Prescribed Fire and Design:

Two Biocultural Design Case Studies from Northwestern Ontario

by

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ABSTRACT

This thesis presents a review of two prescribed burns undertaken in northwestern Ontario. The purpose of this research was to explore the design elements that influenced the prescribed burns utilizing a biocultural design. Biocultural design is a framework for exploring and designing cultural landscapes by considering descriptive and evaluative design elements. Design elements were used to guide the semi-structured interviews and organize the data. Interviews were conducted with community members and fire personnel. The key findings of this research are that there are cultural areas and practices that should be included in future prescribed burn designs. However, there are operational limitations and biological and cultural factors that limit the feasibility of the prescribed burn's outcomes. The conclusion of this research is that future prescribed burns will benefit from a more intentional designing process that includes cultural elements from the community along with biological and operational factors.

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ACRONYMS

AFFES – Aviation Forest Fire Emergency Service
CR – Conservation Reserve
LOW – Lake of the Woods
OMNRF – Ontario Ministry of Natural Resources and Forestry
PB – Prescribed Burn
WIN – Wabaseemong Independent Nation

CHAPTER 1: INTRODUCTION

1.1 Introduction

Prescribed burning has been a tool used by humans to manage landscapes for centuries (Pyne, 1982). It is the act of intentionally lighting fire on a landscape to achieve specific cultural values or uses. Weber & Taylor (1992) describe prescribed burning as "the knowledgeable application of fire to a specific landscape to accomplish predetermined objectives" (p. 324). Current methods of prescribed burning require careful planning and design, as the consequences of an escaped and out of control fire can be devastating. In Ontario, there are strict requirements and guidelines that must be followed in order to use prescribed fire on a landscape.

In northwestern Ontario, the Ontario Ministry of Natural Resources and Forestry (OMNRF) have used prescribed fire for various management objectives. For example, the Kenora District Aviation and Forest Fire Emergency Service (AFFES) has begun a hazard reduction prescribed burn project with the community of Wabaseemong Independent Nation (WIN). The AFFES also worked in conjunction with the Kenora district of the Ministry of Natural Resources and Forestry (OMNRF) on a prescribed burn project on the islands of the Lake of the Woods Conservation Reserve between the years of 2012 and 2015. The Lake of the Woods (LOW) prescribed burns were conducted as a study of local fire ecology and as a first step to reintroduce of fire on the landscape for the purpose of maintaining ecological integrity.

One of the OMNRF's justifications for the use of prescribed fire on Lake of the Woods is for the maintenance of red and white pine stands. Maintaining red and white pine stands is part of the Ontario Ministry of Natural Resource's *Lake of the Woods Conservation Reserve Resource*

Management Plan (2006) as well as the *Old Growth Policy for Ontario's Crown Forests* (Ontario Ministry of Natural Resources, 2003). In the resource management plan, prescribed burning is recommended as a means for the reintroduction of fire in order to regenerate and maintain old growth white pine ecosystems (Ontario Ministry of Natural Resources, 2006). The *Old Growth Policy for Ontario's Crown Forests* also calls for the maintenance, protection, and restoration of old growth red and white pine stands and advocates for the use of fire in achieving those objectives (Ontario Ministry of Natural Resources, 2003).

Another justification for the use of prescribed fire is laid out in the OMNRF's *Wildland Fire Management Strategy* (Ontario Ministry of Natural Resources, 2014b). The *Wildland Fire Management Strategy* supports the use of prescribed fire as a means to reduce wildfire hazard in order to "prevent the loss of human life and injury" and to "prevent and mitigate losses, economic disruption, and social disruption" (Ontario Ministry of Natural Resources, 2014b). Hazard reduction prescribed burns involve the use of fire to pre-burn potentially dangerous landscapes and forest fuels, thus depriving ignition sources and fuels for wildfires.

The OMNRF has an established prescribed burning protocols and planning guidelines that directs how prescribed burns are conducted (Ontario Ministry of Natural Resources, 2014a). The OMNRF's prescribed burn guidelines cover the values to be considered when conducting a prescribed burn, what the objectives and desired results of the burn are, as well as operational considerations such as timing, treatable area, fuel management, and others (Ontario Ministry of Natural Resources, 2008a). Properly applied, prescribed burning has been shown to be an effective tool, and one of the only available tools, for regenerating and maintaining white pine ecosystems (Beverly & Martell, 2003; Mcrae, Lynham, & Frech, 1994). In addition, prescribed

burning is cost-effective and fits well into resource management plans due to its simulation of natural fire and its subsequent benefits to wildlife, ecological integrity, and biodiversity (Weber & Taylor, 1992).

The islands of Lake of the Woods and the landscape of Wabaseemong Independent Nation are cultural landscapes. Cultural landscapes are those that are shaped by the "perceptions, values, institutions, technologies, and political interests" (Davidson-Hunt, 2003, p. 20), of both local and wider society. The landscapes of Lake of the Woods and Wabaseemong contain interactions between nature and culture, prescribed burning being one of those interactions (Davidson-Hunt et al., 2012). Prescribed burning and the presence or absence of fire is one way in which cultural values are present in the structures and patterns of northwestern Ontario landscapes.

One of the features of Lake of the Wood's cultural landscape is the fire regime and the presence of fire dependant species, like red and white pine. On Lake of the Woods, white pine stands are valued for their contribution to wildlife habitat and also act as representatives of values such as biological diversity and ecological integrity (Beverly & Martell, 2003; Rowe & Scotter, 1973). White pine also have important symbolic value to Ontario and Canada, being the provincial tree of Ontario and the subject of paintings done by the famous Canadian artists in the Group of Seven (Beverly & Martell, 2003). Old growth white pine have also been shown to have a high level of aesthetic value for people in Ontario; pictures of old growth white pine were the most preferred by the public, resource managers, and environmental groups amongst a series of pictures of forest types presented in a study (Haider, 1994). The *Old Growth Policy for Ontario's Crown Forests* acknowledges the public concern for old growth forests and

incorporates the values associated with white pine into the natural heritage component of park and conservation area planning.

Wabaseemong Independent Nation is a community in which numerous activities and values are embedded in the landscape. For instance, hunting and gathering takes place around the community for both subsistence and medicinal purposes. Kuzivanova (2015) and Davidson-Hunt (2003a, 2003b) describe how activities such as blueberry and wild rice harvesting on the landscape of northwestern Ontario and around Wabaseemong have contributed to the development of a cultural landscape in this region. Davidson-Hunt describes a cultural landscape as "the physical expression of the complex and dynamic sets of relationships, processes and linkages between societies and environments" (2003a). The cultural landscape of Wabaseemong is a result of the relationships and linkages between the culture and actions of the community and surrounding landscape.

In the Lake of the Woods Resource Management Plan, the reintroduction of fire through prescribed burning is identified as an ends and a means for re-establishing a certain desired ecosystem in the area; fire is considered both a natural component of the ecosystem as well as a method for creating and maintaining white pine ecosystems (Ontario Ministry of Natural Resources, 2006; Pyne, 1995). In the *Old Growth Policy for Ontario's Crown Forests* (2003), it is recognized that human activity alters the state of old growth forests; therefore, long-term planning is necessary to achieve forest health while considering the values of forest users and communities. The policy also lists ecological, social, economic, and cultural values that the people of Ontario have in relation to old growth forests. The intention of the *Old Growth Policy* is to incorporate these values into long-term forest planning to balance sustainable

development with biological diversity and ecological processes. The *Old Growth Policy* includes a component on fire management as a means for maintaining and renewing forests and states that the presence of old growth forest in the boreal is directly related to the prevalence of fire.

The planning aspect of the *Old Growth Policy* is based on an adaptive approach that "involves progressively improving management policies through a built-in learning process" (*Old Growth Policy for Ontario's Crown Forests*, 2003, p. 14). Essentially, the process is meant to facilitate learning from previous implementations of management plans and adapt in order to improve future policy directives. As part of this learning process, the policy utilizes public consultation and involvement. The *Old Growth Policy* also calls for public involvement in identifying the values, impacts, and implications of human forest use in old growth forests. Public consultation is considered essential in Crown land-use planning in setting objectives, assessing options, and implementing decisions intended to meet social, economic, and environmental objectives (Ontario Ministry of Natural Resources, 2003).

Ontario's *Wildland Fire Management Strategy* (Ontario Ministry of Natural Resources, 2014b) is another document that outlines the control and use of fire, both wildfire and prescribed fires. While recognizing the ecological benefits of fire, the *Wildland Fire Management Strategy* outlines the goals and objectives necessary to protect human life, property, and social and economic stability. In order to achieve its objectives, the *Strategy* includes a section on working with communities to identify values at risk and opportunities for using fire as a tool on the landscape (Ontario Ministry of Natural Resources, 2014b). Wildfire managers must deal with a complex set of factors while planning for and dealing with fire. Diverse land management uses and objectives, the expansion of urban areas into fire-prone

environments, changing fire regimes in response to climate change, and the need for fire in maintaining ecological integrity; these factors play a role in fire management decision making (Ontario Ministry of Natural Resources, 2014b). One objective of the *Wildland Fire Management Strategy* is the use of prescribed fire for both reducing the hazard of wildfire and maintaining ecological integrity (Ontario Ministry of Natural Resources, 2014b).

In 2012, 2013, and 2015 the OMNRF conducted prescribed burns on eleven islands in Lake of the Woods. The purpose of the prescribed burn project was to reintroduce fire to the landscape in order to recover a natural pattern of wildfire disturbance and maintain a level of ecological integrity based on historical wildfire. The prescribed burn project was also conducted as a study into the response of the plant life on the islands to fire. The results of this study will be used to inform future fire management decisions in the Lake of the Woods Conservation Reserve (Ontario Ministry of Natural Resources, 2010). Written into the *Lake of the Woods Conservation Reserve Resource Management Plan* is the direction that:

> "This Resource Management Plan recognizes fire as an important ecosystem process, fundamental to restoring and maintaining the ecological integrity of the natural environment represented within this Conservation Reserve (p. 18)."

This directive indicates that fire is meant to be used as a means to produce a specific environmental outcomes; namely, a landscape that is representative of natural values associated with the area (Ontario Ministry of Natural Resources, 2006).

The decision regarding what landscape and ecosystem type to manage for is essentially a design decision. In *Fire in America*, Stephen Pyne (1982) states that "fire burns in a cultural environment" (p. 166) meaning that any decisions regarding fire are linked to cultural values

and fire management cannot be disentangled from the culture involved in managing it. Therefore, the decision to suppress fire, light prescribed fire, or allow natural fires to burn, are all based on design considerations relating to particular cultural goals (Pyne, 1982).

Although the Lake of the Woods and Wabaseemong fire management directives are not presented as design projects, exploring the process and outcomes of prescribed burning through the lens of design will provide a useful analysis for understanding how decisions were made, what factors influenced the implementation of prescribed burning, and whether the outcomes met the goals of managers and local communities. Using a human-centered design framework for exploring the prescribed burns done in Wabaseemong and Lake of the Woods also provides an opportunity to use public involvement as part of the learning process in the adaptive management approach laid out in the *Old Growth Policy for Ontario's Crown Forests.*

The process of design follows two distinct phases, a divergent phase and a convergent phase. At the beginning stages of design, the compositional or descriptive design elements *materials*, *values*, and *techniques* are considered. Descriptive design elements describe the motivation, the action, and the stuff that bring an idea into physical existence. During the first design phase, constraints and capabilities are evaluated according to their desirability, feasibility, and viability (Brown, 2009). In *Change by Design* (2009), Brown describes these evaluative design elements as follows: desirability is defined as "what makes sense to people and for people." Feasibility considers "what is possible within the foreseeable future," based on the capabilities and materials involved. And viability is "what is likely to become part of a sustainable business model" (Brown, 2009).

Biocultural design is a conceptual framework that considers the link between culture, design, and the environment in a process of intentional change (Davidson-Hunt et al., 2012). Incorporating components of design thinking, ethnobiology, materiality, and collaborative design, biocultural designing is a process for using local knowledge in the development of innovative solutions to challenges that face communities at the interface with the biological landscape (Davidson-Hunt et al., 2012). The initial design phase of a biocultural design project involves an exploration of the capabilities, constraints, and elements related to the project. This phase and involves gathering input from those involved in the planning, the implementation, and the recipients (clients, consumers, or stakeholders) of the design solution. The purpose of this exploration is to identify innovative ideas or reveal knowledge gaps before the design process begins the solution-finding stage (Brown, 2009; Davidson-Hunt et al., 2012).

Biocultural design provides a method for incorporating the diverse values and complex relationships involved in resource management by utilizing a design framework of learning-by-doing (Davidson-Hunt et al., 2012). By using a biocultural design framework resource managers and local communities have the potential to direct local environmental change according to their values and desired outcomes (Davidson-Hunt et al., 2012). In addition, the biocultural design framework provides a means of evaluating the knowledge, techniques, and outcomes of a design and directing future design iterations according to the constraints of desirability, feasibility, and viability; this looping process creates learning opportunities, which can be used in future designs and implementation (Davidson-Hunt et al., 2012).

Multiple outcomes need to be considered in the implementation of prescribed burning. Biocultural design provides a framework that allows for multi-stakeholder collaboration and

public participation in the management or design of landscapes and ecosystems, similar to what is called for in the *Old Growth Policy for Ontario's Crown Forests* and the *Wildland Fire Management Strategy* (Davidson-Hunt et al., 2012; Ontario Ministry of Natural Resources, 2003).

Charnley, Long, and Lake (2014) identify the following benefits that come from collaboration in forest management that can also apply in the case of prescribed burning in Lake of the Woods and Wabaseemong:

1) more information to better meet the ecological and socio-economic goals of forest management,
2) sharing of information, data, and analysis amongst local communities,
3) enhancing the legitimacy and acceptability of management decisions amongst stakeholders, and
4) providing redress for underrepresentation in management decisions.

This research considers the prescribed burns on Lake of the Woods and in Wabaseemong as potential biocultural design projects and begins the initial divergent phase of design. For Lake of the Woods and Wabaseemong, biocultural design can be used as a lens to look back onto the way prescribed fire has been implemented, evaluate the past use of prescribed fire, and identify design elements that may lead to innovations in future prescribed burn designs. Utilizing a biocultural design framework to reflect upon the outcomes of the prescribed burn programs on the islands of Lake of the Woods and Wabseemong can provide suggestions as to what design features different stakeholders prioritize. In doing so, future prescribed burning projects can learn from the techniques used from the previous prescribed burns, identify values held by different stakeholders, include policy objectives, and build understanding of the role of

prescribed burns for these areas. The benefit of using a biocultural design framework for this research is that it allows for clients (community members) and practitioners (the OMNRF) to provide input into the design elements and thus contribute to a framework of evaluating the past burns, thus providing information as to what factors should be considered for future burns.

1.2 Research Purpose, Questions, and Contributions

The purpose of this research is to explore the recent use of prescribed fire and how it can be used to achieve multiple landscape-level objectives on Lake of the Woods and in Wabaseemong First Nation. This project analysed these two prescribed burn programs through the lens of biocultural design, providing design-based information with implications for the desirability, feasibility, and viability of current practices, which can be used by managers for future prescribed burning in the management of the Lake of the Woods Conservation Reserve and Wabaseemong First Nation.

The questions that guided this research were:

1. What are the design elements that influenced the planning, implementation, and outcome of the prescribed burns on Lake of the Woods and in Wabaseemong?
2. What are the enabling and constraining factors of prescribed burning that affect its ability in achieving multiple outcomes?
3. What outcomes did managers hope to achieve through the use of prescribed burning on the LOW islands and in Wabaseemong and has the use of prescribed burning met those goals? Were these goals and outcomes consistent with the values set out in OMNRF guiding policies and documents?

The contributions of this research are:

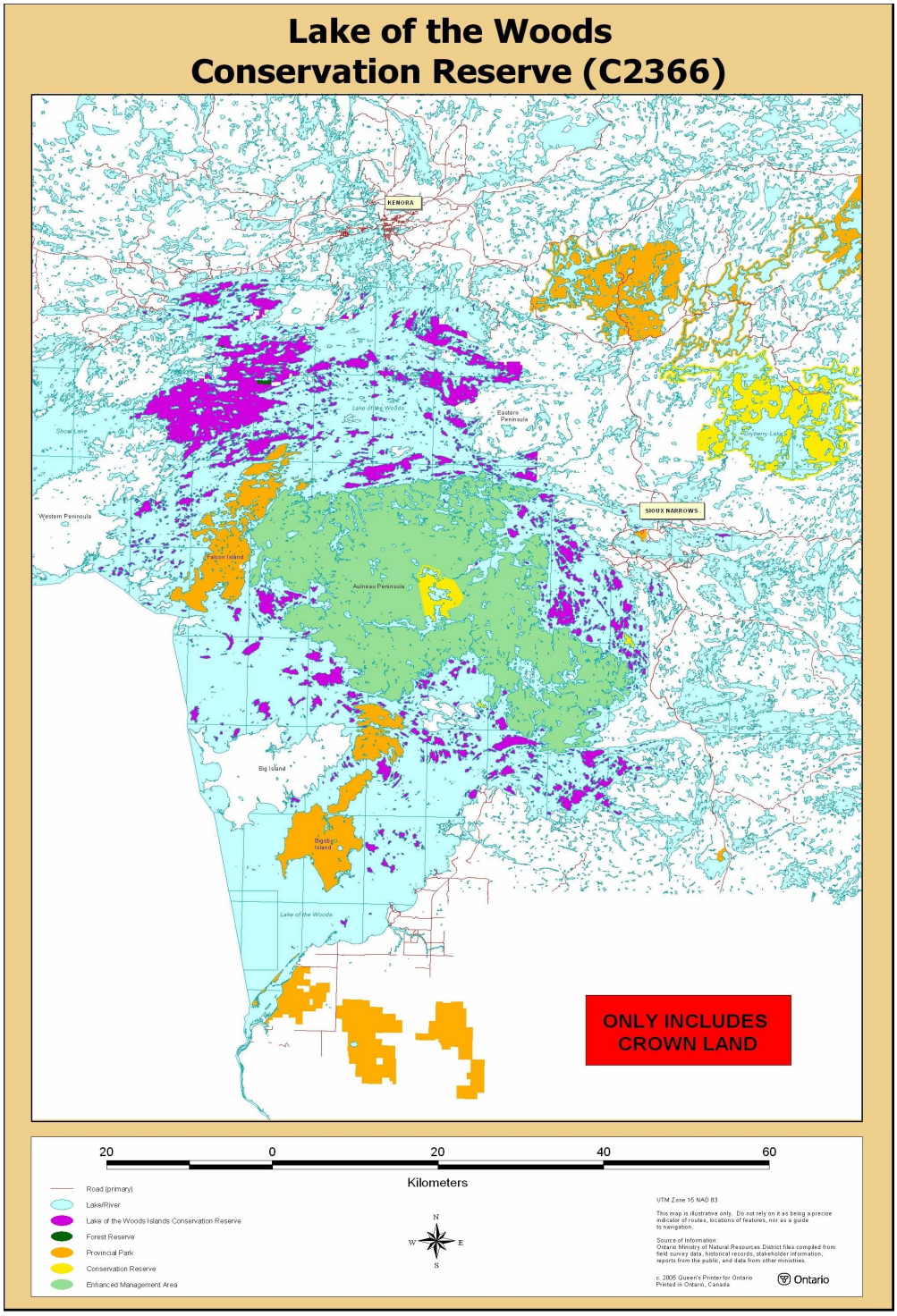
1. Develop a technique, using the framework of biocultural design, for evaluating biocultural design case studies and contributing to the first, divergent phase, of the biocultural design process.
2. Provide information that can inform future prescribed burn planning within the Lake of the Woods Conservation Reserve and Wabaseemong First Nation.
3. Consider how biocultural design can be applied in a constrained context, such as prescribed burning, in a way that meet the technical requirements of operational constraints while considering diverse stakeholder values in design outcomes.

1.3 Study Area

This research looked at two case studies, one in the Lake of the Woods Conservation Reserve and one in Wabaseemong Independent Nation.

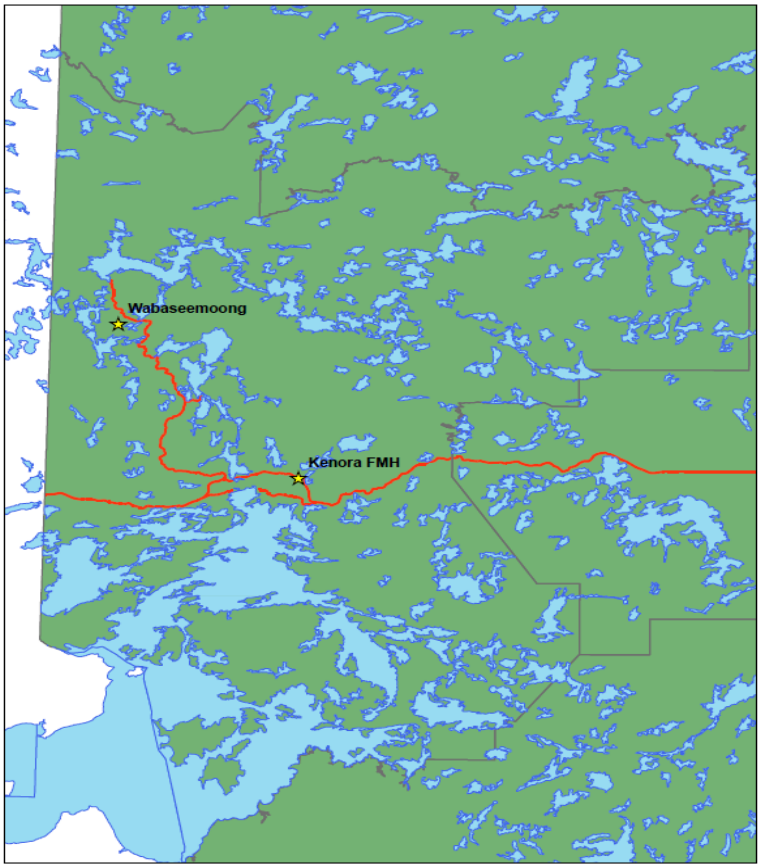
The lake of the Woods Conservation Reserve is located in the OMNRF Kenora district in North Western Ontario. The Ontario communities surrounding the conservation reserve consist of Kenora, Sioux Narrows/Nestors Falls, Morson, Rainy River, the Minnesotan towns of Warroad and Baudette, as well as the first nations communities of Big Island, Big Grassy, Northwest Angle #33 and Northwest Angle #37, Onegaming, Shoal Lake #39 and Shoal Lake #40, Washagamis Bay, Whitefish Bay, Rat Portage, and Rainy River (Ontario Ministry of Natural Resources, 2006). The conservation reserve “is approximately 45,960 hectares in size and includes the majority of the islands on Lake of the Woods”, but does not include

islands that are already covered under provincial park status (Ontario Ministry of Natural Resources, 2006, p. 5).



Map 1: Lake of the Woods Conservation Reserve. The area shaded purple is the Lake of the Woods Conservation Reserve, the town of Kenora is labelled to the north

Wabaseemong Independent Nation is located in the boreal forest of north western Ontario, 120km north west of the city of Kenora and 13 km east of the Manitoba border. Included in Wabaseemong Independent Nation are the communities of Whitedog, Swan Lake, and One Man Lake.



Map 2: Wabaseemong Independent Nation

1.4 Case Study Selection

The case studies for this research were selected based on practical considerations. The relatively few prescribed burns taking place in central Canada limited the number of case studies available for selection. The proximity of north western Ontario influenced the selection of this as a study area. The timing of the prescribed burns also played a role in case study selection, the prescribed burns on the Lake of the Woods had been performed relatively

recently and the Wabaseemong burns were ongoing. Part of the selection criteria included prescribed burns that had a strong cultural element, meaning that they were close to and experienced by local communities. The high density of cottages, homes, and recreation on Lake of the Woods and the proximity of the Wabaseemong prescribed burns to the community made these prime candidates. Lastly, there was interest and support for this research by the OMNRF and the community of Wabaseemong.

1.5 Methods

This research project used a qualitative research approach and is structured as two biocultural design case studies. The methodology of the study was guided by a biocultural design framework (Davidson-Hunt et al. 2012), which will be elaborated on below. Data was collected using semi-structured interviews and document review. Participants included OMNRF district planners, AFFES operational staff and specialists, and local community members. Participants were those who had knowledge, skills, values, and experiences associated with wildfire and prescribed burning on Lake of the Woods and in Wabaseemong. Semi-structured interviews were used to gather data regarding the design elements that influenced the prescribed burning that took place on Lake of the Woods and in Wabaseemong. Local community members and OMNRF staff answered questions about the factors that influenced the prescribed burns that they were associated with. Interview questions focused on what the materials, values, and techniques were that composed the prescribed burns, their planning and implementation, and what the enabling and constraining factors were that affected the desirability, feasibility, and viability of the burns.

1.6 Study Significance

This project has demonstrated the role biocultural that biocultural design can play in back-casting onto landscape and community level projects by developing the conceptual framework of biocultural design into a tool for gathering and evaluating design-relevant data. This framework can be used in other scenarios, not limited to prescribed burning, for beginning the first phase of a biocultural design project. Using this framework also allows for opportunities for practitioners, researchers, designers, and community members to learn from each other while participating and contributing to the process of biocultural design.

This research has also shown that prescribed burn planning and design can benefit from a biocultural design approach, it provides insights into how diverse values can be gathered and considered in prescribed burn planning while recognizing the technical and safety constraints of this management practice. The consideration of multiple perspectives and the diverse set of factors that may enable or constrain a prescribed burn addresses the complexity of this fire management tool. Utilizing biocultural design and the accompanying perspective of biocultural heritage, PB planners gain the following insights: A) By considering the relationship between culture and landscape entities, planners and designers can recognize the role that culture plays in shaping nature (a fire-driven landscape). Recognizing this relationship allows for more intentionality in the outcomes or effects of a prescribed burn. B) biocultural design provides the means of gaining insights into design elements that can inform, support, and identify barriers to prescribed burns, thus ensuring a higher likelihood of success and acceptability of a prescribed burn project both externally (the communities impacted) and internally (the agency planning and implementing the burns).

Lastly, the findings of this research can be applied to the specific contexts of the case studies described in this research. While the framework and tools developed in this research can be applied to other cases, the findings described here only apply to their specific cases. This demonstrates the contextual applicability of prescribed burning. The next step for a biocultural design project for the Lake of the Woods and Wabaseemong prescribed burn programs would be to use the design data gathered here to inform the next phase of design. Using the design elements described in this research has the potential for these prescribed burn projects to better meet the needs and desires of both the communities involved and the Ontario Ministry of Natural Resources.

CHAPTER 2: LITERATURE REVIEW

2.1 Fire in the Boreal Forest

There is evidence of fire being an important factor in the North American ecosystem since before the arrival of the earliest human populations in North America, such pre-human fire was most likely caused by lightning strikes (Heinselman, 1973). However, since the arrival of humans, at least 12,000 years ago, there has been evidence of human use of fire in altering the landscape (Waldrop, White, & Jones, 1992). The combined effects of the retreat of the glaciers covering most of Canada and the arrival of anthropogenic fire means that many of the ecosystems in this area evolved in relation with the human use of fire (Waldrop et al., 1992). As such, it is nearly impossible to disentangle the multiple and complex relationships humans have in respect to fire and the way it has shaped ecosystems and landscapes (Pyne, 1982). The complexity of this human-fire-landscape relationship, coupled with the dynamic, climatically variable, and historically dependant cycle of fire, means that there is no discernably 'natural' fire cycle in the boreal forest (Johnson, Miyanishi, & Weir, 1998).

Fire plays a profound and integral role in the biology, landscape, and culture in North America; many species, humans among them, have evolved in a relationship with fire (Pyne, 1995). The term pyrophytes typically refers to plants that have evolved adaptations to tolerate fire, such as thick bark ("Pyrophyte: Definition of Pyrophyte by Merriam-Webster," 2015), but Stephen Pyne (1995) argues that humans are also pyrophytes, 'creatures of fire', due to their historic and interdependent relationship with fire. Although there is evidence that fire has played an important role in North American ecosystems since before the arrival of people

(Heinselman, 1973), Pyne and others argue that anthropogenic fire has played a dominant role in the impact that fire has had on earth (Pyne, 1982; Rowe & Scotter, 1973; Steward, 2002).

The boreal forest is a prime example of an ecosystem composed of pyrophytes and serotinous species. Serotiny refers to a phenomenon amongst plants in which seeding is induced by some form of disturbance. When the disturbance happens to be fire, the process is called pyriscense (Biodiverseed, 2014). An example of pyrisence is demonstrated in the need for fire to open the seed cones of certain conifers (Schwilk & Ackerly, 2001). In *Fire in America*, Pyne (1995) states that "fire is the dominant fact of forest history" (p. 35), this is true in the type of species that fire produces and promotes, the composition of forest structure and type, and in the landscape mosaic of ecosystems type and age created by human and nonhuman fire regimes (Johnson et al., 1998; Miyanishi, Bridge, & Johnson, 2002; Rowe & Scotter, 1973). In the temperate boreal forest region, with slower rates of decomposition, and seasons of high temperatures and low precipitation, fire is the primary process of nutrient liberation (Pyne, 1995). As Pyne describes it, fire frequency and intensity is correlated with the need for nutrient cycling and plant regeneration; fire does the work required of it by the forest (Pyne, 1995).

The prevalence of fire in the boreal and the dominant forest type usually result in large, stand replacing crown fires, in which wildfires burn large areas of forest and result in large patches of young trees with small patches of old growth trees (Johnson et al., 1998; Miyanishi et al., 2002). These large fires are a result of the tree and canopy type common in the boreal. Pyriscene conifers, such as black spruce and jack pine, are most common in the boreal and the structure of these trees and their accompanying underbrush result in a closed canopy forest with ladder fuel from the ground to the canopy. Once a surface fire is ignited in this forest type,

it easily climbs into the crowns of the trees and moves from tree top to tree top due to the close and continuous canopy (Miyanishi et al., 2002). The landscape-scale implications of this type of fire regime is that old-growth tree stands are rare and the mosaic produced by fire is that of large areas burned with subsequent smaller burns within and around them, along with small patches of old growth trees that escape burning (Johnson et al., 1998; Miyanishi et al., 2002). The forest fire regime in the boreal indicate that old growth forests did not dominate the landscape prior to European settlement and that forest fire cycles have more to do with climate and land use change than with forest age or fuel buildup (Johnson et al., 1998). Fire intensity is a product of weather and fuel, but the prevalence of fine fuels does not vary between old and new growth forests; therefore, large, high intensity fires are primarily driven by weather or climatic change (Johnson et al., 1998; Miyanishi et al., 2002).

An exception in the trend of boreal stand replacing fires are the stands of white pine (Pinus strobus) that can be found in Northwestern Ontario. White pine stands are an example of a pyrophyte tree species where frequent surface fire actually produces and maintains old growth stands (Beverly & Martell, 2003; Waldrop et al., 1992). The difference between white pine stands and other boreal forest stands is the open canopy structure. The elevated crown of the tree, which distances it from surface fires, and the lack of ladder fuels, prevent surface fires from climbing into the canopy and creating stand replacing crown fires (Johnson et al., 1998). The resilience of white pine stands is demonstrated in older stands that are 150-350 years old, compared with jackpine stands which typically burn in 50 year cycles (Heinselman, 1973). Without frequent surface fires, white pine stands often undergo successional change resulting in closed canopy ecosystems, which increase the chance of stand replacing fires. Understory

competition is also more prevalent in the absence of surface fire, which can result in the outcompeting of white pine seedlings by other species (Johnson et al., 1998; Mcrae et al., 1994; Weber & Taylor, 1992).

The ability of mature white pine to survive fire is due to its thick, insulating bark, the distance of the needle canopy from the forest floor and the ability to self-prune, which prevents the spread of surface fires from the ground into the canopy (Mcrae et al., 1994; Scherer-Lorenzen, Körner, & Schulze, 2005; Schwilk & Ackerly, 2001). Unlike other boreal conifers, which encourage fire through enhanced flammability and post-fire seeding, white pine engage in a fire avoidance strategy through adaptations that protect mature trees and their seeding capabilities from fire (Schwilk & Ackerly, 2001). Despite the fire avoidance strategy of mature white pine, seedlings do require fire. Surface fires reduce the organic layer over mineral soil and decrease understory competition and overstory shading by removing non-fire adapted plants; in this way, conditions conducive to the regeneration of white pine are produced (Mcrae et al., 1994; Weber & Taylor, 1992).

White pine ecosystems are a component of the boreal forest in the Lake of the Woods and are most commonly found on islands in this region of Northwestern Ontario (Heinselman, 1973). White pine ecosystems depend on surface fires for their regeneration and maintenance and there is reason to believe that the prevalence of white pine in Northwestern Ontario is linked with the historic use of fire by humans (Mcrae et al., 1994; Waldrop et al., 1992). The creation and maintenance of white pine ecosystems in Lake of the Woods is linked with the historic use of fire by indigenous people. Across North America there has been evidence showing that the existence of these ecosystem types have been dependant on frequent and

intentional burning conducted by indigenous peoples (Pyne, 1982). Beginning in the 1500's, written accounts of European explorers describe pine and savannah landscapes that have since been shown to be the product of frequent burning conducted by indigenous people (Waldrop et al., 1992). In the late 1700's and early 1800's, accounts written by David Thompson and Alexander Henry provided the first written descriptions of the way the Anishinaanbe people in the Lake of the Woods region used fire for intentionally altering the landscape (Davidson-Hunt, 2003a).

Indigenous peoples used fire for hunting, herding, clearing brush, improving pasture, increasing berry and other harvest yields, producing building materials, controlling insects, reducing fire risk, and warfare (Anderson, 2005; Davidson-Hunt, 2003a; Lewis & Ferguson, 1999; Pyne, 1982; Steward, 2002). Managing the landscape with fire was a regular and important act performed by indigenous people. Lighting fires was a way of life that defined the cultural landscape (Pyne, 1995; Steward, 2002). However, due to the closed canopy nature of most of the boreal, understory burning was not possible for indigenous land use purposes; therefore, the landscape fire mosaic of the boreal was created primarily by lightening fire (Lewis & Ferguson, 1999). The difference in areas such as Lake of the Woods was the presence of open canopy forests and fire surviving species like white pine; in these areas, where understory burning could be conducted, anthropogenic fire became a dominant factor of disturbance on the landscape (Waldrop et al., 1992).

The white pine ecosystems on the islands of Lake of the Woods owe their existence, in large part, to the prevalence of historic anthropogenic (Davidson-Hunt, 2003a; Heinselman, 1973; Waldrop et al., 1992). The Anishinaabe people periodically burnt these islands and maintained

the white pine savannah on them for hunting and gathering purposes, such as blue berry production and the creation of forage for prey animals, they also may have burned for reasons such as ease of travel, the production of plants used for manufacture and building, warfare, or unintentionally (Anderson, 2005; Davidson-Hunt, 2003a; Steward, 2002). The result of this historic burning was the creation of a cultural landscape shaped by fire and reliant on fire for its maintenance. Fire, on Lake of the Woods, was as much a cultural phenomenon as the landscape that it was meant to produce (Pyne, 1982, 1995).

Although anthropogenic fire had a long history of use by indigenous people and by European settlers on the landscape of North America, a number of events and changing social and economic factors eventually led to widespread cultural fear and stigma of wildland fires (Davidson-Hunt, 2003a). As Europeans moved west across North America they encountered a mosaic of grassland and open canopy forests that were the product of indigenous burning. However, as the frequency and prevalence of fire was diminished by the reduction of Indigenous populations and the change in land-use brought about by European settlers, dense and continuous forests became the norm along the prairie-forest fringe (Pyne, 1982; Waldrop et al., 1992). According to Pyne (1982), indigenous peoples had little use for large expanses of unbroken forest and neither did the frontier settlers who adopted indigenous fire practices. However, the advent of industrial logging and the formation of continuous forests through the displacement of indigenous peoples resulted in an economic line of reasoning that favoured the protection of timber from destruction by wildfire (Pyne, 1982). The exclusion of wildfire from forests became a way for industrial loggers to protect timber values and secure land rights.

