental health problems, resulted in extremely high rates of arrests and disorderly behaviour.
  - Because of this, stakeholders questioned the payment process and suggested the possibility of payments instead following the evacuation period. This suggestion was based on two key considerations:
    - Returning home, residents were faced with significant costs associated with sudden departure of and/or wildfire operations in their communities. These payments can help to ease the return and bridge the wait for insurance.
    - Evacuees, for the most part, are perceived to have their basic needs fulfilled at evacuations centres, which means they do not require any funds during the evacuation period. This may be dependent on the length of the evacuation and the type of community people are evacuated to.
- Communities receiving evacuees also reported opportunistic behaviour from local businesses, such as increasing gas prices, hotel rates, and other key necessities when evacuees arrived.

- Conversely, reception communities also noted that evacuees often had high expectations for the level of service and amenities provided to them, straining local resources.

Post-Wildfire Experiences

The impacts of wildfire on WMB partners and stakeholders extend beyond the duration of the wildfire event. Stakeholders faced a number of challenges following wildfire events in their communities.

- Stakeholders expressed difficulty when returning to their personal and professional lives following the incidents. Unlike imported resources, local resources (including local administrations) were presented with a number of additional challenges beyond the regular scope of their positions.
- Stakeholders emphasized the burden of managing a wildfire event and maintaining the day-to-day operations of their community on individuals and organizations.
- Due to a lack of resources following a wildfire event from wildfire partner agencies, many stakeholders reported ongoing challenges to their personal and professional lives.
- In general, stakeholders recognized this challenge as one not directly related to WMB, but rather to provincial emergency response agencies in general.

APPENDIX H – BEST PRACTICES AND EMERGING TECHNOLOGY IN DETECTION

Alberta's detection program uses several methods for detection with different attributes and capabilities. This review revealed that the competencies of Alberta's detection network are becoming increasingly tested by both further development into the Wildland Urban Interface (WUI) and extreme hazard conditions. However, Alberta can look to best practices and emerging technology to better understand and apply new methods for detection.

Best Practices

Program Partnerships

Beyond the scope of provincial wildfire programs, opportunities exist for cooperation and partnership with industry and communities for funding, developing, and operating wildfire detection networks. This possibility, brought forward by Saskatchewan wildfire operations, is especially attractive in remote or heavy industrial areas, where detection is made challenging by the remoteness of locations. As seen from data regarding high-risk wildfires (i.e., industry, lightning, incendiary), a significant portion of wildfires are detected and reported by the public. Because of this, it is a logical extension to consider formalizing that detection and reporting process in the form of a partnership.

In addition, these types of partnerships would allow governments to leverage the technology and resources of sophisticated industry operations, many already in place to protect and monitor industry infrastructure. In the case of communities, involvement in wildfire management may help to promote education and engagement with those residing in the WUI.

Data-Supported Detection

Fixed-wing aircraft is a lower-cost method of aerial patrol. When combined with modelling software, this method of detection optimizes cost efficiencies and detection performance. In Ontario, the Aerial Detection Demand Index (ADDI) is used to inform fixed-wing (FW) patrols throughout partial and full coverage areas. ADDI incorporates past weather, detection, and fire behaviour data to predict points of ignition based on current year weather and fuels data. FW aerial patrol routes are developed based on these predicted points, designing detection coverage around both high hazard and past behaviour indicators. For example, a high incidence of recreational wildfires in popular fishing areas in May would demand coverage similar to an area of high HFI as both pose risk to the landscape. Modelled patrol routes are developed through central operations then validated with Regional Duty Officers to ensure that local considerations are taken into account.

It is important to note that within this system, after a FW patrol has detected a wildfire, the aircraft does not remain at the ignition point. Rather, appropriately resourced aircraft is deployed to conduct the initial attack and the FW aircraft continues along its planned patrol route. This serves to deconflict the airspace near the wildfire and allows continuous coverage of the area of responsibility.

Detection Cameras: As Used in Saskatchewan

Various forms of camera technology have been used in research, field, and operational applications. In Saskatchewan[35], FireWatch cameras have been phased in, to replace the manned tower system that was in place prior. Saskatchewan decided to transition away from the manned tower system as a result of changing Operational Health and Safety legislation regarding working at heights and working alone. The cameras were also a way to mitigate growing maintenance and infrastructure requirements – each tower costing approximately $100,000 to replace. As these towers age, the cameras will be relocated to nearby communication towers in lieu of further repairs to existing infrastructure.

The FireWatch cameras use visual imagery to detect smoke and flame appearances on the landscape. The network of 42 cameras are attached to previously manned lookouts in full-coverage areas[36], rotating observation near VAR. These cameras are equipped with low-light capabilities, offering improved visibility and performance in clouded or darkened conditions, compared to that of a human eye.

All 42 cameras are overseen centrally by two to four highly trained observers that detect, confirm (when possible), and report wildfires with the support of intelligent camera software. This software identifies anomalies in the field of vision for review by the observer as well as potential alternative views for confirmation of smoke or flames. The observer has the ability to “take control” of tower cameras in order to obtain better or more detailed views of the detection point to confirm a wildfire. This centralized staffing model also allows for continuous development of detection expertise and knowledge of the technology and the landscape it observes.

A reported challenge of the manned lookout system was that staffing remote lookouts was becoming increasingly challenging, and that turnover resulted in resources with minimal training operating many lookouts. The camera system maintains consistent staffing year-around, allowing for greater knowledge continuity and detection ability. Compared to manned lookout performance, the camera detection being used in Saskatchewan has reported comparable detection numbers to previous years, indicating that performance, at a high level, was not negatively impacted from the transition.

In addition, the camera system has isolated capture and playback of camera footage capabilities, allowing observers to not only detect wildfires, but to identify them and confirm their growth in many cases. As well, images of detection views are captured and stored to support any investigatory or legal proceedings following a wildfire. All data captured and reported from the camera system is stored in a centralized information management system accessible to all operational resources.

Versions of FireWatch cameras are also used in South Africa, Oregon, and other global jurisdictions. In South Africa, the camera detection system uses automated detection software, rather than that of manned observation as in Saskatchewan. Experience in Saskatchewan emphasized the importance of maintaining the technical expertise that manned observation permits. For example, false alarm reports from automated systems, caused by factors such as dust or other debris, cannot be distinguished with existing technology. However, limitations of a camera tower system in general, manned observation or otherwise, include factors such as weather monitoring (e.g. identification of “wet” or “dry” storms) and other wildlife and environmental reporting. An additional

[35] All Saskatchewan data referenced in this section was obtained through interview with S. Roberts, Executive Director Wildfire Operations Saskatchewan (November 26, 2019).

[36] As discussed in the summary table, Saskatchewan operates wildfire management zones that are either full or partial coverage, based on the presence and density of VAR within them.

challenge of a camera system is access to a reliable connection in remote areas without incurring significant capital cost. This challenge was faced by Ontario, who tested the camera system in 1990.

Perhaps most pointedly, the camera system allows for adoption of emerging technologies to improve outcomes and performance. The infrastructure of the camera system can be linked to remote monitoring technologies, such as satellite, as the timing and quality of satellite imaging becomes more applicable to detection functions. For the cameras themselves, advances in digital capture capabilities, improved data packages, and better energy usage all have the potential to be integrated with the current system as they become available. Therefore, when considering investment in detection technologies, consideration should be given about the current and future developments of complementary technology.

Emerging Technology

Unmanned Aerial and Remote Piloted Vehicles (Drones)

Drones have been used and tested for wildfire management in various jurisdictions. Most prominently, unmanned aerial vehicles (UARs) or remote piloted vehicles (RPVs) have been used to assess the size and growth of a wildfire as part of suppression efforts, using visual or thermal cameras to detect and map flames.[37] However, due to the newness of drone technology, there are limited applications at this time of consistent detection performance. Under the Canadian Aviation Regulations, drones cannot be flown beyond line of sight by the operator, dramatically limiting the range of drone use.

Satellite Imaging

Satellite imagery, such as MODIS (Moderate Resolution Imaging Spectroradiometer), has the ability to cover large landscapes with semi- or fully automated technology, but lacks the precision of detection (timing and wildfire size) to make it a useful detection tool in Alberta. Long periods between satellite visits make it challenging to promptly detect wildfires.[38] The quality and capability of satellite imaging is limited to larger wildfires with restricted resolution and interference of precipitation and/or cloud cover.

There are significant limitations to satellite imagery with available technology. However, geospatial orbit telescopes—satellites that match the rotation of the earth—combined with infrared sensors and detection computing capabilities are being developed to accurately identify and geolocate wildfires as small as $12m^2$ (0.0012 ha).[39] While in early stages, this prototype furthers the conversation with Saskatchewan, indicating a distinct shift toward advanced technological systems that may be available for use in the detection field in the coming years, building on technology available today.

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37 Allison, R. S., Craig, G., Jennings, S., Johnston, J. M. *Airborne Optical and Thermal Remote Sensing for Wildfire Detection and Monitoring*. Sensors 2016.

38 Ibid.

39 Pennypacker, C.R.; Jakubowski, M.K.; Kelly, M.; Lampton, M.; Schmidt, C.; Stephens, S.; Tripp, R. FUEGO — Fire Urgency Estimator in Geosynchronous Orbit — A Proposed Early-Warning Fire Detection System. ***Remote Sens.*** 2013.

Other Detection Technology

In addition to the semi- or fully-automated technology described in this section, further technological aids have been used to improve human surveillance of wildfires. For example, the use of night-vision goggles (NVGs) have been field-tested in Ontario as a means to improve detection and aerial patrol flame detection.[40] NVGs enable infrared-like detection but with ocular movement; essentially, the user is able to look as one would in daylight, but without light, optimizing the benefits of both ocular and infrared detection.[41] Of course, NVGs are not equivalent to full day time vision.