They achieved this by removing the sources of ignition from forests, the indigenous peoples and uncooperative settlers (Pyne, 1982).

The introduction of industrial logging and European agricultural practices into the boreal forests surrounding the Great Lakes coincided with a period of climatic warming and drought, which produced the conditions for the catastrophic fires that would help cement the growing cultural fear and stigma around fire (Davidson-Hunt, 2003a; Pyne, 1995). Agricultural settlements were established in areas recently logged and farmland was established through the practice of burning. Large amounts of slash fuel, left over from the industrial logging process, contributed to the size and intensity of wildfires, which eventually grew into large conflagrations that surrounded and destroyed entire towns; between 1870 and 1930, over 200 communities were overrun by fire and thousands of people lost their lives as a result (Pyne, 1982). Railroads acted as a catalyst for these devastating wildfires as they provided additional sources of ignition, brought more people into the areas affected, and increased accessibility to newly logged and opened areas to settlers and farmers (Pyne, 1982). Pyne (1982), describes the firestorms of this period as comparable to the bombing of Dresden and Tokyo during the second world war. The first-hand accounts of these fires provided the fear and traction for future fire suppression laws and efforts. The after-effects of these wildfires were a cultural shift towards greater suppression and prevention efforts, an overall fear or distrust of fire on the landscape.

Northwestern Ontario experienced similarly devastating wildfires around the same time period and between 1880 and 1930 Canada began writing fire prevention and protection into law (Davidson-Hunt, 2003a). The consequence of this legislation was the restriction of

Anishinaabe burning practices in the area and the beginning of a fire exclusion regime, the likes of which had not existed before (Davidson-Hunt, 2003a). The need for timber during world war two inspired even greater efforts to protect timber and the increase in fire-fighting technology following the war allowed for greater suppression success (Pyne, 1982). Following the war years, fire prevention found huge success in commercial advertising; in 1968 Smokey bear was the most popular symbol in the United States (Pyne, 1982). Similar campaigns in Canada and Ontario, supplemented with strict enforcement, further cemented the public perception that forest fire, in all forms, is bad (Davidson-Hunt, 2003a; Rowe & Scotter, 1973). Due to changing economics and demographics in the area, fire suppression and prevention began to shift focus from timber value protection to community and cottage protection (Pyne, 1982). Fire suppression continues to be a primary concern for fire management, forest communities, and forest users as fires continue to threaten and consume communities, lives, and infrastructure (Warnica, 2016).

The legacy of the devastating wildfires and industrial timber interests persist in fire management and public perceptions of fire, while the recent 'rural renaissance', which Pyne (1995) describes, continues to exacerbate and perpetuate the conflicts between modern society and pyriscene ecosystems. Communities are being built within flammable ecosystems and, in some cases, forests are being brought back into the landscapes of towns and cities without considering the flammability and fire regimes of the area (Pyne, 1995). In addition, predictions are being made that climate change may be increasing the frequency and intensity of forest fires, through longer fire seasons, increased temperatures, evaporation, drought, and increased potential for lightening ignition (Flannigan, Amiro, Logan, Stocks, & Wotton, 2006;

Flannigan, Stocks, Turetsky, & Wotton, 2009; Flannigan, Krawchuk, De Groot, Wotton, & Gowman, 2009). The result of these phenomena are frequent, devastating, and high profile fires within and around communities in the boreal forest, what fire agencies term wildland-urban interface fire, which may serve to re-establish or entrench traditional, negative perceptions of all types of forest fire (Pyne, 1995).

Forest fire in the boreal is both a natural and cultural phenomenon and it is important to make distinctions between what is good fire and what is bad fire (Pyne, 1995). There are many different ideas and opinions about the naturalness of fire or how much human action has shaped the fire regime of the boreal, but the reality is that human management of fire was and is a historical and contemporary necessity. The practice of allowing natural fires to burn, excluding or suppressing fire, or lighting intentional fires are all based on particular cultural values and produce different social and ecological outcomes (Heinselman, 1973; Pyne, 1982; Rowe & Scotter, 1973; Weber & Taylor, 1992).

2.2 Prescribed Burning as a Management Tool

Indigenous people in North America and around the globe have used fire as a management tool throughout history. Pyne (1982) argues that the landscapes and ecosystems most useful to humans have been shaped and maintained by the use of intentional fire. For many indigenous groups, the use of fire had significance beyond the practical, it was “a tool and a presence on the landscape” (Pyne, 1982, p. 71). Tending and shaping the land was a right and a responsibility, “a land unburned was a land uncared for” (Pyne, 1995, p. 13). In the boreal forest, where understory prescribed burning was difficult or dangerous, the majority of intentional fires were lit along the natural fire breaks created by shorelines, streams, meadows,

swamps and marshes, thus creating yards and corridors of fire maintained ecosystems (Lewis & Ferguson, 1999). The burning done in Lake of the Woods most likely followed a similar pattern; fires lit for blueberry harvesting could be contained on islands or by the numerous lakes, streams and swamps in the area (Davidson-Hunt, 2003a). The early written accounts describing this area seem to confirm this as they refer to fire maintained landscapes along the shore lines. These landscapes were maintained by fire in order to produce berry harvests, pasturage for ungulates such as deer and moose, which were hunted, and provided places to set up camps (Davidson-Hunt, 2003a).

As mentioned above, the arrival of European colonists brought changes to indigenous fire practices and fire cycles. Beginning with laws and enforcement, traditional burning was curtailed and following the development of more advanced fire-fighting technology and science, non-human fire began to be excluded from certain regions (Davidson-Hunt, 2003a; Pyne, 1982). Recent studies have begun to show that there is little evidence for the effectiveness of fire suppression in reducing the total area burned in the boreal forest; therefore, in much of the boreal the fire regime is driven by climatic factors and not unnatural fuel buildup or the loss of a human-driven fire regime (Miyanishi et al., 2002). However, around Lake of the Woods, where the ecosystem was drastically shaped by a human and non-human fire regime, the near exclusion of fire has had a profound impact on the landscape (Heinselman, 1973; Rowe & Scotter, 1973).

Much like the traditional burning conducted by indigenous people, modern prescribed burning involves “the knowledgeable application of fire to a specific landscape to accomplish predetermined objectives” (Weber & Taylor, 1992. p. 324). In fact, the knowledge required for

prescribed burning was nearly lost with the push to eradicate fire from the forests and suppress indigenous fire practises. It was only because traditional fire practices were continued on reserve land that the knowledge survived (Pyne, 1982). Today, prescribed burning is regaining acceptance and has proven to be a viable tool for achieving landscape management objectives (McCaffrey, 2006; Mcrae et al., 1994).

Reintroducing fire to a landscape after a period of exclusion has proven to be difficult without extensive preparation and long-term planning (Mcrae et al., 1994; Pyne, 1982). Weber and Taylor (1992) identify the following five objectives that prescribed burning is currently being used to achieve: 1) fire hazard reduction: the burning of forest fuel build up so as to reduce the risks presented by uncontrolled wildfire 2) silviculture: the reestablishment of particular forest stand types with burning being one method of site preparation 3) insect and disease control: pest insects, parasitic plants, fungus, and diseases, such as mountain pine beetle, dwarf mistletoe, and Dutch elm disease can be controlled directly by burning and sanitizing infected trees and areas or indirectly by broadcast burning and promoting biological activity that inhibits the spread of pests 4) wildlife habitat enhancement: altering food supplies for specific animals by promoting plant growth, reducing cover, and changing forest and plant types in an area through burning 5) conservation of natural ecosystems: burning to maintain ecological integrity and diversity. Prescribed burning has proven to be a cost-effective management tool for forest and wildlife management objectives and has been part of Ontario policy directives since 1962 (Weber & Taylor, 1992).

Despite the success of prescribed burning projects in B.C. and Ontario, the practice has continued to develop slowly in these provinces and elsewhere in Canada (Weber & Taylor,

1992). The resistance to the use of prescribed burning may be due to public and departmental misunderstanding of the value and use of fire, a cultural fear of fire, and the complexity inherent to the use of fire as a management tool (Pyne, 1995; Weber & Taylor, 1992). In the past, fire was seen as a positive force, cleansing and world-creating, but the maldistribution of fire (the wrong kind, in the wrong place, at the wrong time) has since changed cultural perceptions of fire to one primarily negative (Pyne, 1995). Thus, fire managers must consider public perceptions in their use of fire, especially in multi-use forests (Weber & Taylor, 1992).

In studying public perceptions of prescribed fire, Bright and Newman (2006) and McCaffrey (2006) found that people were generally accepting of the use of prescribed burning, but acceptance was based on the context of the burn. McCaffrey (2006) found that 80-90% of respondents were in favour of prescribed fire, but there were clear links between the respondents' understanding of the purpose and intended benefits of prescribed burning and their acceptance of its use. People tended to have concerns related to the smoke produced by prescribed burning, the risk of escaped fire, and their level of trust of fire managers (McCaffrey, 2006). However, in engaging with the public, building relationships, and creating dialogue, fire managers established trust and increased public acceptance of prescribed burning (McCaffrey, 2006). Bright and Newman (2006) also found a correlation between public acceptance of fire and its proximity to urban areas; fires that were lit in remote areas had higher levels of acceptance than those closer to urban areas. In addition, the history of fire in an area and the primary use of the forest also changed acceptability; a forest with a recent history of fire was deemed acceptable for burning and forests with high levels of public use were deemed unacceptable to burn (Bright & Newman, 2006).

Building trust and acceptability around prescribed burning requires public dialogue and understanding of the processes and outcomes that can be expected. In order for managers to maintain this trust, proper planning and techniques must be utilized in order to best achieve the predicted outcomes (Mcrae et al., 1994). The public values associated with white pine indicate that fire managers must consider the impacts that prescribed fire has on white pine mortality. In the case of surface fire, the principle cause of white pine morality is crown scorch (Beverly & Martell, 2003). Although white pine have a low level of mortality due to surface fire, crown scorch is the principle cause of fire mortality; high surface flame intensity can result in crown scorch, with higher percentages of crown scorch resulting in higher rates of mortality (Beverly & Martell, 2003). Flame intensity refers to the level of heat energy released by a surface fire and is driven primarily by fuel and weather (Beverly & Martell, 2003).

In order to conduct prescribed burns in white pine with minimal tree mortality, there are a number of procedures that Mcrae et al. (1994) suggests: First, identify burning conditions that maintain the flame intensity below a critical level to reduce crown scorch. White pine with 81-85% of their crown scorched still have a 50% rate of mortality, but rate of survival increases if the scorch occurs before budding in the spring; therefore, prescribed burns should ideally be conducted in the spring before budding. Surface fuel buildup increases flame intensity, so reducing the amount of surface fuels can be achieved by physically removing the fuel from the area, cutting and scattering the fuel, or piling and burning the fuel in the fall. Monitoring the Canadian Forest Fire Weather Index (FWI) is also essential for predicting surface flame intensity. If the Fine Fuel Moisture Code (FFMC) is above 90 then all forms of aerial ignition should be avoided. Aerial ignition usually involves starting multiple fires, when these fires meet

in areas called junction zones they create convective currents that produce higher flame lengths, which cause a higher likelihood of crown scorch. Finally, multiple understory burns should be conducted with regular visits to the burn sites in order to assess the outcomes and plan for future burns. Mcrae et al. (1994) also suggests conducting white pine understory prescribed burn in the spring because of the difficulty in getting a surface fire to spread after leaf out in low FFMC conditions. However, due to the complexity of prescribed burning, the risks involved, and public perceptions, managers may have to adapt best practice guidelines in order to achieve outcomes of higher priority.

Agencies that conduct prescribed burns, such as the Ontario Ministry of Natural Resources, have in depth planning guides, protocol, and legislation that guide the planning and implementation of prescribed burning. The provincial statutes and policies that pertain to prescribed burning in Ontario are the *Forest Fire Prevention Act,* the *Fire Protection and Prevention Act,* the *Environmental Assessment Act,* the *Environmental Bill of Rights,* and the *Endangered Species Act* (Ontario Ministry of Natural Resources, 2014a). *The Lake of the Woods Resource Management Plan's* recognition of the importance of fire in maintaining ecosystem integrity and its prescribed burning directive are related to the *Environmental Bill of Rights,* which aims to protect, conserve, and restore ecological integrity, sustainability, and environmental health (*Environmental Bill of Rights*, 1993; Ontario Ministry of Natural Resources, 2014a).

The OMNRF prescribed burn plans also consider values at risk and stakeholder concerns. According to OMNRF planning documents, the primary planning concerns are related to smoke drift and the risk of escaped fire and its impacts on property values (Ontario Ministry of Natural

Resources, 2008a, 2014a). In planning prescribed burns, managers must identify values that could potentially be affected by escaped fire or smoke drift, include these values and concerns in their burn plan, and take precautions to mitigate risk (Ontario Ministry of Natural Resources, 2008a, 2014a). In particular, values within five kilometers of the planned burn must be identified and considered in the plan (Ontario Ministry of Natural Resources, 2008b). External communications are another component of the OMNRF prescribed burn plan; every prescribed burn must have a communication plan that informs the public, private industries, government officials, and other agencies of the prescribed burn project (Ontario Ministry of Natural Resources, 2014a).

2.3 Collaborative Resource Management

Managing fire is a complex process with no clearly right or wrong solutions; fire is natural and cultural, but cultural perceptions change and so it is not obvious what fire management strategies are the most appropriate (Pyne, 1995). The practise of collaborative resource management addresses the complexity inherent to fire management by allowing local stakeholders to participate in decision making regarding prescribed burn strategies (Charnley et al., 2014). The OMNRFF has incorporated collaborative management, in the form of local public consultation, in the *Old Growth Policy for Ontario's Crown Forests* (2003). The desired result of collaborative management is a practise that is contextually appropriate, has a higher level of local legitimacy, and fosters learning from implementation by having local feedback on outcomes (Armitage et al., 2009; Berkes, 2009).

The type of collaborative resource management this project will focus on is similar to adaptive co-management, as described by Armitage et al. (2009) and Berkes (2009), which is

also written into the *Old Growth Policy*. The difference between co-management and collaborative management, in respect to fire management, is that there is less devolution of power to local participants due to the risks inherent to fire management and the expertise required for its implementation. However, many aspects of co-management can be used to the benefit of collaborative fire management, such as the emphasis on trust building, bottom up decision making, and collaborative problem solving (Armitage et al., 2009; Berkes, 2009).

Collaborative management is a process that relies on social-ecological feedback in order to assess the impacts of decisions and learn and modify future action in order to achieve the most appropriate strategy for a particular area and community (Armitage et al., 2009; Berkes, 2009). Trust and a common purpose is essential for effective collaboration (Schusler, Decker, & Pfeffer, 2003). It is not necessary for all participants to work together harmoniously; the presence of conflict as well as cooperation contribute to effective management solutions (Charnley et al., 2014). Conflict can be constructive in this process and the act of collaboration must accommodate diverse participation, unrestrained thinking, and open communication (Schusler et al., 2003). Key to trust building, constructive conflict, and collaboration is that participants must be confident that their participation is contributing to real, productive, outcomes (Charnley et al., 2014). In order to achieve this, collaborative relationships need to maintain extended engagement in an ongoing process of assessment, reflection, and new rounds of problem solving (Armitage et al., 2009; Berkes, 2009; Schusler et al., 2003). The benefits of collaborative management are improved relationships between resource managers and communities, increased community support for management projects, and management plans that incorporate economic, social, and ecological concerns (Charnley et al., 2014).

Two examples of collaborative fire management are provided by Charnley et al. (2014) in their report on socioecological resilience in the Sierra Nevada and Southern Cascade range forests. First, fire learning networks involve collaboration between organizations and agencies, through regional and national networks, in making landscape strategies for fire hazard reduction and restoration of fire ecosystems (Charnley et al., 2014). Second are prescribed fire councils, which involve local, state, federal, tribe, non-government organization, academic institutions, and private individuals interested in using prescribed fire. These councils aim to remove the barriers to prescribed fire and increase its responsible use through the dissemination of knowledge, techniques, and technology (Charnley et al., 2014). Other similar collaborative relationships are wildfire community protection plans and fire safe councils (Charnley et al., 2014). The benefit of the collaborative relationships are their shared purposes and ability to work across jurisdictional, societal, cultural, and other barriers, which the phenomenon of fire spans.

Public collaboration and adaptive management play an important role in the *Old Growth Policy for Ontario's Crown Forests* (Ontario Ministry of Natural Resources, 2003); this document describes the need for soliciting public input in order to assess the values and objectives in planning and managing for old growth conservation. In addition to public involvement, the *Old Growth Policy* (2003) also follows an adaptive approach to policy development. An adaptive approach means that the process of implementing management techniques and plans will also include a learning process, which includes gathering data from past and current implementations and improving on policies and strategies from the lessons learned (Ontario Ministry of Natural Resources, 2003). An adaptive approach to policy implies a feedback loop

that allows managers and policy writers to learn from the results of their policies and techniques. Public collaboration and involvement is one way in which the *Old Growth Policy* (2003) provides a means of gathering information and learning.

2.4 Biocultural Design

Design is a process of composition, in which an imagined idea is brought into existence through a combination of design elements (Davidson-Hunt et al., 2012; Nelson & Stolterman, 2003). In the actual creation of an idea, values, materials, and techniques influence how the idea is shaped and brought into existence (Davidson-Hunt et al., 2012). Creating a composition of these factors, bringing an idea to life, requires an initial impetus, an intentional action to get the ball rolling; therefore, design must be an intentional act, imagined by a person or persons, and then brought into being (Davidson-Hunt et al., 2012).

Biocultural design is a process of local development, or intentionally directed change, that integrates cultural identity with social, ecological, political, and economic goals. The process supports self-determination and endogenous development through a collaborative framework, ensuring that the outcomes achieved are those desired by the community, thus reducing the risks associated with top-down decision-making and power imbalances (Davidson-Hunt et al., 2012). The framework of biocultural design builds on previous work involving adaptive co-management and traditional ecological knowledge in an effort to address the complexity of resource management and the power imbalance represented by other management and design approaches (Armitage et al., 2009; Berkes, 2009; Davidson-Hunt et al., 2012). Biocultural design utilizes ethnobiology, materiality, and design to accomplish intentional, human-centered change in response to wicked problems, a concept that will be

elaborated on further below. The contextual, empowering characteristics of ethnobiology make biocultural design work for communities by evaluating the desirability, feasibility, and viability of a project in relation to the community in question and by utilizing their knowledge, values, and skills in composing the desired outcomes (Davidson-Hunt et al., 2012).

Ethnobiology is essentially the study of relationships between people and the living world around them (Paul et al., 2011). An ethnobiological approach can provide insight into alternative ways of using and valuing a landscape (Maffi, 2007), because people who interact with different landscapes and ecosystems are shaped by those places; culture and landscape influence each other (Johnson & Hunn, 2015). Thus, ethnobiology provides a means to understand the relationship between people and places, people and the natural environment, in an in-depth and contextual way (Paul et al., 2011). Context is important, in the same way that landscapes and ecosystems can differ widely, so do the cultural and community values, knowledge, and skills that emerge in association with those landscapes (Maffi, 2005). Landscapes are often shaped by local communities, so understanding a landscape or ecosystem and understanding the cultures associated with them requires studying the relationship between those cultures and landscapes (Johnson & Hunn, 2015). In doing so, ethnobiology must take into account the local values, knowledge, and skills relating to the culture and landscape in question. This implies collaborative research and decision making that produces outcomes important to the community involved (Hunn, 2007). The collaborative and pluralistic characteristics of ethnobiology, in its study of human-biota relationships, are the essential aspects that it lends to biocultural design (Davidson-Hunt et al., 2012).

Materiality refers to the essence of the non-human materials that humans interact with. The physical attributes of a material, the social and historically situated meaning or its agency, and the life of a thing all inform the materiality of a thing (Ingold, 2010). Ingold makes a distinction between objects and things. Objects are conceived of and defined as what something actually is, an entity with clearly defined boundaries and some kind of internally consistent essence (Ingold, 2008, 2010). Things, however, 'leak', they change and interact with the other things in the environment, they are alive because they form and exist in their constant movement and interaction with other things (Ingold, 2008). An object is really only a snapshot, one static point along a continuous line of change that a material travels along. But materials are not just a straight line of change, they are also interacting with the materials around them; therefore, a material is actually better thought of as an entanglement, "not a network of connections, but a meshwork of interwoven lines and movements" (Ingold, 2008). Malafouris, et al. describe nature as being "on the move," a tangle of forms and processes with differing velocities and rythms of change (2008). The environment, according to Ingold (2008), is a 'zone of entanglement', a place where there is constant interaction and change between entanglements, a 'meshwork' of living, evolving things.

According to Malafouris et al., the notion of place as bounded and static needs to be replaced with the idea that places are "temporal processes… of people, non-humans, economies, technologies, ideas and more.." (2008. p. 87). Correspondence is necessary in order to account for the inevitable change that occurs in these zone of entanglements (Ingold, 2012). Correspondence means considering the history of the materials and things being studied as well as continuous observation and interaction in order to understand how things change;

rather than being concerned with what things are, we need to pay attention to what things do (Ingold, 2012). Only through correspondence with materials can their properties, the ways they interact, be known (Ingold, 2012).

In an effort to reshape design thinking in a way that encompasses real world complexities and uncertainties, design thinkers have come up with the concept of wicked problems, a concept that is meant to reframe problem solving in a way that accurately reflects the complexity of the real world (Buchanan, 1992; Nelson & Stolterman, 2003). A wicked problem is defined by its indeterminacy, its lack of boundaries, and its lack of definitive solutions, they are not easily encapsulated or tackled by a single discipline, and further analysis of the problems merely leads to more levels of analysis; essentially, wicked problems are the embodiment of our inherent inability to fully comprehend the complexity of the real world (Buchanan, 1992; Nelson & Stolterman, 2003). Carroll et al. (2007) and Chapin et al. (2008) describe wildfire management situations that can be construed as wicked problems; as Carrol et al. point out "The evidence that the wildfire issue fits the "wicked problem" trope is abundant. Different stakeholders see the fire issue as a symptom of a higher order problem, but disagree on the nature of that problem." (p. 239).

The nature of wicked problems require designers to discard the idea that a single solution can be achieved by simply problem solving; instead, intentional and purposeful change is directed by the composition of different perspectives and disciplines to achieve 'working solutions', which must be able to adapt over time (Davidson-Hunt et al., 2012; Nelson & Stolterman, 2003). The concept of working solutions is similar to the process of adaptive

management used in resource management, such as the adaptive approach used in the *Old Growth Policy for Ontario's Crown Forests (2003),* discussed above.

The need to incorporate different perspectives and disciplines means that the role of the designer as expert is shifted to that of facilitator of collaboration (Escobar, 2013). Collaborative design requires that different values be expressed in the design process and the audience or client takes a more central role in determining outcomes. Value sensitive design, human-centered design, and designing for profound experiences and meaningful interactions, are all examples of how bottom up, context specific approaches, can be used to produce more ethical, meaningful, and collaborative outcomes (Cummings, 2006; Jensen, 2002; Medeiros, 2002; Oosterlaken, 2009). The importance of these various design approaches is that they recognize the end-user of design as an important contributor to the process of design in achieving desirable outcomes.

Biocultural design utilizes ethnobiology, materiality, and design-thinking in order to accomplish intentional, meaningful, human-centered change in response to complex or wicked problems. The contextual, empowering characteristics of ethnobiology make biocultural design work for communities by evaluating the desirability, feasibility, and viability of a project in relation to the community in question and by utilizing their knowledge, values, and skills in composing the desired outcomes (Davidson-Hunt et al., 2012). The iterative, 'looping' process of biocultural design encourages correspondence with materials; thus, creating opportunities to learn through the process of doing and gain understanding of the properties of the materials being used (Davidson-Hunt et al., 2012). Including local, contextual knowledge also means that existing pools of knowledge, values, and skills, regarding materials, can be readily accessed for

design plans. Biocultural design is also context specific and human-centered making it a viable framework for addressing wicked problems. Working solutions are determined after a process of inquiry, then implemented, and then adapted according to how the outcomes are evaluated.

Fire management represents a complex situation in which differing and diverse values and priorities are at play. The wickedness of landscape fire management is a result of factors such as the growth of the wildland urban interface, the area where wildfires have the potential to transition from forest fuels into urban fuels, and the lack of agencies or industries that deal with the reality of living with wildfire (Smith et al., 2016). Competing landscape uses and differing beliefs as to how certain landscapes should be managed, as well as overlapping fire protection and resource management jurisdictions and responsibilities all contribute to the wickedness of wildfire management. In addition, climate change is expected to increase the frequency and severity of wildfires, which may limit the effectiveness of wildfire suppression efforts (Flannigan et al., 2009).

The complexity of fire management scenarios and their lack of definitive solutions, calls for a careful exploration of the design elements needed to develop working solutions. The prescribed burning recently conducted on the islands of Lake of the Woods and in Wabaseemong provide a situation where biocultural design can be used to explore the various facets influencing fire management strategies and their outcomes.

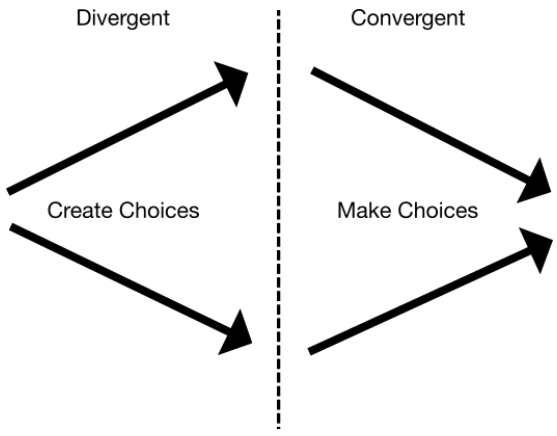
2.5 Biocultural Design Process

A design process has two distinct phases, what Brown (2009) calls the divergent and convergent phases. In the divergent phase of design, capabilities and design elements are

explored in order to allow innovations to emerge and to increase the number of choices available for the next design phase. The divergent phase is all about gathering information in order to multiply the number of options available for the creation of design solutions (Brown, 2009).The second phase of design is the convergent phase, this is the phase that leads to working solutions. In the convergent phase, choices or options that were gathered in the divergent phase are analysed and narrowed down. Where divergent thinking is about creating choices, convergent thinking is about making choices (Brown, 2009).

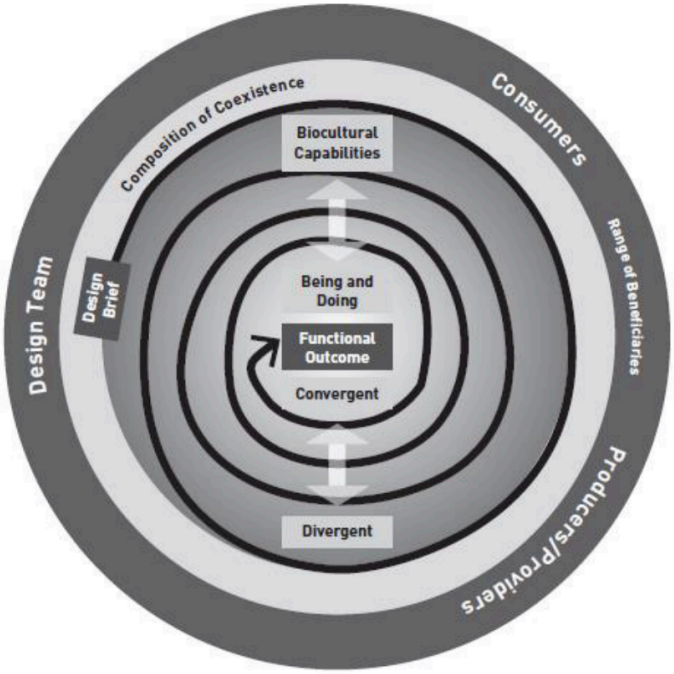
The divergent phase of design is where inspiration takes place, it is the stage of the design process where observation and learning take place in order to understand the lives, hopes, desires, and knowledge of those for whom the design is for. Ideation follows inspiration and this is where divergent thinking transitions to convergent thinking; it is here where ideas are generated and choices are made that eventually lead to solutions that can be implemented or tested (IDEO, 2015a).

Figure 1: Divergent and Convergent Thinking in Design. Source: (Brown, 2009)



Biocultural design utilizes this concept of divergent and convergent thinking. The biocultural design process begins with a design brief, which is informed by local biocultural heritage and novel ideas from elsewhere. This design brief draws on information gathered at the divergent stage of design and then the design process spirals in and converges on a design solution (Davidson-Hunt et al., 2012). The biocultural design process is visualized in figure 2 below.

Figure 2: Convergent Process of Biocultural Design. Source: (Davidson-Hunt et al., 2012)

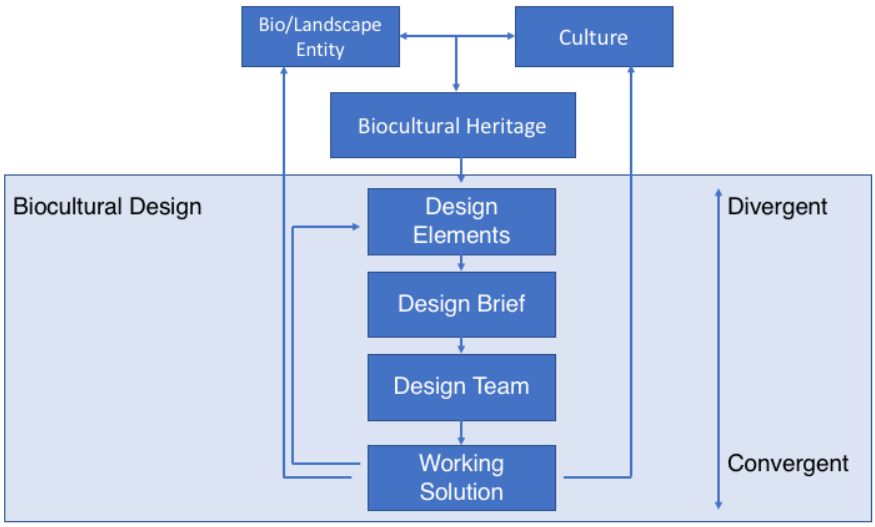


The research performed in this thesis represents the first phase of the biocultural design process. Using biocultural design's conceptual framework, this research evaluates and gathers design-relevant information that is meant to inform the next, convergent phase of a larger biocultural design project. This research is not the performance of an entire biocultural design project, but the first step in the process of biocultural design. The design elements gathered in

this research can be used to make future choices in the design and planning of prescribed burns.

Figure 3 below is an outline of how the biocultural design process works. The relationships between a landscape entity and a culture influence each other to create biocultural heritage. In the case of fire, cultural use of fire has shaped fire-driven landscapes, influencing forest structures and compositions. On the other side of this relationship, tree types, forest structure and other environmental factors create chemical conditions conducive to fire, thus encouraging the use of fire in some landscape types. Biocultural heritage is the resulting composition from these relationships and influences. Biocultural design describes and evaluates biocultural heritage through the use of design elements. These elements inform a design brief, which a design team uses to come up with working solutions that can be implemented, which in turn shapes relationships linking culture and landscape.

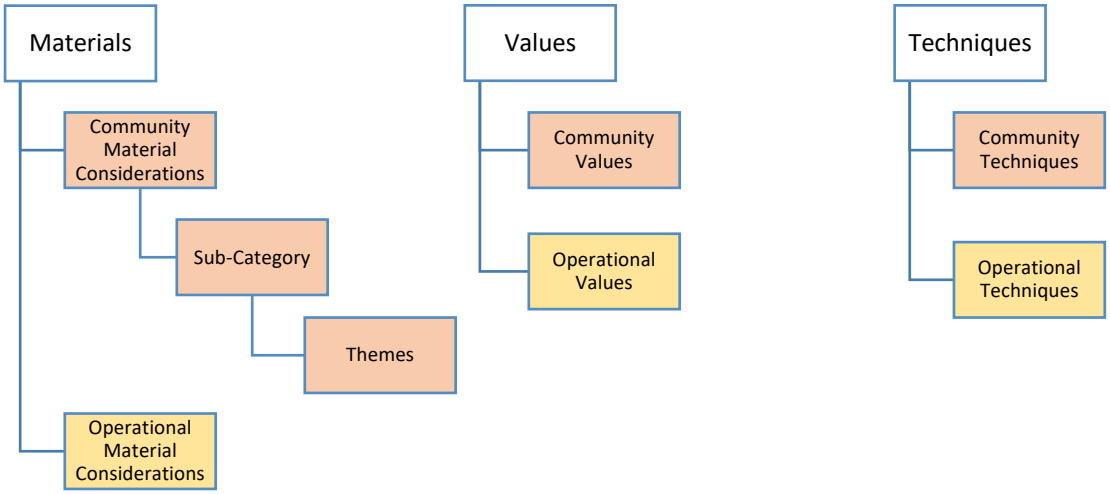
Figure 3: Biocultural Design Process in Relation to Biocultural Heritage



As mentioned above, the design elements of biocultural design can be broadly categorized as descriptive and evaluative. Descriptive design elements encompass the compositional factors of the thing or process to be designed; materials, values, and techniques, are the stuff of composition, the elements that are used to produce a final product. Evaluative design elements are the factors involved in assessing a composition or product; desirability, feasibility, and viability are constraints that design must work within in order to be successful, especially when the design is intended to be human-centered design. Desirability considers what people value and what makes sense them, feasibility looks at what is technically possible given current technologies and capabilities, and viability considers the factors that contribute to the long-term sustainability of a project (Brown, 2009).

In this research, biocultural design provided the conceptual framework that informed the interview questions and the organization of data into design elements, community or operational consideration, and the sub-categories of the design elements. Themes that emerged from interviews were grouped into these elements, considerations, and sub-categories. Figures 4 and 5 below show the visual structure of the descriptive and evaluative design element framework. In Figure 4 the *materials* element show the full breakdown into considerations, sub-categories, and themes. For simplicity, the figures used in the case studies only show the design elements, considerations, and sub-categories; the themes that populate these categories are displayed in tables with supporting quotes. In the figure below and in the figures and tables in the following chapters, community considerations are labelled in orange while operational considerations are labelled in yellow.

Figure 4: Descriptive Design Elements

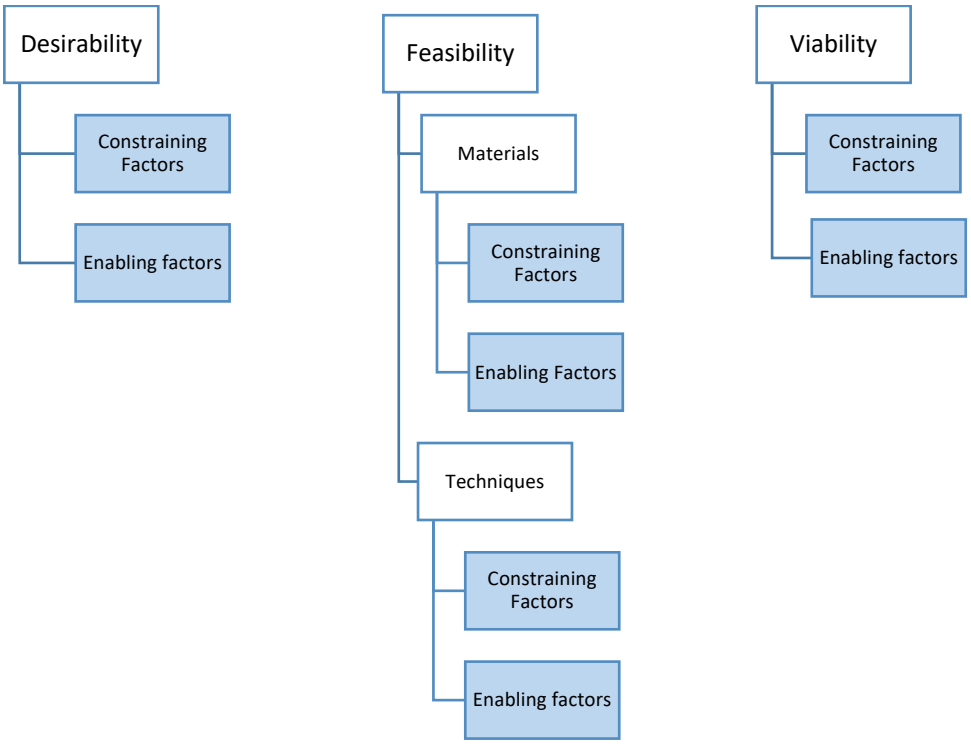


A design process is not open ended, there must be clearly defined parameters and constraints that bound a project (Brown, 2009). Due to biocultural design's focus on both capabilities and constraints (Davidson-Hunt et al., 2012), sub categories were also created to differentiate between the enabling and constraining factors that influenced the evaluative design elements, as shown in figure 5 below.

The semi-structured interviews conducted for the case studies in this research used questions that explored the six descriptive and evaluative design elements. These six design elements were then used as broad data classification categories. Based on the concepts of human-centered design and collaborative management, it was decided that there should be a distinction between themes that community members and OMNRF participants contributed to the design elements. This separation is grounded in the design principle that collaboration for human centered design should include the end-user, the people for whom the design is being

conducted, as an active agent (Brown, 2009). Community members who live in and on a landscape build competencies and knowledge about that landscape, and therefore provide unique insight into collaborative design (Davidson-Hunt & Berkes, 2003; Davidson-Hunt et al., 2012). Separating the community perspective from the operational/planning perspective allows for community/client-specific distinctions; furthermore, the operational branch also has unique considerations, as they are the ones who must consider the techniques and feasibility of the prescribed burns.

Figure 5: Evaluative Design Elements



The design elements and their sub-categories were then described by themes that emerged from interviews. While analysing the interviews, themes or topics were grouped into sub-categories under the design element that they were related to. Some themes did not group into one specific design element and so they were classified under one or more design element

or sub-category; that is, some themes influenced more than one design element. Design elements guided the exploratory process of this research and helped to organize and visualize the compositional components that need to be considered in designing prescribed burns.

This research project has begun the first steps in the human-centered design process described by Brown (2009), identifying relevant constraints and developing a framework by which to evaluate those constraints. Successful human–centered designs for the WIN and LOW PBs will need to consider the evaluative design elements shown below and bring them into what Brown (2009) calls a “harmonious balance”; although unequal weight may be given to one design element, consideration must be given for each of the three elements for a design to be successful.

CHAPTER 3: METHODOLOGY

3.1 Philosophical Worldview

A pragmatic worldview, which focuses on pluralistic approaches to problem solving with direct real world implications (Creswell, 2014), guided the direction of this study. This research is meant to be used in a collaborative design process between fire and resource managers and community members in Wabaseemong and Lake of the Woods. The outcomes of this research will help in designing future prescribed burns by taking multiple perspectives and outcomes into consideration while meeting the objectives of the *Old Growth Policy* (2003), the *Lake of the Woods Management Plan* (2006), and the *Wildland Fire Management Strategy* (Ontario Ministry of Natural Resources, 2014b). Pragmatism is concerned with what works in finding solutions to problems; therefore, actions, situations and consequences take precedent over methods (Creswell, 2009). Pragmatism allows freedom to choose between methods, techniques, and procedures that are most likely to achieve the desired outcomes (Creswell, 2009).

Biocultural design's focus on finding real world working solutions, based on the capabilities and materials available, lends itself to a pragmatic worldview in that both seek to problem solve and use the best methods available to achieve those ends. In relation to the prescribed burn projects in WIN and LOW, a pragmatic worldview, focused on the evaluation of consequences and the application of solutions, provides a direction for research that aims to provide results that can be used for problem solving. The results of this research are intended to be used by prescribed burn planners, community members, and designers to identify problems and opportunities to achieve better results in future burns.

3.1 Research Design

The design of this research relies on a qualitative research approach. According to Creswell (2014), a qualitative research approach favours an exploration of the meanings behind social problems. Qualitative research utilizes multiple sources of data and relies on the meaning that participants have in relation to a problem or issue, thus providing an in-depth, holistic account to complex situations (Creswell, 2009). In addition, qualitative research usually takes place in a natural setting, which involves the researcher going out to observe and interview to collect data that is then interpreted through a specific theoretical lens (Creswell, 2009). Thus, the researcher and the participants themselves shape the study, directly and indirectly. This research design is useful in complex and changing research contexts and, through its flexibility, can adapt to the needs of the participants (Creswell, 2009). The flexibility, potential for collaboration and participation, and holistic nature of qualitative research make it well suited to an exploration of biocultural design and the complex situations surrounding forest fire management.

In the divergent phase of a biocultural design project, which this research represents, qualitative data plays a more important role than quantitative data, as the purpose of this design phase is to discover and identify the choices, options, and capabilities that are available. As the design process proceeds, other methods become necessary; but in the beginning, descriptive, qualitative data provides the means of creating a palette of potential ideas, which the design process will use for later compositions.

3.2 Strategy of Inquiry

The strategy of inquiry used in this research was a case study. According to Creswell (2009) a case study strategy applies to a study encapsulated in a discrete time frame and focuses on a selected program, event, process, individual, or group. The focus of this research pertained to specific communities, processes and issues and the study was largely exploratory and descriptive in nature, because of this it was well suited for a case study approach. Case studies can be employed in qualitative, quantitative and mixed methods research designs; therefore, a wide variety of methods can be employed by a case study researcher (Baxter, 2010). Flexibility in methods allows for a depth of understanding characteristic of case studies. This research project was developed as a qualitative case study, because the relevant information regarding stakeholder perspectives and relationships with forest and fire management did not need to conform to statistical generalizability in order to be relevant to the issue (Baxter, 2010).

The primary characteristic of case study research that relates to this research is its ability to develop understanding of specific contextual situations (Creswell, Hanson, Clark Plano, & Morales, 2007). According to Jamie Baxter, qualitative case studies provide the means for idiographic research, which are characterized by in-depth research into the way things interact within a bounded system (Baxter, 2010). In-depth understanding is particularly important in exploring the contextual issues experienced by a community in reference to a particular event such as a forest fire or prescribed burn. Some communities may experience this type of event differently and the goal of this research is not to come up with a universal set of rules for community-based fire management. Instead, by exploring and understanding the

ways in which one community relates to forest fire management this study demonstrates that contextual understanding and local collaboration is necessary for developing relevant and effective management and design strategies. Following from this need for in-depth contextual understanding, Baxter (2010) points out that case studies are also useful in resolving concrete issues.

This case study was exploratory; new issues or themes emerged and were identified in conducting and analysing the research. In addition, this study fell into what Baxter (2010) calls a cross-sectional study, a study that takes place with a particular group at one point in time. Although a cross-sectional case study can provide in-depth understanding of a specific subject, it is important to recognize that social phenomena are not static; therefore, the information derived from a cross-sectional case study are susceptible to change after the study, thus affecting its relevance (Baxter, 2010). The goal of this research was not to discover generalizable and timeless facts about community perceptions of forest fire management, but to explore perceptions and values in a specific place and contribute to a process of collaborative fire management.

In response to previous research perspectives that devalued indigenous knowledge in favour of scientific knowledge, new knowledge producing processes have been developed with the goal of considering both indigenous people and researcher as active agents working toward common goals (Davidson-Hunt & O'Flaherty, 2007). Biocultural design is a process for designing collective solutions, which often requires cross-cultural communication and openness to alternative perspectives (Davidson-Hunt & O'Flaherty, 2007). Biocultural design utilizes a pluralistic perspective, in which multiple ways of knowing are considered. Pluralism refers to

the diversity of perspectives present in a given context; this implies working closely with the participants of the study in order to understand their point of view (Baxter & Jack, 2008). Close collaboration with research participants and including diverse perspectives are integral parts of the biocultural design framework used in this research. The inclusion of non-specialist community members in the evaluation of the prescribed burn project in Wabaseemong and their identification of materials and values pertinent to future prescribed burn planning demonstrate biocultural design's use of pluralism in identifying meaning and value.

Generalizability, or whether the information and conclusions generated by one case study can be applied in other contexts, is a question of concern for those conducting case study research. Baxter (2010) calls this concept 'external validity' and argues that theories derived from case studies can be generalized as long as they are not abstracted too much from their original contexts. There may be findings that apply across cases, and so they have transferability, or certain shared characteristics that can facilitate extrapolation. However, statistically significant findings are rarely the goal of case studies meaning that generalizability, understood as statistical validity, does not apply (Baxter, 2010). The generalizability in this study is not the content of the design elements as identified by the participants, but the process of utilizing the biocultural design framework for data gathering, analysis, and evaluation.

3.5 Data Collection Methods

3.5.1 Design Workshops

The defining characteristic of a design workshop is its ability to facilitate discussion, interaction, exploration, and learning within a group of participants. By having participants engage with each other, the researcher is able to see how people within a study agree or disagree with each other, learn and problem solve, and interact in general, providing insight into the process of decision making and group interaction as well as providing a space and situation where participants are able to think about, formulate, and contribute their perspective in a way that otherwise may not be possible (Cameron, 2008).

In their Field Guide to Human-Centred Design (2014), the international design and consulting firm IDEO recommends using design workshops, in which people from the community in question participate in the design process. Participants meet in one place and are given supplies and tools that they can use to develop ideas. Different techniques can be used to help inspire creativity such as brainstorming, conversation starters, or rapid prototyping. It is important to record the feedback of participants, but to treat them as designers and not as interviewees (IDEO, 2015b).

Brainstorming is one method that IDEO (2014) recommends for the preliminary and investigative stages of design. A facilitator can provide a prompt or question and participant explain their ideas as they write them or post them on the wall (IDEO, 2015b). Conversation starters begin dialogue around a particular theme by presenting ideas to participants and seeing how they react; these ideas can be accepted or discarded as the process is intended to initiate creative thinking (IDEO, 2015b).

Only one design workshop was performed for each of the case studies in this research. In the workshops that were performed, 3 to 6 key contacts met and the topic of prescribed burn research and design was introduced. The discussion was moderated to keep on the topic at hand, but generally the participants freely interacted; explored ideas, and were free to disagree, and question each other. Notes were kept by the workshop facilitator and the outcomes of the workshop were agreed upon before the workshop ended.

The most significant contributions that the design workshop provided for this study was to build rapport with the key research participants, establish connections between the participants, and ensure that the participants understood who was involved in the study and what that the purpose of the research was to facilitate future collaborative design between the groups that the participants represented. The design workshop also served as a brainstorming session in which participants shared ideas as to how the research could be directed and who future interview participants might be.

3.5.2 Semi-structured Interviews

Semi-structured interviews were the primary source of data gathering for this research. Semi-structured interviews maintain some of the order of structured interviews while allowing freedom for the interviewer to pursue interesting or emerging themes that present themselves during an interview; flexibility and predetermined structure define the semi-structured interview (Dunn, 2008). Semi-structured interviews are primarily content focused, dealing with issues that the interviewer deems relevant, but having the ability to go off script if the content it relevant (Dunn, 2008). An added benefit of the semi-structured interview is that it allows the interviewer to ask probing questions or the clarification of answers (Barriball & While, 1994).

Barriball and While (1994) list the following benefits of semi-structured interviewing and its attendant probing technique: 1) the interviewer can choose appropriate wording and whether or not to follow up with a probe 2) emergent points can be clarified 3) sensitive issues can be explored or avoided 4) high quality of interview data 5) building off previous interviews by exploring inconsistencies or emergent themes 6) flexible dialogue can assist interviewees recall information from memory.

Semi-structured interviews were used to explore the values and experiences that community members had in association with the prescribed burns in the landscape of Wabaseemong. These interviews informed the design elements composing these prescribed burns projects; the materials, values, and techniques involved as well as the desirability, feasibility, and viability of the prescribed burns. Semi-structured interviews were also conducted with Kenora district planners and fire managers in order to explore the materials, techniques, and values associated with the prescribed burns and to determine what operational elements influenced the desirability, feasibility, and viability of the prescribed burns.

The interview questions conducted for this study were developed based on the conceptual framework of biocultural design. The design elements formed the basis of the questions asked, with follow-up questions regarding the enabling and constraining factors that influenced these elements. Interviews were conducted with OMNRF Kenora District Biologists and Planner, Kenora District AFFES planning and firefighting staff, members of Wabaseemong Independent Nation Band Council and Resource Management Office, local Wabaseemong firefighters and community members. Interview participants were selected based on their

knowledge and experience with the prescribed burn programs, using purposive and snowball sampling methods. Key contacts within the organizations or community were identified and these participants were used to identify further potential interview participants.

Interviews were conducted in the offices or spaces where the participants worked. A total of 24 interviews were conducted. 10 interviews were with OMNRF staff and 14 were conducted with Wabaseemong community members. The interviews were recorded on a portable recording device and then transcribed.

3.6 Data Analysis

During the fieldwork component of this study, data was obtained through recorded interviews, field notes, and the products of a design workshop. Documentation and recording were transcribed and the data was coded according to themes that emerged from the interviews and classified into their most relevant design element (Creswell, 2009; O'Connor & Gibson, 2003). Data analysis focused on the design elements of biocultural design and the use of prescribed burning. The descriptive and evaluative design elements were used to classify date into materials, values, techniques or desirability, feasibility, or viability.

Using NVIVO, codes were created to classify interview data into themes related to the design elements materials, values, techniques, and desirability, feasibility, and viability. Distinctions were made between themes that were related to community or operational considerations as well as whether a theme was an enabling or constraining factor for a specific design element. Tables were then made for the design elements and their sub-categories and were populated with the themes that came out of the interviews related to those elements.

As part of the data analysis, large diagrams were made for displaying the design elements. Visual representations and key words were used to represent the themes that emerged from the research and were arranged and rearranged into the design element categories. This process represented the visualization of the biocultural design framework and helped categorize the data that emerged from the interviews; this process also helped to identify relationships between the design elements and themes, informing what themes played a role in enabling and constraining the prescribed burns.

3.7 Sampling

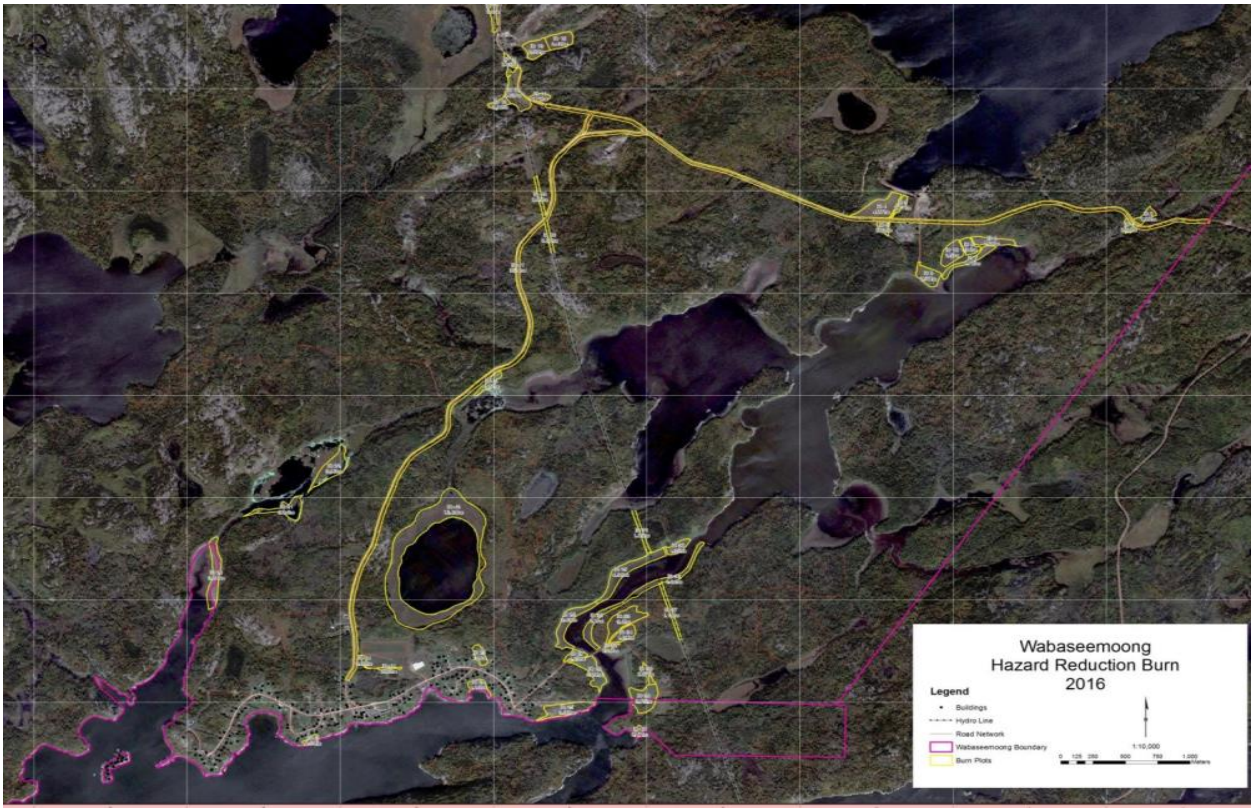
Purposeful sampling was used in this research. In purposive sampling, the researcher chooses the sample for which the research question will be presented; this can involve a key informant sample, where informants with expertise are selected, or snowball sampling, where informants recommend future candidates for the study (Marshall, 1996). For these sampling techniques, the appropriate size of the research sample is determined by how adequately the research question is answered (Marshall, 1996). If data collection continues and no new or emergent themes arise, then data saturation has been reached and the sample size will consist of the amount of subjects who have already contributed to the study (Marshall, 1996).

In this research, key participants were identified and contacted from the Kenora district MNRF, Kenora AFFES, and Wabasemong Independent Nation. These contacts then recommended other contacts they believed would be best able to speak to the issue of prescribed burning. From these secondary contacts, other contacts were occasionally recommended.

3.8 Validity and Reliability of the Study

Validity refers to the level of accuracy of the findings according to the researcher, participant, and audience (Creswell, 2009). This study incorporated validity into its structure through triangulation and member checking, which involved checking the themes and findings of interviews in follow-up interviews with key research participants (Creswell, 2009).

CHAPTER 4: WIN CASE STUDY



Map 3: WIN hazard reduction burn, 2016. The areas marked in yellow are the areas that were treated with prescribed fire. Source: (OMNRF)

Fire is a common occurrence on the landscape in and around the community of Wabaseemong. In the past, wildfires have burned in the boreal forest surrounding the community; in some cases, these fires have resulted in the evacuation of the community. In addition to these naturally occurring wildfires, Wabaseemong Independent Nations (WIN) and Whitedog have had numerous human-caused wildfires lit in and around the community. These human-caused fires have been a concern for both the community and the OMNRF Kenora district Aviation, Forest Fire, and Emergency Services (AFFES). According to the AFFES, the Wabaseemong area makes up 20-40% of the Kenora district's annual fire load, with a historical average of 15-25 human caused fires within the community each year (OMNRF, 2016).

In response to the high occurrence of wildfire in the Wabaseemong area, the Kenora AFFES began a low complexity hazard reduction prescribed burn program. Beginning in 2014, the prescribed burn program was implemented in conjunction with a local fire crew training and skill development initiative and a fuel treatment project. The main objective of the prescribed burn program was to "reduce the spring fire hazard that is associated with the yearly buildup of grassy fuels in areas where the AFFES historically responds to wildfires within Wabaseemong Independent Nations." (OMNRF, 2016). Map 3 shows the areas that were treated in 2016, the areas marked in yellow were burned with prescribed fire.

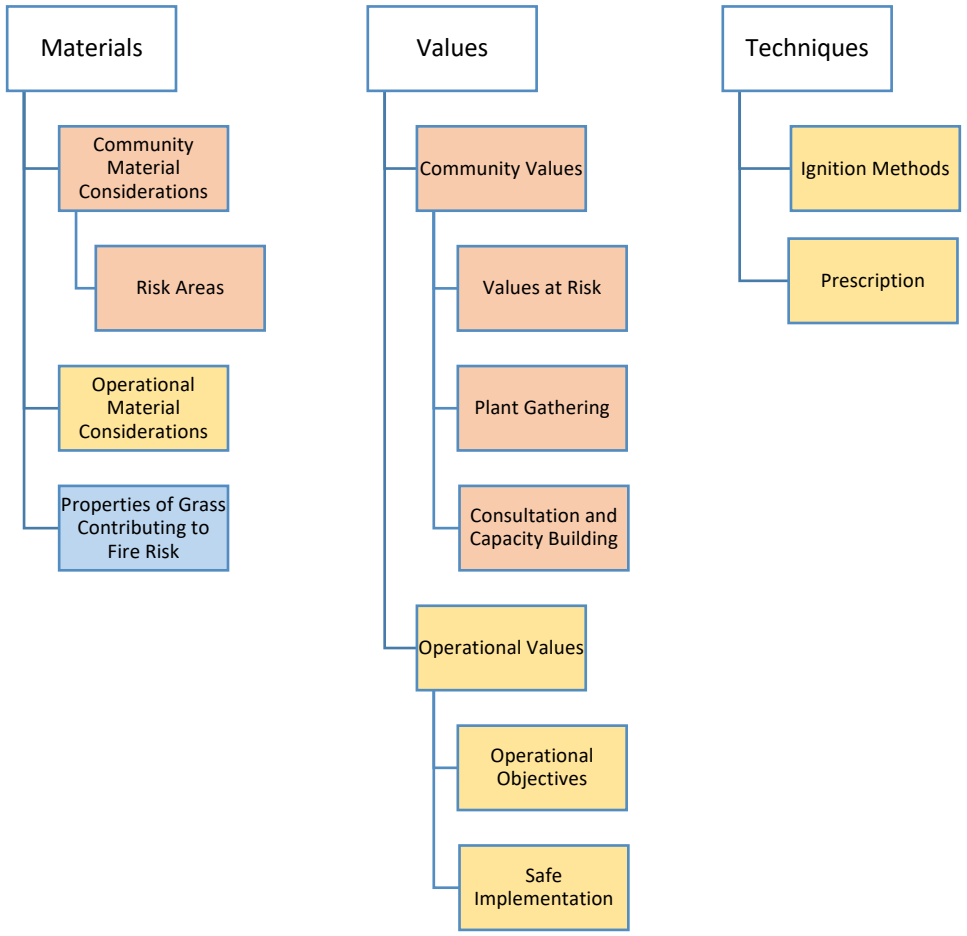
This chapter will look at the materials, values, and techniques that influenced the design and implementation of the Wabaseemong prescribed burn program. In addition, the prescribed burn program will be evaluated according to its desirability, feasibility, and viability. The data presented in this chapter has been gathered from interviews performed with Wabaseemong community members, staff from the OMNRF AFFES, and documents provided by the OMNRF.

4.1 WIN PB: Descriptive Design Elements

This section will look at the descriptive design elements and their respective themes. As shown below in figure 5, the descriptive design elements have been arranged according to whether they fall into materials, values, or techniques. These descriptive design elements have been divided into community consideration (in orange), operational considerations (in yellow), and considerations that were identified by both groups (blue). Separating operational from community considerations allows for comparison and differentiation between these sub-

categories. Tables 1 to 10 represent the sub-categories of the operational and community considerations and the themes that compose them.

Figure 6: WIN PB: Descriptive Design Elements



4.2 WIN PB: Materials

This section presents the materials that influenced the WIN prescribed burns. Materials, as they relate to prescribed burns, are broadly defined and do not specifically refer to the vegetation that act as fuel a hazard reduction prescribed burn. Instead, materials encompass environmental factors, the geography of the materials in question, the intermix of non-

vegetative fuels within the targeted hazard fuels, and the properties of these fuels that contribute to their wildfire risk and prescribed burn outcomes.

The *materials* design element is separated into *community considerations*, *operational considerations*, and *properties of grass contributing to fire risk*, because community members and OMNRF operational staff have different perspectives relating to the factors that most influence material considerations. The sub-category, *properties of grass contributing to fire risk*, labelled blue, refers to material considerations that both the OMNRF and WIN community members brought up, these material considerations are overlapping between OMNRF and WIN.

4.2.1 Materials: Community Material Considerations

According to interview participants, intentionally lit wildfires are common in and around the community and they occur in areas with dry grasses that are easily accessible off roadways, walking paths, or open common areas. Based on the data that interview participants provided regarding the conditions in which wildfires occur, the sub-category for *community material considerations* has been labelled as *risk areas*, this is because community members consistently pointed out areas where wildfires had occurred in the past or where they feared future fires might start or easily spread to. Risk areas are broadly defined as the landscapes in and around the community that are susceptible to ignition. They pose an immediate risk to life and property if they were to ignite and burn in the right conditions. The table below defines the seven risk areas identified by community members and provides a description that interview participants gave about the nature of those areas and the potential risks they posed.

Table 1: WIN PB: Risk Areas

Themes: Risk Areas	Description
Swamps	• "In my parents' area alone, there is a swamp right behind their yard, so that's all full of grass and whatnot. So, any given time, someone can walk down, there is a trail that runs parallel to this road here, anybody can walk down that trail there and flick a cigarette and light a grass fire in the back here and it would eventually creep up towards our home. So, we decide to take the fuel away from our home before anything gets ignited" (C. Carpenter, interview, Apr. 5, 2017).
Shorelines	• "I would like to see more PBs along the shore. Every year it burns and I have to protect it [my home] with a garden hose. Steep slope, cannot be cut. Last year a house next door almost burnt down" (G. Kent, interview Apr. 4, 2017).
Grassy Areas near the School	• "Right by our school they torched all the junkyard cars and it went out of hand" (J. and L. Cameron, interview, Apr. 5, 2017).
Roadsides	• I"n this neck of the woods it's mainly grass… We do have a whole whack of grass along the roadsides all the way down to Kenora" (G. Ignace, interview, Apr. 4, 2017) • That would be the main road, because that's where everything starts. Anywhere along that, because it could potentially go either west or east and then we would be trapped. Anything around our main road coming in, that would be ideal…(H. Carpenter, interview, Apr. 5, 2017).
Gravesites	• "I can remember back in the early 80s, there would be grass fires all through there, burning all of the crosses, so that became an issue and concerned people, not knowing where their loved ones are. We try to eliminate that by doing this every year. That's our number one priority area" (G. Ignace, interview, Apr. 4, 2017) • "The graveyard never used to be torched like that, so people are just like, they flick a match and puff away they go, as long as it starts and then they walk off" (J. and L. Cameron, interview, Apr. 5, 2017) • "These are our graveyards, it's all open area with grass. We've got graveyards here that have grown in, these are the very first ones. There's graveyards all over here. When the fire goes through here, I think the main concern is actually the forest on fire. Most of these crosses here, they don't really burn, but they do burn sometimes, but a lot of them are going to the headstones" (M. Lee, interview, Mar. 23, 2017).
Empty Buildings	• "Then the youth target the buildings, the cars, the kids that are not supervised, they start targeting empty buildings, empty houses, things like that" (J. and L. Cameron, interview, Apr. 5, 2017)
Tall Grass Around Homes	• "A lot of them had big yards at times and sometimes they let it get away on them and the grass grows long. My biggest priority is getting these homes that have grass right up to their wall to get that taken care of now before somebody else comes and decides, oh we're going to spark it up" (C. Carpenter, interview, Apr. 5, 2017).

Most of the areas identified by community members were immediately adjacent to, or intermixed with, the homes of the community of Whitedog. Exceptions were some swampy areas and shorelines, sections of the roadside, and the gravesite, which is somewhat removed from the community; however, all of these areas have the potential to spread fire from their location into the community and nearby values, given the right wind direction and burning conditions, due to the connectivity of fuel between the risk areas and the community. In addition to being areas where fire may occur and spread from, areas such as the gravesite, tall grass around homes, and the grassy area near the school, are locations with values within them and thus posed immediate risk to values as well as posing a danger to adjacent values.

4.2.2 Materials: Operational Material Considerations

The material considerations of the OMNRF planners and firefighters are defined by OMNRF documents such as the *Ontario Ministry of Natural Resources Prescribed Burn Manual* (Ontario Ministry of Natural Resources, 2014a) and the *Low Complexity Prescribed Burn Plan* and include fire weather indices and wildfire fuel types, which will be discussed below. The five themes displayed in the table below (*treatable area*, *O1A, embedded garbage, indices, and season*) are the operational material considerations identified by OMNRF interview participants. The five operational material considerations all interact with the primary fuel in question, O1A – dried matted grass.

Table 2: WIN PB: Operational Material Considerations

Themes: Material Consideration	Description
Treatable Area	• "The sites were selected based on two sources of input. We looked at historical fire records of where we usually responded to fires, pretty much every year within the community… we look at the historical fires and we also received input, collaborated with the community itself, getting input from the chief and council of areas that they deemed were, they were concerned about or areas of concern where they wanted the threat of grass fires eliminated" (J. Mash, interview, Feb. 24, 2017).
O1A (Dried matted grass)	• "Like I said, it's all O1A stuff, grass fuel areas. This is what we're targeting, generally this is where the fires are starting from, it takes a rip into the bush, this way we're able to eliminate that, we'll have no fires there. We're eliminating the O1A stuff" (G. Ignace, interview, Apr. 4, 2017).
Embedded Garbage	• "There are challenges such as garbage and stuff that's out there that may be hidden in the grass itself, so people have to be careful to keep the smoke in front of them, not being too far into the smoke, especially in certain areas where there might be more garbage than you want" (D. Mclean, interview, Mar. 29, 2017).
Indices (Weather)	• "Again, it all comes back to mother nature, the weather factors are huge... In some areas, they were able to do some ignition, but they are dealing with cloud cover, they are dealing with higher RHs, the snow melt going on, that's affecting some of their burns, no wind, they're probably getting an intensity class 2, but it's not going anywhere, it's just sort of burning, just creeping; the wind isn't there to help move it along… There is a threshold there with the wind. The indices are usually the driving factor" (D. Mclean, interview, Mar. 29, 2017).
Season	• "As soon as the snow melts right up till whenever it greens up, so usually end of march through April maybe into mid-May… in the spring time we are really under the gun with the amount that we have already taken on. To try to get the area that we have identified done as soon as the snow melts the clock is ticking" (P. Harvey, interview, Feb. 28, 2017).

Treatable area refers to the size and location of the prescribed burns, determined by low complexity prescribed burn guidelines, historical fire data, and community input. The areas selected for burning were decided through a process of analyzing previous fire origin history in the area and by collaborating with community leaders (J. Mash, interview, Feb. 24, 2017). According to P. Harvey (Interview, Feb. 28, 2017), the size of the treatable area initially pushed the hazard reduction burn from a low complexity to a high complexity burn, meaning that more

planning and stricter guidelines would have to be implemented, severely restricting the effectiveness of the prescribed burns. However, by dividing the treatable area into four hectare blocks, the prescribed burn planners were able to keep the burn in low complexity status.

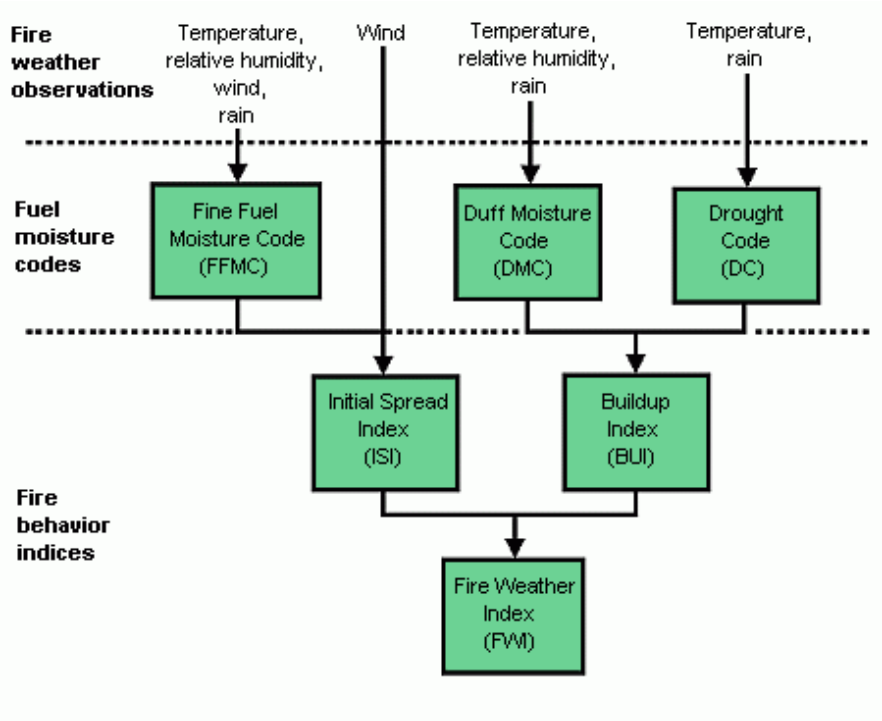
The AFFES and other Canadian wildfire agencies follow the Canadian Forest Fire Danger Rating System (CFFDRS), which classifies wildfire fuel types. The fuel type O1 is described as "continuous grass cover, with no more than occasional trees or shrub clumps that do not appreciably affect fire behavior", O1A is the cured and matted grass common in spring after snowmelt (Canadian Wildland Fire Information System | Natural Resources Canada - FBP Fuel Type Descriptions," n.d.). Matted grass is the primary fuel of the hazard reduction burns due to the yearly buildup of dry grass, the frequency of ignition that starts in this fuel type, and the fast moving fires that are a feature of O1A fuel types (Ontario Ministry of Natural Resources, 2016). Fire in other fuel types, such as trees, was specifically avoided (D. Mclean, interview, Mar. 29, 2017). O1A is the key material for the WIN PBs, but the properties of O1A change depending on other factors, as identified by the other four material considerations in this section.

Embedded garbage, which is garbage intermixed with grass, is included as a material consideration because the garbage also burns when the grass is lit in a prescribed burn. When grasses and garbage burns, the smoke produced is considered hazardous to OMNRF firefighters (D. Mclean, interview, Mar. 29, 2017). The quantity and embeddedness of the garbage has become an important material consideration for firefighters attempting to light prescribed burns (P. Harvey, interview, Feb. 28, 2017). Thus, garbage is a material that alters matted grasses' composition and the smoke that the prescribed burns produce.

The term *indices* refers to the components of the Canadian Forest Fire Weather Index System (FWI), specific weather factors that influence wildfire and prescribed burns. Firefighters and PB planners monitor indices in order to predict how a fire will behave. Although the components of the FWI include fire weather observations, fuel moisture codes, and fire behavior indices, fire personnel typically use the term 'indices' to described all of these components.