Review and Comparison of Existing Detection Technologies[42]

With an understanding of existing and potential technology available for detection applications, the following table compares and contrasts their efficacy. While there are a number of options for consideration in Alberta, due to the uniqueness of operations and landscapes between jurisdictions, further evaluation would be required to better understand their application in the province's forest lands.

Table 13: Summary of Emerging Technology Capabilities

Comparison	Camera Based Techniques (Automated)	Camera Based Techniques (Manual Observation)	Satellite Based Techniques	UAV / Air Borne Techniques
Cost Efficiency	High	Medium	Very High	High
Frequency of use in literature	Medium	Medium	Very High	Medium
Detection device mobility	Fixed	Fixed	Mobile	Mobile
Power source	Rechargeable	Solar	Rechargeable Device	Rechargeable Device
Detection to notification delay	Long	Small	Very Long	Long
False alarm	Medium	Small	Very Low	Medium
Wildfire localization error	High	Small	Very High	High

[40] Allison, R. S., Craig, G., Jennings, S., Johnston, J. M. *Airborne Optical and Thermal Remote Sensing for Wildfire Detection and Monitoring*. Sensors 2016.

[41] Ibid.

[42] Chowdary, V., Gupta, M. K., Singh, R. A Review on Forest Fire Detection Techniques: A Decadal Perspective. International Journal of Engineering & Technology 2018.

Appendix I – Evaluation Approach

Evaluation Definitions

Table 14: Evaluation Definitions

Evaluation Component	Definitions
Relevance	The extent to which the objectives of a project or programme are consistent with overarching stakeholder needs and overarching mandate
Efficiency	A measure of how resources/inputs (funds, expertise, time, etc.) are converted into outputs
Effectiveness	The extent to which a project or programme achieves its objectives and outcomes
Data Source Type	**Data Source Definitions**
Interviews	Interviews or focus groups involving staff, management, senior leadership and stakeholders
Desktop research	Review and synthesis of guiding documents (e.g. department SOPs, policies, procedures, research documentation, best practices research and other studies)
Benchmarking/ leading practices	Interviews and data collected from BC, Ontario and possibly other jurisdictions as related to individual program components
Financial analysis	Analysis of expenditures over the past five to 10 years, including comparisons to benchmark jurisdictions where possible
Performance Analysis	Assessment of hazards, conditions and program results over the past five to 10 years, including comparisons to benchmark jurisdictions where possible
Trend Analysis	Review of program trends over the past five to 10 years and where relevant, longer term trends in climate, economics or resource development

Guiding Evaluation Questions

Table 15: Evaluation Questions and Data Collection

Evaluation Questions	Data Sources	Source Details
Relevance and Strategic Focus		
1. What is the Province's risk tolerance with respect to wildfire on the landscape? How is this different in a wildland context compared to the wildland-urban and wildland industrial interfaces?	• Interviews • Desktop research	• Senior leadership interviews, protocols • Staff and stakeholder interviews, protocols • Document list

Evaluation Questions	Data Sources	Source Details
2. What is the anticipated future forest and fire season context expected to be?	• Interviews • Desktop research • Trend Analysis	• Staff and stakeholder interview list, protocols • Document list • Relevant trend data
3. What is the expected future provincial population and population distribution expected to be?	• Interviews • Desktop research • Trend Analysis	• Staff and stakeholder interview list, protocols • Document list • Relevant trend data
4. Considering the province's risk tolerance and anticipated future context, how are expectations and needs changing, and what are the implications of these changes across the program areas?	• Interviews • Desktop research • Trend Analysis	• Staff and stakeholder interview list, protocols • Document list • Relevant trend data
5. Which program areas are best positioned, and which are not, to meet these changing needs?	• Interviews • Desktop research • Trend Analysis	• Staff and stakeholder interview list, protocols • Document list • Relevant trend data
Delivery and Efficiency		
6. Are existing management policies, procedures and standards appropriate given the Province's risk tolerance and strategic focus?	• Interviews • Desktop research • Benchmarking/ leading practices • Performance Analysis	• Staff and stakeholder interview list, protocols • Document list • Benchmarking survey and interview results • Program outcomes and performance data
7. Are existing management policies, procedures and standards considered to be current and providing clear direction?	• Interviews • Desktop research • Benchmarking/ leading practices • Performance Analysis	• Staff and stakeholder interview list, protocols • Document list • Benchmarking survey and interview results • Program outcomes and performance data
8. Have managers, staff and/or partners raised any specific concerns over the delivery of these program areas?	• Interviews • Performance Analysis	• Staff and stakeholder interview list, protocols • Program outcomes, FIRES data and other and performance data

Evaluation Questions	Data Sources	Source Details
9. Are resources being appropriately allocated to the program areas of highest importance?	• Desktop • Interviews • Financial analysis • Performance Analysis • Trend Analysis	• Document list • Staff and stakeholder interview list, protocols • FIRES expenditures, IMAGIS • Program outcomes, FIRES data and other performance data • Relevant trend data
10. Are there any constraints that limit the ability of management to effect changes to the allocation of resources?	• Interviews • Performance Analysis • Trend Analysis	• Staff and stakeholder interview list, protocols • Program outcomes, FIRES data and other and performance data • Relevant trend data
11. Are the available resources considered sufficient for the purposes of delivering on each of these program areas?	• Interviews • Benchmarking/ Leading Practices • Financial analysis • Performance Analysis • Trend Analysis	• Staff and stakeholder interview list, protocols • Benchmarking survey and interview results • FIRES expenditures, IMAGIS • Program outcomes, FIRES data and other and performance data • Relevant trend data
12. Have performance measures been established in relation to each of the program areas. Are they useful to report on the state of activities, "outputs" and planned outcomes?	• Desktop • Performance Analysis • Benchmarking/ leading practices	• Document list • Program outcomes, FIRES data and other and performance data • Benchmarking survey and interview results
13. Are Performance measures appropriate given the Province's risk tolerance and strategic focus?	• Desktop • Performance Analysis • Benchmarking/ leading practices	• Document list • Program outcomes, FIRES data and other and performance data • Benchmarking survey and interview results
14. How is the resulting information being used?	• Desktop • Interviews • Performance Analysis	• Document list • Staff and stakeholder interview list, protocols • Program outcomes, FIRES data and other and performance data
Effectiveness		
15. Were the expectations of executive, management, and staff met in terms	• Desktop • Interviews	• Document list

Evaluation Questions	Data Sources	Source Details
of realized results with each of these program areas?	• Performance Analysis	• Staff and stakeholder interview list, protocols • Program outcomes, FIRES data and other and performance data
16. Were the expectations of communities, associations and others met in terms of the program area results?	• Desktop • Interviews • Performance Analysis	• Document list • Staff and stakeholder interview list, protocols • Program outcomes, FIRES data and other and performance data
17. Can these results be maintained over time? Is there a need to rebalance the level of service/resourcing with expectations, needs and the expected future context?	• Interviews • Benchmarking/ leading practices • Trend Analysis	• Staff and stakeholder interview list, protocols • Benchmarking survey and interview results • Relevant trend data
18. Have there been any unanticipated results, either positive or negative, that can be attributed to the program areas?	• Interviews • Financial analysis • Performance Analysis	• Staff and stakeholder interview list, protocols • FIRES expenditures, IMAGIS • Program outcomes, FIRES data and other and performance data
19. How successful has the Ministry been at implementing recommendations from the 2015 Fire Season and Wildfire Management Program Review?	• Desktop • Performance Analysis	• Document list • Program outcomes, FIRES data and other and performance data
20. How successful has the Ministry been at implementing recommendations from the Review of the 2016 Horse River Wildfire?	• Desktop • Performance Analysis	• Document list • Program outcomes, FIRES data and other and performance data

APPENDIX J – BENCHMARKING SUMMARY AND IT SYSTEMS OVERVIEW

As part of the program evaluation, a jurisdictional scan was carried out to provide additional insights and best practices. The jurisdictions mutually agreed upon for this review were British Columbia (BC), Saskatchewan (SK), Ontario (ON) and Northwest Territories (NWT). The work included several interviews with key personnel in these other regions and a review of documentation provided by those personnel upon request.[43]

The most important elements identified through this exercise are directly incorporated into the main report where they support one or more of the key findings or recommendations. Other elements less directly relevant to the key findings and recommendations are outlined in this supplementary document.

The following document consists of two main parts: 1) high-level jurisdictional comparison that includes commentary and data points derived from interview and documentation reviews and 2) information technology systems analysis and jurisdictional comparison.

High-Level Jurisdictional Comparison

Of all the jurisdictions reviewed, Alberta perhaps has the most in common with British Columbia in terms of wildfire risk, total number of wildfires, density of values-at-risk on the landscape and other key defining factors. As an example, Saskatchewan, Ontario, and the Northwest Territories more typically adopt a modified response to wildfire management than Alberta and British Columbia and are less aggressive with initial attack (IA) in remote areas. British Columbia and Alberta are less inclined to adopt modified response strategies due to the greater number of values-at-risk distributed across the landscape. This also drives more aggressive IA systems.

For this reason (and others), detection and prevention activities, and their associated budgets, are expected to be quite disparate between the jurisdictions reviewed. Overall, preparedness and suppression are less disparate but still have distinct differences as evidenced by the data provided below.

Like Alberta, the other jurisdictions have observed increased frequency and impact of active and severe fire seasons, though Ontario appears to have experienced fewer severe seasons over the last 5-10 years than before. The acknowledgement that wildfires are a natural and inherent part of the landscape, the clear trends towards more severe fire seasons, and limitations on financial and human resources has, to varying degrees across these provinces, led to increased emphasis on strategic management of wildfire, including modified response and indirect attack. This emphasis further frames increased awareness of the importance of strategic planning, incident planning (including short and long-term forecasting and predictive analysis), use of technology and focused spending.

Broadly speaking, these provinces are facing many of the same or similar challenges that were identified by WMB personnel and other informed individuals in Alberta over the past several years. The manner in which these jurisdictions are responding and adapting to these challenges, however, is different. The differences reflect the different landscapes, values, communities at risk, public expectations and resources.

[43] Note: MNP encountered significant challenges in gathering all the information requested. The analyses presented herein should be understood to be limited by the inconsistency and incompleteness of the data received. Even with the reliable data we did receive, when applied to a comparative analysis, it is apparent that the various jurisdictions track and capture information differently which can make direct comparison between jurisdictions difficult. As a result, the reader should not overvalue the data and analysis presented herein.

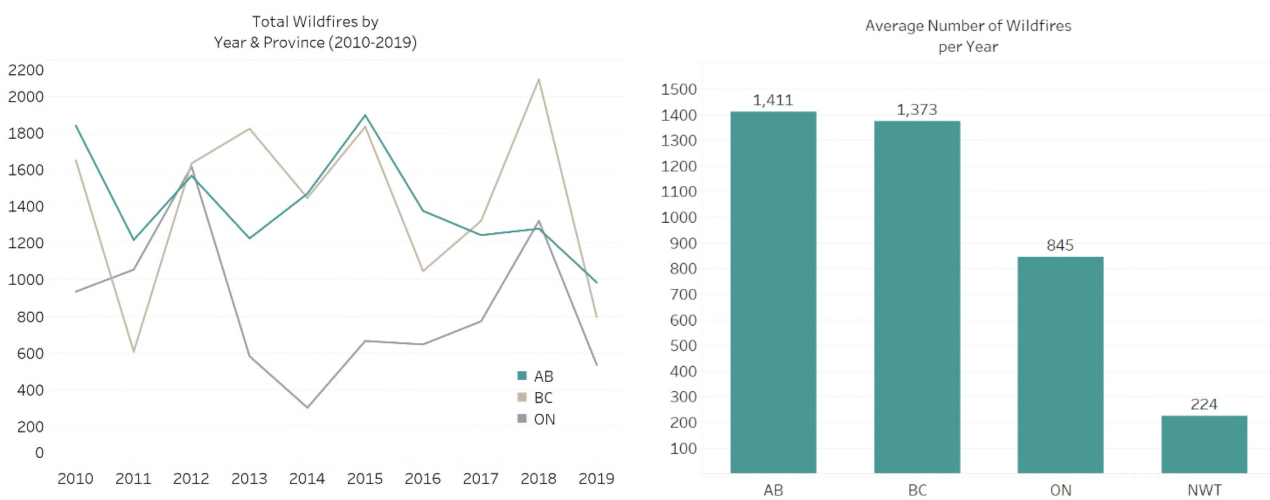
For example, in both Ontario and Saskatchewan there is an increased focus on interagency cooperation and integration. Saskatchewan's wildfire management program is in the midst of a transition to a more unified emergency management / emergency response program that blends wildfire management with 911 emergency response and other functions under a single crown agency.

In Ontario, there is a heightened focus on working with municipalities and local communities in the wildfire region to improve the overall ability to prevent wildfires. Structural protection in these communities tends to be something for which the provincial entity takes more responsibility than in Alberta, for instance.

Also, in Ontario, there is a push for increased flexibility in establishing and resourcing the "bases" from which manpower and equipment are deployed to the frontline. This flexible physical wildfire management framework is supported by improved fire weather / fire behaviour forecasting and values-at-risk mapping data brought together through improved system integration. In other words, Ontario, like other provinces, is improving its ability to deploy resources to where they are most needed and to limit over-resourcing as much as possible.

The following exhibits describe several interesting comparative data points to illustrate some of the similarities and differences between the jurisdictions. These exhibits must be interpreted with an appreciation of the different populations, climates, geographies, topographies, histories, and industries in these jurisdictions. Because of these differences, a pure "apples to apples" comparison is not feasible even where consistent and complete data is available.

Figure 45: Wildfires Per Year in Alberta and Other Jurisdictions



As per Figure 45, Alberta and British Columbia have a similar average number of wildfires per year, though it should be understood that wildfire severity can vary greatly (i.e., that not all wildfires are the same size / scale). Ontario and Northwest Territories have seen significantly fewer wildfires over the same period. It is also important to note that there is significant volatility in all regions in terms of number of wildfires per year, indicating the need to understand wildfire weather, forecasting, short-term and long-term trends, etc.

Figure 46: Wildfire Cause Comparison Between Alberta and Other Jurisdictions

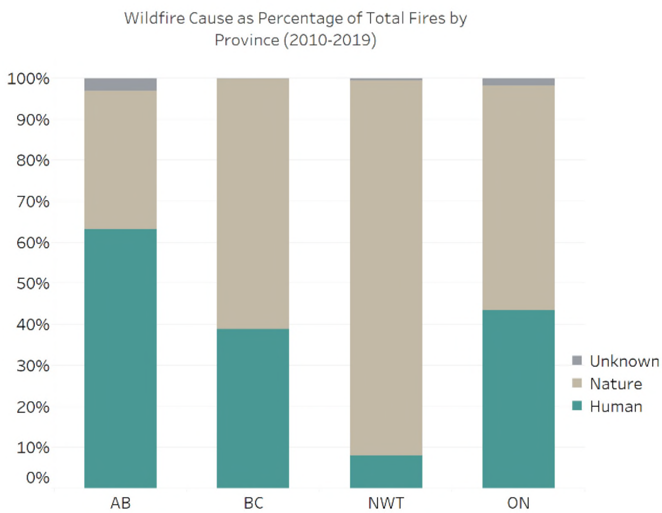
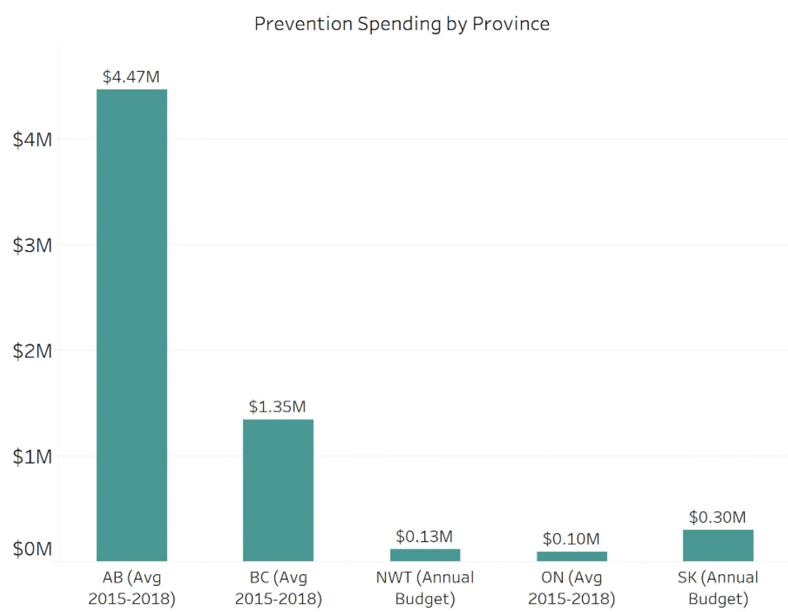


Figure 46 illustrates that human-caused wildfires are proportionally lower in other jurisdictions relative to the total number of wildfires, in comparison to Alberta.[44] The cause of this discrepancy is not obvious from the data alone, however, whatever the cause is, this should indicate an area of concern for WMB.

Figure 47: Prevention Spending in Alberta and Other Jurisdictions



[44] The ability to investigate and accurately identify cause of wildfire may vary from region to region and the definition of human-caused, or what that classification includes, may not be consistent across jurisdictions.

Alberta has emphasized the value of prevention activities and their impact on overall wildfire management outcomes and have allocated budget accordingly.[45] The discrepancy between jurisdictions evident in Figure 47 appears to be in part because Alberta includes more activities/items in the prevention budget envelope than other provinces. This makes a direct comparison of prevention budgets difficult.

Other provinces may have different strategies and collaborative prevention frameworks. It is also appreciated that Alberta, at the time of writing, is known to have the most mature implementation of FireSmart (and by association, the highest FireSmart related costs) of all jurisdictions analyzed.

Figure 48: Analysis of Maximum Wildfire Size (i.e., Extinguished Size)

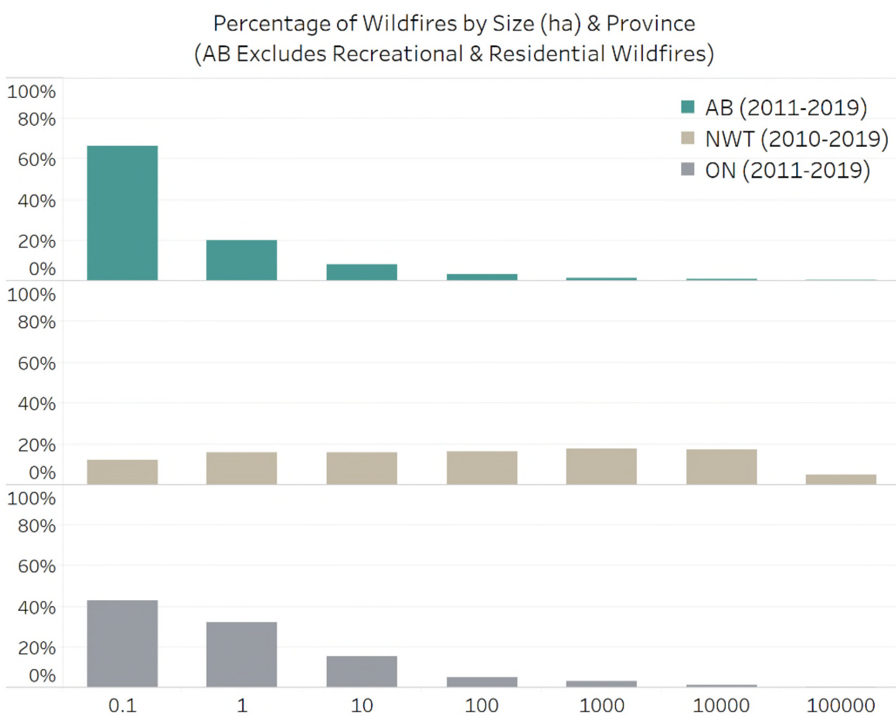


Figure 48 is illustrative of the difference in strategic approach to wildfire management in Alberta to other jurisdictions, especially Northwest Territories, where direct attack is often replaced with a modified response (monitor and contain versus direct suppression). Anecdotally (i.e., without data available for Saskatchewan and BC), with a lower amount of values at risk on the landscape, Saskatchewan's approach to wildfire management is more aligned with Northwest Territories and Ontario while British Columbia is more similar to Alberta.