The FWI system uses daily weather observations of temperature, relative humidity, wind speed, and rainfall to determine fuel moisture codes. Fuel moisture codes consist of the Fine Fuel Moisture Code (FFMC), Duff Moisture Code (DMC), and the Drought Code (DC). The FFMC refers to the moisture content of cured fine fuels and gives an indication as to how easily a fire will ignite. DMC is a measure of the moisture in loosely compacted layers of organic surface material and is used to predict fuel consumption in moderate-sized woody material and surface duff layers. DC rates the moisture levels in deep, compacted organic layers below the surface of the forest floor and indicates the depth a fire will burn or smolder and the likelihood of fire persisting in those layers. In turn, these fuel moisture codes are used to calculate the Fire Behavior Indices: Initial Spread Index (ISI), Buildup Index (BUI), and the Fire Weather Index (FWI). The ISI combines wind speed with the FFMC to determine a fire's expected rate of spread without taking into consideration factors such as fuel continuity. The BUI incorporates the DMC and DC to predict the amount of fuel available to burn. Lastly, the FWI uses the BUI and the ISI to predict a fire's overall intensity, it is used to assess overall fire danger ("Canadian Wildland Fire Information System: Canadian Forest Fire Weather Index (FWI) System," 2017). The figure below shows the structure of the FWI system.

Figure 7: Canadian FWI System Structure. Source: (http://cwfis.cfs.nrcan.gc.ca/background/summary/fwi)



Season also plays a role in material properties; the type and quantity of fuels available for combustion and weather factors that influence fire are driven largely by seasonal timing. The Wabaseemong prescribed burns are conducted in the spring due to the presence of snow under the shade of the forest canopy. Wet or frozen ground also prevents fire from burning deep, and the lack of 'green-up' – the presence of new plant growth that slows fire and inhibits its ignition and spread.

4.2.3 Materials: Grass Properties Contributing to Fire Risk

In interviews with both community members and OMNRF personnel grasses were consistently identified as the primary material influencing fire risk in the community of Wabaseemong.

Photo 1: OMNRF PB in grass. Source: (OMNRF)

Given their experience with grass fire, community members and OMNRF staff brought up specific attributes of grass that made it susceptible to ignition and capable of sustaining large, fast moving, hard to contain fires. The first theme presented is *spread potential*; grass, being a fine fuel, has the potential to burn at a high rate and fire spreads easily through a grassy area, especially given strong winds. Participants indicated that the rapid spread of grass fires allowed it to quickly move into forested or built areas. The second theme, *accessible ignition points*, refers to the ease of accessing grassy areas where ignition is favorable and spread is likely. The third theme is *volume and height* (quantity of grass); the high volume of grass in and around Wabaseemong means that there is more grass to burn and denser grass results in more intense fires. Closely related to grass volume is *grass height*, participants indicated that taller grass supports harder to control fires while shorter grass provided a barrier to fire; tall grass is prevalent in Wabaseemong. *Regeneration,* the seasonal cycle of grass dying off in the fall, curing, and drying out in the spring, creates an annual fire risk as fuels build up and dry out. The regenerative quality of grass means that fire risk is a yearly occurrence and solutions cannot be one-time implementations. Lastly, the location of fuel plays a role in its risk to values, the closer in proximity dense O1A fuels are to homes and infrastructure, the higher the wildfire risk for these values. *Proximity to values* describes how in Wabaseemong, homes and infrastructure have grass that grows right up against them, increasing the threat to them from wildfire.

Table 3: WIN PB: Grass Properties Contributing to Fire Risk

Themes: Grass Properties	Description
Spread Potential	• "A lot of these areas here, this is all grass field here going up the side of a hill that goes up into evergreens. If that catches off, then that has potential to take off too. I know about all of these areas here, I know this personally, I travel this lake every summer, every fall, this is where I do my hunting. I know this area, for a fact, is always dry" (C. Carpenter, interview, Apr. 5, 2017). • "You get fairly significant fire behavior and the flame fronts are fast moving. We have had fires in that area, within the last three or four years, that have exceeded 100 meters a minute spread rate" (J. Mash, interview, Feb. 24, 2017).
Accessible Ignition Points	• "Anybody and everybody who has a lighter walks by and they want to start up a grass fire, they start it usually…People are sparking off fires on the side of this hill here, every day, day in and day out, people don't realize that sparking a fire going up a hill takes off quick" (C. Carpenter, interview, Apr. 5, 2017). • "That's where the grass is so that's where the fire will take off. Those are the worst spots, that's where people will light them up" (G. Kent, interview, Apr. 4, 2017).
Volume/Height	• "There's a lot of grass here in the community…" (C. Carpenter, interview, Apr. 5, 2017). • "If they would do the controlled burn, when there's an abundance of grass, I think that would be, people won't have the intention to go there and try to burn the grass" (J. Land, interview, Apr. 4, 2017).
Regeneration	• "These areas burn every year, we don't see a reduction in the tons per hectare and the density of the fuel type. It comes back pretty much the same every year. If anything, the amount of grasslands grows a little bit each year, because of the burns on the fringe of the forest line and that succession takes place, you get the grass kind of expanding" (J. Mash, interview, Feb. 24, 2017);
Proximity to Values	• "My biggest priority is getting these homes that have grass right up to their wall to get that taken care of now before somebody else comes and decides, oh we're going to spark it up" (C. Carpenter, interview, Apr. 5, 2017). • "Garnet, our community fire officer gets requests from people to burn their grass in their back yard and some other areas, but a lot of ones we are not prepared or set up to start burning back yards where there is grass, like waist high grass right up to the back-door step" (P. Harvey, interview, Feb. 28, 2017).

4.3 WIN PB Values

This section looks at the values design element that community members, OMNRF prescribed burn planners, and firefighting personnel hold in relation to the use of prescribed fire in and around the community of Wabaseemong. The values discussed here play a direct

role in understanding the desirability of prescribed fire in Wabaseemong. Like the *materials* design element, the *values* element has been divided into *community values* and *operational values*, based on the differing perspectives and concerns that each of these groups have in relation to hazard reduction burns. In this section, the term values encompasses physical objects, environmental conditions, practises and skills, relationships, and places that are valued by the community and OMNRF.

4.3.1 Values: Community Values

Interviews conducted with residents of Wabaseemong brought to light a number of different values with direct and indirect relationships to prescribed burning. Community participant values were identified as they described the real or potential outcomes they saw resulting from the prescribed burns and whether those outcomes were positive or negative. As community values were identified in the interviews, the following three sub-categories emerged:

- Values at Risk
- Plant Gathering
- Consultation and Capacity Building

4.3.1a Values at Risk

Values at risk refer to the people, places, property, and things that community members believe are threatened by out of control wildfire. *Values at risk* are community values that have potential to be protected by hazard reduction burns and which need to be considered when applying prescribed fire.

Table 4: WIN PB: Values at Risk

Themes: Values at Risk	Description
Homes	• "The majority of home owners have approached our regional fire chief up here, which is G. Ignace, they have approached him about wanting to have their yards burnt off within the actual community (C. Carpenter, interview, Apr. 5, 2017) • Each and every spring we run into a lot of concerned people that are worried about hazard fuels around their homes, the lodges up in Whitedog also" (G. Ignace, interview, Apr. 4, 2017).
Hydro Poles	• "The hydro gets affected, because they burn the hydro poles and they [must] replace them, so that is expensive" (J. and L. Cameron, interview, Apr. 5, 2017). • "The hydro poles… [catch] on fire. That affects the community" (J. Land, interview, Apr. 4, 2017).
Evacuation Routes	• "The purpose of the one road here that was put in for a logging operation, they put in a side road here that links up to the road; the purpose of that is that if there is a fire here we have an alternate [route out of town]. Cause if the fire is up in this area and comes this way, there is an opportunity to take off. That was the purpose of that road, it's at the east end of our community" (M. Lee, interview, Mar. 23, 2017) • "They call it the escape route, the standby route, the evacuation road. It's not entirely accessible. The only time is in the winter… Right now, the only way you get through this is with a four wheel drive, because it's all mud" (H. Carpenter, interview, Apr. 5, 2017).
Air Quality (Smoke)	• "For the ones that are being set intentionally, yes. The smoke does get thick at times, even when you're trying to close your windows, you can still smell the smoke inside your house. Last summer that happened when they set a fire up where we live and that wind was carrying all that smoke towards where we were living. I have grandkids and I don't like my grandkids having to breath that in. It was kind of concerning, health wise" (J. Land, interview, Apr. 4, 2017). • "There are people with asthma, I guess I'm considerate for other people, for their wellbeing. People put their laundry out on the line, having your laundry out on the line, you don't want all your work putting laundry out on the clothes line and then having it smell like grass fire. I think about other people and what they need" (V. Quewezane, interview, Apr. 5, 2017).
Safety	• "We feel safer, I'm pretty sure everybody feels the same, I know I feel safer. Knowing that could be the start of a big fire, if somebody does that and its not done in a controlled way, like if someone just comes by and lights it just because he wants to light it…" (M. Lee, interview, Mar. 23, 2017).
Gravesites	• "That area is one of our main concerns is somebody lighting a grass fire up the transmission line here and it catching onto the graves again, because it's happened already. A lot of crosses were burnt and a lot of graves were lost. You can't really find where the graves were" (C. Carpenter, interview, Apr. 5, 2017) • "The graveyards… The area there, most of the graves are marked with 2x4's, 2x6's, wooded crosses. My father's buried there and his cross is burned and now we have to mark the area just so we know where his grave is, because the cross was burnt already, because somebody lit up the grass there. So when the fire comes in … it usually comes in pretty hard and fast" (V. Quewezane, interview, Apr. 5, 2017).
Traditional Areas	• "Traditional stuff, offerings, in the bush, I don't want it burned. Prescribed burning can protect those traditional areas and offerings" (G. Kent, interview, Apr. 4, 2017).

The value of *homes* in the community is perhaps best described by H. Carpenter, who is the manager for Wabaseemong housing department, “I have a list, it’s ongoing, I have maybe 500 people on standby who need a house and the number is just getting bigger.” (Interview, Apr. 5, 2017). Several homes have been lost due to fire and although those fires weren’t wildfires, the scarcity of homes in Wabaseemong means that protecting homes from wildfire is a critical issue. The homes in Wabaseemong are vulnerable to wildfire, due to their proximity to wildfire fuels, as discussed in the materials section, and are a high priority value for community members.

Hydro poles are also a value that community members identified as being at risk from wildfire. A Hydro One power line passes through the community of Wabaseemong and wooden power poles support the line that supplies the community with electricity. Wooden hydro poles are susceptible to fire and in the past poles have been destroyed by fire, which resulted in power outages as well as additional costs for Hydro One in replacing those poles (Ontario Ministry of Natural Resources, 2016). A long-standing dispute between Wabaseemong and Hydro one has made hydro issues somewhat precarious, a situation that wildfire destroyed hydro poles only exacerbates (H. Carpenter, interview, Apr. 5, 2017).

Photo 2 and 3: Fire damaged hydro pole and prescribed burn around hydro pole in WIN. Source: (OMNRF)

Evacuation routes are another concern for the community. According to G. Ignace (Interview, Apr. 4, 2017) Wabaseemong was evacuated in 1988 and the entire community had to be flown to Gimli, Manitoba after a large fire started on highway 17 (the Trans-Canada Highway) west of Kenora. Currently there is one all-season road leading out of Whitedog to highway 525; a second winter road was constructed to access the highway, but it is only passable in the winter months (H. Carpenter, interview, Apr. 5, 2017). Community members believe that a second all-season evacuation route is necessary, in the event that wildfire cuts off the road out of Whitedog.

Air quality, as affected by smoke, is threatened by wildfire and needs to be considered carefully in planning hazard reduction burns. Community interview participants voiced concerns about the health effects, especially on children, the elderly, and those with health conditions caused by smoke resulting from grass fire near their homes.

The fifth value at risk, *safety*, emerged from the interviews as a general concept relating to the sense of community safety that residents felt after the implementation of the prescribed burn program. The interview participants who mentioned safety felt that the prescribed burns reduced the danger presented by wildfire in and around their community; as a result, the *safety* theme represents a positive response of community members towards the OMNRF prescribed burn program. Safety would be compromised in the absence of the prescribed burn program.

In addition to being a risk area, *gravesites* were identified as a value at risk, due to the value represented by the area and its vulnerability to wildfire. There are two community gravesites near Whitedog; the Whitedog graveyard is situated to the east of the community, on the east shore of the Whitedog River. The second gravesite, Goshawk, is north of the

community and just to the south of Goshawk Lake. The graveyards in Whitedog are maintained according to the traditional beliefs; M. Lee describes these traditions:

> *"Our graveyards, we don't maintain them, that's a belief that we have here, if you keep your graveyard maintained, you're preparing for somebody else to die. That's a belief of our people so we just let our graveyard. That's our belief, preparing graveyards, if you're keeping them maintained, the belief here is that you're preparing for more people to die. These are our graveyards, it's all open area with grass."* (Interview, March 23, 2017).

The combination of the community's traditions and the prevalence of grass fire in Wabaseemong has resulted in fires being started in or near the gravesite areas resulting in crosses and other grave markers being burned or destroyed and the potential of fire to spread from the gravesite to other areas. The gravesites of Wabaseemong represent an area in need of careful design consideration given the location's role as a fire source (*risk area*), a place imbued with community and cultural significance (*value at risk*), and the traditional practices that place limits on the amount and type of work allowable in the area.

Lastly, there are *traditional areas* in the landscape of Wabaseemong where offerings are left and where there is cultural or spiritual significance imbued in the area. Interview participants voiced their desire to have these areas protected from wildfire and prescribed burning was considered an acceptable option to achieve that protection, although care would be needed in implementing those burns.

4.3.1b Plant Gathering

Plant gathering emerged from the interviews as a theme that didn't quite fit into risk areas or values at risk, as certain plants were believed to either helped or harmed by fire, and plants, as described here, have a unique character of being naturally occurring on the landscape. *Plant gathering* constitutes a value held by community members and prescribed

burning may have the opportunity to support or maintain certain harvesting practices or, if not done carefully, may harm them; thus, prescribed burning has the potential to add additional value to the community by incorporating awareness of plant gathering practices into its design and implementation.

Table 5: WIN PB: Plant Gathering

Themes: Plants Gathering Practices	Description
Medicines	• "Some plants that we would use as medicine, it takes a longer period for them to regenerate, to grow again. The animals do their own pruning of the plants and that's welcomed, because they flourish, but if you burn it, it goes a little bit further down into the roots and probably kills the plants, some of the plants, so that's a concern, you just have to go a little bit further to search for healthy plants…Fire would affect it, yes…Negatively, because it would take longer for it to rejuvenate" (D. Cameron, interview, Apr. 5, 2017).
Wild Rice	• "We're trying re-establish rice in this area and if we could burn areas along the edges, because the bullrush reeds, they compete with the rice as they grow because it takes up ricing areas. If that would be possible to burn, because I was thinking about that, it would be pretty hard to burn right up to the lake" (M. Lee, interview, Mar. 23, 2017). • "Years ago we used to burn along this rice field, the bulrushes and whatever, we used to burn this whole area off" (G. Ignace, interview, Apr. 4, 2017).
Blueberries	• "They've said that they [used] to burn areas that would produce berries, my mom talks about it, she says they used to do that, it [was] also a controlled burn… The years when my mom talks about, it is back then, she was born in '42, and I'm not sure if she's actually experienced it herself or if it's stories from my grandfather who was born in 1903, so it could have been his stories" (M. Lee, interview, Mar. 23, 2017).
Giant Hogwort	• "I've noticed… giant hog wort, but I'm not sure if it is, I can't remember what it is, I'm not one of those plants persons. I don't know plants myself. I've noticed those popping up in the area, I never noticed them before. [These] plants might be a result of the sides of the roads being burnt or it could be the result of something else, I don't know" (M. Lee, interview, Mar. 23, 2017).

According to D. Cameron, a school teacher in Whitedog and a harvester of traditional plants in the area, harvesting of wild plants is an important practice in Wabaseemong. Kenora is the closest city to Wabaseemong and it is nearly a two-hour drive for community members who

want to drive there to go grocery shopping. The distance to Kenora, health concerns such as diabetes, and traditional practices make harvesting wild plants an important value to community residents of Wabaseemong. D. Cameron describes this importance:

> I have many allergies to processed food, so I stay away from that and I just eat the traditional foods. You'll find a lot of people who are having dietary issues, whether it be diabetes, heart disease or just auto-immune diseases that require special diets. There are some people that don't go into Kenora to purchase food, they just eat off the land and that's really important (Interview, Apr. 5, 2017).

Medicinal plant gathering is one of the plant gathering practices that D. Cameron brought up and which she felt needed consideration when prescribed burns were planned and implemented. There are specific areas where plant gathering is practiced and some of the plants used for medicine may be adversely affected by intense fire.

The community of Wabaseemong has a history of wild rice harvesting and recently efforts have been made to improve wild rice harvests and perpetuate the practice of harvesting in the community (Kuzivanova, 2015). M. Lee works for the Wabaseemong Independent Nations as the Resource Information Officer, he has been involved with the wild rice restoration project, and harvests wild rice himself. As part of wild rice restoration and maintenance, M. Lee believes that wild rice harvesting may benefit from prescribed fire, by removing cattails that grow amongst the wild rice plants (Interview, Mar. 23, 2017). According to G. Ignace, a community member and OMNRF Community Fire Officer, prescribed fire has been used in the past for wild rice management (G. Ignace, interview, Apr. 4, 2017).

There is historical evidence of communities using wildfire in northwestern Ontario to promote blueberry production (Davidson-Hunt, 2003a); however, the community members interviewed for this research had never personally experienced this practice. The practice of blueberry picking after wildfires has also been documented in indigenous communities in

northwestern Ontario, blueberries being a plant species adapted to wildfire that thrives post-burn and an important plant for indigenous harvesters (Davidson-Hunt, 2003b). T. Henry (Interview, Apr. 5, 2017) and M. Lee (Interview, Mar. 23, 2017) both spoke of hearing about the practice of burning for blueberry production or picking blueberries in areas that a wildfire had recently burned. V. Quewezane (Interview, Apr. 5, 2017) remembered blueberry picking as a child in areas where wildfire had recently occurred. The practice of harvesting blueberries and the historical precedent of burning for blueberries in the area provides a potential direction for the use prescribed burning in the future.

Lastly, Giant Hogwort (Heracleum *mantegazzianum*) is an invasive plant that has been spreading in southern and central Ontario, the plant grows in ditches, along roadsides and streams; Giant Hogwort has sap that is toxic to touch and potentially causes blindness if it contacts a person's eyes ("Giant Hogweed," 2012). Without having definitively identified the plants, there is a concern that these plants may have been seen following the implementation of the hazard reduction burn, which raised a concern about the possibility of the prescribed burn promoting the growth of an unwanted plant.

4.3.1c Consultation and Capacity Building

The following table contains the themes related to *consultation and capacity building*. Capacity building refers to the building of skills, networks, knowledge, and equipment necessary for the community to respond to wildfires and perform prescribed burns themselves. Regarding consultation, community members were most concerned about learning about the prescribed burns, being better informed about them as well as having a stronger educational component that worked in conjunction with the prescribed burn program.

Table 6: WIN PB: Community Consultation and Capacity Building

Themes: Relationship and Capacity Building	Description
Communication of PB timing with the community	• "I think that information [should be given] to the community members, letting them know where the fires will be happening. It gives us the knowledge and the awareness to prepare for it, knowing that we will be safe with it. I think precautions, in anything in life, it's really important so that we can respond appropriately and respectfully" (D. Cameron, interview, Apr. 5, 2017).
Dissemination of PB Results	• "I would like to see the results of the PB. I know you don't get the results until a few years down the road, [but] I would like to see that" (J. and L. Cameron, interview, Apr. 5, 2017).
PB and wildfire education	• "Education for high school about the importance of PB or a community session" (R. Carpenter, interview, Apr. 4, 2017). • "Simply, there is no education in that area. The whole community has to be involved in it, coming from our leadership, our chief and council. It's my job to try to educate them, sometimes it's really tough, no one wants to come out… It all comes down to education, we have to educate our people, because they think that if your house burns down you're going to get another one, it doesn't work that way" (H. Carpenter, interview, Apr. 5, 2017).
Local crew training	• "I wish someday that we do get a few more crews trained and possibly, to the MNR standards, where we can look after this ourselves come spring time…we'd be able to handle this and basically free the hands of people in Kenora in regards to where they can call their crews to fires where they are required. Because there are a lot of spring fires in Kenora in the spring months. One of these years, we'll have enough trained people here to look after this themselves, they do all that and have all the support they need in regards to water tanks and fire trucks in the town. This is what we are striving for, this is what this is all about…We have a lot of ex-firefighters out of Whitedog, a number of people who have fought fires over the years who just no longer do it" (G. Ignace, interview, Apr. 4, 2017).
Community participation in PBs	• "I think it should be more 50/50… Somebody should be hired to watch over the graves when they do the prescribed burning… if there was some kind of arrangement being done with the families, so if a family member stands by the relative's grave, when the PB is done, that person only watches over their grave, so the grave doesn't burn. That's what I'm recommending, contact a family member or somebody knowledgeable to stand by the graves" (L. Fisher, interview, Apr. 4, 2017).

The first theme in *consultation and capacity building* is *communication of the PB timing with the community*. Interview participants voiced their desire to have more advanced notice of where and when the prescribed burn was taking place. Advanced notification would allow them

to prepare for the burns, which would increase their sense of safety. Participants also felt that the OMNRF, being the agency that plans and implements the prescribed burns, should be the source of the prescribed burn timing notifications and other data. The second theme, *dissemination of PB results*, is similar in that community members would like to hear, from the OMNRF, what the burns have achieved.

The grass fires in Wabaseemong are often the result of intentional ignition; interview participants identified both children and adults as the sources of intentional ignition fires, although the source of the wildfires was most often attributed to children.

> Every year, every spring time they make spring fires, the adults, the kids, sometimes they're unsupervised. And then for the meantime, the past couple of years have been the worst. If you park your car, if you ditch your car on the reserve, they will torch it, something like that, they will burn it (J. and L. Cameron, interview, Apr. 5, 2017).

As for the motivation behind the child-caused fires, most interview participants could not identify the reason for them; however, some speculated that learning from their parent's actions was one possible cause, another was the children's desire to see the water bombers fly over their community. The deeper causes of these fires and the motivations behind them may stem from broader social or cultural issues, outside the scope of this study.

C. Carpenter, a wildland firefighter who lives in Whitedog, described the experience of an acquaintance of his, "I happen to know the lad who sparked that fire off, is was intentional, he just wanted to see what would happen. He didn't think it was going to go all the way up." After this episode, C. Carpenter's acquaintance eventually became a firefighter himself, "He's also a firefighter now too, so he has a whole new appreciation for fire." According to C. Carpenter, one of the main reasons for the prevalence of grass fires in Wabaseemong is a lack

of understanding how a fire behaves, “people don’t realize that sparking a fire going up a hill takes of quick.” (C. Carpenter, interview, Apr. 5, 2017).

In addition to intentional ignition fire, local prescribed burns, fires lit by residents to burn the grass in their yards, have also been a source of out of control wildfire. D. Scott relates a situation where a neighbour’s grass fire got out of control:

> There was one guy, this house, last year he was cleaning up his yard and he made a grass fire, he has tall grass here the same problem, he almost lit his house on fire. It was on a Friday, us firefighters, we heard that he almost burnt his house down (D. Scott, interview, Apr. 5, 2017).

Based on these observations, interview participants felt that an education campaign was necessary, in conjunction with the prescribed burn program, to address the causes of the wildfires in the community. Participants felt that educating the community about the prescribed burn program could also include education about the risks and impacts of wildfire.

The fourth theme in this section is *local crew training*; in the past, Wabaseemong has had its own wildfire suppression crew and currently the OMNRF is working with the community to train and develop a support program for a community wildfire suppression crew (Ontario Ministry of Natural Resources, 2016). There is wildfire suppression experience and knowledge in the community of Wabaseemong; community members have worked as wildland firefighters at the AFFES in Kenora and wildland firefighting has become a tradition in some families throughout generations. Based on the knowledge and experience of wildfire suppression within the community, the capacity for local wildfire suppression crews is high. Community members expressed the desire to have the capabilities within their community to deal with the fires there themselves. Some interview participants believed that the fires within the community were their own responsibility and that the AFFES should not have its resources tied up fighting fires

within Wabaseemong. The idea also emerged that local crews would have better knowledge of the details and layout of the community and its surrounding. The availability and experience of potential firefighters in the community, combined with the advantages that local crews may have, make local crew training a significant value worth considering for community capacity building.

Community participation in the PBs is a concept that involves community members other than the local wildfire crews. According to L. Fisher (Interview, Apr. 4, 2017), one possible way in which community members could participate in the hazard reduction burns is by supervising the areas that they are concerned with while crews ignite and manage the fires. The example L. Fisher gives is the Whitedog gravesite, where community members could watch over and tend to the graves that they are concerned about, thereby allowing for the gravesite to have the wildfire hazard mitigated, while ensuring that those who care most about the graves are managing them.

4.3.2 Values: Operational Values

OMNRF fire personnel involved in the planning and implementation of the Wabaseemong prescribed burns were interviewed to determine what values influenced the planning and implementation of the burns around Whitedog. The themes that emerged from these interviews were grouped into two sub-categories:

- Operational Objectives
- Safe Implementation

4.3.2a Operational Objectives

This section looks at the outcomes that the OMNRF aims to achieve through its hazard reduction prescribed burn program. Operational objectives had either direct relationships, or immediate benefits, with the PB program, such as the removal of wildfire hazards, or they had indirect, or long-term benefits, such as the building of relationships within the community.

Hazard reduction is the first and most obvious value that the OMNRF has towards the WIN PB program. The purpose of the prescribed burn is, as one of the primary planners of the WIN PB points out, "to reduce the spring fire hazard associated with the yearly buildup of the grass fields and the travel corridors, areas adjacent to the community itself, people's homes, values, and other infrastructure." (J. Mash, interview, Feb. 24, 2017). Based on the primary material in question, O1A (dry grass), and its yearly recurrence as a fire hazard, the WIN PB's main value is in the removal and reduction of that fuel source and the subsequent community safety that results.

Another impetus for the WIN PB is cost; it is expensive for the OMNRF to fight numerous fires in and around Wabaseemong so a cost analysis was done to determine whether the cost of a yearly PB program would be less than the cost of wildfire suppression efforts. According to P. Harvey (Interview, Feb. 28, 2017), a Fire Management Supervisor for the OMNRF, the WIN PB program is estimated to be one quarter of the cost of wildfire suppression efforts in WIN. In addition, *cost effectiveness* is an important value that influences the ongoing implementation of the WIN PBs; keeping PB costs low is an important value for the OMNRF.

Table 7: WIN PB: Operational Objectives

Themes: Operational Objective	Description
Hazard Reduction	• "The purpose of the Wabaseemong PB was to reduce the spring fire hazard associated with the yearly buildup of the grass fields and the travel corridors, areas adjacent to the community itself, people's homes, values, and other infrastructure" (J. Mash, interview, Feb. 24, 2017). • "We are trying to eliminate some of our spring issues and grass fires up that way" (D. Mclean, interview, Mar. 29, 2017).
Cost Effectiveness	• "We also try to be cost effective, which is another constraint" (J. Mash, interview, Feb. 24, 2017). • "At the same time, I did a lot of work with my boss and the district manager, we wanted to do something different to reduce cost. Fighting all of these fires up in Wabaseemong is expensive… we did a lot of work doing research looking at how many fires we had been to over the last 10 years, how much did that cost on an average basis, what's our PB program forecast to cost to burn over the same kind of area, so we are looking at a quarter of the cost or less, depending on the season, to get rid of the same hazard under well-defined parameters" (P. Harvey, interview, Feb. 28, 2017).
OMNRF Skill Development and Training	• "It [the PB program] provides our staff with excellent opportunities to utilize their training through a hands on, operational level exercise. It definitely builds our own capacity and our own confidence level with our staff. That's a huge benefit to our fire program" (J. Mash, interview, Feb. 24, 2017).
Increased PB efficacy	• "As we are getting more comfortable burning up there, seeing how two ignition crews work this year, having a more open burn window to work with this year to work with, see if that makes it more successful. It would be really nice if we could burn everything off before the end of the burn window, before it's too late" (P. Harvey, interview, Feb. 28, 2017).
WIN Fire Crew Capacity Building	• "I am looking at this as being a very long term project where at the end of it we are going to be able to turn this program over to the community and let them do their burning and they can plan it out and let us review the plan and let us know when they are going to burn, kind of like what we do with slash pile burning with the forestry guys. So, part of this whole thing involves building capacity within the community…" (P. Harvey, interview, Feb. 28, 2017).
Relationship Building	• "There's a lot more to it than just going up and just burning everything and just walking away. We try to maintain good communications, good relationship building, that type of stuff that the local community" (D. Mclean, interview, Mar. 29, 2017). • "Some of the other positive impacts involved with this have been the relationships that we have built between the Fire Program and the Ontario MNR and the community; it kind of acted as a catalyst for other projects" (J. Mash, interview, Feb. 24, 2017).

One of the indirect benefits of the WIN PB for the OMNRF is the skill development and training the program provides for wildfire suppression crews. Wildfire suppression crews that participate in the WIN PB have the opportunity to experience how fire behaves and practice hand ignition techniques that can be used in fire suppression scenarios. According to the OMNRF interview participants, the hands-on experience and ignition practice that the WIN PB provides fire crews is a valuable asset to the OMNRF. As a result, wildfire crews are cycled through the WIN PB program to provide for as many crews as possible an opportunity to participate and benefit from the experience.

With the skill development and training that the WIN PBs provide, there follows an increase in the efficacy of implementation of the PBs. As PB planners and crews gain experience in conducting PBs in Wabaseemong, they get more efficient and effective at attaining the primary goal of the PBs, the removal of hazard fuels. Efficacy is especially important given the narrow window of conditions in which the PBs can be implemented.

Another indirect benefit of the WIN PB program is the opportunity it provides for local crews to gain training and experience by participating in the hazard reduction burns. As P. Harvey explains, the long-term goal of the WIN PB program is to eventually turn over the responsibility of the prescribed burn program over to the community, with the OMNRF playing a supervisory and planning role (Interview, Feb. 28, 2017). The training opportunities that the WIN PB provides meshes well with the community's desire for capacity building and the wildfire experience prevalent within the community.

Lastly, the OMNRF hopes that the PB program will lead to stronger relationships built between the OMNRF and the community of Wabaseemong. OMNRF staff recognize that

including the community in as many aspects as possible in the planning, design, and implementation of the prescribed burns is important criteria to follow in order to achieve the best outcomes.

Without the partnership of the community, the OMNRF participants recognize that the effectiveness of their programs will be greatly reduced. Relationship building provides opportunities for developing other projects in the community that the OMNRF would like to eventually pursue, such as a community Firesmart program. The inclusion of traditional ceremonies, the use of community information networks, wildfire education, and celebrations of community-OMNRF successes have been some of the ways that the OMNRF has tried to build stronger relationships with the community through the WIN PB program.

4.3.2b Safe Implementation

The second sub-category in the *operational values* is *safe implementation*; the OMNRF participants identified safety as a value not only as an outcome of the hazard reduction burn, but also as a value in the implementation of the prescribed burn itself. Three themes or safety concerns relating to the safe implementation of the hazard reduction burns were brought up by OMNRF interview participants: Grass fire, smoke, and PB control. It may seem obvious that safe implementation is a value in a hazard reduction burn, but including this value category offers insight into other value factors, other than objectives, that influence planning and implementation of the WIN PBs.

The first safety concern is *grass fires*, which is in reference to the danger presented by the fast moving, volatile characteristics of grass fire. Consequently, precautions are taken by the OMNRF fire crews by following strict safety guidelines.

Table 8: WIN PB: Safe Implementation

Themes: Safety Concern	Description
Grass Fire	• "The lite fuel types are ones that, ironically, we don't take lightly, those are the ones that we recognize as being a threat to fire fighter safety and community safety… Usually it is the flashy fuels that have affected people's safety. You get fairly significant fire behavior and the flame fronts are fast moving" (J. Mash, interview, Feb. 24, 2017).
Smoke	• "As well, we didn't want to put people at risk with smoke issues or burning people's personal property…We take advantage of advantageous winds, so when we burn we don't have any smoke negatively impacting anybody's community or road networks or causing a risk to the highway network up there" (J. Mash, interview, Feb. 24, 2017). • "There are challenges such as garbage and stuff that's out there that may be hidden in the grass itself so people have to be careful to keep the smoke in front of them, not being too far into the smoke, especially in certain areas where there might be more garbage than you want" (D. Mclean, interview, Mar. 29, 2017).
PB Control	• "Drip torch, exclusively drip torch. We find we have really excellent control with the fire behavior that we are looking at, the best tool to use for safety and what not... We closely monitor each block too, the low complexity burn boss and the ignition boss will be talking continuously with the suppression boss to make sure that they're comfortable with the amount of fire that's laid down at any given time and that nothing is going to get away on them, because we definitely don't want anything to get out of the bag on us, to be a threat to the community because that was one of the things that would shut down the program very quickly" (J. Mash, interview, Feb. 24, 2017).

One of those precautions is the firefighting guidelines LACES, an acronym for *lookouts, anchor points, communications, escape routes, and safety zones* (J. Mash, interview, Jan 18, 2017). These guidelines mean that someone is always monitoring the fire, the work that is started on the fire begins at a safe spot that the fire is unlikely to burn out or around, all crew members

are linked by effective communication, there are routes that firefighters can take back to safety if the situation deteriorates, and there are accessible zones where firefighters can find safety.

Smoke as safety concern applies to firefighters as well as community members. When conducting the prescribed burns, consideration is given to wind direction so that smoke does not have negative impact on the community or road networks (J. Mash, interview, Feb. 24, 2017). An additional safety concern is added by smoke from burning garbage that is embedded in the grass, this smoke is more toxic than grass smoke and makes it difficult for firefighters to conduct prescribed burns in areas with a high concentration of garbage.

Lastly, the firefighters conducting the prescribed burns must keep the fire under control. To accomplish this, the fire crews use hand held drip torches as their means of ignition, which allows a high level of control over how much fire is applied to an area as well as the application of fire in carefully planned patterns.

4.4 WIN PB Techniques

This section looks at *the techniques* design element, which encompasses the planning and ignition techniques that OMNRF PB planners and firefighting personnel used in implementing the WIN PBs. Based on the themes that emerged from interviews with operational personnel, the techniques section has been divided into three sub-categories: *OMNRF PB guidelines*, *ignition methods*, and *prescription*. The *techniques* section only includes operational considerations, because the implementation of the prescribed burns is solely within the jurisdiction of the OMNRF.

4.4.1 Techniques: OMNRF PB Guidelines

OMNRF prescribed burn guidelines can be found in the OMNRF *Prescribed Burn Manual* (Ontario Ministry of Natural Resources, 2014a). This manual lays out the legislations and policies that govern the use, planning, and application of prescribed burns in Ontario. The *Forest Fires Prevention Act* (*Forest Fires Prevention Act*, 1990) indicates that any fire outside a set of parameters (piles of material to be burned less than two meters in diameter and height, fires less than two meters from other flammable sources, total area burned is less than one hectare in size, and etc.) must have a prescribed burn plan. Prescribed burn plans are classified as either high complexity or low complexity and have accompanying guidelines. The OMNRF *Prescribed Burn Manual* lays out how a prescribed burn's complexity is determined*:*

> The complexity key is used to determine whether a burn project is classified as high or low complexity. The planning detail required in the preparation of a prescribed burn plan considers: the duration of the burn; burn objectives; project size; resource requirements; ignition type; potential for social disruption; negative environmental values and fire escape. (Ontario Ministry of Natural Resources, 2014a)

A complexity assessment is conducted for every prescribed burn plan and, given certain parameters related to the prescription, the prescribed burn is rated high or low complexity. Low complexity prescribed burns must follow the OMNRF's *Low Complexity Prescribed Burn Template*, while high complexity burns must be developed according to the *Guide for High Complexity Prescribed Burn Planning*. Prescribed burn planning and approval must follow a schedule that outlines the time-line for the entire process, this allows for the appropriate amount of time given to address concerns, review, and approve the plan well before implementation (Ontario Ministry of Natural Resources, 2014a).