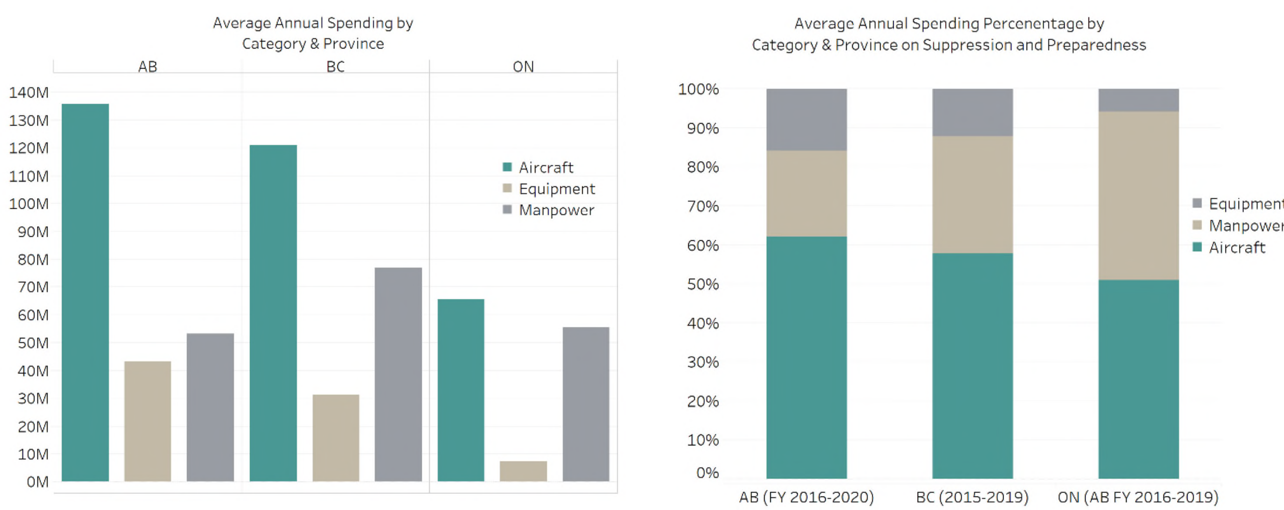
[45] This exhibit should in no way suggest that Alberta is over-spending in respect to prevention activities. It is more indicative of a different framework and collaborative framework with municipalities and stakeholders.

Figure 49: Preparedness and Suppression Spending in Alberta and Other Jurisdictions

Figure 49 compares preparedness and suppression spending, which together represent the majority of wildfire management expenditures in all jurisdictions, including Alberta. Ontario's total expenditure on preparedness and suppression relative to Alberta and British Columbia is surprisingly high, compared to the total number of wildfires and the knowledge that both Alberta and British Columbia have experienced one or more very severe fire seasons in the period analyzed, with large areas burned, whereas Ontario has not.

Figure 50 shows that Alberta spends proportionately more on aircraft and equipment than BC or Ontario. This may be an indication that there is room for improved cost-efficiency in Alberta.

Figure 50: Preparedness and Suppression Spending Breakdown in Alberta and Other Jurisdictions



Information Technology Systems Analysis and Jurisdictional Comparison

MNP reviewed eight information management systems that are used by Government of Alberta's (GOA) Wildfire Management Branch (WMB). These systems include: FIRES, Dispatch, AWARE, Wildfire Mapping Program, Alberta Wildfire Website, FireBans, Inventory Management Information System, and FireWeb.

Key functionality of each system was identified, including the strengths and weaknesses of each system.

This section contains MNP's high level review of the overall system assessment, a comparison to what other jurisdictions are using, and an assessment of each individual system.

Overall System Assessment

During MNP's review of key WMB systems, it was determined that WMB is in the process of modernizing their software systems. Fujitsu Consulting Canada (Fujitsu) was hired in 2018 to review the existing systems and develop a roadmap to transform and modernize the systems that WMB uses. During the review Fujitsu held workshops, meetings, and interviews to understand business requirements and to identify gaps between the business requirements and functionality provided by WMB's existing systems. A final report was delivered to WMB in 2019 that provided an overview and assessment of the current state, target state vision, road map, and costs. Fujitsu's conclusion was that the key challenges of WMB's existing systems are:

- Most systems are old, written in legacy technologies and in a state that makes it difficult or impossible to take advantage of emerging technologies to help transform WMB operations.
- Systems employ manual and cumbersome processes with a significant amount of paper.
- Significant data duplication exists between systems.
- Systems are siloed with limited data integration.
- The key FIRES system lacks GIS functionality.
- Network connectivity is lacking in remote areas.

Based on the high-level review MNP performed of WMB's systems, MNP agrees with the assessment made by Fujitsu. Three of the core systems, FIRES, Dispatch, and IMIS, are approximately 25 years old and are using legacy technologies that are difficult to maintain. FIRES and IMIS were written in the software development tool called PowerBuilder that has compatibility issues with Windows 10 and potential compatibility issues with other future operating systems. Additionally, PowerBuilder systems are difficult to maintain due to a lack of skilled PowerBuilder developers.

The main system, FIRES, is a very large system used to track wildfire details, aircraft contracts, aircraft details, employee training certifications, employee payrates, and fire permits. It has siloed data, a difficult to learn user interface, a lack of GIS functionality, and an inability to make use of newer technologies, such as linking to mobile devices, downloading data collected by drones, and integrating with workflow and document management systems.

AWARE is the most advanced implementation of the Canadian Forest Fire Danger Rating System in Canada. It is a web browser-based application that is a deployed to a central server. This makes system updates easier when changes only need to be made to a central server; compared to a desktop application, where the application needs to be installed and deployed to each workstation. Its user interface is easy to use.

MNP recommends that WMB continue with the legacy modernization project to provide functionality required by WMB to help improve the delivery and help reduce the impact of wildfires in Alberta.

Jurisdictional Comparison

MNP performed a high-level review of Ontario's Ministry of Natural Resources wildfire management support programs. The British Columbia Wildfire Service was contacted but not able to participate in the exercise. The table on the following pages provides a list of systems used by Ontario, and identifies the name of the software that is used by WMB to provide similar functionality in Alberta.

The following are key findings in the comparisons between Alberta's and Ontario's systems.

- Overall, Ontario's key wildfire support systems have similar capabilities as Alberta's.
- Most of Ontario's systems, except for IMIS and ACIMS, are web browser based and are not desktop or Citrix based. This makes it easier to distribute the application to users because no local software installation is needed. Application updates are installed on a central server and users access the systems through a web browser. This may be a good model for WMB to consider.
- Ontario's main system, FMIS, has a sub module called AFFES Mapper that provides GIS functionality. There is no GIS functionality provided in WMB's FIRES.
- DFOSS, PIMS, IRT, and Mapper are all independent systems that are launched through FMIS and are not modules of FMIS. This allows DFOSS, PIMS, IRT, and Mapper to be independently updated, enhanced, tested, and deployed without impacting functionality of the other modules. This contrasts with WMB's FIRES where a large amount of functionality is contained within FIRES, and modifying one module of FIRES requires a full regression test of the entire FIRES system and a new deployment.
- Most of Ontario's systems are 15 to 20 years old and were built using legacy web technologies. Ontario was in the process of developing a plan and roadmap to modernize systems when the program was halted due to budget and cost concerns.
- Similar to Alberta, Ontario is utilizing Geocortex and ESRI ArcGIS Server to build web browser-based GIS applications.
- The public web map, FFIM, provides more functionality and data than GOA's WildFire Status map.

Table 16: Jurisdictional Comparison Between Alberta and Ontario

Ontario System	Description	Date Originally Developed	Technology	Alberta System
Fire Management Information System (FMIS)	Fire Management Information System (FMIS) is an umbrella architecture that incorporates the concept of one integrated fire management information database and application/system It is used for access and account management to the DFOSS, PIMS, Mapper and IRT applications	2003	Web based - Oracle 11/Websphere 8.0.011 (written in J2EE)	There is no umbrella system for Alberta's systems They are all stand along applications that are launched individually
Personnel Information Management System (PIMS)	PIMS provides tools to support all aspects of Fire Response personnel management, including: • Recording basic personal information to create an inventory of staff who perform fireline functions • Recording individual training courses • Tracking requests, mobilizations, status, locations, and demobilization of staff • Recording hours worked to calculate and summarize cost information • Producing reports listing and summarizing the above information • Recording staff qualifications and experience	2003	Web based - Oracle 11/Websphere 8.0.011 (written in J2EE)	FIRES
Daily Fire Operations and Support System (DFOSS)	DFOSS comprises modules that AFFES staff uses to: • Record and store weather (observed and forecast), incident and wildfire information as it is reported • Calculate Fire Weather Indices and fire behaviour predictions to support daily planning and decision making	2002	Web based - Oracle 11/Websphere 8.0.011 (written in J2EE)	FIRES

Ontario System	Description	Date Originally Developed	Technology	Alberta System
	• Produce reports listing and summarizing the above information • Control different aspects of the system, such as starting up weather stations			
AFFES Mapper (mapper)	AFFES Mapper provides GIS mapping capability to all AFFES modules in support of wildfire management decision-making activities, including displaying: • DFOSS Data (weather, initial reports, wildfire and lightning) • Fire Behaviour Prediction Information • Land Information Ontario Data • Values-at-risk • Satellite Imagery	2014	Web Based – GeoCortex	DISPATCH, AWARE
IMIS (warehousing)	Fireline equipment tracking and inventory management software	2005	Citrix based application	IMIS (Same System)
FFIM Forest Fire Information Map (external facing)	Interactive map visually shows active wildfires, current fire danger across the province and restricted fire zones The map shows perimeters for some wildfires over 40 hectares in size	2016	Web Based – GeoCortex	Wildfire Status Map, FireBans Alberta's wildfire status map only contains point locations for wildfire and does not contain wildfire perimeter
ACIMS	Captures information on all aspects of aviation management including air carrier information, requisitioning, flight planning, hiring, utilization and post-flight cost information	2004 - Currently under modernization	Citrix based application, PowerBuilder	FIRES

Ontario System	Description	Date Originally Developed	Technology	Alberta System
Initial Reporting Tool (IRT)	IRT is a reporting system for capturing initial calls of potential events	2012	Web based - Oracle 11/Websphere 8.0.011 (written in J2EE)	DISPATCH, FIRES
Aviation Maintenance and Inventory Management System (WinAIR)	WinAir manages maintenance data for aircraft including scheduled, unscheduled and maintenance due; inspections and compliance reporting and all maintenance documents, service bulletins and detailed costs of repairs used for inventory management	2005	COTS application	No functionality demonstrated.
Detection Route Planner (DRP)	Detection Route Planner is a web-based information system that supports the Detection Leader in the planning and coordination of aerial detection patrols. This is an interactive tool that allows the Detection Leader to identify areas of concern and design patrols routes using many factors common to detection planning, including: • 24 & 7 day lightning strike data (by type +/-) • Rainfall • Fire Weather Indices • Fire Occurrence Prediction Models (lightning and person) • Response Objective Indicator • Head Fire Intensity • Active Wildfires • Active large wildfire perimeters • Aerial Detection Demand Index	2016	Web Based - GeoCortex	No functionality demonstrated

Ontario System	Description	Date Originally Developed	Technology	Alberta System
	• Functionality includes: o Calculating flight duration from distance and aircraft cruise speed o Producing the daily detection coordinate sheet for pilots/observers o Producing images of maps for briefings o Producing geo-referenced images, and/or GIS data of routes and active wildfires for use in tablet devices to assist in navigation duties			

WILDFIRE MANAGEMENT BRANCH SYSTEMS ANALYSIS

The following is a high-level review of key systems used by the WMB.

System Name: FIRES

Purpose

Fire Information Resource System (FIRES) is the main software system used by the WMB to track information for the GOA wildfire program. It contains information about wildfires, aircraft contracts, aircraft inventory, contract costs, flight costs, flight records, aircraft specifications, crew contracts, resource costs, lookout locations, lookout staffing levels, detection messages, wildfire location details, wildfire assessment details, fuel caches, tracking of wildfire complexes, tracks resources, resource requests, weather forecasting, and fire permits.

There are approximately 700 named users of FIRES.

Key Functionality

FIRES is a very large system and the following is a high-level overview of key functionality.

- Wildfire Detection Message **-** FIRES stores the original wildfire detection message that is created in Dispatch. Details stored include data, location, caller details, and wildfire size.
- Wildfire Details - FIRES stores details about a wildfire, including assessment information. This includes information recorded but not limited to: assessment date, wildfire name, longitude, latitude, legal description, region, wildfire type, fuel type, and spread rate.
- Aircraft Contracts – Details on long-term and short-term aircraft contracts are stored in FIRES. Details stored include: company name, contact details, contracts start date, end date, aircraft used, unit cost, total cost, billing code, flight crew names, and crew schedule. Flight log information is also stored including up time, down time, meter start, and meter finish.
- Aircraft Inventory – FIRES keeps track of all aircraft and specifications. Specifications include: fuel type, burn rate, and GPS tracking equipment details.
- Fuel Cache – FIRES tracks locations of remote fuel caches that can be used by rotary aircraft to refuel. Details include: fuel type, fuel amounts and usage.
- Resource Requests – FIRES tracks resource requests that are received from field staff.
- Lookouts – Tracks the location of lookouts, status of the lookout, and observation level.
- Weather Forecasting - FIRES tracks weather forecasts that are entered into FIRES twice a day by weather forecasters. Weather forecasting information is shared with the AWARE system.
- Personal Information – FIRES keeps track of details about staff. Details stored included first name, last name, contact information, training certifications, accidents, pay rates, and garnishes.
- Tracking of Fire Retardant – FIRES tracks the amount of fire retardant used and what is available in the tanks. Additionally, the system records the daily recirculation details of fire retardant that is stored in tanks.
- Fire Permits – FIRES tracks details about fire permits, including: permit date, permit holder name, burn location, purpose of burn, and burning restrictions.

- Reports – FIRES has many pre-canned reports that are used to report on information that is stored in FIRES (e.g. wildfire report).

TECHNOLOGY

- PowerBuilder
- Oracle Database

AGE

- 24-25 years old

DATA INTEGRATION POINTS

- AWARE, Dispatch, Contracts Administration System (CAS)

STRENGTHS

- FIRES has been able to provide the core functionality required by WMB for a long period of time.

LIMITATIONS/WEAKNESSES

- The system is an older legacy system that was developed in PowerBuilder. There are compatibility issues running PowerBuilder applications in Windows 10.
- Modifications to this system are difficult to make because there is a lack of skilled PowerBuilder developers.
- The architecture of FIRES is very tightly coupled together, making it difficult to make enhancements and grow.
- There is a significant amount of paper produced using FIRES and other software programs used by WMB.
- There is no Geographic Information Systems (GIS) integration with FIRES.
- A lot of information that is stored within FIRES is not shared with other systems.
- Resource allocation functionality is weak.
- The user interface for FIRES is not user friendly and is difficult to learn.
- There is some data duplication between AWARE, Dispatch and FIRES.
- Data stored within FIRES is not easily accessible.

KEY POINTS

- FIRES has been able to provide the core functionality required by WMB for a long period of time. However, due to the architecture, it is difficult to make use of new technologies that didn't exist when the system was first created. This includes Geographic Information System integration, smartphones, improved satellite technology, business analytics, drones, and high definition video.
- FIRES is written in an old version of PowerBuilder and has compatibility issues with Windows 10.

System Name: Dispatch

Purpose

Dispatch is the main situational awareness tool for resource management, including aircraft and ground based resources. It is a Geographic Information System (GIS) based system that has a map that displays features, including: fire locations, aircraft locations, crew location, lookout locations, and a variety of other mapping layers. The key purpose of the system is to provide functionality to dispatch resources to combat wildfires.

Key Functionality

- Users can select features from the map and display details about the feature, for example:
    - Wildfire: wildfire #, assessment date, corporate region, fire status, current size, fire name, latitude, longitude.
    - Aircraft: registration, latitude, longitude, speed, heading, altitude, carrier, make/model.
- Live Feed from FIRES
    - Dispatch has a live feed from the FIRES database that provides the wildfire details and displays it on the map.
- Fire Detection Message Creation
    - When new wildfires are detected a detection message is created and entered into dispatch that includes date reported, latitude, longitude, legal description, location description. When the message is completed it is uploaded into the FIRES program.
- Airtanker Request
    - Dispatch allows for airtanker requests to be created and assigns aircraft for the request. Notifications of assignments are currently done through radio or phone. There are plans to implement an electronic dispatching tool in the future.
- Ground Based Resource Assignment
    - Dispatch provides functionality to assign ground-based resources to wildfires.

TECHNOLOGY

- Dispatch is a commercial off-the-shelf system purchased from Selkirk Systems that is used in British Columbia, Yukon, Saskatchewan, and the State of Alaska. The system that Alberta is using is an older version and newer versions are available.

AGE

- 20-25 years old

DATA INTEGRATION POINTS

- Wildfire detection details are entered into Dispatch and uploaded into FIRES.
- Live feed from the FIRES system for wildfire details.
- GIS layers are from Genesis.

STRENGTHS

- The system is map-based and helps provide situational awareness by displaying wildfires, air, and ground-based resources on a map.
- The user interface is simplistic and easy to use.

LIMITATIONS/WEAKNESSES

- Aircraft need to check in every thirty minutes by radio, leading to increased radio traffic. There is a plan to change this in the future, such that if the aircraft is still tracking in Dispatch, they won't have to check in.
- One wildfire can have multiple detection messages, but Dispatch does not have the ability to have more than one.
- Dispatch does not have the ability to group resources together to make it easier to dispatch.
- Dispatch does not have a way to determine the nearest fuel depot for helicopters.
- Dispatch does not have a fire growth analysis function. Other systems provide this functionality. It would be useful if Dispatch has this functionality as well.
- It would be useful if Dispatch integrated with AWARE.
- Dispatch was originally built for pre-suppression and it was not intended as an incident management system. This is currently a manual process; it is not done electronically.
- Notifications for resource assignment are currently done over the radio or phone and are prone to errors.
- Dispatch is a desktop-based tool and must be installed on every workstation where it is intended to be used. This is unlike a web browser-based tool that just needs to point to a web site.
- System is old and written 20 to 25 years ago. There are newer versions of Dispatch that are utilized by British Columbia and Saskatchewan.