OMNRF prescribed burn policy requires a prescribed burn application and plan before approval is given to begin ignition. The prescribed burn application contains a complexity site description (map, topography, fuel description, and values), objectives, timing of the burn, desired results, treatable area, acceptable impacts outside of the treatment area, and complexity assessment. Approval of the prescribed burn application leads to the prescribed burn plan, these plans "define the logistical and tactical requirements to ignite, control and carry out the burn safely while meeting the objectives of the burn. Prescribed burn plans state the objectives of the burn, describe thought processes for planning the burn, provide operational requirements for conducting the burn, assign responsibility, and serve as documentation for review purposes." (Ontario Ministry of Natural Resources, 2014a). Prescribed burn plans contain the following components:

- Detailed fuel description
- Boundary assessment
- Values
- Fire prescription
- Fire behaviour predictions
- Fire behaviour observations
- Weather
- Personnel
- On-site visitor protocol
- Maps
- Records/Documentation of the burn
- Internal communications plan
- Ignition plan
- Suppression/operations
- Problematic control
- Suppression outside the treatment area
- Fire assessment report
- Declaration of a wildfire
- Logistics
- Cost estimates
- Safety plan
- External communications
- Problematic control
- Notification

Detailed instructions of how to conduct these assessments and prepare prescribed burn plans are available in the OMNRF's *PB Toolbox.*

4.4.2 Techniques: Ignition Methods

Ignition methods covers the tools and procedures used in the field, as the prescribed burn is being lit and managed.

A drip torch is a cylindrical metal canister with a spiraled spout on the top and a wick on the end and is used by OMNRF crews for igniting the prescribed fires in Wabaseemong. The canister holds fuel, typically a blend of gasoline or diesel, and oil, mixed in a ratio that provides ease of ignition and longer burning time. The wick on the end of the spout remains lit during the prescribed burn; as the canister is tilted the fuel passes by the wick, ignites, and splashes onto the ignition target (ground vegetation). According to the OMNRF, the drip torch is used exclusively by the ignition crews for its ease of controlling the amount of fire applied to the landscape and therefore it allows better control of fire behaviour. The drip torch allows for the safe and efficient application of fire.

Photo 4: Driptorch. Source: (Kurtis Ulrich)

Control lines are barriers in the landscape such as roads, water, wet swamps, previously burned areas, or forest with snow still under the canopy; these areas are not conducive to burning or carrying fire, so ignition crews start their burns along the edges of these barriers. Fires are lit along control lines with the wind pushing the fire into the control line, then strips

Table 9: WIN PB: Ignition Methods

Themes: Ignition Methods	Description
Drip Torch	• "These PBs are strictly hand ignition. We use the hand-held drip torches and there are different methods" (D. Mclean, interview, Mar. 29, 2017).
Control Lines	• "When we built all of the compartments, we planned out some good control lines: roads, water with swamps with the grass, or adjacent blocks if they are burnt off become a good one with a blackened edge. The areas that are picked out for the PB have pretty good control lines around them. Because of the prescription with snow in the bush, that's a pretty good control line too, for burning with a surface fire" (P. Harvey, interview, Feb. 28, 2017).
Wet Lines	• "You can basically go up to the tree line and light there and another guy will come along with a backpack pump and just put it out and meanwhile it will back down into the ditch and into the road… We can put down wet lines as well and we can burn from them." (D. Mclean, interview, Mar. 29, 2017).
Tandem Ignition pattern	• "Say if you had a ten-hectare field and the wind was coming out of the south, so basically you would go up to the north and you would start making the lines, whether your lines are 50 feet apart, and you would start burning. You would have one group walking, laying out a line and you would have another group coming up behind them. A tandem type ignition pattern. It takes great coordination" (D. Mclean, interview, Mar. 29, 2017).
Second Ignition Crew	• "We've had two years under our belts and we are getting comfortable within the district office and the region and they are not so leery, so [we added] a second ignition crew and [that way] we can up our production of areas burned and we won't be so under the gun with the clock" (P. Harvey, interview, Feb. 28, 2017).
Suppression Crews on Standby	• "What happens is, we have our small team, consisting of one or two ignition crews and those are three person each. Those are supported by a number of type 1 and type 2 suppression crews… Normally we have a fire engine, one of our wildland fire engines, immediately on scene as well in the event that we do have an escaped fire we'll have a little bit more horsepower there to put out any excursions that do take place" (J. Mash, interview, Feb. 24, 2017).
Slow PB Ignition Process	• "The Key to any ignition operation is to start really slow. When we start off in the spring, our crews are coming back, so they are just getting back into it. So, you have to start slow and build off of that, let people get confident. You don't want to put a lot of fire on the landscape right off the bat because you will surprise people and you might run into problems with the pumps and what not" (J. Mash, interview, Feb. 24, 2017).
Around the Gravesites	• "We do a boundary around the gravesite itself and then back-burn. We leave the grass inside the core area [of] the graveyard, because we don't want to [torch] anything off in regards to flowers or anything else that might be on the graves. If there was anything to be done with that, it would have to be with the band itself, who go in there with whatever, snippers and everything and take things down. We do the outside boundary area to eliminate that problem. We look after that" (G. Ignace, interview, Apr. 4, 2017).

are successively burned back from the control line and previous burns; in this way, the control line is continuously widened, the fire is never able to build up a lot of momentum, and fire behaviour is kept at a low level.

Wet lines are control lines that the ignition and suppression crews create when no existing control lines are available. This might occur next to hydro poles or in grassy fields that do not have a control line with the necessary wind direction. Wet lines are created by using ignition crews and suppression crews simultaneously. An ignition crew will begin lighting a line of fire with drip torches and allowing the fire to burn a narrow strip. Before the fire is able to get too big or move to fast, a suppression crew, following behind the ignition crew, will extinguish the line of fire with back pack pumps and hand tools. The resulting strip of burned and extinguished grass will provide a control line for the next strip of fire.

Tandem ignition patterns are an ignition technique where two ignition crews are lighting fire simultaneously, but in a staggered fashion. The first ignition crew will begin lighting their burn against a control line, the second ignition crew will follow closely behind, letting their fire burn into the recently burned line of the crew in front of them. The tandem ignition pattern allows more area to be burned at once, but requires more ignition crews.

A second ignition crew allows for more complex ignition patterns, such as tandem ignition, and increases the amount of area that the OMNRF can burn while operating in Wabaseemong. As the prescribed burn program in Wabaseemong has progressed and shown success, the addition of a second ignition crew has become an option.

In addition to ignition crews, suppression crews are required for the prescribed burns. Suppression crews consist of four firefighters and a wildland fire engine. These crews monitor

the prescribed burn in the event that the fire gets out of control and needs suppression efforts to keep them from spreading. Suppression crews add additional safety and control measures to the prescribed burn operation.

Safety and control of the prescribed burn is also associated with the speed at which the ignition process takes place. Putting too much fire on the landscape at once can result in surprises, the fire may behave in unexpected ways or crews may not be prepared for a fire that has had a lot of area and fuel ignited in a short time. Therefore, it is important for ignition crews to start slowly and read the reaction of the fire as it is applied (J. Mash, Interview, Feb. 24, 2017).

Lastly, as G. Ignace describes, the OMNRF has a procedure for burning around the perimeter of the Whitedog gravesite. “We do a boundary around the gravesite itself and then back-burn. Although we leave the grass inside the core area, the graveyard, because we don’t want to [torch] anything off in regards to flowers or anything else that might be on the graves.” (G. Ignace, interview, Apr. 4, 2017). The OMNRF has a prescribed burn techniques meant to protect the graveyard by reducing the hazard around the site, but the area amongst the graves is left untreated.

4.4.3 Techniques: Prescription

Prescription refers to the set of conditions that determine whether a prescribed burn will be approved or denied by the OMNRF, these conditions are largely determined by weather conditions. Prescription ensures, on one end, that a prescribed burn will be successful; the target fuels will be in a condition to ignite, burn, and carry fire, therefore removing the hazard. On the other end, prescription sets the upper limit in which prescribed burns are allowed in

Table 10: WIN PB: Prescription

Themes: Prescription	Description
Low fire intensity	• "There are different methods, the biggest thing is not to create a whole lot of intensity out there…You don't want to create a head fire, you don't want to stand on the side of the road with the wind at your back and you drop fire on the ground and you watch this thing rip across the field, it's probably not the smartest thing you could do" (D. Mclean, interview, Mar. 29, 2017).
Indices	• "The fire will die out right at the bush line, the indices are just not there to support it "(G. Ignace, interview, Apr. 4, 2017). • "The indices are usually the driving factor [behind prescription]" (D. Mclean, interview, Mar. 29, 2017).
Wind speed and direction	• "[We want burning conditions] under 20km an hour, anything over than that could carry [fire] into the top of trees, firebrands could carry further, there is a risk of losing containment "(W. Skead, interview, Feb. 7, 2017). • "[Prescription] depends on if it's wind driven, where is the wind coming from" (D. Mclean, interview, Mar. 29, 2017).
Treatment area size	• "All of the blocks within a treatable area are identified ahead of time. They are less than four hectares in size, so they are manageable sections" (J. Mash, interview, Feb. 24, 2017). • "Even though we are talking [about burning] 140 hectares, we are only burning 4 ha chunks at a time. By doing that and by doing it with hand ignition, we are able to make it an easier planning process" (P. Harvey, interview, Feb. 28, 2017).
Time of year	• "Mostly it's the time of year, [that determines when we burn]. There's still snow on the ground at the time of year we start burning. We planned for that so it doesn't go into the bush, because usually the fires get to the bush line and they just go out, because there is so much frost on the ground or snow "(W. Skead, interview, Feb. 7, 2017). • "In the spring time we are really under the gun with the amount [of burning] that we have already taken on. To try to get the area that we have identified done as soon as the snow melts the clock is ticking" (P. Harvey, interview, Feb. 28, 2017).
Larger prescription window	• "This winter, John worked with the PB specialist to come up with new prescriptions where we're going to be able to burn with 30% snow in the bush and some other factors. So, we're going to be able to open our burn window a little bit more. We'll be able to take care a little bit more of the area that we already have treated "(P. Harvey, interview, Feb. 28, 2017). • "This year we changed our prescription to have more of a tiered prescription based on the amount of snow and wind speed, which affects the ISI (Initial Spread Index). With this new tiered system, there is going to be a lot less pressure, because there are only a few days in the spring when we can burn when we are within prescription, when the winds are not too crazy and the smoke impacts are not going to negatively impact the community or the fire is going to create safety issues with the community" (J. Mash, interview, Feb. 24, 2017).

order to keep the burn manageable and under control; within these conditions, the fire behavior is calculated to be within the range of ignition and suppression crew control.

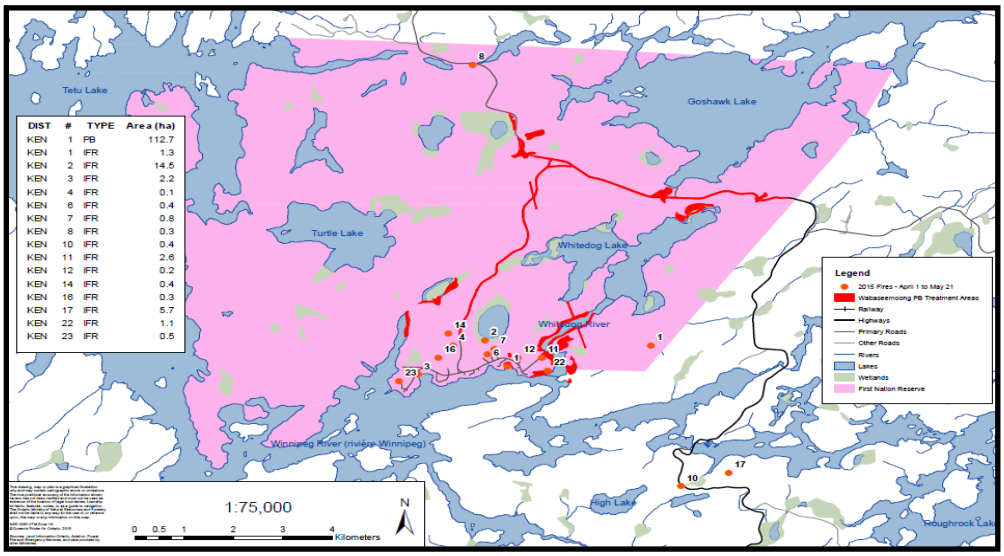
Fire intensity is a complex concept in wildfire science, but here it refers to flame lengths and energy output of a fire, representing the radiant and convective energy of a forest fire, which gives an indication of how a fire will spread (Alexander, 1982; Keeley, 2009). Maintaining a low fire intensity, in order to control a fire and keep it within control lines, is the primary reason for having a prescribed burn prescription. In the table above, the four themes: i*ndices, wind speed and direction, treatment area size,* and *time of year* influence the prescribed burn's intensity. PB specialists plan the burns around these conditions that limit fire intensity and behaviour. Achieving a low fire intensity allows ignition and suppression crews to better control fires that they light and reduces the likelihood of the fire escaping control by throwing sparks (spotting) into areas outside of the treatment area or spreading rapidly (running) beyond a crew's ability to put it out.

As mentioned in the section on *operational material considerations*, *indices* refer to specific weather factors that influence fire fuels, spread rates, and fire behaviour. Prescription is primarily influenced by indices; if indices are in critical values, such as high wind-speed or extremely dry fuel, then prescription will be exceeded and the prescribed burn will not be able to continue.

Wind speed and direction, is a weather factor that indices measure, but it is presented as its own theme because it was mentioned specifically by OMNRF staff and plays a primary role in determining if weather conditions will put a prescribed burn within or outside of prescription. During a prescribed burn, wind is necessary for pushing the fire. Wind spreads a

prescribed fire and in this way the fire is able to consume the fuels targeted for removal/combustion. Wind speed that is too low will not allow for enough fire spread and the fire may burn too deeply, while not burning enough of the surface fuels. If the wind speed is too high, the chances of losing control of the fire increases and safety also becomes an issue. The direction of the wind also plays a role as control lines can only be utilized with advantageous winds. Lastly, wind direction and speed influence how smoke might affect crews or nearby homes.

Map 4: WIN PB treatment area. The area marked in red is the treatment area. Source: (OMNRF)



The size of the treatment area (the area scheduled for burning) alters prescription because it encompasses the amount of fuel that will be burned; also, a larger area requires more resources to light, monitor, and suppress if control is lost. The size of the treatment area also acts on prescribed burns complexity (P. Harvey, Interview, Feb. 28, 2017). As described above, high and low complexity prescribed burns require different planning protocols; a high complexity burn requires more stringent planning guidelines and makes the process for approval and ignition more difficult. By keeping the PB low complexity, the OMNRF increases

the likelihood that a burn will be approved and implemented successfully. Instead of burning large blocks at one time, making the PB high complexity, OMNRF planners divided the treatment area into four hectare blocks, thus keeping the PB low complexity.

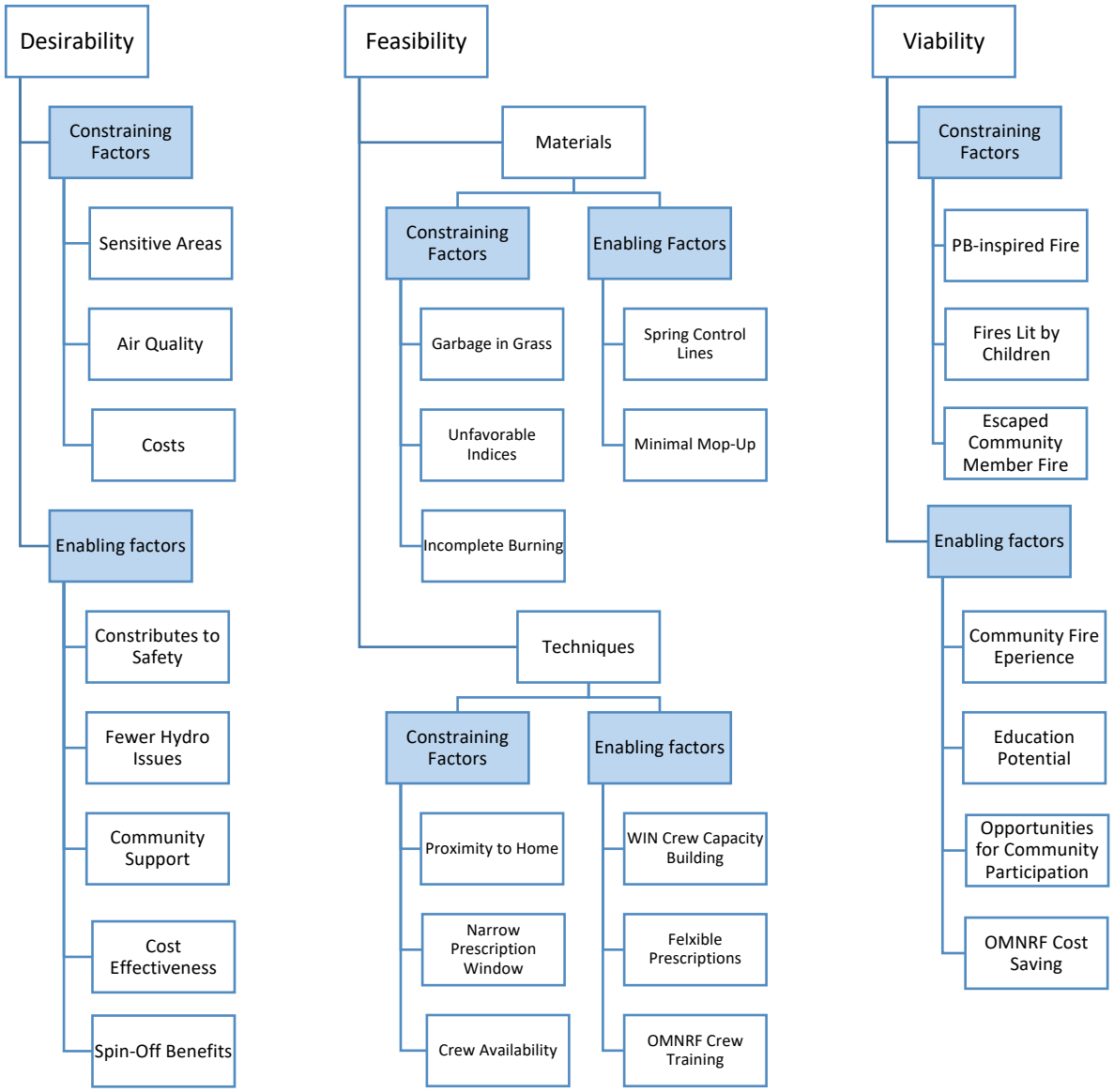
The time of year plays a role in prescription due to the amount of snow or moisture available. Early spring is an effective time to conduct prescribed burns because there is still snow under the shade of the forest canopy. This snow acts as a control line and prevents fire from spreading into forested areas and into the crowns of trees. The weather window in the spring is narrow; the prescription requires that the grass be dry enough to ignite and carry fire, which requires warm and drying weather, but this weather also speeds the process of snow melt under the canopy of the forest. OMNRF crews must be able to get to the treatment areas and burn them before the forest dries out and moves the PB out of prescription.

The narrow prescription window for PBs in the spring makes it difficult for PB planners and crews to meet the objectives of the hazard reduction burn, there are few days when weather conditions make burning possible while control conditions, such as snow under the forest canopy, remain. To address this difficulty, OMNRF planners have applied for more flexible prescriptions that allow for a greater range of action, increasing the amount of days in which they can burn while maintaining the safety and control standards of the *Prescribed Burn Manual*. OMNRF planners have been able to justify a more flexible prescription by using the lessons and experience they have gained by conducting the Wabaseemong PB since 2014.

4.5 WIN PB: Evaluative Design Elements

The following sections cover the evaluative design elements related to the WIN PB. As shown below in figure 7, the evaluative design elements have been arranged according to their desirability, feasibility, and viability. The sub-categories of these elements arrange themes that emerged from interviews into enabling or constraining factors.

Figure 8: WIN PB: Evaluative Design Elements



4.6 WIN PB Desirability

Desirability is the first evaluative design element considered for the Wabaseemong prescribed burn program. This section will look at the enabling and constraining factors that influence the desirability of prescribed burns. The themes that compose the enabling and constraining factors of desirability are primarily derived from the *values* descriptive design element along with other specific themes that emerged from interviews. Themes that influence desirability are shown in right hand column in the tables below.

Table 11: WIN PB: Desirability

Constraining Factors	Description	Related Themes
Sensitive Areas	• "The people of Whitedog, their main concern is the graveyard area, they want that approached properly and burned out properly, because all of their loved ones are there. There are a few gravestones in there, but the majority are crosses, people want to know where their loved ones are" (G. Ignace, interview, Apr. 4, 2017).	- Homes - Gravesites - Traditional Areas - Wild Rice - Medicines - Giant Hogwort
Air Quality (smoke)	• "The smoke does get thick at times, even when you're trying to close your windows, you can still smell the smoke inside your house. Last summer that happened when they set a fire up where we live and that wind was carrying all that smoke towards where we were living. I have grandkids and I don't like my grandkids having to breath that in. It was kind of concerning, healthwise" (J. Land, interview, Apr. 4, 2017).	- Air Quality - Smoke
Costs	• "We also try to be cost effective, which is another constraint. It's not a constraint, per se, but it's something we keep in mind, to keep the costs down" (J. Mash, interview, Feb. 24, 2017).	- Cost-Effectiveness

The first constraining factor in the desirability design element is *sensitive areas*. *Sensitive areas* encompass the homes, gravesites, and traditional areas in and around Wabasemong as well as the plant gathering areas where wild rice and medicinal plants are

harvested. This category is called *sensitive areas*, because these are the places that community members identified as being potentially at risk from prescribed fire in the community.

Table 12: WIN PB: Desirability (Continued)

Enabling Factors	Description	Related Themes
Contributions to Safety	• "There was an immediate positive impact in terms of providing community safety, creating fire safe areas. In the spring time we burned the largest tracts of grass fuels on the travel corridors going into the community as well as some of the large fire receptive swamps and open fields and along power line infrastructure. When you do that you provide safety, burning under controlled conditions, there is less of a chance of a resident or a community member or someone else starting a fire and that fire getting away on them, causing a forest fire, which would be a direct threat to the community" (J. Mash, interview, Feb. 24, 2017).	- Homes - Safety - Communication of PB Timing and Results - PB and Wildfire Education - Local Crew Training - Hazard Reduction
Fewer Hydro Issues	• "[Prescribed burning] also means that there have been fewer power outages in the community due to down power lines. It's more anecdotal, we don't have good information on how many power outages have been caused by fires up there, but I suspect that it's a bit of a reduction in that sense" (P. Harvey, interview, Feb. 28, 2017).	- Hydro Poles
Community Support	• "In my opinion, [prescribed burning] is generally thought of as a good thing, because you don't want it to get out of hand, especially with the proper personnel doing it" (H. Carpenter, interview, Apr. 5, 2017 • "I think it's all positive what they do, I think it's better and I think it's about time that they've done it and I'm glad" (V. Quewezane, interview, Apr. 5, 2017).	- Safety - Community Participation in PBs
Cost-Effectiveness	• "Fighting all of these fires up in Wabaseemong is expensive … so we are looking at a quarter of the cost or less, depending on the season" (P. Harvey, interview, Feb. 28, 2017).	- Cost-Effectiveness - Increased PB Efficacy
Spin-off Benefits	• "We're trying to re-establish rice in this area and we could burn areas along the edges, because the bulrush reeds, they compete with the rice as they grow cause it takes up ricing areas" (M. Lee, interview, Mar. 23, 2017).	- Wild Rice - Blueberries - Local Crew Training - OMNRF Skill Development and Training - Relationship Building - WIN Fire Crew Capacity Building

What makes these themes constraining factors are the limitations that they put on how and where prescribed fire can be applied. Considering these limitations will play a role in the way community members feel about the PB program and its results.

Air quality is a constraint that community members and OMNRF staff recognize, PBs that are lit in or near the community need to consider wind direction and proximity to homes and roads in order to reduce the impact that smoke will have.

Cost-effectiveness is a constraint for OMNRF planners. One of the main objectives of the Wabaseemong PB program is to reduce fire suppression costs resulting from multiple grass fire suppression actions per year. If the PB program is unable to operate below the costs of suppressing the fires in Wabaseemong, that could potentially become an obstacle for continuation of the program.

The first enabling factor, *contributions to safety*, encompasses the community member perceptions and the OMNRF objectives relating to the PB program results. Community members described feeling safer knowing that the prescribed burns were being conducted and believed that the added benefits of local crew training and education about wildfire and PBs could potentially add to the community's safety from wildfire. M. Lee and H. Carpenter both admitted to feeling safer knowing that trained OMNRF personnel were burning off the grass around the community and thus making it difficult for community members to light intentional wildfires.

In the past Wabaseemong has experienced power outages resulting from burnt hydro poles due to grass fires. The protection of these hydro poles (*fewer hydro issues)* is an added benefit of the prescribed burns.

Community support is an enabling factor that has combined the themes *safety* and *community participation in PBs*, but community support also emerged as its own theme as community members offered their opinion on the PB program in general. Interview participants saw the PB program as a positive thing for their community and wanted to see more hazard reduction burns done in other parts of the community.

The cost-effectiveness of the Wabaseemong PB program is a desirable outcome for the OMNRF; being able to operate in a way that achieves departmental objectives and saves money is one of the goals of the OMNRF and the PB program has shown itself to be one way of doing so. As the program has progressed, the planning and implementation of the PBs has become more efficient; operational staff have gained knowledge about the factors they must consider and ignition staff have developed skills and knowledge related to the application of fire. It is conceivable that the PB program will become more cost-effective as it is developed and refined.

Spin-off benefits are indirect benefits, outside the primary objectives of the hazard reduction burn, that prescribed burning can or does bring to the community of Wabaseemong and the OMNRF. One example of a spin-off benefit for the community is the potential for prescribed burns to be used in conjunction with the reestablishment of wild rice areas. M. Lee, the band Resource Information Officer and a harvester of local wild rice, spoke of the possibilities of using prescribed fire to remove bulrushes, which have begun to outcompete the wild rice plants in some areas, and thus promote the growth of more wild rice (M. Lee, interview, Mar. 23, 2017). A spin-off benefit for the OMNRF is the opportunity that the Wabaseemong prescribed burns offer to fire crews. OMNRF staff J. Mash and P. Harvey both pointed out the additional benefits of the Wabaseemong PB program, in providing hands on

training and experience for firefighters doing hand ignition (J. Mash, interview, Feb. 24, 2017 and P. Harvey, interview, Feb. 28, 2017).

4.7 WIN PB Feasibility

Feasibility is the design element that evaluates what is technically possible, this can refer to the tools and techniques available as well as the capabilities of the organization, agency, or community involved in planning and implementing design solutions. The *feasibility* design element is composed of the descriptive design elements *techniques* and *materials.* The *techniques* design element provides enabling and constraining capabilities of the OMNRF, while the *materials* design element describes how the materials involved in the prescribed burns enable or constrain the effectiveness of those techniques. Along with *materials* and *techniques*, additional themes related to feasibility were identified from the *values* design element. Themes such as *WIN crew capacity building* and *OMNRF crew training* play a role in enabling the feasibility of the Wabaseemong prescribed burns, although they do not fit into the categories of techniques or materials.

4.7.1 Techniques Influencing Feasibility

The theme proximity to homes is a reference to the constraint OMNRF crews have in how close they can conduct prescribed burns to homes and building in the community of Wabaseemong. The inclusion of the areas nearby and adjacent to homes and buildings would add significantly to the treatment area, which J. Mash points out would move the PB into a scale outside the current capabilities of the OMNRF.

Table 13: WIN PB: Techniques Influencing Feasibility

Constraining Factors	Description	Related Themes
Proximity to Homes	• "We didn't go right into the community, immediately adjacent to peoples' homes or structures, because of the scale of that would be too big when we started the project. As well, we didn't want to put people at risk with smoke issues or burning people's personal property, which could be, in this particular fuel type, it could be embedded, like personal belongings in the tall grass; we didn't want to get into that" (J. Mash, interview, Feb. 24, 2017).	- Treatment Area Size
Narrow Prescription Window	• "Last year we were only able to burn 50 percent of the treatable area that was pre-identified and that was because we had an abnormally dry spring and that reduced the amount of snow cover in the bush, which was one of the factors of whether or not we would burn. The burn window basically closed very quickly, the snow sublimated and evaporated really quickly and we were out of prescription" (J. Mash, interview, Feb. 24, 2017).	- Indices - Time or Year
Crew Availability	• "Because [the PB] is in the spring we don't have our full complement of our fire crews and historically we've been burning [as early as] March and the fire crews don't get hired until April. It's kind of a balance, a juggling act, we have to sometimes consider bringing in other technicians to assist with the PB, but when you do that then your costs go way up because you are travelling people across Ontario" (J. Mash, interview, Feb. 24, 2017).	- Second Ignition Crew - Suppression Crews on Standby
Enabling Factors	Description	
WIN Crew Capacity Building	• "I am looking at this as being a very long term project where at the end of it we are going to be able to turn this program over to the community and let them do their burning and they can plan it out and let us review the plan and let us know when they are going to burn… So, part of this whole thing involves building capacity within the community… "(P. Harvey, interview, Feb. 28, 2017).	- Second Ignition Crew - Suppression Crews on Standby - Increased PB Efficacy - WIN Crew Capacity Building - Local Crew Training
Flexible prescriptions	• "This year we changed our prescription to have more of a tiered prescription based on the amount of snow and wind speed, which affects the ISI; it's kind of a tiered system… it will give us a larger window to burn, as well it won't be such a rush because of the weather" (J. Mash, interview, Feb. 24, 2017).	- Larger Prescription Window - Treatment Area Size
OMNRF Crew Training	• "It [the PB program] provides our staff with excellent opportunities to utilize their training through a hands-on, operational level exercise" (J. Mash, interview, Feb. 24, 2017).	- Increased PB Efficacy - Second Ignition Crew - Tandem Ignition Pattern - OMNRF Skill Development and Training

The next barrier to PB feasibility is the prescription that guides the PB plan. A narrow burn window, bounded by receding winter conditions and drying spring conditions, makes it difficult for PB planners to create a plan and get crews up to Wabaseemong in time to implement the burn. Prescriptions are necessary for burns to be implemented successfully, meaning that fuels will be dry enough to burn while maintaining control through adequate control lines, low wind conditions, and a limited availability of easily combustible fuel. Spring is the ideal time of year for the Wabaseemong prescribed burns, because the receding snow remains longer under the forest canopy while the dried and matted grasses from the previous season dry out, this allows for the forest to act as a control line and reduces the likelihood of a fire moving from the grass and into the forest canopy. Spring is also the time of year when grass fires are commonly lit within the community of Wabaseemong, so removing those fuels as they dry also removes the hazard they present when out of control fires occur in the community. However, for safety reasons and ideal burning conditions, prescriptions make burning at this time of year difficult.

Crew availability also plays a role in the feasibility of implementing the prescribed burns. Early spring is when seasonal firefighters are being rehired by the OMNRF and as a result, full crews may not be available when the prescription window for burning opens up. Depending on the year, the snow may be gone by mid-March, which opens the possibility for conducting the prescribed burns, but firefighters are generally hired in April, which means that there may not be enough crew members to light and control the prescribed burns. Wildland firefighters are typically seasonally employed, so finding available firefighters before the typical start date can

be difficult as they may be otherwise employed, travelling, or attending school (J. Mash, interview, Jan 18, 2017).

WIN crew capacity building contributes to the feasibility of the Wabaseemong PBs because the training of local fire crews increases the capabilities of the OMNRF in implementing and controlling the burns. P. Harvey explains that the long-term goal of the Wabaseemong prescribed burn project is to allow local crews to take over the responsibility of implementing the PBs (P. Harvey, interview, Feb. 28, 2017). The addition of WIN fire crews also may address such issues as a lack of OMNRF crew availability, the increased efficiency and safety of extra ignition and suppression crews, as well as the availability of local fire crews in the event that OMNRF crews are needed for fire action elsewhere.

Increasing the flexibility of prescriptions is a project that PB planners J. Mash and P. Harvey have undertaken in order to increase the efficiency and likelihood of success for the yearly prescribed burns. By creating a tiered prescription system specific to the Wabaseemong PBs, OMNRF planners have been able to increase the size of the spring burn window and therefore increase the amount of treatable area burned and the success of removal of fuels in those areas.

The prescribed burns in Wabaseemong offer an opportunity for OMNRF fire crews to train and gain experience in prescribed burn techniques and fire behaviour. These experiences are a benefit to the crews and the OMNRF in other firefighting situations, but they also act as a feedback loop by providing more experienced firefighters for future burns in Wabaseemong. Experienced crew members can also act as trainers for less experienced crew members when conducting prescribed burns. The training that OMNRF fire crews receive while doing the

Wabaseemong prescribed burns increases the OMNRF's capabilities and technical expertise in this field, which contributes to the PBs feasibility.

4.7.2 Materials Influencing Feasibility

The first material factor that constrains feasibility is *garbage in grass*; the OMNRF is limited in the amount of treatable area that they can safely burn due to the presence of garbage embedded in the grass. The OMNRF's main concern is the safety of their fire crews and those community members who may be exposed to the smoke from the garbage burning in the grass. The presence of garbage embedded in the grass in and around the houses of Wabaseemong means that the OMNRF is unable to safely conduct prescribed burns in those areas.

Unfavorable indices are another material factors that can have a constraining influence on prescribed burn feasibility. Indices, being weather conditions, wind speed, relative humidity, and the availability and depth of combustible fuel, all play a role in how likely a fire is to ignite, how quickly it will spread, and how long or deep it will burn. Unfavorable indices limit feasibility by being either too high, which means that lighting a prescribed burn is too risky as it has a high probability of getting out of control, or by being too low, which means that a fire will be too difficult to light and will not burn consistently throughout the treatment area. Indices are a prime factor in determining prescription and can easily push the PB out of prescription as weather changes over the course of days or even hours.

Even when the PB is within prescription, there are factors contextual to the treatment area that affect the complete combustion of the hazard fuels.

Table 14: WIN PB: Materials Influencing Feasibility

Constraining Factors	Description	Related Themes
Garbage in Grass	• "Areas that they want to burn are full of garbage. So, the next big piece of the puzzle that we are working on with the fire crew up there is to start cleaning up some of those areas…"(P. Harvey, interview, Feb. 28, 2017).	- Smoke - Embedded Garbage
Unfavorable Indices	• "In some areas they were able to do some ignition, but they are dealing with cloud cover, they are dealing with higher RHs, the snow melt going on, that's affecting some of their burns, no wind, they're probably getting an intensity class 2, but it's not going anywhere, it's just sort of burning, just creeping; the wind isn't there to help move it along… There is a threshold there with the wind. The indices are usually the driving factor" (D. Mclean, interview, Mar. 29, 2017).	- Indices (weather) - Season - Time of Year - Indices - Wind Speed and Direction
Incomplete Burning	• "Some of the spots we've lit, that we wanted to burn, won't burn because of high moisture, water level, or swampiness. There are patches that just won't go, you'll think it will go because it looks cured, but I guess the ground is saturated more than the rest of the area. On the sides of roads we will light and it will burn, but then it will stop. That is because there is more moisture in the ground there and it kind of goes through and sometimes it just won't support combustion, so you just keep on going. You just light up what you can and there will be unburned patches all along" (W. Skead, interview, Feb. 7, 2017). • "Let's say for example that they burn here, they will burn part of it and leave part of it. So when the dry season comes, the kids will go and burn the rest of it and it will get away from them. I have seen that…" (L. Fisher, interview, Apr. 4, 2017).	- Indices (weather) - Season - Time of Year - Indices

W. Skead, an OMNRF firefighter who has participated in multiple prescribed burns in Wabaseemong, described how wet and swampy areas and moisture in the ground prevented the prescribed fire from burning the entire treatment area (Interview, Feb. 7, 2017). The incomplete burning that results from these conditions leave behind large quantities of unburned fuel, which become sources for ignition once fire crews leave and weather conditions continue to dry out the areas and fuels. Community members identified the areas where

Table 15: WIN PB: Materials Influencing Feasibility (Continued)

Enabling Factors	Description	
Spring control lines	• "Mostly it's the time of year there's still snow on the ground at the time of year we start burning, so we planned for that so it doesn't go into the bush, because usually the fires get to the bush line and out of an open area and they just peter off because there is so much frost on the ground or snow" (W. Skead, interview, Feb. 7, 2017).	- Indices (weather) - Season - Time of Year - Indices
Minimal mop up	• "Because of the time of year, they would pretty much go out, you could tell even during the day time you could start telling when the RH started dropping because fires don't carry anymore and the they start putting themselves out and we just kind of just let it burn where it will burn. We make sure there is no out of control fire before we are leaving like say that it is reaching into the bush line, reaching up into the trees, we won't let that happen… There is still a lot of frozen ground out there, when the RH dips in the afternoon everything just kind of quiets down even the grass won't burn anymore" (W. Skead, interview, Feb. 7, 2017).	- Indices (weather) - Season - Time of Year - Indices

incomplete burning occurred as sources of out-of-control grass fire later in the season and suggested that the OMNRF attempt to re-burn these areas in order to remove the hazard fuels.