KEY POINTS

- The system is map-based and helps provide spatial situational awareness by displaying wildfires, as well as air and ground-based resources on a map.
- System is old.

System Name: AWARE

Purpose

AWARE is the main system used by WMB to calculate and display the Fire Weather Index, calculate and display Fire Behaviour Prediction, and to develop daily IA Resource Deployment Plans.

Key Functionality

- Fire Weather Index Calculation
    - o Calculates and Displays Fire Weather Index, including: Daily Severity Rating, Fine Fuel Moisture Code, Duff Moisture Code, Initial Spread Index, Fire Weather Index. The Fire Weather Index layers are built based on 125 weather stations across the province that capture temperature, rain, wind, and relative humidity. The inputs go into the Canadian Forest Fire Danger Rating

System. The outputs are the Drought Code, Duff Moisture Code, Build Up Index, Initial Spread Index and Fire Weather Index.

- Fire Behaviour Prediction
    - Analyzes, calculates and displays Fire Behaviour Prediction, including: Head Fire Intensity, Rate of Spread, Foliar Moisture Content. These are calculated based on software written by the Canadian Forest Service that generate predictive models for fire behaviour. These models are generated based on inputs including Fire Weather Index, Fuel Raster Type, and Digital Elevation Terrain Model.
- IA Resource Deployment Planning
    - AWARE allows District Duty Officers to create daily resource plans for each Forest Area. AWARE allows resources to be allocated to a Forest Area, including firefighting equipment, aircraft, vehicles and crew. Different resource plan scenarios can be created to maximize area coverage and to maximize cost effectiveness. The plans are completed everyday by 5pm and then shared with the provincial Duty Officer for review.

TECHNOLOGY

- Google Chrome Web browser
- ESRI ArcGIS Server
- Geocortex

AGE

- 2 years old

DATA INTEGRATION POINTS

- AWARE utilizes weather stations data from FIRES database to generate the Fire Weather Index and Fire Behaviour Prediction models.
- Resource Plans generated in AWARE are uploaded into the FIRES database.

STRENGTHS

- AWARE is the most advanced implementation of the Canadian Forest Fire Danger Rating System.
- User interface is easy to use.
- AWARE is web browser-based application that is a deployed to a central server, which makes system updates easier compared to a desktop application, where the application needs to be installed and deployed to each workstation.

LIMITATIONS/WEAKNESSES

- Every cell in the Raster Fuel Grid has the same probability of a wildfire. This isn't accurate as different locations have a higher probability of a wildfire, such as along roadways, railways and towns. WMB is working with the University of Ontario and University of Toronto to develop a Fire Occurrence Prediction Model that will be deployed into AWARE.

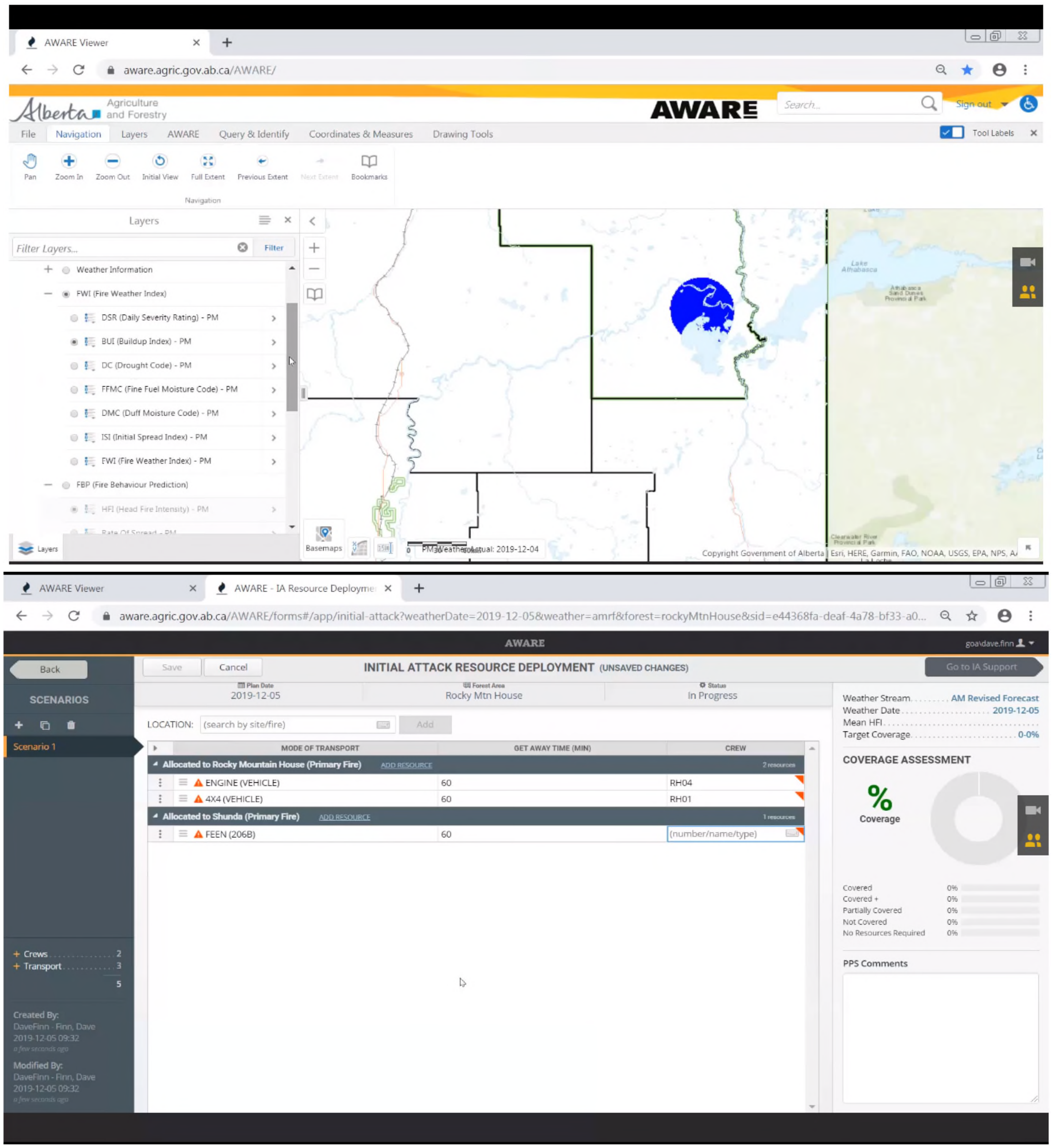
- Integration or consideration of resource location across Forest Areas is not currently accommodated in AWARE. This limits the ability to expand coverage calculations across Forest Area borders and improve the efficiency of resource allocation in the preparedness framework.

KEY POINTS

- AWARE is the most advanced forest fire modelling system in the country.
- There is still room for improvement through supporting a borderless provincial model

SCREEN CAPTURE

Figure 51: AWARE Screen Caption



System Name: Wildfire Mapping Program

Purpose

The purpose of the Wildfire Mapping Program is to provide onsite GIS tools to a wildfire command team during a wildfire incident. The tools consist of workstations, ArcGIS Desktop, GPS, tablets, network storage devices, printers, plotters, and network equipment. The equipment is set up to run in a stand-alone environment disconnected from the corporate network and is preloaded with software and spatial data. There is enough equipment to provide GIS capabilities for four large wildfires. Equipment is ready to be sent out to an incident immediately.

After the incident has been completed, data from the wildfire incident is stored on a network folder for each Forest Area. This data includes PDF files, ESRI MXD Files, ESRI Shape Files, and ESRI file Geodatabases.

Key Functionality

- Basic GIS Functionality
    - The Wildfire Mapping Program utilizes ESRI ArcGIS Desktop to track details of an incident including firelines, fire points, assignment breaks, fire perimeter.
- Fire Tools
    - There are over 50 custom ArcGIS tools that provide the following functionality:
        - GIS layer management;
        - Creating and managing firelines;
        - Creating and managing fire points;
        - Creating PDF Maps;
        - Photo tagging of imagery;
        - Importing and Exporting of GPS Files; and,
        - Creating of maps and sharing through Avenza Maps that can be used on mobile devices.

TECHNOLOGY

- ESRI ArcGIS 10.3 is in the process of being updated to ArcGIS 10.7
- Fire Tools are written in Visual Studio VB.NET

AGE

- Fire Tools: 10-15 years

STRENGTHS

- The ability to provide disconnected GIS functionality at fire command posts.
- No other jurisdiction in Canada has a system as advanced, with portable GIS equipment and software tools.
- There is an extensive training guide on the use of Fire Tools, which is being adopted by Parks Canada.

LIMITATIONS/WEAKNESSES

- There is a lack of network connectivity to updated central systems, such as FIRES, AWARE and Dispatch. This is due to lack of network connectivity to remote locations of wildfires and difficulty to get past GOA Internet firewalls, even when network connectivity is available. The equipment used is not part of the Alberta Governments Managed Environment. Because of this limitation they are not allowed to connect to the Alberta Government's virtual private network. This is a significant problem because it does not facilitate data sharing that could be critical during an incident.
- ESRI ArcGIS Desktop is going to be eventually replaced with ESRI ArcGIS Pro. The custom Fire Tools will need to be rewritten to work in the new platform.

KEY POINTS

- No other jurisdiction in Canada has a system as advanced, with portable GIS equipment and software tools.
- The GOA's security firewalls limit the ability facilitate geospatial data sharing during a wildfire incident.

System Name: Fireweb

Purpose

The purpose of Fireweb is to provide a web browser-based GIS tool to facilitate the sharing of spatial wildfire data between government departments and external agencies, and to provide basic GIS drawing capabilities for wildfires that are not a Type 1 fire.