Spring control lines are a material factor that enable the prescribed burns in Wabaseemong; the under-canopy snow that persists into the spring provides control lines against which OMNRF crews can burn and thus safely contain their prescribed burns. The existence of spring control lines means that the OMNRF can burn areas that otherwise would fall out of prescription due to the presence of continuous fuels. Early spring is the only time this material condition is available to be utilized by prescribed burners and spring control lines have been factored into the new Wabaseemong PB prescriptions, allowing more flexibility for when and where the OMNRF can light prescribed fires (P. Harvey, interview, Feb. 28, 2017). Spring

control lines are especially useful because warming and drying spring weather, which prepares open grassy areas for ignition, doesn't act as quickly on the snow and moisture under the shade of the forest canopy.

Lastly, the time of year and subsequent moisture and frost remaining in the ground and deeper fuels means that fire burns the surface fuels quickly without burning deeply and becoming persistent sub-surface fires. The lack of deep-burning fire means that crews are required to perform minimal mop-up. Mop up is the task of finding fire that may still be smoldering in large fuels such as logs or in deep fuels such as organic soil, peat, or moss and digging them up and extinguishing them. Mop-up is an essential activity of fire suppression because these slowly burning fires can persist for long periods of time, even surviving through light rain events, and eventually re-emerge during dry, windy conditions to re-start a fire that was thought to be out. Such long-smoldering fires are called hold-overs. As W. Skead relates, spring conditions reduce the likelihood of hold-over fires and reduce the amount of time that suppression crews need to devote to mop-up in order to ensure that the prescribed burn is completely out (Interview, Feb. 7, 2017).

4.8 WIN PB Viability

Viability is the third evaluative design element considered in the biocultural design framework. There are constraining and enabling factors that contribute to the viability of the Wabaseemong PB program, some of these factors have been derived from the descriptive and evaluative design elements and their related themes, which are shown in the right-hand column.

Table 16: WIN PB: Viability

Constraining Factors	Description	Related Themes
PB Inspired Fire	• "But what I didn't like was that it was being copied by the children, so they started their own fires. [Fires are] being copied by the younger generation and they think, because the adults are doing it, why not us? We learn through observation… It is a mimicking exercise… to understand fully and holistically what you are being taught in the language and the culture, so it's natural for the kids to mimic what is happening, what the adults are doing" (D. Cameron, interview, Apr. 5, 2017).	- Proximity to Homes - Narrow Prescription Window - Incomplete Burning - Unfavorable Indices - Garbage in Grass
Fire Lit by Children	• "I just wish that the parents would talk to their little ones, because that's where the fires come from…"(H. Carpenter, interview, Apr. 5, 2017). • "Every year, every spring time [the kids start] spring fires, the kids, sometimes they're unsupervised… about a couple years ago, when I was going home, a parent was showing their child how to burn the grass and leave it. There was actually a parent doing that. And that's almost a whole family that's doing that, and that's a large family that does that and they're teaching their little ones to. They find a large patch of grass that is not even their yard, it's inside the community. That kid was only probably 8 years old and they start doing that and just leaving it" (J. and L. Cameron, interview, Apr. 5, 2017).	- Proximity to Homes - Narrow Prescription Window - Incomplete Burning - Unfavorable Indices - Garbage in Grass
Escaped Community Member Fires	• "I had an experience once, my neighbor had a yard sale and the stuff they didn't sell, they burnt it, so the wind picked up and went into my yard and it burnt my shed down (L. Fisher, interview, Apr. 4, 2017); I've seen instances where fires have gotten away on people. There was just one here this past, I think last year there was a fire, there was grass here and that took off this way and it burnt quite a bit" (M. Lee, interview, Mar. 23, 2017).	- Proximity to Homes - Narrow Prescription Window - Incomplete Burning - Unfavorable Indices - Garbage in Grass

The first constraining factor in viability is *PB inspired fire*, a concept voiced by D. Cameron, a teacher and resident of Whitedog. Cameron's concern is that the presence of fire crews lighting prescribed burns in the community might provide the impetus or inspiration for children to light fires of their own. According to Cameron, the traditional language spoken by local people, Anishinaabe, "is a descriptive language where action is required to understand the

concepts being taught in language." (D. Cameron, interview, Apr. 5, 2017). The way children learn and conceptualize is by acting and doing and this, says Cameron, can lead to an increase in fires lit by children as they mimic the fires they see lit by prescribed burn crews. If the presence of PB inspired fires is not explored and addressed, the viability of the PB program may be limited. The frequency of fires may increase as the presence of prescribed fire increases near the community.

Fires lit by children was another theme that a number of community members brought up; interview participants who mentioned this theme attributed the cause of wildfires in the community to youth or children who were intentionally lighting fires. Interview participants who brought up fires that were being lit by children felt that it was important to address the cause of these community wildfires. Although the aim of the Wabaseemong PB program is to remove the fuel available for ignition, the difficulty in removing all fuels combined with the presence of ignition sources will mean that the goal to reduce the occurrence dangerous wildfire in the community may not be viable.

The final factor constraining PB viability is escaped community member fires. Residents in Wabaseemong often conduct their own PBs in order to clean up the dead grass around their homes and reduce the risk of a fire being ignited in their yard or coming into their yard from elsewhere. One source of wildfire in the community, according to interview participants, was local prescribed fires that had escaped control of the person who had lit it. Protecting their homes and properties from this type of escaped fire was one of the reasons some community members cited for conducting their own prescribed burns. L. Fisher describes when a neighbor's fire escaped and burnt down his shed (Interview, Apr. 4, 2017) and M. Lee recalled

seeing fires that had escaped from residents and burnt large areas in the community (Interview, Mar. 23, 2017).

Table 17: WIN PB: Viability (Continued)

Enabling Factors	Description	
Community Fire Experience	• "Some people go around their own yards to protect their homes to protect them from big grass fires, I see people burning grass, it's controlled burning" (M. Lee, interview, Mar. 23, 2017).	- WIN Fire Crew Capacity Building - Local Crew Training
Education Potential	• "Simply, there is no education in that area. Some of these homeowners aren't educated in that area as well, because they don't take their homes seriously. It all comes down to education, we have to educate our people…" (H. Carpenter, interview, Apr. 5, 2017). • "The whole reserve shouldn't be burnt. That's the thing, I think they need to be educated… Our community members need to be re-educated about [fire]. If the MNR comes in and does their workshop or something like that, they need to see or hear, they need to be educated where their boundaries are" (J. and L. Cameron, interview, Apr. 5, 2017).	- PB and Wildfire Education - Garbage in Grass - PB Inspired Fire - Fire Lit by Children - Escaped Community Member Fires - Spin-Off Benefits - Community Support - Relationship Building
Opportunities for Community Participation	• "One of these days, hopefully not far down the road, we will look after this ourselves. We have a lot of ex-firefighters out of Whitedog, a number of people who have fought fires over the years who just no longer do it" (G. Ignace, interview, Apr. 4, 2017). • "On the other hand, we should have some kind of crew on our reserve that handles that situation, instead of wasting resources outside the community" (L. Fisher, interview, Apr. 4, 2017). • "I am looking at this as being a very long term project where at the end of it we are going to be able to turn this program over to the community and let them do their burning and they can plan it out and let us review the plan and let us know when they are going to burn…" (P. Harvey, interview, Feb. 28, 2017).	- Relationship Building - WIN Fire Crew Capacity Building - Local Crew Training - Community Participation in PBs - Community Fire Experience - Gravesites - Traditional Areas - Sensitive Areas - Community Support - Spin-Off Benefits
OMNRF Cost Saving	• "We did a lot of work doing research looking at how many fires we had been to over the last 10 years, how much did that cost on an average basis, what's our PB program forecast to cost to burn over the same kind of area, so we are looking at a quarter of the cost or less, depending on the season, to get rid of the same hazard under well-defined parameters" (P. Harvey, interview, Feb. 28, 2017).	- Cost Effectiveness - Increased Efficacy - OMNRF Skill Development and Training - WIN Crew Capacity Building

Like the fires caused by youth and children, escaped community member fires are a source of ignition in the community and threaten the goals and viability of the Wabaseemong PB program.

The first enabling factor for PB viability is closely related to the discussion on escaped community fire. *Community fire experience* refers to the commonality of fire experience for many residents in Wabaseemong. Whether it is the use of prescribed fire around personal property, yards and homes as related by M. Lee, V. Quewezane, R. Carpenter, L. Fisher, and C. Carpenter, or whether its fire used for traditional purposes such as sweat lodges or campfires, as discussed by J. and L. Cameron, the people of Wabaseemong have had exposure and experience with fire, wild and controlled. This community experience with fire potentially plays a role in the viability of the PB program, as it provides experienced people to participate in planning, take roles local wildfire crews, as well as by making the idea of prescribed fire less of a foreign and misunderstood concept.

Based on the causes of wildfire in the community of Wabaseemong, constraining factors such as garbage in grass, and the values that community members have regarding PBs and wildfire education, there appears to be an opportunity for the current PB program to act as an education opportunity. *Education potential* is the next enabling factor considered. Wabaseemong resident, H. Carpenter felt that education is the key to addressing the causes of wildfire in the community of Wabaseemong, stating that “The whole community has to be involved in it” from the community leaders to community members, everyone should be educated about wildfire risk (H. Carpenter, interview, Apr. 5, 2017). In addition to addressing some of the causes of wildfire in the community, using the Wabaseemong PBs as an

educational opportunity has the potential to achieve operational objectives such as community-OMNRF relationship building as well as spin-off benefits like building community support.

The theme*, opportunities for community participation*, combines the OMNRF operational objectives of WIN fire crew capacity building and relationship building with the community values of *local crew training* and *community participation in PBs*. It is the OMNRF's long-term goals that Wabaseemong fire crews will eventually assume the responsibility for implementing the hazard reduction burns. The fire crew training programs that the OMNRF conducts in Wabaseemong (Type 1 Fire Ranger Training Initiative), along with the inclusion of local firefighters in the hazard reduction burn has already begun the process of including the community in opportunities for participation (Ontario Ministry of Natural Resources, 2016). The community's fire experience, along with the expressed desire for local crew training, compliments these OMNRF's goals.

Further spin-off benefits and community support could also be derived by including community members and fire crews in other ways to help with the hazard reduction burn. For example, using local community members or firefighters to monitor any prescribed burning around the gravesites, would reduce the possibility of unwanted impacts in the area (L. Fisher, interview, Apr. 4, 2017). An arrangement that would include community members who are not trained as firefighters could present obstacles that conflict with the operational values of *safe implementation*, but if burn plan along these lines was pursued it would provide the OMNRF with the opportunity to conduct prescribed burns in risk areas that are also sensitive areas. Sensitive areas within the prescribed burn treatment area, such as gravesites, traditional use areas, and plant gathering areas, could be burned under the observation of community

members and crews, thus achieving the OMNRF goals of *hazard reduction* and *relationship building,* with the added benefits of growing community support through community participation.

Opportunities for community participation contributes to the PB program's viability by creating opportunities for community buy-in, including community resources, and by continuing to build stronger relationships between the community and the OMNRF. Sensitive areas that the OMNRF may have been unable or unwilling to treat with prescribe fire in the past may become treatable, with the inclusion of local crews and local direction, within the scope of the OMNRF's prescription and safe operating procedures. Local crew training and community educational opportunities may also result, which community members value in addressing the source of wildfire in Wabaseemong.

OMNRF cost saving is another important condition of viability, the financial sustainability of the program plays a role in its long-term viability. Currently, the advantage of the Wabaseemong prescribed burn program is that it is estimated to cost the OMNRF a quarter of the expense it would require for suppression efforts to respond to multiple spring grass fires in and around the community. The financial viability of the hazard reduction burns will benefit from the OMNRF skill development and training along with the WIN crew capacity building, as these factors contribute to the efficiency of implementing the prescribed burns and give a greater role to the community, thus potentially reducing the costs for the OMNRF.

4.9 WIN PB Summary and Main Findings

4.9.1 Overview

The tables below give an overview of the descriptive and evaluative design elements and the data related to them that emerged from interviews with OMNRF staff and community members of Wabaseemong Independent Nation. This case study has demonstrated the complexity and diversity of elements that influence the planning, implementation, and outcome of prescribed burns in this community. Given the complexity of the WIN PBs, these design elements and their constituent themes should be taken into consideration when designing future prescribed burns in Wabaseemong First Nation. Exploring and utilizing the themes and elements below has the potential to increase the desirability, feasibility, and viability of future prescribed burn projects in this community.

Descriptive design elements provide a picture of what the current environment looks like for prescribed burning in Wabaseemong. Community members and the OMNRF have different perspectives on what descriptive factors take priority in the prescribed burning environment of the community, which demonstrates the need for collaborative design and the collection and assessment of both community and operational considerations.

Enabling and constraining factors were identified for each of the three evaluative design elements. The presence of these factors indicates opportunities and barriers for the WIN PB project.

For desirability, the constraining factors are those values that limit the potential of the prescribed burns. Certain areas and values need to be considered in order for the PB program to achieve outcomes that the community and OMNRF find meaningful and valuable. On the

other hand, there are enabling factors, those values that support the prescribed burn and demonstrate that there are meaningful outcomes being achieved or there is potential for the PB program to achieve.

The section on feasibility is an overview of the limitations and capabilities that play a role in whether the Wabaseemong prescribed burns are technically possible. The constraining factors limit the feasibility of the prescribed burn program, namely in the extent of treatable area and the timing of the prescribed burns. These are only aspects of the PB program's feasibility, they are limitations, but not factors that make the program unfeasible on the whole. Enabling factors provide some solutions to the constraining factors and demonstrate the feasibility of other aspects of the PB program. Increased crew capabilities adds to the efficiency and effectiveness of the PB, while advantageous prescriptions aid in the planning and implementation of the hazard reduction burns.

Lastly, there are factors that constrain the viability of the Wabaseemong prescribed burn program, namely the continued presence of human-caused wildfire in the community. However, the enabling factors for viability show potential opportunities for addressing these constraining factors. The viability of the Wabaseemong PB program rests on continued funding and cost saving along with the continued inclusion of the community in the planning and implementation of the hazard reduction burns.

Table 18: WIN PB: Descriptive Design Elements Overview

Descriptive Design Elements			
	Materials	Values	Techniques
Community Considerations	Swamps	Homes	
	Shorelines	Hydro Poles	
	Grassy Areas near the School	Evacuation Routes	
	Roadsides	Air Quality (Smoke)	
	Gravesites	Safety	
	Empty Buildings	Gravesites	
	Tall Grass Around Homes	Traditional Areas	
		Medicines	
		Wild Rice	
		Blueberries	
		Giant Hogwort	
		Communication of PB timing with the community	
		Dissemination of PB Results	
		PB and wildfire education	
		Local crew training	
		Community participation in PBs	

Table 19: WIN PB: Descriptive Design Elements Overview (Continued)

	Materials	Values	Techniques
Operational Considerations	Treatable Area	Hazard Reduction	Drip Torch
	O1A (Dried matted grass)	Cost Effectiveness	Control Lines
	Embedded Garbage	OMNRF Skill Development and Training	Wet Lines
	Indices (Weather)	Increased PB efficacy	Tandem Ignition pattern
	Season	WIN Fire Crew Capacity Building	Second Ignition Crew
		Relationship Building	Suppression Crews on Standby
		Grass Fire	Slow PB Ignition Process
		Smoke	Around the Gravesites
		PB Control	Low fire intensity
			Indices
			Wind speed and direction
			Treatment area size
			Time of year
			Larger prescription window

Table 20: WIN PB: Descriptive Design Elements Overview (Continued)

	Materials	Values	Techniques
Grass Properties Contributing to Fire	Spread Potential		
	Accessible Ignition Points		
	Volume/Height		
	Regeneration		
	Proximity to Values		

Table 21: WIN PB: Evaluative Design Elements Overview

Evaluative Design Elements		
Desirability	Enabling Factors	Constraining Factors
	Contributions to Safety	Sensitive Areas
	Fewer Hydro Issues	Air Quality (smoke)
	Community Support	Costs
	Cost-Effectiveness	
	Spin-off Benefits	
Feasibility	Enabling Factors	Constraining Factors
	WIN Crew Capacity Building	Proximity to Homes
	Flexible Prescriptions	Narrow Prescription Window
	OMNRF Crew Training	Crew Availability
	Spring Control Lines	Garbage in Grass
	Minimal Mop-up	Unfavorable Indices
		Incomplete Burning
Viability	Enabling Factors	Constraining Factors
	Community Fire Experience	PB Inspired Fire
	Education Potential	Fire Lit by Children
	Opportunities for Community Participation	Escaped Community Member Fires
	OMNRF Cost Saving	

CHAPTER 5: LOW CASE STUDY

The Lake of the Woods case study explores the prescribed burns that were conducted on islands in the Lake of the Woods Conservation Reserve in 2012, 2013, and 2015 for the Lake of the Woods Conservation Reserve Prescribed Burn Pilot Study. The Lake of the Woods conservation reserve is approximately 45,960 hectares in size and contains over 3,500 islands along with portions of the surrounding mainland (Ontario Ministry of Natural Resources, 2010).

According to the *Lake of the Woods Prescribed Burn Pilot Study* (Ontario Ministry of Natural Resources, 2010), fire has been a dominant natural disturbance in the area since the last ice age and as a result the lifecycles of may plant and animal species is tied to fire. Based on historical fire records and adjacent forest fire cycles, the *Lake of the Woods Prescribed Burn Pilot Study* (Ontario Ministry of Natural Resources, 2010) estimates that 15,980 hectares should have burned within the Conservation Reserve between the years 1960 and 2009; however, fire history data shows that only 220 hectares have burned in this timeframe, a difference of 15,760 hectares. This difference in expected burned area and actual burned area is called the fire deficit. The fire deficit and the desire to reintroduce fire in a manner that recovers and maintains ecological integrity provided the rationale for the *Prescribed Burn Pilot* Study (Ontario Ministry of Natural Resources, 2010). The problem that the *Prescribed Burn Pilot Study* is attempting to address is the general lack of information about fire on Lake of the Woods and the subsequent difficulty of developing well-informed objectives for fire management (Ontario Ministry of Natural Resources, 2010).

The pilot study resulted in the Lake of the Woods Low Complexity Prescribed Burn Program, which was a partnership between the Kenora District Ministry of Natural Resources and

Forestry (OMNRF) office and the Kenora Aviation, Forest Fire, and Emergency Services (AFFES). Over the years of 2012, 2013, and 2015 eleven islands, totalling 21.3 hectares, were burned in the conservation reserve. In the fall of 2012, five islands were burned, totalling 9.7 hectares; three islands were burned by hand ignition crews and two islands were burned by aerial ignition.

Photos 4, 5, and 6: Hand ignition on island 3394 in 2012. Source: (OMNRF)

Photos 7, 8, and 9: Aerial Ignition on island 2954 in 2012. Source: (OMNRF)

In the fall of 2013, two islands were ignited by aerial ignition.

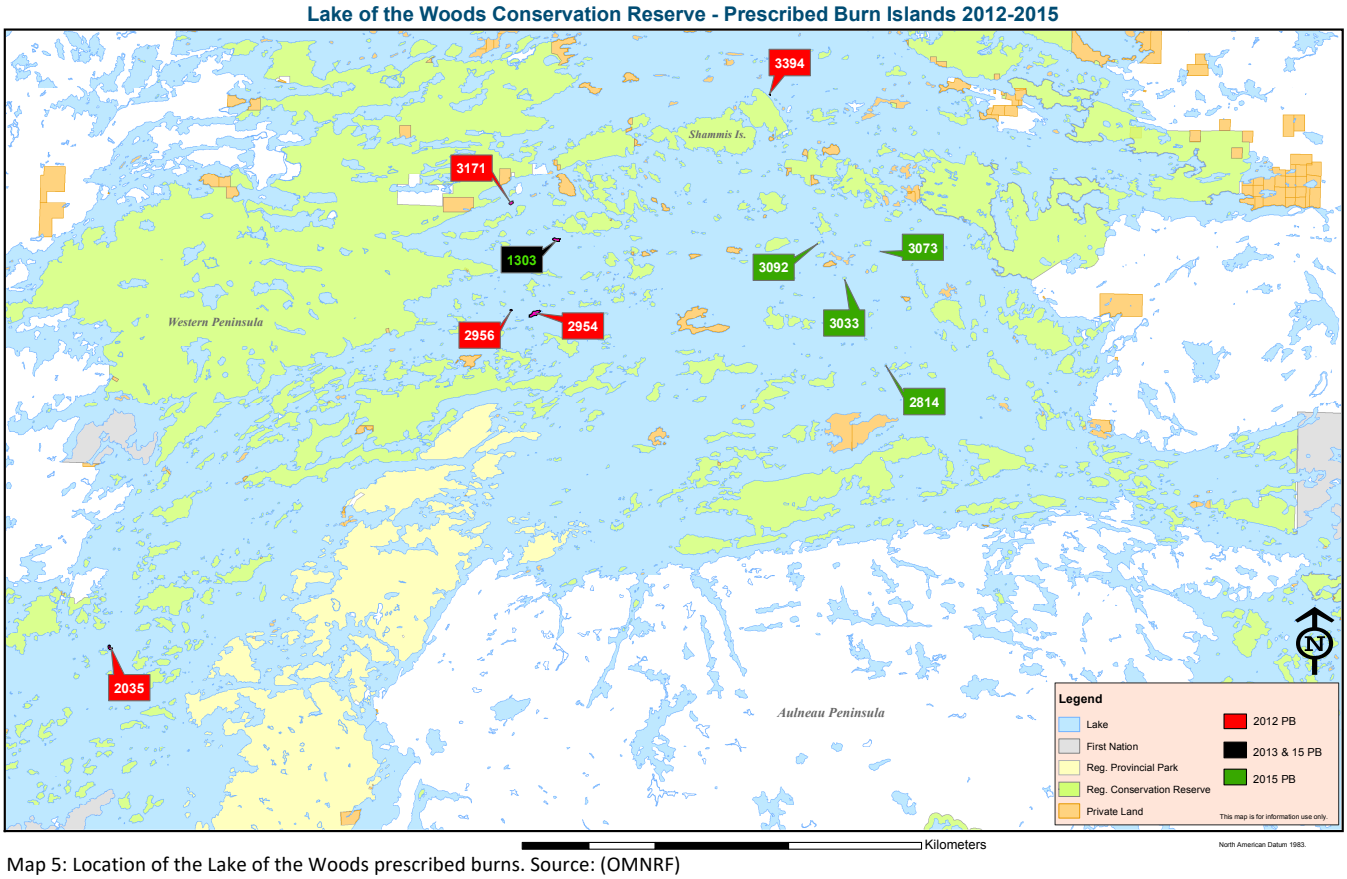
Photos 10 and 11: Aerial Ignition on islands 1303 and 1467 in 2013. Source: (OMNRF)

In the spring of 2015, five islands were ignited with aerial ignition.





Photos 12, 13, 14, 15, and 16. Aerial ignition on islands 2814, 3033, 1303, 3092, and 3073 in 2015. Source: (OMNRF)



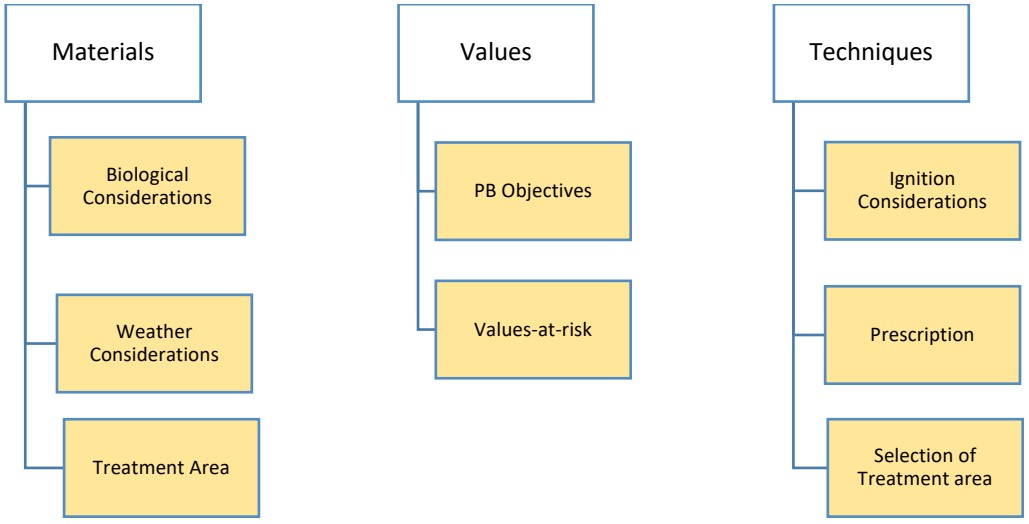
Map 5: Location of the Lake of the Woods prescribed burns. Source: (OMNRF)

The following chapter will look at the materials, values, and techniques that influenced the design and implementation of the Lake of the Woods prescribed burn program. In addition, the prescribed burn program will be evaluated according to its desirability, feasibility, and viability. The data presented in this chapter has been gathered from interviews performed with planners and scientists from the Kenora District OMNRF, staff from the OMNRF AFFES, and documents provided by the OMNRF.

5.1 LOW PB: Descriptive Design Elements

The sections below look at the descriptive design elements that influence the LOW PBs and the sub-categories and themes that were identified from interviews with the OMNRF. As shown in figure 8 below, the descriptive design elements have been arranged according to whether they fall into materials, values, or techniques. Because there were no community participants for the LOW PB case study, there are no sub-categories for these considerations. Only sub-categories for operational considerations are displayed in the table below.

Figure 9: LOW PB: Descriptive Design Elements



5.2 LOW PB: Materials

This section presents the *materials* design element and its influence the LOW prescribed burns. As with the WIN case study, materials, as they relate to prescribed burns, are broadly defined and do not specifically refer to the vegetation that act as fuel for a wildfires and prescribed burns; instead, materials also encompass environmental factors, the geography of the materials in question, the intermix of non-vegetative fuels within the hazard fuels, and the properties of these fuels that contribute to their wildfire risk and prescribed burn outcomes. The sub-categories and themes for *materials* were derived from interviews where participants discussed physical and contextual factors that influenced prescribed burns or wildfires and their impact in the Lake of the Woods area.

The *materials* design element has been broken down into three sub-categories: *biological considerations*, *weather conditions*, and *treatment area*. The *biological considerations* section refers primarily to the vegetation that either affect or are affected by the prescribed burns. The response of island vegetation to prescribed fire was one of the goals of the LOW prescribed burn study and vegetation provides the fuel for prescribed fire. Weather conditions play a large role in influencing prescribed fire behaviour; the *weather conditions* sections looks at what weather conditions most influenced the LOW prescribed burns. Lastly, the *treatment area* section looks at how the characteristics of the islands and where the islands are situated played a role in the outcome of the prescribed burns.

5.2.1 Materials - Biological Considerations

This section looks at the biological considerations that influenced the planning, implementation, and outcomes of the LOW prescribed burns. The themes here emerged from interviews with Kenora district planners and OMNRF fire personnel. Most of the biological considerations refer to vegetation, except for the *species at risk theme*, which refers to eagles and eagle nests.

White pine is an abundant species in the LOW region and four themes relating to white pine were identified: *white pine abundance*, *fire susceptibility*, *fire survival*, and *regeneration*. During the LOW prescribed burns, islands with white pine on them were ignited and due to burning conditions and the vegetation conditions on the islands, a number of white pine trees were burned. Although white pine needles carry fire well, these trees were expected to survive a moderate-intensity surface fire; however, a number of white pine failed to recover from the prescribed burn. The loss of these pine is suspected to be the result of the depth of the burn and seedlings are expected to return in burn areas as white pine is a species of tree that regenerates with fire.

Old growth forest was not given any specific weight in the LOW prescribed burn study, as the purpose of the study was to understand how various plant and ecosystem types within the LOW regions responded to fire. Avoiding or favoring old growth would have defeated the purpose of the study. As one of the district planners responsible for planning the LOW PB study pointed out, if an ecosystem is being managed according to a natural disturbance regime (ie. wildfire) then it does not follow that old growth forest should be given priority over other forest successional time periods (C. Bowling, Interview, Feb. 6, 2017).

Table 22: LOW PB: Biological Considerations

Themes: Biological Considerations	Description
White Pine – Abundance	• "It's one of the main species in the great lakes St. Laurence forest region, it's not necessarily unique, and it's not necessarily given any special significance… [on] at least half of [the islands] white pine were not the dominant species, some islands were very shrubby… "(A. Anderson, interview, Jan. 18, 2017).
White Pine – Fire Susceptibility	• "The hard part with white pine is you have all that litter layer with needles, right underneath the white pine, if you have any intensity at all it's going to create pretty good heat and potentially scorch the trees" (S. Wiseman, Interview, Jan. 30, 2017).
White Pine – Fire Survival	• "Some of the white pine we expected them to survive, but a lot of them didn't and that kind of surprised us and I think in the first year it had to do with the fact that it was so dry and there was no wind the fire didn't get pushed along the islands and it sort of went deeper into the ground than we expected and it killed a lot of the roots. So, you expect white pine to survive, because it has thick bark, so it should survive the fire, but it burned deep into the ground and burned the roots and a lot of the trees fell over" (A. Anderson, interview, Jan. 18, 2017).
White Pine - Regeneration	• "The white pine take a few years to, we haven't seen very many come back yet, but we are going to be doing the five year post burn re-measurement of the first islands that we burned this summer 2017. Hopefully we see start to see some new seedlings" (A. Anderson, interview, Jan. 18, 2017).
Old Growth	• "There is nothing special, necessarily about the old growth ecosystem. They are no more important, from a fire ecology perspective of a fire driven ecosystem landscape, than something that is one year post-burn. From a time sequence, they are just older. But there is nothing special about them. They may be special because they present the opportunity for special niches for certain plants to thrive on or occupy, because of their vertical structure, so these big trees are closer to the sun than any plant that is one year old after the burn" (C. Bowling, Interview, Feb. 6, 2017).
Vegetation - Diversity	• "There is just so much diversity on any particular island. We saw islands in the far south of the conservation reserve that were kind of exotic species for our area like green ash and stuff we don't see in the rest of our district and we don't necessarily get exposed to in the NW fire region of Ontario… I can't stress enough the diversity of the islands we see in the North compared to the south or even locally based on exposure to wind. It was incredible" (J. Mash, interview, Jan 18, 2017).
Vegetation – Fine Fuels	• "If you are in another area where you do have the finer fuels out there, say the white or the red pine, and you have the understory of the balsam [the fire] sort of sits in there. Now you've got a good combination of the fine fuels and the ladder fuels and then once you get a good mix of that and throw a little bit of wind in there it's enough to carry fire along. In most red or white pine stands you do have that balsam understory in there that will help that" (D. Mclean, interview, Mar. 29, 2017).

Table 23: LOW PB: Biological Considerations (Continued)

Vegetation – Ladder Fuels	• "When we burned in the fall, obviously, the main carrier of the fire spread would have been the conifer understory on a lot of the islands. Even in white pine, mixed stands with white pine as the dominant species, you would need some of those ladder fuels from balsam and spruce fuel types to carry the fire up into the crown or some of the ladder fuels… [the PB] may have consumed some of the ladder fuels, damaged some branches, even some mortality, but that's not to say that wouldn't happen naturally" (J. Mash, interview, Jan 18, 2017).
Vegetation – Fire Resistant	• "If you are in September still and all the rose bushes and the beech and the hazel are still leaf on, it creates its own little moisture climate underneath and that affects trying to get fire underneath it to burn because you need a finer fuel to burn and something to carry the fire…You will also have the broadleaf flora that will hinder that as well" (D. Mclean, interview, Mar. 29, 2017).
Vegetation – Late Succession	• "That is why most of these islands have been replaced with deciduous stands now. Most of these islands, the white pines are 150-200 years old and there are no white pines coming up, it's all deciduous. It's birch, it's poplar, it's balsam…. A lot of the plants up here are successional species from fire, they require fire in order for them to prosper and grow. In the absence of fire, you have these intolerant species, a lot of the hardwoods, the birches, the poplars, you have these trees coming in and thriving, the balsam fir are thriving, because we have taken fire out of the equation" (S. Wiseman, Interview, Jan. 30, 2017).
Fire Adapted Species	• "A lot of what people might consider rare plant species out there, aside from white pine, are all adapted to fire, because we're within in the great lakes - St. Laurence - boreal forest regions and a lot of the species out there are adapted to fire so you would expect them either to survive the fire or somehow thrive afterwards… We also spoke to our provincial plant expert in Peterborough just to see if he had any concerns if any of these species showed up on our islands and he said, "burn away," because they are adapted to fire, so he had no concerns at all with that" (A. Anderson, interview, Jan. 18, 2017).
Poison Ivy	• "It was identified that there was a high concentration of poison ivy on some of the islands… some of [the] islands that were selected were [not] done based on the high concentration of poison ivy… it was identified that there was a high concentration of poison ivy on some of the islands, we didn't want any of that smoke impacting people negatively, that goes for the public as well as our staff. Anytime we saw that there was a lot of poison ivy on any particular island, we tried to use aerial ignition" (J. Mash, interview, Jan 18, 2017).
Species at Risk	• "I would say that the biggest influence from a policy perspective on the implementation of this plan, was the policy related to rare, threatened, and endangered species…We weren't allowed to burn where eagles nested… Even if there was no active eagles activity on a nest, we had to cancel that island for burning…We got to the islands that everyone agreed would be good candidate, we started to put in our plots and bingo there's a rare, threatened, or endangered species [plant]" (C. Bowling, Interview, Feb. 6, 2017).

Other aspects of island vegetation were brought up by interview participants. Vegetation diversity fluctuated within islands and between islands, making each island unique in its response to prescribed burn treatment. Fine fuels are small, light, flammable fuels, such as grasses and pine needles, that ignite and burn easily. Fine fuels were prevalent on the islands and allowed for prescribed fire to be ignited easily and spread where they were abundant. Ladder fuels are typically fine fuels that provide a pathway for fire from the forest floor into the canopy of trees. OMNRF personnel spoke of the abundance of ladder fuels on the islands and how they contributed to the spread of ground fire into the canopy. Some islands or parts of islands had vegetation that hindered the ignition and spread of prescribed fire. In the cases where vegetation hampered ignition, broadleaf deciduous trees were abundant, which typically correspond with higher moisture areas. S. Wiseman, an OMNRF fire operations supervisor, spoke of how the tree forest type on the Lake of the Woods islands has moved from confer to deciduous trees in the absence of wildfire. These tree types are less dependent on fire for reproduction and so fire suppression may be resulting in the replacement of fire adapted species, such as pine, with fire intolerant species such as poplar.