Key Functionality

- Viewing of Operational Layer
    - Fireweb allows for the viewing of operational data, including: fire advisory, fire restrictions, notice to airmen, fire data, hotspots, FireSmart treatment, and fire behaviour indicators.
- Viewing of Base Feature Layers, Base Maps, and World Top Map
    - Fireweb allows for the viewing of basic feature layers, such as lakes, rivers, roads, topographic maps.
- Basic Drawing Tools
    - Fireweb allows for the drawing of Basic GIS features, including: point, line, polygon, rectangle and freehand.
- Navigation
    - Fireweb provides the ability to easily navigate to a location by a variety of different mechanisms including: go to address, go to place name, go to township or quarter section, go to national topographics system and go to disposition.
- Saving of Projects
    - Fireweb allows users to save projects and open previously saved projects.

TECHNOLOGY

- ESRI ArcGIS Server, Geocortex Viewer
- Data Integration Points
- Fireweb integrates with the enterprise geodatabase that is utilized by AWARE and Dispatch

STRENGTHS

- Allows for the sharing of operational wildfire data between WMB and external agencies.
- Provides a tool to allow external agencies to utilize GIS functionality if they do not have the capability or access to more powerful GIS tools.

LIMITATIONS/WEAKNESSES

- Fireweb only allows basic GIS drawing capabilities. It does not have the same tool suite that is available through the Wildfire Mapping Program.

KEY POINTS

- Allows for the sharing of operational wildfire data between WMB and external agencies.

System Name: AlbertaFireBans.ca

Purpose

The purpose of AlbertaFireBans.ca is to provide a mechanism to notify the public of active fire advisories, fire restrictions, fire bans, OHV restrictions, and forest area closures across Alberta.

AlbertaFireBans.ca provides functionality through a public website and mobile applications available on Android and Apple Devices.

Key Functionality

- Map display
    - The system displays a map of municipalities with fire bans and restrictions. Users can select the municipality and view details about the ban/restriction.
- Municipal Updates
    - Fire Chiefs and authorized municipal officials can login and post their fire bans and restrictions on the site.

TECHNOLOGY

- ESRI ArcGIS Server
- Firebans Server - Docker
- iOS - Swift targeting iOS 10+ on both iPhones and iPads
- Android - Java

AGE

- 4-6 years old

DATA INTEGRATION POINTS

- None

STRENGTHS

- Provides a simple to use interface.

LIMITATIONS/WEAKNESSES

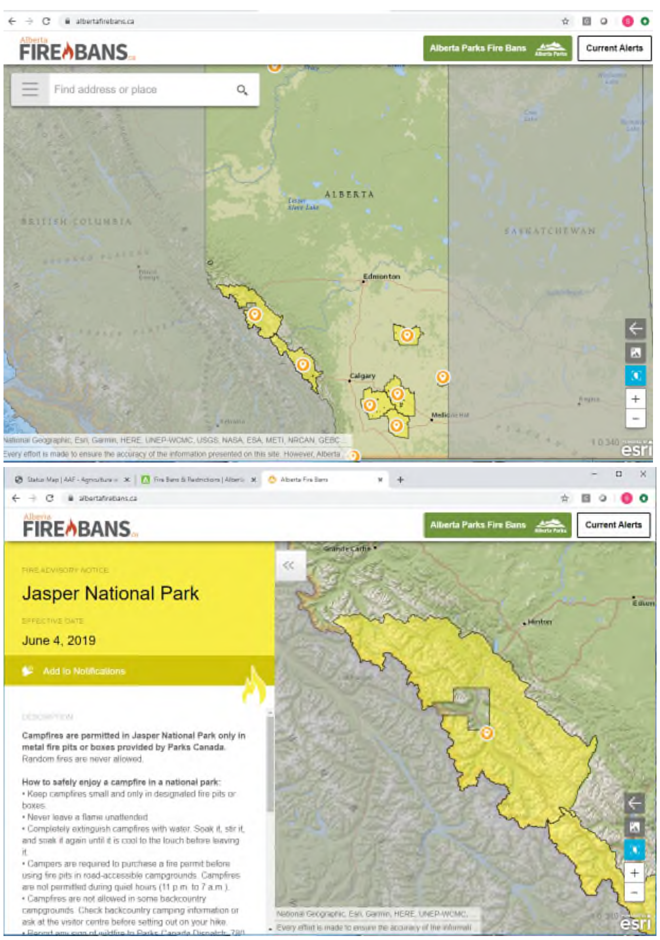
- Alberta Parks has a similar system that contains fire bans and fire restrictions in Alberta Parks. There is no data sharing between the two systems. This is duplication of functionality, with two different systems managing fire bans, which could lead to missing data and public confusion. It would be very useful if there was once source of truth for fire bans and restrictions.
- It would be useful if no fly zones could be shown on the map.

KEY POINTS

- Provides a simple to use interface for the public view fire bans and restrictions.

SCREEN CAPTURE

Figure 52: FireBans Screen Captures



System Name: Alberta Wildfire Website

Purpose

The purpose of the website is to provide the public information about WMB and wildfire status.

Key Functionality

- The website provides the following information: wildfire status, compliance and enforcement, FireSmart, wildfire operations, wildfire prevention, recruitment and resources.
- Wildfire status contains a map that displays the ten Forest Areas and the location of each wildfire. Users can select the wildfire from the map and view basic information for it.

TECHNOLOGY

- Android – Java and Kotlin
- iOS – iOS 0 + on iPads and iPhones in Objective C

AGE

- 7 years old

DATA INTEGRATION POINTS

- Wildfire locations are pulled from the FIRES database.

STRENGTHS

- Provides a simple map to display wildfire's locations and their status.

LIMITATIONS/WEAKNESSES

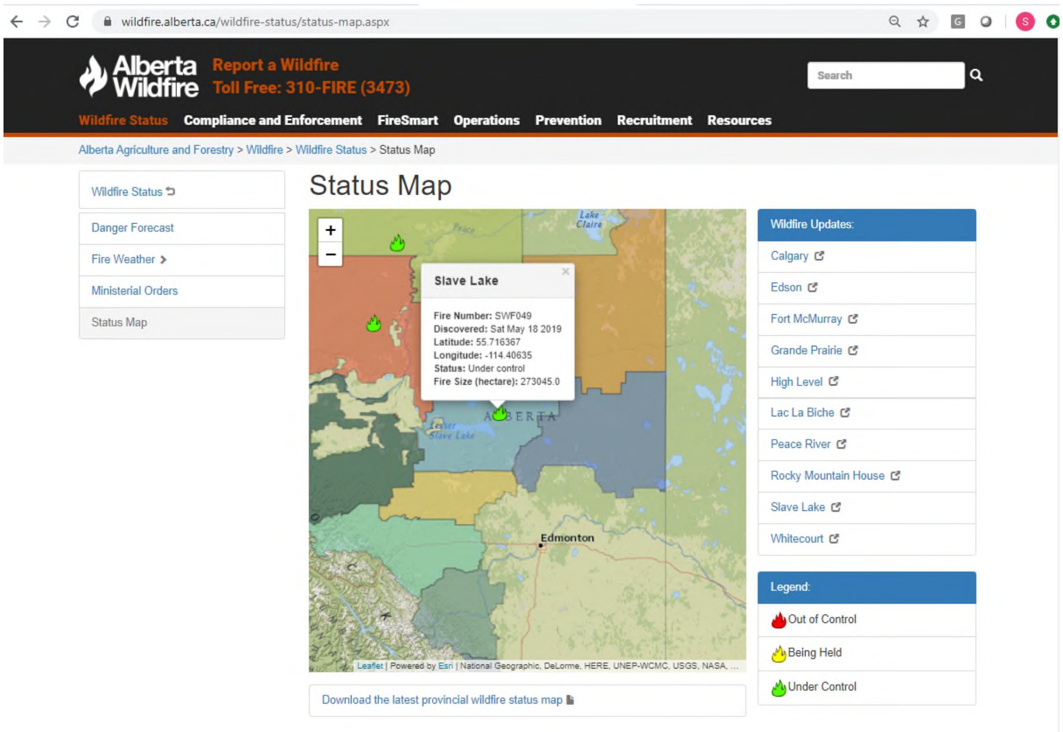
- Originally there was functionality that allowed users to subscribe to notifications when a wildfire was discovered in a Forest Area they subscribed to. The software that provided this functionality was out of date and it needed to be removed. There were complaints from internal GOA users and members of the public when this functionality was removed.
- There is no way for a member of the public to report a wildfire through the website.
- There is limited information about a wildfire displayed on the map.

KEY POINTS

- Provides a simple map to display the wildfire's locations and their status. There is limited information about a wildfire.

SCREEN CAPTURE

Figure 53: Alberta Wildfire Website Screen Capture



System Name: Inventory Management Information System (IMIS)

Purpose

The purpose of IMIS is to track and manage the inventory of wildfire firefighting equipment at WMB warehouses. The system was originally developed by the Government of Ontario and a copy of the source code was purchased by the WMB. The source code was then customized to meet the specific needs of the WMB.

Key Functionality

- Order creation
- Order fulfilment
- Shipment
- Reports

TECHNOLOGY

- PowerBuilder
- Oracle database

AGE

- 20-25 years old

STRENGTHS

- IMIS has been a very stable system
- IMIS does a good job meeting the inventory management requirements

LIMITATIONS/WEAKNESSES

- The system is an older legacy system that was developed in PowerBuilder. There are issues running PowerBuilder applications in Windows 10. Additionally, modifications to this system are difficult to make, because there is a lack of skilled PowerBuilder developers.
- There are no electronic equipment ordering. Warehouses receive equipment orders through a paper-based system that generates a lot of paper. In the future, it would be useful if equipment could be ordered electronically.
- There is no ability for crews at incident command posts to use the system to determine what equipment is available in warehouses.
- There is no ability for IMIS to manage mechanical parts. Modifications to IMIS is required to accomplish this.