Fire adapted species was another theme that came out of the interviews. Due to the historic presence of fire on the islands of Lake of the Woods, there are plant species present on some islands that respond well to fire through serotenous reproductive processes. Some fire adapted species, such as the eastern prickly pear cactus (*Opuntia humifusa)* are considered rare or endangered and part of this could be a consequence of historic fire suppression in the

region. Scientists and planners involved in the LOW prescribed burns expect fire adapted species to respond well to the reintroduction fire.

Poison ivy (*Rhus radicans* L.), is a plant toxic to humans, usually causing a rash on the skin when coming in direct contact, but also capable of causing serious symptoms when the plant's oils are vaporized when the plant is burned ("Poison Ivy," 2016). During their surveys of candidate islands in Lake of the Woods for prescribed burning, some islands were found with high concentrations of poison ivy and due to the risk these plants represent, these islands were excluded from the study.

Lastly, islands with eagle nests were excluded from the prescribed burn study, due to the risk that these operations would pose to these species.

5.2.2 Materials – Weather Conditions

Weather conditions were brought up by interview participants as key factors that influenced the planning, implementation, and outcome of the prescribed burns. Weather acts on vegetation fuel sources and can impede or accelerate the ignition and spread of a prescribed burn. This section looks at the weather conditions that were brought up by interview participants in relation to the LOW PBs.

Weather plays a significant role in fire behavior and as a result, prescribed burn planners have to work around weather conditions in order to achieve the results that they are aiming for. OMNRF prescribed burn planners pointed out that weather conditions matter more than vegetation type when trying to plan and ignite a prescribed burn. Prescribed burn planners also use weather conditions to determine what the best ignition method is in order to achieve the desired results.

Table 24: LOW PB: Weather Conditions

Themes: Weather Conditions	Description
Weather	• "When you're burning on the lower end of the numbers, I don't think it matters what the forest type is as compared to when the numbers start to get higher, then that's the real difference factor (S. Wiseman, Interview, Jan. 30, 2017). • The environmental factors dictate what you're going to use [to light the PBs]" (D. Mclean, interview, Mar. 29, 2017).
Wind	• "I think in the first year it had to do with the fact that it was so dry and there was no wind the fire didn't get pushed along the islands and it sort of went deeper into the ground than we expected and it killed a lot of the roots" (A. Anderson, interview, Jan. 18, 2017). • "The day of the burn there was absolutely no wind to speak of, RH was low, temperatures were high; everything burned. Everything burnt down…[I] think that what happened was with a lack of wind, and how dry it had been for the entire month, the fire burnt in place before it moved across the surface of the islands, so we had deep burning. Where if we had a wind, an average wind for that time of year, we would have had more lateral burning across the surface of the island and maybe a narrower band of scorched material from the top of the forest floor. But what happened was, almost every root system of every tree got burned" (C. Bowling, Interview, Feb. 6, 2017).
Season	• "Spring time you can get some ridiculously low RHs you can get some crazy wind events and the other one is, if you have something go, you can fight it all summer. If you do the fall time, your window is much more limited. You're not going to get haunted for a month, a month and a half. You can't burn the forest in the spring. Holdover time is too long, you will get haunted, you'll have a wind event come up in two weeks and it will blow your fire right out again" (S. Wiseman, Interview, Jan. 30, 2017). • "There is a higher risk to do it in mid-summer. In some cases, it is harder to burn islands when there is full leaf on and there is higher moisture in the leaves and it simply isn't going to work. Ideally you would pick a really hot and dry summer, but then your risk increases substantially. You will get your natural, really intense, hot, burn; however, you will have more risk of the fire jumping islands and making its way to places where there is more human habitation" (C. Martin, Interview, Feb. 6, 2018);
Island Micro-Climate	• "You have to remember you are trying to light an island on fire that is surrounded by water so your humidity already should be up there a little bit. So, you are fighting a little bit of that plus the climate that is going on already on that island. Some of that is micro, but it does have an effect" (D. Mclean, interview, Mar. 29, 2017). • "There are a lot of micro environmental factors, with wind on a lot of those islands" (J. Mash, interview, Jan 18, 2017). • "It also showed that the reason why don't get a lot of fires on LOW; the moisture regime out there is quite high, so it's very touchy to get fires up and running and moving around on the lake" (P. Harvey, interview, Feb. 28, 2017).

Wind drives the spread of a prescribed burn. Ideally, a moderate amount of wind is desired when igniting a prescribed fire. If winds are high, then the potential for the fire to escape controls lines is high. If winds are low, as was the case for one island that was burned, then the fire tends to spread less and burn deeper.

Time of season also factors in to prescribed burn planning. S. Wiseman indicated that spring was not an ideal time for burning due to the chance of high wind events, low relative humidity, and the potential for a fire to burn throughout the fire season into the fall, if weather conditions do not improve (Interview, Jan. 30, 2017). Mid-summer weather conditions also present a challenge with high temperatures and low humidity, increasing the chances of extreme fire behavior. The fall season is ideal, as temperatures begin to drop and the burning season is limited by the onset of winter.

OMNRF fire specialists also spoke of an island micro-climate that was present in Lake of the Woods. According to these fire specialists, the forests on small islands, situated in a large body of water, had high humidity than similar forest types on the mainland, which made it more difficult to ignite fire.

5.2.3 Materials – Treatment Area

Treatment area refers to the area in which the prescribed burns were planned. In this case, treatment area includes the islands in the Lake of the Woods region and how characteristics of the islands and region influence fire behavior.

The candidate islands for prescribed burning were selected through a semi-random process, one of the criteria for selection were islands less than 20 hectares in size. The reason

for selecting this size of island was to reduce the complexity of the prescribed burns and make the control of the prescribed fire easier.

Another characteristic of the islands that were selected was topography. Certain topographical features, such as steep cliffs, resulted in some islands being removed from the list of candidates as they posed a risk to firefighters. However, elevation change was still present on many islands and elevation change can influence fire behavior. Fire travels faster uphill; flames preheat fuel above the fire as the heat of the flames rise, thus drying out fuels and speeding combustion. According to the prescribed burn specialists involved, the topography on the islands in Lake of the Woods was enough to increase the intensity of fire behavior in some situations.

According to district planners A. Anderson and C. Bowling, the Lake of the Woods is situated within three biomes, the Great Lakes/St. Laurence biome, the boreal biome, and the prairie biome. The boreal and prairie biomes, says C. Bowling, are both fire driven ecosystems, the result being the presence of fire adapted species within this region and a corresponding susceptibility to fire (C. Bowling, Interview, Feb. 6, 2017 and A. Anderson, interview, Jan. 18, 2017).

Being a largely fire driven ecosystem, there is a predicted fire cycle for the region. C. Martin, a district planner and biologist, estimates that over a 143 year period the Lake of the Woods region should have 16000 hectares of forest area burned; however over the past 50 years only 200 hectares have burned. This is what Martin calls the fire deficit, which could be the result of fire suppression or micro-climate. The importance of this aspect of the treatment

area is that although the region is a largely fire-driven ecosystem, fire has been absent from a large portion of it (C. Martin, Interview, Feb. 6, 2018).

Table 25: LOW PB: Treatment Area

Themes: Treatment Area	Description
Island Size	• "When we went out with fire crews they hadn't done prescribed burning in a long time so this was sort of an exercise for them to regain that knowledge and expertise and experience so they said they wanted islands less than 20 hectares in size" (A. Anderson, interview, Jan. 18, 2017). • "There was a randomization of picking islands. We weren't picking islands in a biased way, to just bring back red pine or white pine or something else. So, if you look at the map the islands are all over the place. Some are really tiny islands, some are medium sized islands" (P. Harvey, interview, Feb. 28, 2017).
Topography	• "Some of our islands that were selected were done based on the high concentration of poison ivy as well as topography… it's not like they were parking lots, they had their own little topography, even though they weren't deemed a hazard to the firefighters, but there were still hills and stuff and it's hard to get a drip torch in some spots" (J. Mash, interview, Jan 18, 2017). • "Topography played a big factor in that one because I think the elevation from the water level to the top of that island was probably about 50 to 80 feet tall, so a steep slope was helping that fire become such a high intensity fire" (W. Skead, interview, Feb. 7, 2017)
Ecozone	• "We're within in the great lakes - St. Laurence boreal forest regions and a lot of the species out there are adapted to fire so you would expect them either to survive the fire or somehow thrive afterwards" (A. Anderson, interview, Jan. 18, 2017). • "The lake is a confluence of three biomes, we have the boreal biome, we have the great lakes - St. Laurence biome, and we have the prairie biome. Two out of the three of those are fire driven ecosystems, the great lakes being the exception, that is more of a wind driven ecosystem, but the prairies and the boreal are fire driven ecosystem" (C. Bowling, Interview, Feb. 6, 2017).
Fire Cycle/Suppression	• "The fire cycle of the adjacent mainland along LOW is about 143 years, so you expect that an area equal to the area you are interested in would burn once in every 143 years. When you take that fire cycle and you look at the last 50 year history in the LOW CR islands, you would expect the proportion of the area burned across the CR to be about 35 percent, so your expected area to burn is about 16000 hectares of island area. What actually burned is 220 hectares, so a much smaller area actually burned. That does include natural caused and human caused. What I call the fire deficit number here is you would expect another 15000 hectares to burn if we weren't suppressing fire. So, you'd expect 16000 to burn and only 200 has burned over the last 50 years" (C. Martin, interview, Feb. 6, 2017).

5.3 LOW PB Values

This section looks at the sub-categories and themes composing the *values* design element. The values discussed here play a direct role in understanding the desirability, positive or negative, of prescribed fire in the Lake of the Woods Conservation Reserve. In this section, the term *values* is used to encompass physical objects, things, or places that are valued by the community or OMNRF, as well as environmental conditions, operational objectives, practises and skills, well-being, and community-OMNRF relationships. The LOW PB *values* section is divided into two sub-categores, *PB objectives* and *values at risk*. *PB objectives* is a category that includes the values that guided the LOW prescribed burn project, the justification for the project and the goals it was meant to achieve. The *values at risk* sub-category contains the themes related to the values that constrained the implementation of the prescribed burns.

5.3.1 Values - PB Objectives

PB objectives are the values that guided the planning and implementation of the LOW prescribed burn study. *The Lake of the Woods Conservation Reserve Prescribed Burning Pilot Study* (Ontario Ministry of Natural Resources, 2010) lays out three objectives:

1) To reintroduce fire in a scientifically rigorous manner that allows extending knowledge gained from experimental (burned) islands to the greater Lake of the Woods island landscape.
2) To examine current vegetation on the islands within LOW to gain a better understanding of the prevailing forest and ecosite types.
3) To determine the effects of fire on the islands and the potential successional patterns resulting from the reintroduction of fire.

Other objectives and goals laid out in the study were:

- Reintroduce fire to islands in a manner that provides for the protection of human lives and well-being and select natural and cultural heritage features
- Develop Partnerships with internal and external stakeholders interested in supporting the proactive use of fire on the islands
- Determine whether to proceed with a forest fire management plan for Lake of the Woods Conservation Reserve (Ontario Ministry of Natural Resources, 2010).

These objectives are reflected by the themes that emerged from interviews with OMNRF district planners and fire staff. The first three themes in the *PB objectives* table below, *re-introduction of fire*, *manage according to natural processes*, and *pre and post burn analysis*, relate to the first three objectives laid out in the project plan. The other three themes in the table below, *intensity class 2*, *PB capacity building*, and *no fire spread from islands*, correspond with the additional objectives and goals laid out in the study plan.

The first objective, the re-introduction of fire on the islands of Lake of the Woods, is a result of a history of fire suppression in the region. The Lake of the Woods region is a historically fire driven landscape, fire acts as a disturbance that restarts forest succession and allows certain plant species to re-seed and compete. A history of fire suppression in the area has meant that fire has largely been excluded from the landscape. In an effort to manage the conservation reserve along historical ecological patterns, the district wanted to understand the response of the island ecosystems to fire. Re-introducing fire in a way that emulates natural fire, while also following methods that allow for scientific analysis of the results of the prescribed fire, provided justification for the prescribed burn study and the methods for implementing it.

Table 26: LOW PB: PB Objectives

Themes: PB Objectives	Description
Re-Introduction of Fire	• "For me, this was an opportunity to get fire back on to a fire driven landscape, where there hasn't been fire, by design, where we have suffocated the fires for so long now, we need to put fire out there, because that's what keeps this system alive. By fighting all of the fires it's actually like putting a pillow on someone's face. Fire is the life blood of the ecosystem" (C. Bowling, Interview, Feb. 6, 2017). • "The first one in particular is one I really pushed for, reintroduce fire to LOW CR islands in a manner that emulates the distribution and behavior of natural forest fires in order to recover and maintain ecological integrity…from the district perspective, ultimately we just wanted fire to be applied in a way that most closely mimicked what would happen naturally" (C. Martin, Interview, Feb. 6, 2018).
Managing According to Natural Processes	• "We are trying to [manage] in a way that's not conflicting with the natural world, in terms of how these ecosystems develop … if we assume and believe that the LOW Conservation Reserve is actually representative of two biomes that are fire driven biomes and the third, maybe being the great lakes/st. Laurence, but the other two are the majority. If we assume that and we are trying to manage within understanding and respecting natural processes on the landscape, then we need to apply fire on the landscape under our jurisdiction, otherwise we are not managing in a natural way… I think the proper prescription, proper application of fire, in areas where it's the natural agent of change on the landscape, is the proper thing to do, when you can do it" (C. Bowling, Interview, Feb. 6, 2017). • "Personally, I might advocate for managing things naturally and come what may, as long as we think we are emulating natural fires as close as possible as we understand how frequent and intense they are. Whatever comes back, comes back and leave it at that… Ecological integrity would be the number one priority. Folks that are managing provincial parks and conservation reserves do need to think about whether or not they are achieving that number one goal in whatever other activities they are doing" (C. Martin, Interview, Feb. 6, 2018).
Pre and Post Burn Analysis	• "What we were able to do with this project was kind of run up the middle, between a fully set up experiment and a survey. What I mean about that is, a fully laid out experiment you would have perfect control of the fire, so the fire would be laid down on top of the plots in a controlled fashion; we couldn't do that on a plot by plot basis. We couldn't stand over a plot and guarantee that our drip torch was going to burn it at this rate. On the other hand, it was more than a survey, because a survey we would just throw some temporary plots in and just do four trees, just do a prism sweep or something like that, measure some mensurational data on the tree and then come back and do another survey somewhere on the island after it was burnt. What we have is something in the middle, where the plans was we need to do this to these islands, we're going to put in some plots before-hand" (C. Bowling, Interview, Feb. 6, 2017).

Table 27: LOW PB: PB Objectives (Continued)

Intensity Class 2 PBs	• "We were trying to get intensity class two burning through the understory… Going to the plan, in that plan their goal was to simulate intensity class 2 type fire behavior to an island. That was my primary goal, doing it safely, trying to achieve an intensity class type fire that was already pointed out in the plan" (D. Mclean, interview, Mar. 29, 2017). • "They were really interested in intensity class 2. They preferred an FFMC around 85, 80 is low, 90 is high, they wanted to keep it around 85 to keep it in intensity class 2. They wanted to try to burn the islands so they hit an intensity class 2" (S. Wiseman, Interview, Jan. 30, 2017).
No Fire Spread from the Islands	• "From [the AFFES's] perspective, we were most concerned about unwanted fire spread outside of the treatable area, which in this case was the islands identified by Abby" (J. Mash, interview, Jan 18, 2017).
PB Capacity Building	• "We had excellent management from the fire side, they got the big picture, they understood that it wasn't a crazy thing to do. They had their own agenda for getting involved, because they had lost through attrition in the civil service, they had lost some people who knew how to do fire in a prescribed way, so this was their impetus for getting involved, it wasn't about the response of the ecology to burning, it was about building skill internally for the fire program" (C. Bowling, Interview, Feb. 6, 2017).

Managing the conservation reserve according to natural processes is the over-arching justification for the reintroduction of fire on the landscape of Lake of the Woods. Rather than trying to preserve specific species or forest types, the conservation reserve is managed according to the natural processes that drive forest succession and age distribution. The historic suppression of fire and the safety issues that accompany wildfire means that prescribed burning might be justified in order to emulate the forest disturbance that wildfire would normally provide. Supporting this is the OMNRF Wildland Fire Management Strategy (Ontario Ministry of Natural Resources, 2014b), in which wildfires may be allowed to burn, provided they are within certain safety and containment parameters determined by the OMNRF modified response plan. This modified response plan allows for wildfires to run their course, without suppression, if they are not posing a risk to other values.

The third theme in the chart above, *pre and post burn analysis* refers to the component of the study that adds scientific rigour to the project. Understanding vegetation, forest, and ecosystem types, their response to fire, and the successional trajectories that result from fire requires comparing island vegetation before and after fire has been applied. Pre and post burn analysis required sample plots to be established on the candidate islands. Vegetation surveys were done before the prescribed burns were applied. In the years following the prescribed fires, surveys of the sample plots are being conducted in order to determine the response to the fire and successional species that appear. These methods allow for a comparative analysis to be done and will better inform the vegetation response to fire as it is reintroduced to the Lake of the Woods islands. The Introduction and Methods section of *Lake of the Woods Conservation Reserve Prescribed Burning Pilot Study* (Ontario Ministry of Natural Resources, 2010) lays out the protocol for establishing the permanent sample plots, pre-fire sampling, and post-fire sampling.

The fourth objective, *intensity class 2 PBs*, refers to the intensity of fire that was desired for the fires as they were lit on the islands. An intensity class 2 fire is a surface fire, a fire that does not spread into the ladder fuels or the crowns of the trees, and burns with a moderate intensity. In comparison, an intensity class 1 fire is a smoldering surface fire with little flame activity, while an intensity class 3 fire has a vigorous surface fire that includes some fire climbing into the ladder fuel and canopy of individual trees. An intensity class 2 fire was desired for safety and easier control of the fire as well as to limit tree mortality; higher intensity fires usually have the effect of killing trees by burning through bark or burning the canopy and foliage. The table below gives an overview of forest fire intensity class rankings.

Figure 10: Forest Fire Intensity Classes. Source: (OMNRF)

Related to the desired PB intensity class is the fifth objective, *no fire spread from the islands*. OMNRF fire personnel were most concerned with ensuring that the prescribed fires did not escape the boundaries of the prescribed burn and maintaining an intensity class 2 fire contributed to that objective (J. Mash, interview, Jan 18, 2017).

Lastly, the OMNRF fire program also valued the LOW prescribed burn for the opportunity it provided to build prescribed burning capacity within their agency. Prescribed burning is not a common opportunity for the Kenora area fire program, so it has been difficult for them to build prescribed burning skills and experience with new staff. The LOW PB study allowed OMNRF staff to practice planning and implementing prescribed burns.

5.3.2 Values – Values-at-Risk

This section covers *values at risk*, a sub-category that corresponds with the OMRF objective to "reintroduce fire to islands in a manner that provides for the protection of human

lives and well-being and select natural and cultural heritage features" (Ontario Ministry of Natural Resources, 2010). Values at risk refer to the people, places, property, and things that the OMNRF identified as being potentially threatened by out of control wildfire.

Table 28: LOW PB: Values-at-Risk

Themes: Values-at-Risk	Description
Human Life and Property	• "The second [objective], of course it's important that we protect human lives and well-being, so we want to reintroduce fire in a manner that achieves that" (C. Martin, Interview, Feb. 6, 2018). • "I was overseeing the entire operation, making sure that all of the goals were fulfilled… and that things were done in a safe manner providing for public safety… Fire response is our primary responsibility, to provide for public safety and firefighter safety. That always takes precedent and the public I'm sure is wanting that" (J. Mash, interview, Jan 18, 2017).
Public Use areas	• "I think if there was clearly a well-used camp site then we didn't burn that one because we knew that people have an attachment to that island" (A. Anderson, interview, Jan. 18, 2017).
Aesthetics	• "They didn't want large tree mortality, because they are very visible islands, there are a lot of tourist traffic on them" (S. Wiseman, Interview, Jan. 30, 2017).
Eagle Nests	• "If there was an eagle's nest we scrapped those [islands] because a lot of times we tell people that they can't develop on their private land if there [are] natural heritage values nearby or if there is an eagle's nest, so we don't want to turn around and burn an island that has an eagles nest" (A. Anderson, interview, Jan. 18, 2017).
Air Quality	• "LOW is a very highly populated area, with all of the cottages, we did the first burn at the end of the summer, I think it was September, so some of the cottagers weren't even there, but we wanted to make sure that they were conducted in a manner that wasn't going to negatively impact properties or even people with smoke… we didn't want any of that smoke impacting people negatively, that goes for the public as well as our staff" (J. Mash, interview, Jan 18, 2017).

The first and primary value-at-risk identified by district planners and fire staff is the safety and protection of human life and property. As J. Mash pointed out, the priority of the OMNRF fire program is to provide safety to the public and to the wildland firefighters who are lighting and controlling the prescribed burns (Interview, Jan 18, 2017). The protection of human

life and property influenced which islands were selected for burning based on proximity to private property as well as the material elements on the island that may have compromised the safety of the firefighters, such as steep cliffs and poison ivy.

Public use areas was another value-at-risk identified. The prescribed burn planners wanted to avoid burning places that the public used frequently, so if an island had a well-used campsite on it, that island would not be considered for prescribed fire.

Similar to the theme *public use areas*, landscape aesthetics were also a concern for the prescribed burn planners. Lake of the Woods receives a lot of tourism and recreational use. Conducting prescribed burns where a high rate of tree mortality results could cause public backlash as the aesthetic value of the area would be altered.

Eagles nests were a concern for prescribed burn planners, partly influenced by species-at-risk legislation, but also as a continuity of principle; private development is limited if it threatens eagle nesting sites, so it would not look good, from a public relations perspective, if the OMNRF burned islands that had eagle nests on them.

Lastly, air quality is a value that is potentially threatened by prescribed fire in areas with homes and cottages nearby. By selecting a time of year when fewer people would be on the lake and by selecting islands that were not within close proximity to private property, the OMNRF prescribed burn planners limited the amount of smoke that people in the surrounding landscape would be exposed to.

5.4 LOW PB Techniques

This section looks at the techniques design element, which encompasses the planning and ignition techniques that OMNRF and AFFES PB planners and firefighting personnel used in implementing the LOW PBs. The techniques discussed here give an overview of the methods available in conducting PBs and, along with the materials design element, informs the feasibility of PBs by providing insight into the enabling and constraining factors that affect the operations involved in prescribed burning. Based on the themes that emerged from interviews with operational personnel, the techniques section has been divided into three sub-categories: *Ignition considerations, prescription*, and *selection of treatment area*.

5.4.1 Techniques – Ignition Considerations

Ignition considerations include the tools used for lighting the prescribed fires, the methods used for achieving specific fire behavior and intensity, and the logistics involved with the specific ignition methods.

The OMNRF and AFFES prescribed burn specialists determined that the ideal intensity class for the prescribed burn on the target islands was an intensity class 2 fire. This fire type is considered a low intensity surface fire, with no fire spreading up into the trees or forest canopy. The ignition methods and other techniques used reflected the desire to maintain a low intensity class fire.

Photo 17: Premo aerial ignition device. Source: (OMNRF)

Table 29: LOW PB: Ignition Considerations

Themes: Ignition Considerations	Description
PB Intensity Class 2	• "The ignition specialist was Doug Maclean in 2015 and he used the Premo and a lot of what he did was low intensity burns. He didn't want them to get up into intensity class 3, so he purposely burned with the intent of keeping it an intensity class 2 fire" (S. Wiseman, Interview, Jan. 30, 2017).
Aerial Ignition – 08/Premo	• "If you go to the Premo, everything is basically put inside the cab of the helicopter and I have one technician working the machine in the back and that's it. We can go out and do a lot of burning, one mission is usually about 2.5 ours using the Premo. We can fly right out of headquarters here and be down by the south end of LOW, burn off anywhere from 5-8000 balls on an island and then come home" (D. Mclean, interview, Mar. 29, 2017).
Aerial Ignition – 08/Premo Pattern	• "08 balls are dropped and they are not all dropped on one spot. The ignition specialist looks for opportunities to carry the fire, especially when they saw the fire wasn't progressing. It's not like Abby's group set locations and plots and we just came over with the helicopter and dropped 08 balls right on top of the burn plots that were established" (J. Mash, interview, Jan 18, 2017). • "What he [the ignition specialist] would do is he would start off with a strip, not running with the wind, but backing into the wind and just backing off of that. So, he's not allowing the fire to get any head fire runs… He tried to keep the intensity down, based upon his pattern, his spacing of the balls, the saturation, how many balls he put down in an area, by targeting specific fuels, he'll look on the ground and see if there are any snags or anything like that. If you start to fire up the snags and let the wind run with it, you'll get pretty good intensities, so he's trying to do it so that he's not doing that. He's trying to have the fire back into the accumulated fuel areas, rather than run forward into it" (S. Wiseman, Interview, Jan. 30, 2017).
Aerial Ignition – 08/Premo Fire Behavior	• "[With] aerial ignition, the 08 balls were used and it wasn't necessarily a point source ignition. The first year we had some very good indices and there was drought, it didn't take many 08 balls to get some good fire behavior, some fire momentum… it wasn't as much of a point source [ignition], we used multiple 08 balls just to meet the objectives to introduce fire on the landscape" (J. Mash, interview, Jan 18, 2017). • "With the Premo device, we didn't get really good consumption on some islands, because it was just a little bit too moist out there, but on the flip side we opted with using the Premo because it gives you a less intensive fire. We didn't want fire getting up into the trees and torching trees, we wanted to keep it more of a surface fire; the Premo is good for that" (P. Harvey, interview, Feb. 28, 2017).
Aerial Ignition Heli-Torch	• "The northern heli-torch basically involves a drum fuel and to use these things we need to find an area that is fire safe, gravel pits are usually the best… I usually have a minimum of two technicians that come with me and they both work from the ground… If the humidity is higher, if there is a little bit of moisture, if it rained the day before, you might want to look at the torch because it will create more intensity" (D. Mclean, interview, Mar. 29, 2017).

The first ignition methods covered are aerial ignition, which involves dropping fire onto the treatment area with a helicopter, using an 08/Premo machine or a helitorch. The 08/Premo machine (hereafter referred to as the Premo) is an aerial ignition device that is mounted inside a helicopter that holds and drops ping-pong ball sized spheres in a controlled way. The ignition spheres are held in a hopper and before they are dropped they are injected with ethylene glycol, which causes them to ignite shortly after being dropped from the dispenser. The Premo was used by the OMNRF for ignition of islands that were deemed unfit for hand ignition. The Premo allowed for efficient ignition operations as it only required a pilot, an ignition specialist, and an ignition technician. The Premo-equipped helicopter also could fly directly from the local fire base to the target island and with a capacity of 5000-8000 ignition spheres, could light multiple fires on one or more target island.

For the theme *08/Premo pattern*, AFFES prescribed burners discussed the ignition pattern that was used with the Premo and how that pattern influenced fire behavior. To begin with, the burners did not intentionally drop fire onto the sample plots on the treatment islands. The burners wanted to allow the fire to gain some intensity, so they would select advantageous areas, places where there were fuels that were likely to ignite, fine fuels such as grass or pine needles, and drop fire onto those locations. In order to limit and control fire intensity they would start ignition on the down-wind side of an island. Starting downwind meant that the fire would not have the chance to build up a dangerously high intensity as it burned across the entire island, being pushed by wind. This is called 'backing the fire' into an area; burners would try to back the fire into fuels that had the potential of exceeding the targeted intensity.

The fire behaviour that was achieved with the Primo is discussed in the *08/Premo fire behaviour* theme. According to AFFES prescribed burn specialists, fires ignited with the Premo are lower in intensity than other ignition methods. When dropping ignition spheres with the Premo, it was common to use multiple spheres to light the fire, so none of the prescribed burns

Table 30: LOW PB: Ignition Considerations (Continued)

Aerial Ignition - Logistics	• "A lot of it is logistics, once you have decided on what kind of ignition device you are going to use. If you are going to use the northern heli-torch the logisitics are a little bit more complicated than using the Premo… We can fly right out of headquarters [with the Premo] here and be down by the south end of LOW, burn off anywhere from 5-8000 balls on an island and then come home. The logistics there would be so much easier" (D. Mclean, interview, Mar. 29, 2017). • "There is a big distance between the islands, if you have to travel across 20 min to find the next island, it takes a lot of time, whereas with the helicopter you can skip over the top of them. You can cover a large distance in a short time… The Premo is, logistically speaking, the simplest, fastest, the quickest way to get a burn off. You can carry a lot of balls… with the torch you have to refill your drum every 40 min, an hour, depending on how you are burning" (S. Wiseman, Interview, Jan. 30, 2017).
Hand Ignition – Drip Torch	• "There was two ways we ignited the islands, one was aerial ignition and one was hand held ignition… from island 1 to island 3 in the first year we did hand held ignition" (J. Mash, interview, Jan 18, 2017). • "If you are just trying to do a light understory burn, then you would use the [hand] torches because you have more control. You can also have a couple guys with piss packs in the event that it starts torching some trees you can settle it down… if you have a 30 hectare island and you want to get it done in half a day, couple hours, you'll never get that done with hand ignition" (S. Wiseman, Interview, Jan. 30, 2017).
Hand Ignition – Fire Behavior	• "We saw higher intensities with ground ignition… Based on the amount of fire that was directly applied and that they had more control over applying it to areas that they knew would burn… and they are under the canopy at times, they are underneath the ladder fuels" (J. Mash, interview, Jan 18, 2017). • "You can be a lot more precise with hand torches on the ground. For limiting your intensity and everything else, versus the helicopter" (S. Wiseman, Interview, Jan. 30, 2017). • "We had the hand ignition and John would be able tell you a little better than I could how it was used, but I think it was applied in a zig zag pattern across the island so when you have a drip torch and it's a couple feet from the ground obviously that's going to be a little more intense, we found that on the hand ignition islands the burn severity was a lot higher, it was probably around 80 percent [of fuel consumed]" (A. Anderson, interview, Jan. 18, 2017).

lit by Premo were single source ignition points. Part of the reason for this is the low intensity of fire that the Premo typically produces, multiple ignition spheres were required to maintain ignition and ensure that the fire intensity and coverage were adequate.

The second type of aerial ignition mentioned by prescribed burn specialists is the heli-torch. The heli-torch consists of a fuel drum, containing a gelled mix of diesel and gasoline, with a nozzle and wick that is slung beneath the belly of a helicopter. The wick is lit, which ignites fuel that is sprayed from the nozzle, the stream of fuel is controlled by a prescribed burn specialist in the cockpit of the helicopter. The heli-torch was not used in any of the prescribed burn ignitions for the LOW PBs, but prescribed burn specialist, D. Mclean, mentioned it as a potential tool for island prescribed burns. The advantage of the heli-torch is its ability to create higher intensity fires, which is useful when weather conditions make igniting a fire difficult.

Photo 18: Heli-torch. Source: (Kurtis Ulrich)

The sixth ignition consideration, *logistics*, compares the efficiency of the various ignition methods. The advantage of aerial ignition is the ability to leave the fire base and ignite treatment islands quickly. With aerial ignition, there is also the ability to light prescribed burns on distant islands in a relatively short period of time. Logistically speaking, the difference between the Premo and the heli-torch is the amount of fire that can be applied over a period of time. The heli-torch uses a lot of fuel and must be refilled roughly every 40 minutes, while the Premo can drop upwards of 8000 balls, meaning more ignitions can be accomplished over a longer period of time. Secondly, refuelling and lighting the heli-torch requires more personnel

and time, while the Premo is a more simple process of re-filling the sphere hopper.

The second ignition method used on the islands was hand ignition with a drip torch. A description of a drip torch is provided in the WIN PB Techniques section above. According to PB specialist S. Wiseman (Interview, Jan. 30, 2017), the advantage of using drip torch ignition is the control it provides; as a burner ignites a fire with a drip torch, a second firefighter can follow and extinguish or cool the fire thus controlling the direction and intensity of the burn. The limitation of drip torch ignition is the amount of treatment area that can be burned in a day. Due to the amount of staff needed to perform a drip torch ignition and the relative slow progression of such a burn, treatment area size or number of islands burned is limited compared to aerial ignition.

The fire behaviour achieved by drip torch ignition on the islands was somewhat higher in intensity than with aerial ignition. OMNRF PB specialists attribute this to the fact that the burn crews applied a lot of fire with the drip torches and targeted the fine fuels more accurately than aerial ignition and were able to apply fire to fuel below the forest canopy. As the hand-held ignitions proceeded, the crews were able to achieve intensity class 2 fires by slowing down their rate of ignition and applying less fire with the drip torches (J. Mash, Interview, Jan. 18, 2017).

5.4.2 Techniques – Prescription

Prescription refers to the set of conditions that determine whether a prescribed burn will be approved or denied by the OMNRF, these conditions are largely determined by weather conditions. Prescription ensures, on one end, that a prescribed burn will be successful; the target fuels will be in a condition to ignite, burn, and carry fire. On the other end, prescription

sets the upper limit in which prescribed burns are allowed in order to keep the burn

Table 31: LOW PB: Prescription

Themes: Prescription	Description
Indices	• "The environmental factors dictate what you're going to use. If the humidity is higher, if there is a little bit of moisture, if it rained the day before, you might want to look at the torch because it will create more intensity" (D. Mclean, interview, Mar. 29, 2017).
Spring Burns	• "Basically, as I recall, the decision to burn in the fall was based primarily from direction from the district planner, that's where they initially wanted to and then subsequent years, when we found we weren't getting the results that we wanted we switched to a spring burn when there would be more solar radiation and more fine fuels available for combustion on the forest floor, so it would be better to carry the fire" (J. Mash, interview, Jan 18, 2017).
Island Size	• "The other aspect of it was if the island that was really big, we used aerial ignition" (J. Mash, interview, Jan 18, 2017). • "When we're doing some of the small islands, it's really simple, but some of the bigger ones it's difficult to get the crews in there and do the work" (P. Harvey, interview, Feb. 28, 2017). • "If you have a 30 hectare island and you want to get it done in half a day, couple hours, you'll never get that done with hand ignition" (S. Wiseman, Interview, Jan. 30, 2017).
PB Complexity	• "We have low complexity and high complexity prescribed burning programs right? You put in all of the information about boundaries and what kind of devices you are going to use, the amount of area you are going to burn and all of that kind of stuff. At the end of the key it will tell you if it's low complexity or high complexity. If you're a low complexity PB, it's a much simpler planning process. If it's a high complexity, like you're using the heli-torch and burning 1000 hectare cut blocks, then it goes into a very significant planning process. One of the big variables is if you are going to use a helicopter to do your PB, doing any sort of ignition, you are automatically bumped up into high complexity" (P. Harvey, interview, Feb. 28, 2017).
Burn Window	• "I just want to make sure that everyone understands that we had the burn window open and we had a set time frame for when we could burn and maybe that wasn't the best approach because, in a certain amount of time, like 90 days in the fall, the actual prescription wasn't open as long as we would have liked. So sometimes we felt, oh we've got to get it done today and if not today then a big rain event was going to come and shut us down… Looking back at it now, if we had been a little bit more patient and we changed the burn window a bit we probably could have committed hand held ignition resources and just been a little bit more careful like to burn some of the larger islands, depending upon how the topography and the poison ivy played out" (J. Mash, interview, Jan 18, 2017).

manageable and under control; within these conditions, the fire behavior is calculated to be within the range of ignition and suppression crew control.