KEY POINTS

- The system is an older legacy system that was developed in PowerBuilder. There are issues running PowerBuilder applications in Windows 10. Additionally, modifications to this system are difficult to make because there is a lack of skilled PowerBuilder developers.

APPENDIX K—SUMMARY OF RECOMMENDATIONS

The following summary table highlights all recommendations and associated actions.

Table 17: Summary of Recommendations

		Recommendation	Action(s)
GOVERNMENT-WIDE	1	Immediately implement a government wide, disaster resilience and prevention focused task force to enhance the adoption of FireSmart activities and principles across government, at the community level and to incorporate wildfire prevention in community services.	• Identify and implement alternative building codes for vulnerable communities. • Identify and implement modified subdivision development rules for vulnerable communities. • Identify and implement further risk-sharing programs for communities that continue to develop further into forested areas. • Formally incorporate FireSmart into a broader provincial disaster resiliency strategy to improve community engagement in preventing wildfires. • Continue to work with Industry and relevant associations to prevent and mitigate industry caused wildfires — this could include increasing the cost-recovery programs. • Determine specific key performance indicators (KPIs) for reducing human-caused wildfires and mitigate industry caused wildfires. • Implement the November 2018 Auditor General Recommendations and report on progress accordingly.
WMB	2	Immediately develop a comprehensive strategy for incendiary fire prevention to reduce the number and severity of incendiary fires.	• Increase the number of ground patrols in high risk community zone areas to limit the opportunity to set wildfires and increase speed of detection. • Work with Community and Industry leaders to develop education and enforcement programs targeted to at-risk communities. • Increase a targeted media campaign to encourage public reporting and outlining increased enforcement and compliance measures that will be taken including consequences for offenders.

		Recommendation	Action(s)
GOVERNMENT-WIDE	3	Conduct a more comprehensive review of Wildfire Management Branch (WMB) communications and stakeholder engagement strategies, systems and processes with an objective of improving the experience of community members and stakeholders who are directly or indirectly being impacted by wildfire or other natural disasters.	• Conduct an audience analysis to determine if the tools are enabling messages to reach their intended targets effectively. • Once Wildfire Management Branch has identified their intended audiences it would be prudent to develop outcome-based strategies to determine their effectiveness, with a continuous improvement model. • Ensure flexibility from normal government communication protocols during emergency time periods; identify and implement specific strategies to utilize social media venues. • Continue to work with recreation areas and relevant associations to improve awareness and ultimately prevention of recreation wildfires. • Improve consistency of stakeholder management across Forest Areas. Many leading practices exist across the province, and each Forest Area could benefit from further sharing. • Clarify the role of the Industry Liaison across Forest Areas. • Clarify the role of the Information Officer across Forest Areas. • Review communication protocols and ensure they are set well in advance of the fire season and respect the specialized nature of emergency communications. Set specific direction for all government agencies to follow during periods of Unified Command.
WMB	4	Develop and implement a new preparedness planning framework that balances risk, hazard, values and cost to improve overall outcomes.	• Reduce the heavy reliance on coverage assessment in the Presuppression Preparedness System (PPS) and increase emphasis on risk analysis based on forecasted workload, weather, and fire behaviour. • Evaluate the new system under worst-case wildfire occurrence and fire behaviour scenarios. • Develop and support staff understanding of how a new PPS can support risk management during periods of uncertainty.

	Recommendation		Action(s)
WMB	5	Improve quality and integration of fire weather and behaviour functions to support strategic preparedness and response.	• Combine fire weather and behaviour functions at Alberta Wildfire Coordination Centre (AWCC) under one organizational structure to ensure improved forecasts, integration of information flow, and utilization of staff. • Utilize probabilistic forecasting for preparedness planning with required 3 and 5 day forecasts. • Implement daily forecasts that better combine weather and fire behaviour forecasts (e.g. including upper air conditions). • Improve products that increase staff awareness of predicted fire behaviour during early fire season hazard and during extreme events. • Improve fuels mapping in and around communities and critical assets. Consider improved resolution (25 metres) for 10 to 20 kilometres around these values.
WMB	6	Accelerate the development and approval of the remaining Wildfire Management Plans (WMPs) to have them completed in the shortest possible timeframe.	• Prioritize northern Forest Area SWMPs due to increased risk of large conflagration incidents. • Increase the direct involvement of key stakeholders including communities and industry in the development of these plans. This will create better integration of their concerns, improve understanding of the risk management decisions being made, and provide support for the tactics and strategies used. • SWMPs at the Forest Area level should be in place to provide the overarching guidance to inform the incident level plans.
WMB	7	Establish a standard operating procedure (SOP) for situations when a wildfire escapes Initial Attack during the high risk conditions and where there are significant values-at-risk. The SOP would identify that a more experienced Incident Commander be assigned immediately to assume command of the wildfire until the first Incident Management Team assumes control.	• Tactical training is required for all mid and lower level Incident Commanders specific to the integration of more indirect suppression tactics, including hand ignition, and to ensure that management support and resources for this approach are realized.

Recommendation		Action(s)
8	Revise standard tactics and strategies for sustained attack to have better, safer, and more cost-effective results.	• Ensure visible senior leadership support for indirect attack strategies recognizing the risks associated. • Review and revise policies to support the merits and appropriate use of direct and indirect tactics and strategies. • Develop proactive public education on the value and use of indirect attack, including ignition (hand and aerial). Ensure Incident Management Teams take a deliberate approach to educating and informing public stakeholders why it is being used. • Encourage the use of hand ignition and ensure all SOPs, operational guidance and training reflects this support. • Revise current practices and standards for use of heavy equipment in fireline construction. Consideration should be given to the following: o Comprehensive approach to fireline construction that embraces indirect attack strategies where appropriate. o Ensure reporting structures for the Heavy Equipment Group Supervisors and associated activities are better integrated and closely coordinated by reporting up through each division within the standard Incident Command System structure. o Emphasis on providing ground support to heavy equipment fireline construction as soon as possible adopting a build, burn out and mop up systematic approach. o Increased emphasis on cost effectiveness in all aspects of heavy equipment use. • Complete the standard template and process under development for Strategic Incident Action Plans for IMTs that are supported by reliable, timely data and forecasting that includes consideration of longer-term risk management strategies and provides continuity from one team to the next as a large wildfire progresses.

		Recommendation	Action(s)
WMB	9	Review current policy and provide direction to wildfire management staff regarding wildfire status to clarify stages of control and the status of wildfires being monitored.	• WMB should adopt the practice of reporting the *percentage containment for all Out of Control wildfires* to reduce the pressure to declare a wildfire Being Held prematurely and to clearly communicate the risk related to future control problems. • WMB should clarify with all Incident Commanders a consistent approach to declaring wildfires Being Held or Under Control and consider providing additional clarity around this process. • Efforts should be made to communicate wildfire status to the public to improve their understanding.
GOVERNMENT-WIDE	10	Develop and train staff, including staff from other ministries, to support Incident Management Team (IMT) deployments and Forest Areas under escalating workloads.	• Develop a roster and train staff outside the Forest Areas to fill IMT and Forest Area support positions (Planning, Logistics, Finance and Admin Sections) to ensure enough staff are available for deployments. • The Alberta government, led by Alberta Emergency Management Agency, should provide targets outside WMB for managers across the government to make staff available for training for support positions on incidents. This will address IMT support capacity deficiencies for wildfire and other incidents. A structured program should be created to help recruit, train and mentor these government staff so they are ready for deployment to wildfires or other emergencies on an annual basis. • WMB and Alberta Environment and Parks (AEP) should review and improve the model for support of WMB during the fire season. Dedication of wildfire financial expertise is required (similar to Recommendation #4 in the 2015 Program Review). • Redevelop training materials to ensure staff have the training and development to successfully implement these shifts in strategies from past practices.
GOVERNMENT-WIDE	11	Implement a common mandatory radio communication plan and system for all WMB wildfire personnel, municipal firefighters and first responders working on wildfire incidents.	Implement as soon as possible.

		Recommendation	Action(s)
WMB	12	Accelerate the development of a safety culture that values incident reporting, hazard assessments, workplace committees and inspections, and the engagement of front-line staff in conversations designed to protect their health and well-being.	• Senior leadership should take a lead role and be visible in leading this initiative. • Assign two senior management champions to accelerate measures underway to improve the overall safety system in WMB (i.e., do not delegate to safety staff); • Key areas of focus are incident reporting, thorough investigations, and communicating lessons learned. • A process to review, learn from, and communicate to staff about aviation or fireline "near misses" or tactical withdrawals should be developed, tested with staff, and implemented.
WMB	13	WMB should continue with the legacy modernization project to provide functionality required by WMB to help improve the delivery of wildfire management activities and help reduce the impact of wildfires in Alberta.	N/A
WMB	14	Undertake a deeper cost-benefit analysis of program spending with a focus on major suppression items.	• Conduct a detailed evaluation of costs and benefits of wildfire suppression including total costs under various conditions and total losses, including those that are not easily quantifiable. • As a starting point focus on the use of helicopters and heavy equipment as areas of high-potential cost-effectiveness improvement.
WMB	15	Accelerate the development and organization of the Intelligence Unit in the AWCC to support strategic risk management and resource planning.	• Reinforce the need for senior leaders to rely on current command structures and work within the operation systems for decision making. • Review and improve the role of the AWCC to include more decision-making authority and cost oversight to make provincial planning more strategic. • Strengthen the role and capabilities of the Intelligence Unit in the AWCC including bringing all predictive services (including weather and fire behaviour) under one organization and structure. Increase the investment in the tools and resources required.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