Indices, such as humidity and fuel moisture content, alter the effectiveness of different ignition methods. The heli-torch can be more effective than other ignition methods when humidity and moisture levels are high, while the Premo's effectiveness is more limited by these indices (D. Mclean, Interview, Mar. 29, 2017).

Initially, the LOW PBs were scheduled to be conducted in the fall, but in order to achieve better ignition and burn coverage, district planners requested that the burns be moved to the spring. Without a leaf canopy on deciduous trees, the spring is typically a better time to burn if a vigorous surface fire is desired.

Island size, which is also discussed in the materials section above, helped determine the ignition method that would be used on particular islands. Due to the efficiency and speed of aerial ignition, the Premo would be used on islands that were above a certain size.

OMNRF prescribed burn complexity criteria dictates the amount of planning and controls necessary to execute a prescribed burn. The use of helicopters for igniting a PB immediately moves a burn into high complexity status, which can limit the opportunities for conducting a burn. However, because the LOW PBs were being conducted on islands with strong control lines (the water surrounding the islands was an extremely effective barrier to the fire potentially escaping the treatment area) the OMNRF was willing to change its PB complexity criteria and allow the LOW PBs to maintain a low complexity status, even when using aerial ignition (P. Harvey, Interview, Feb. 28, 2017). This policy change likely allowed the LOW PBs to proceed at a faster rate than they would as high complexity burns.

Prescription determines burn window; burn window being the indices, season, and weather conditions in which the prescribed burns can be lit. J. Mash (Interview, Jan 18, 2017) felt that the burn window that they allowed themselves was too narrow and limited the OMNRF burners' ability to effectively apply fires to the treatment islands.

5.4.3 Techniques – Selection of Treatment Area

Table 32: LOW PB: Selection of Treatment Area

Themes: Selection Methods	Description
Island Selection	• "Another thing is, by selecting the islands randomly, if we knew which islands we were going to burn, we could then collect data prior to the burn. If we just wait for lightening to strike an island we are not able to get the pre-burn data" (A. Anderson, interview, Jan. 18, 2017). • "We started looking at islands to see what we could do with them and then Chris developed a method of randomly selecting islands, the district wanted to keep this as close to emulating a lightening system coming through as possible. So there was a randomization of picking islands. We weren't picking islands in a biased way, to just bring back red pine or white pine or something else. So if you look at the map the islands are all over the place" (P. Harvey, interview, Feb. 28, 2017).
Vegetation Plots	• "We did veg plots prior to the burns so we could see what was growing there first and we took soil samples and after the burn we are monitoring 1, 3, 5, and 10 years post burn where we are looking at the veg that grows back" (A. Anderson, interview, Jan. 18, 2017).
Vegetation Plot Site Selection	• "We picked areas that represented the different forest types on the islands, so if the island was generally the same then we only put one plot on it but if there was like that one island that had elm on it, we made sure that the plot included the elm and then the other side of the island was kind of shrubby so we put another plot over there so we tried to include the different forest types" (A. Anderson, interview, Jan. 18, 2017). • "It would be impossible to sample the entire island and you want a start size of plot so that you are comparing apples to apples across islands. Once islands were randomly selected, we wanted to make sure that our plots were situated in a way that best represented what was there. So at that point it wasn't so much let's pick a random sight on this island, although that could have been part of it, in some cases the islands were so small there was really only one place where you could fit a 20 by 20 meter plot. Otherwise we just try to make sure that we are best representing the kinds of vegetation that was there. In some cases that included picking some pretty thick, viney, thorny places, which others weren't keen on, but I said, that's what we're here to do" (C. Martin, Interview, Feb. 6, 2018).

This section looks at the methods that determined how islands were selected for prescribed burning. The themes comprising the *selection of treatment area* section apply to the three primary objectives mentioned above from the *Prescribed Burn Pilot* Study (Ontario Ministry of Natural Resources, 2010). Although these techniques do not directly apply to the techniques of applying fire to the landscape, they are useful in understanding how and why islands were selected and provide insight into how future selection of prescribed burn sites may be planned.

According to the *Prescribed Burn Pilot Study* (Ontario Ministry of Natural Resources, 2010) islands were selected at random using ArcGIS. UTM grid lines surrounding the conservation reserve were determined and numbers were ascribed to intersecting grid coordinates. A random number generator was used to select random coordinates.
If a random coordinate fell on an island, that island would be selected, and if a random coordinate fell over water, the nearest island would be selected (Ontario Ministry of Natural Resources, 2010). Due to values-at-risk, OMNRF fire and district staff removed islands deemed to be unsuitable for prescribed burning; thus, the selection of islands is considered a "constrained random sample" or a "random sample of all islands potentially suitable for prescribed burning" (Ontario Ministry of Natural Resources, 2010). The decision to select islands randomly was based on the desire to be able to make "reliable statistical inferences across the conservation reserve regarding prevailing forest and ecosite type and the effects of fires on plant communities" (Ontario Ministry of Natural Resources, 2010).

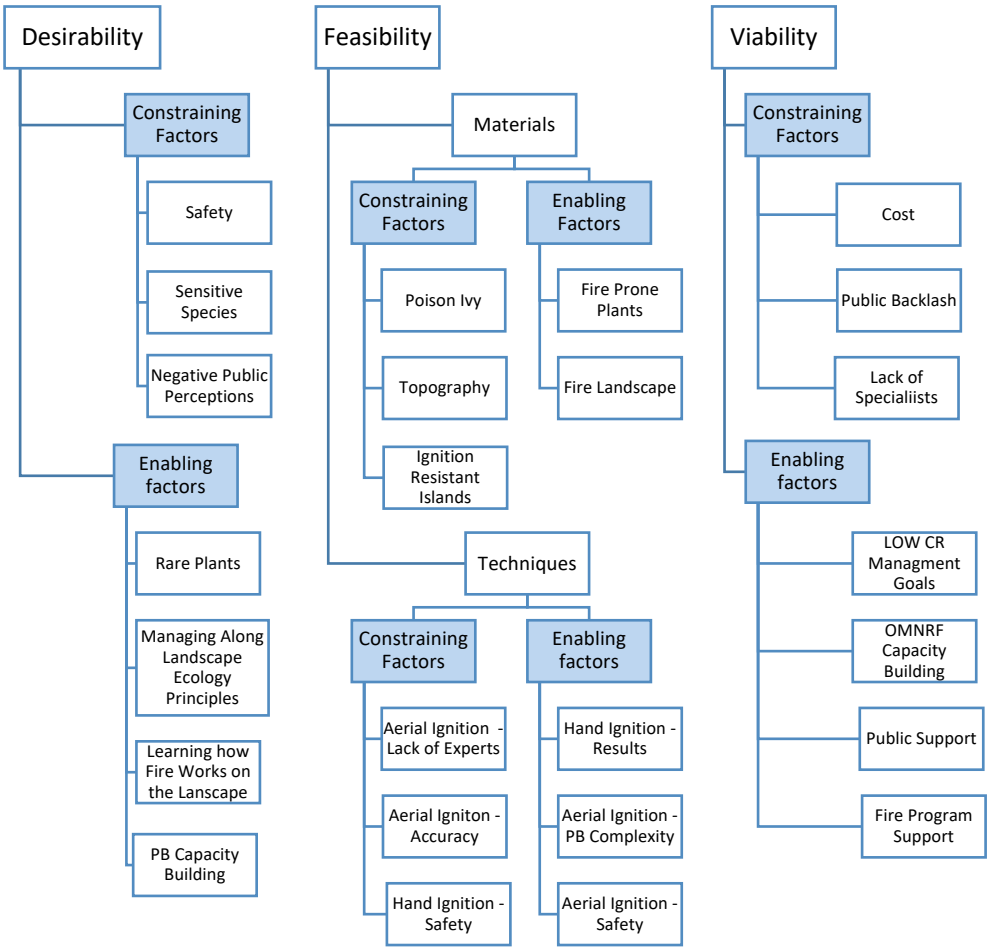
Vegetation plots were established on the candidate islands in order to survey the number and type of plant species and measure the response of the sample plot to fire. The

plots will be monitored 1, 3, 5, and 10 years after the initial prescribed burn in order to follow the succession of the forest (Ontario Ministry of Natural Resources, 2010). The prescribed burn crews were not given the location of the vegetation plots, so fire was not directly applied to the plots.

The vegetation sample plots were 20 meters square and were meant to be placed in areas that represented the "dominant forest type of the island" (Ontario Ministry of Natural Resources, 2010). If an island was large enough to accommodate a second sample plot, spaced at least 40 meters apart from center, then these plots could be used to cover different forest types (Ontario Ministry of Natural Resources, 2010).

5.4 LOW PB: Evaluative Design Elements

Figure 11: LOW PB: Evaluative Design Elements



The following sections look at the evaluative design elements that influenced the LOW PBs. As shown below in figure 10, the evaluative design elements have been arranged according to their desirability, feasibility, and viability. The sub-categories of these elements arrange themes that emerged from interviews into enabling or constraining factors.

5.5 LOW PB: Desirability

Table 33: LOW PB: Desirability

Constraining Factors	Description	Related Themes
Safety	• "Because of human health and safety concerns and boat traffic and that kind of thing, there are good reasons not to choose to do your burn at the same time as [when] there's a lot of folks out on the lake. When there are a lot of people out on the lake there is higher risk of somebody coming close up, being to curious, wanting to get up on the island… At any time of year we wouldn't have chosen an island that was right next to private property or where there was a parcel of private land on the islands. It would be a very dumb thing for us to attempt, especially early on in this pilot project" (C. Martin, Interview, Feb. 6, 2018).	-No Fire Spread from the Islands -Human Life and Property -Air Quality -Poison Ivy -Topography
Sensitive Species	• "If there was an eagle's nest we scrapped those [islands]" (A. Anderson, interview, Jan. 18, 2017).	-Eagles Nests
Negative Public Perceptions	• "The public perception was flavored by the fact that [people thought] "yeah. look at MNR, they burn all these trees and they crash to the ground, how can that be a good thing to do?" (C. Bowling, Interview, Feb. 6, 2017). • "Sometimes when you do see these trees burning off, some people tend to scratch their head and ask, is that what we were trying to do? Maybe some of the results weren't as desired only because a lot of people think that when we go out to put fire on the islands, in their minds they are expecting to see a black island from the beginning right to the end" (D. Mclean, interview, Mar. 29, 2017). • "At the start [the PB program] there was a lot of negative phone calls, like what are you doing out there, you're wrecking the landscape" (P. Harvey, interview, Feb. 28, 2017).	-Public Use areas -Aesthetics

Table 34: LOW PB: Desirability (Continued)

Enabling Factors	Description	Related Themes
Rare Plants	• "We ran into a number of very rare plants, where there is only say half a dozen occurrences of these plants in all of Ontario. Some of the more classic prairie remnant species too on the south facing shores often with burr oak savannah you will also get prickly pear cactus, which is more common out west and June grass and various plants that are fairly rare. In talking with Wasyl Bukowski, a community ecologist down in Peterborough, who works with us at the MNR. Most of these plants are rare because of the lack of natural disturbances, like fire. We have these species that are extremely rare and very isolated in small numbers and we're expecting that some of them will respond quite well to fire and the reason they are rare is because of fire suppression" (C. Martin, Interview, Feb. 6, 2018).	- Ecozone - Species at Risk - Fire Adapted Species
Managing Along Landscape Ecology Principles	• "Myself, trying to look at it from a broader perspective, not that we are trying to recover species x, y, or z, it's that fire has been part of this landscape for millennia and we have been suppressing it effectively for over half a century. If we are trying to manage a, quote, 'natural' ecosystem that relies on fires, there might be some ground that we need to regain, through prescribed burning in addition to our current fire response plan. From the district perspective, ultimately we just wanted fire to be applied in a way that most closely mimicked what would happen naturally" (C. Martin, Interview, Feb. 6, 2018).	- Re-Introduction of Fire - Managing According to Natural Processes
Learning How Fire Works on the Landscape	• "But we do it for a management reason. And our management reason is, we are trying to understand the contribution that these old growth ecosystems make in the environment that we are trying to manage, because we are trying to emulate natural disturbance" (C. Bowling, Interview, Feb. 6, 2017). • "The thinking was we wanted to do something a little bit more on the research or learning side to determine exactly what burning was expected to do, what natural fires and PBs are expected to do in the CR" (C. Martin, Interview, Feb. 6, 2018).	- Re-Introduction of Fire - Managing According to Natural Processes - Pre and Post Burn Analysis -Island Selection -Vegetation Plot -Vegetation Plot Site Selection
PB Capacity Building	• "The [AFFES} had their own agenda for getting involved, because they had lost through attrition in the civil service, they had lost some people who knew how to do fire in a prescribed way, so this was their impetus for getting involved, it wasn't about the response of the ecology to burning, it was about building skill internally for the fire program" (C. Bowling, Interview, Feb. 6, 2017).	-PB Capacity Building

Desirability will be the first evaluative design element that will be considered for the LOW PB program, this section will look at the enabling and constraining factors that influence the desirability of prescribed burns in Lake of the Woods. The themes that compose the enabling and constraining factors of desirability are primarily derived from the values descriptive design element along with other specific themes that emerged from interviews.

The first constraining factor for the implementation of prescribed fire on Lake of the Woods is *safety*. The values that relate to safety, *no fire spread from the islands*, *human life and property*, and *air quality* necessarily restrict the timing and location of the prescribed burns. There is inherent risk in lighting prescribed fires, even with strong control lines such as the water surrounding an island. The effect of smoke on air quality is also difficult to control. The high density of homes, cottages, and people using the lake for recreation, means that safety is a primary concern, especially during mid-summer, when there are high numbers of people using the lake. Safety also applies to the crews that are conducting ground ignition on the islands. The presence of poison ivy, topographical features, and the danger inherent in lighting prescribed fire, constrain the desirability of igniting certain islands with ground ignition.

Sensitive species are another concern that limits the desirability of lighting prescribed fire. It has been determined that eagles' nests represent a value that ought to be protected. Islands with eagles' nests on them, whether they are currently being used or are vacant, are not considered candidates for prescribed fire.

At the beginning of the LOW PB project, the OMNRF received negative feedback from locals who noticed the fires or the areas that had been burned. Lake of the Woods has aesthetic value to the people who use the area and there are islands and waterways that receive high

levels of public use. Without a clear understanding of the value of fire on the landscape and the purpose of the OMNRF's prescribed burns, it is possible that negative public perceptions of prescribed burning and fire on the landscape could limit the overall desirability of prescribed fire and its future use (C. Martin, Interview, Feb. 6, 2018).

The first factor enabling the use of prescribed fire on Lake of the Woods is *rare plants*. The unique location of Lake of the Woods at the corner of three biomes creates an ecozone that supports plants not found in the surrounding landscape and which are generally considered rare species. According to C. Martin (Interview, Feb. 6, 2018), plants like the prickly pear are rare because they rely on disturbance for reproduction and fire suppression in the region limits the amount of disturbance these plant communities experience. The reintroduction of fire through prescribed burning is an opportunity to increase the prevalence of rare plant species.

The second factor that enables the desirability of prescribed fire is *managing along landscape ecology principles*. The goal of district planners is to manage the conservation reserve in a way that allows the area to follow disturbance patterns that would exist with minimal human intervention. There is less of a focus on preserving specific species or populations and more of a focus on allowing the biota on the landscape to follow historic growth and succession trajectories. Prescribed fire might be used to achieve this objective by speeding the reintroduction of fire on a landscape that has had a recent history of fire suppression. Allowing wildfire to burn the difference in the fire deficit may not be feasible due to safety issues, so the use of prescribed fire may be necessary in achieving the historical pattern of disturbance in the conservation reserve.

Learning how fire works on the landscape was another goal of the LOW PB project. District planners wanted to know how plant species would respond to fire so that they could predict the outcomes of future prescribed burns or managed wildfires. The scientific methods underpinning the PBs, such as the random selection of islands, the vegetation plots, and the post burn vegetation analysis, allow the district planners to extrapolate their results and predict how other islands may respond to the reintroduction of fire. This information will inform the future of prescribed fire and wildfire management in the conservation reserve and help meet the goals of managing the reserve along landscape ecology principles.

Lastly, conducting prescribed burns for the LOW PB project allowed OMNRF PB specialists and crews to practise planning and ignition and provided learning opportunities that ultimately added to their capacity to do future prescribed burns. Prescribed burns are complex operations and it can be difficult for fire agencies to maintain their capacity to perform them. The opportunity to practice lighting prescribed fires is desirable to the OMNRF fire program for both future prescribed burning and as training for wildfire suppression operations.

5.6 LOW PB Feasibility

Feasibility is the design element that evaluates what is technically possible, this can refer to the tools and techniques available as well as the capabilities of the organization or agency involved in planning and implementing design solutions. The *feasibility* design element explored here is composed of the descriptive design elements *techniques* and *materials*.

5.6.1 Techniques Contributing to Feasibility

This section looks at the techniques that contribute to the feasibility of the LOW PBs by either constraining or enabling feasibility.

The first technical factor constraining the feasibility of the LOW PBs is the lack of aerial ignition experts. As aerial ignition experts retire from the AFFES, there is a lack of qualified personnel to take their place. This constrains the AFFES's ability to safely and effectively perform prescribed burns.

The second constraining factor is *aerial ignition accuracy;* although aerial ignition specialists are skilled, they cannot apply fire to forest fuels as accurately as hand ignition crews on the ground (J. Mash, Interview, Jan 18, 2017). Aerial ignition is efficient, but not as accurate as ground ignition.

The final constraining factor in this section is *hand ignition safety*. There are safety concerns when fire crews are conducting ground ignition with drip torches. Crews must be able to maintain sight lines with each other and the density of forest on some islands restricts this ability. Other factors such as poison ivy and the smoke it produces, steep cliffs, and other topography that limited escape routes represent risks to burn crews and limit their ability to perform prescribed burns on certain islands.

The first enabling technical factor refers to the effectiveness of the hand ignition with drip torches, *drip torch results*. Based on the ability of hand ignition crews to target specific fuels and apply fire evenly across an island, C. Bowling (Interview, Feb. 6, 2017) believed that drip torch ignition produced better results. Drip torch ignition resulted in more coverage by the prescribed fire.

Table 35: LOW PB: Techniques Influencing Feasibility

Constraining Factors	Description	Related Themes
Aerial Ignition – Lack of Experts	• "Probably the biggest one is the availability of the specialized people to do that kind of work [Aerial Ignition]. Right now, in Ontario, through retirement, trying to get people trained has been really hard on the program and it's not just in Ontario it's all across the board, right across Canada" (D. Mclean, interview, Mar. 29, 2017).	-PB Capacity Building
Aerial Ignition - Accuracy	• "When you're doing aerial ignition with 08 balls, they are highly skilled doing that, but… you're not as accurate and you don't have that fine resolution as when you're on the ground and you can actually see all the fine fuels" (J. Mash, interview, Jan 18, 2017).	-Aerial Ignition – 08/Premo -Aerial Ignition – 08/Premo Pattern
Hand Ignition – Safety	• "Another one is safety; what it's like from the ground, if it's really thick bush and the crews can't have good escape routes then you wouldn't put them in there" (S. Wiseman, Interview, Jan. 30, 2017). • "From my perspective, the hand ignition stuff, you have to have good line of sight between your ignition crews, so with some of these islands with the way they are really clogged with brush and stuff, you are really limited with where you can go. When we're doing some of the small islands, it's really simple, but some of the bigger ones it's difficult to get the crews in there and do the work" (J. Mash, interview, Jan 18, 2017).	-Hand Ignition – Drip Torch -Human Life and Property -Safety -Topography -Air Quality -Poison Ivy
Enabling Factors	**Description**	**Related Themes**
Drip Torch - Results	• "Generally speaking, the drip torch treatment was much more effective at burning. Because it's more of a contiguous burn" (C. Bowling, Interview, Feb. 6, 2017).	-Hand Ignition – Drip Torch -Hand Ignition – Fire Behavior
Aerial Ignition – PB Complexity	• "The LOW PBs helped change the PB policy a little bit. Now people are doing island PBs and they're not considered high complexity unless there are some other factors that come into play. It's not easy, but it's a much easier process and the timelines aren't so unforgiving" (P. Harvey, interview, Feb. 28, 2017).	-PB Complexity -Burn Window

The next enabling factor, *aerial ignition – PB complexity*, refers to how the planning of island prescribed burns has become easier since the start of the LOW PB project. If a prescribed

burn is planned on an island, then the use of aerial ignition will no longer move that PB into high-complexity status, thus allowing for larger burn windows and ease of planning.

Lastly, according to the AFFES PB specialists, aerial ignition is safer than hand ignition, due to the topographical features, the presence of poison ivy, and the inherent safety issues involved with lighting prescribed fire. Thus, the use of aerial ignition increases the feasibility of igniting islands where crew safety is a concern.

5.6.2 Material Factors Contributing to Feasibility

This section looks at the material factors that contribute to the feasibility of the LOW PBs by either constraining or enabling feasibility.

The first material factor that constrained the feasibility of the LOW PBs was the presence of poison ivy on some of the candidate islands. As mentioned above, poison ivy can be harmful both when contacting skin and when burned. The harmful effects of poison ivy when burned presented a particular risk to burn crews, so candidate islands that contained poison ivy were either not burned or ignited with aerial ignition.

Topography also presented a challenge to burn crews, as steep hills and cliffs restricted escape routes for hand ignition crews. Candidate islands with extreme topographical features were either not burned or were ignited with aerial ignition.

The third constraining factor is ignition resistant islands. A number of material features combined to create ignition resistant islands, islands that ignition crews found difficult to ignite, even when burning conditions were ideal. The factors that contributed to an island's resistance to ignition included the island's micro-climate, the dominant vegetation type of the island, the

Table 36: LOW PB: Materials Influencing Feasibility

Constraining Factors	Description	Related Themes
Poison Ivy	• "One was toxic fumes from poison ivy, so that's a no go as far as putting people on the ground where there was poison ivy growing… the smoke off of burning poison ivy is dangerous" (C. Bowling, Interview, Feb. 6, 2017). • "That's another unique thing for the islands on LOW, there is a lot of poison ivy out there and that was one of the things that we had to make sure that our staff was well protected from" (P. Harvey, interview, Feb. 28, 2017).	-Safety -Human Life and Property -Air Quality -Hand Ignition - Safety
Topography	• "If there was a lot of topography, if there was a lot of steep hillsides we didn't want people tripping over while they were ignited" (J. Mash, interview, Jan 18, 2017) • "There needed to be a safe route for the fire crews to escape if necessary so anything that had a big cliff was scratched" (A. Anderson, interview, Jan. 18, 2017).	-Safety -Human Life and Property -Hand Ignition Safety
Ignition Resistant Islands	• "Unfortunately, when we are trying to mimic fire on the landscape there is usually fuels that don't burn and usually they don't burn for a reason. You have to remember you are trying to light an island on fire that is surrounded by water so your humidity already should be up there a little bit. You are fighting a little bit of that plus the climate that is going on already on that island. Some of that is micro, but it does have an effect. You will also have the broadleaf flora that will hinder that as well. Everything is all determined by the time of the season, you may have a drier than normal season or you may have a wet season or a combination of both" (D. Mclean, interview, Mar. 29, 2017). • "Anywhere where there was a denser canopy and a lot of deciduous, a firefighter knows that's not going to do very well. In hindsight, we weren't really involved in the selection process, maybe that's something we could have looked at" (J. Mash, interview, Jan 18, 2017).	-Island Micro Climate -Vegetation – Fire Resistant -Weather -Wind -Season -Ecozone
Enabling Factors	**Description**	**Related Themes**
Fire Prone Plants	• "A lot of what people might consider rare plant species out there, aside from white pine, are all adapted to fire… a lot of the species out there are adapted to fire so you would expect them either to survive the fire or somehow thrive afterwards" (A. Anderson, interview, Jan. 18, 2017).	-Fire Adapted Species -Ecozone -Vegetation – Fine Fuels -White Pine – Fire Susceptibility
Fire Landscape	• "What I call the fire deficit number here is you would expect another 15000 hectares to burn if we weren't suppressing fire. So, you'd expect 16000 to burn and only 200 has burned over the last 50 years" (C. Martin, Interview, Feb. 6, 2018).	-Ecozone -Fire Cycle/Suppression -Fire Adapted Species

time of year the island was ignited, as well as the wind and weather conditions. The ecozone of Lake of the Woods allows for the presence of diverse island forest types, which means that some islands may be receptive to fire while other are highly fire resistant. Certain vegetation types are inherently resistant to fire. There is a short burn window before deciduous trees leaf-out and after they drop their leaves, when ignition is easier in this forest type, but conditions still have to be ideal (J. Mash, Interview, Jan 18, 2017 and D. Mclean, interview, Mar. 29, 2017). The humid micro-climate of particular islands further increase the difficulty of ignition. If ease of ignition and burn coverage is a priority, then fire staff may need to provide input into PB planning in order to avoid ignition resistant islands in the future (J. Mash, interview, Jan 18, 2017).

Material factors also contributed to the ignition of islands and thus the feasibility of the LOW PBs. The first of these factors is *fire prone plants*, fire adapted species and the presence of flammable fine fuels means that may of the islands on Lake of the Woods are highly conducive to ignition and burning. Many fire adapted species rely on fire as a means of reproduction and to gain competitive advantage over other plants, so they inhabit fire prone landscapes and develop features that promote the ignition and carrying of fire. The ecozone of Lake of the Woods includes islands that are particularly susceptible to fire.

The fire history of the Lake of the Woods area, the number of hectares that are expected to burn, and the presence of fire adapted species indicate that the Lake of the Woods area is a fire prone landscape. Being a fire prone landscape increases the feasibility of conducting prescribed burns in the area, as the vegetation is susceptible to ignition and burning and should recover well after a fire.

5.6 LOW PB Viability

This section looks at the factors contributing to the viability of future prescribed burns on Lake of the Woods. There are constraining and enabling factors that contribute to the viability of the LOW PB program, some of these factors have been derived from the descriptive and evaluative design elements and their related themes, which are shown in the right-hand column.

Table 37: LOW PB: Viability

Constraining Factors	Description	Related Themes
Cost	• "Absolutely, cost is always up there in the forefront, it is always something that we look at. If the district wants to do a PB, they need to do all of the planning and all of that stuff, they propose it to us and we put our inputs in and let them know if it is feasible or if it's not feasible. Cost is always huge; the cost of fuel, the helicopter, the operator, the people that are there, you start putting these all together it starts costing money. Especially if you are talking the northern heli-torch, the more the logistics the more the cost. Depending on the amount of hectares that we are looking at burning. There is a dollar value per hectare" (D. Mclean, interview, Mar. 29, 2017).	
Public Backlash	• "Yeah, I think public backlash, for sure, but that's generally what people think because Smokey Bear has been around for so long and the slogan. Within LOW people love LOW and the islands and they do have attachment to some places, like I always go fishing there and now there is a burnt island that I have to look at" (A. Anderson, interview, Jan. 18, 2017).	-Negative Public Perceptions
Lack of Specialists	• "The biggest [limitation for aerial ignition] is the availability of the specialized people to do that kind of work. Right now, in Ontario, through retirement, trying to get people trained has been really hard on the program and it's not just in Ontario it's all across the board, right across Canada" (D. Mclean, interview, Mar. 29, 2017).	-Aerial Ignition – Lack of Experts

The first constraining factor for prescribed burns on Lake of the Woods is cost. Cost can be a limiting factor especially when using aerial ignition methods such as the heli-torch (D.

Mclean, Interview, Mar. 29, 2017). There is a cost value for every hectare burned and the more complex the PB the higher the cost.

Table 38: LOW PB: Viability (Continued)

Enabling Factors	Description	
LOW CR Management Goals	• "The idea is that once we get all of this information it will feed into fire management planning for the conservation reserve, so if we find that the burns are having a overall negative effect and that's just a very general term, negative effect, if it's on the veg or whatever, then maybe we need to say that we should be putting out more fires than we are. Whereas, if it's getting rid of some of those shrubby areas and we see some trees coming back then maybe we will say, no we need to let every fire possible burn out there as long as there is no threats to human value" (A. Anderson, interview, Jan. 18, 2017).	- Re-Introduction of Fire - Managing According to Natural Processes
OMNRF Capacity Building	• "[The LOW PB] was kind of a learning process this first time around and we got better in subsequent years, but definitely based what we saw in the LOW PB, it could be effective to provide fire on the landscape for ecological purposes" (J. Mash, interview, Jan 18, 2017).	-PB Capacity Building
Public Support	• "At the start there were a lot of negative phone calls, like what are you doing out there, you're wrecking the landscape. Eventually, we started getting more calls that were more positive, especially from people that were in some sort of ecological field who were retired" (P. Harvey, interview, Feb. 28, 2017).	
Fire Program Support	• "I think there would be a lot of good value with continuing on with a program out there and trying some different things out" (P. Harvey, interview, Feb. 28, 2017). • "We have the skills, definitely and the resources to do that [continue prescribed burning]" (J. Mash, interview, Jan 18, 2017).	

Public backlash is the second factor constraining PB viability. Based on negative public perceptions of wildfire and prescribed fire and the aesthetic values that people have towards certain areas of Lake of the Woods, there is a risk that further prescribed burn on high visibility islands could result in public backlash that could compromise the viability of future prescribed

burns. These public perceptions and backlash may be linked to the legacy of the Smokey Bear prevent wildfires campaign and misperceptions of the risks and benefits of fire (A. Anderson, Interview, Jan. 18, 2017).

The final factor that emerged concerning limitations to PB viability is the lack of specialists. As mentioned above, the AFFES has lost many PB specialists to retirement and opportunities for training new specialists on actual PBs is limited. This lack of specialists is important as it limits the amount and complexity of PBs that the OMNRF can plan and implement.

The first factor enabling PB viability is the OMNRF goal to manage the Lake of the Woods Conservation Reserve according to natural processes. The goals laid out in the *Lake of the Woods Conservation Reserve Management Plan* (Ontario Ministry of Natural Resources, 2006) and the *Prescribed Burn Pilot Study* (Ontario Ministry of Natural Resources, 2010) encourage the use of prescribed fire if it can be used to meet the objectives of landscape and species management.

The LOW PBs have also contributed to the OMNRF's prescribed burning capacities by providing training opportunities and experience to the prescribed burn planners and crews. This added benefit to the OMNRF has the potential to increase the viability of future PBs as there are operational as well as ecological and management benefits to the PBs.

Initially, there was some public backlash to the PBs on Lake of the Woods, but some calls were eventually received by the OMNRF from people who were supportive of the prescribed burning (P. Harvey, interview, Feb. 28, 2017). It is possible that as the goals and

principles underlying prescribed burning become better known and people are exposed to the idea of prescribed fire, the public may support future prescribed burning in the area.

Lastly, there is institutional support of prescribed burning within the OMNRF both from the district planning and fire operations branches. OMNRF support for prescribed fire increases the viability of future prescribed burning.

5.7 LOW PB Summary and Main Findings

5.7.1 Overview

The Lake of the Woods PB case study has looked at the OMNRF prescribed burn project through the biocultural design framework in order to identify what design elements influenced the prescribed burns. The benefit of this exploration has been the gathering and laying out of the factors that need to be considered for future prescribed burns in this area in order to achieve the goal of desirability, feasibility, and viability. This case study has demonstrated the complexity and diversity of elements that influence the planning, implementation, and outcome of prescribed burns in the Lake of the Woods Conservation Reserve. Given the complexity of the LOW PBs, these design elements and their constituent themes should be taken into consideration when designing future prescribed burns.

The descriptive design elements identified in this case study, provide an overview of what material factors affect and are affected by prescribed burning, the values that inform prescribed burn planning and implementation, and the techniques available. Having an adequate description of what plays a role in influencing prescribed burning, can make the planning and outcome of future prescribed burns more desirable, feasible, and viable.

Table 39: LOW PB: Descriptive Design Elements Overview

Descriptive Design Elements		
Materials	Values	Techniques
White Pine – Abundance	Re-Introduction of Fire	PB Intensity Class 2
White Pine – Fire Susceptibility	Managing According to Natural Processes	Aerial Ignition – 08/Premo
White Pine – Fire Survival	Pre and Post Burn Analysis	Aerial Ignition – 08/Premo Pattern
White Pine - Regeneration	Intensity Class 2 PBs	Aerial Ignition – 08/Premo Fire Behavior
Vegetation - Diversity	No Fire Spread from the Islands	Aerial Ignition - Heli-Torch
Vegetation – Fine Fuels	PB Capacity Building	Aerial Ignition - Logistics
Vegetation – Ladder Fuels	Human Life and Property	Hand Ignition – Drip Torch
Vegetation – Fire Resistant	Public Use areas	Hand Ignition – Fire Behavior
Vegetation – Late Succession	Aesthetics	Indices
Fire Adapted Species	Eagle Nests	Spring Burns
Poison Ivy	Air Quality	Island Size
Species at Risk		PB Complexity
Weather		Burn Window
Wind		Island Selection
Season		Vegetation Plots
Island Micro-Climate		Vegetation Plot Site Selection
Island Size		
Topography		
Ecozone		
Fire Cycle/Suppression		

One of the benefits of using the biocultural design framework in the exploration of the LOW PBs was the identification of enabling and constraining factors. These factors were

identified for each of the three evaluative design elements, desirability, feasibility, and viability. The presence of these factors indicate opportunities and barriers for the LOW PB project.

For desirability, the constraining factors are those values that limit the potential of the prescribed burns. Certain values, such as safety and public perceptions, need to be considered in order for the PB program to achieve outcomes that the OMNRF find meaningful and valuable. On the other hand, there are enabling factors, those values that support the prescribed burn and demonstrate that there are meaningful outcomes being achieved or there is potential for the PB program to achieve, like the management of the LOW CR along landscape ecology principles.

The section on feasibility is an overview of the limitations and capabilities that play a role in whether the Lake of the Woods prescribed burns are technically possible. The constraining factors limit the feasibility of the prescribed burn program, namely in the material features of the treatment area (e.g. ignition resistant islands and poison ivy) and ignition constraints (e.g. the lack of ignition experts). These are only aspects of the PB program's feasibility, they are limitations, but not factors that make the program unfeasible on the whole. Enabling factors provide some solutions to the constraining factors and demonstrate the feasibility of other aspects of the PB program. The use of aerial ignition reduces the safety risks for ground crews and the presence of fire susceptible plants and landscapes make some islands better candidates for burning.

Lastly, there are factors that constrain the viability of the Lake of the Woods prescribed burn program, such as public backlash and a lack of specialists. However, the enabling factors for viability show potential opportunities for addressing these constraining factors. The viability

of the Lake of the Woods PB program rests on the support of the OMNRF fire program and the public. The LOW PBs meet management goals and build capacity building and thus increase the potential for support and viability.

Table 40: LOW PB: Evaluative Design Elements Overview

Evaluative Design Elements		
Desirability	Enabling Factors	Constraining Factors
	Rare Plants	Safety
	Managing Along Landscape Ecology Principles	Sensitive Species
	Learning How Fire Works on the Landscape	Negative Public Perceptions
	PB Capacity Building	
Feasibility	Enabling Factors	Constraining Factors
	Drip Torch - Results	Aerial Ignition – Lack of Experts
	Aerial Ignition – PB Complexity	Aerial Ignition - Accuracy
	Aerial Ignition - Safety	Hand Ignition – Safety
	Fire Prone Plants	Poison Ivy
	Fire Landscape	Topography
		Ignition Resistant Islands
Viability	Enabling Factors	Constraining Factors
	LOW CR Management Goals	Cost
	OMNRF Capacity Building	Public Backlash
	Public Support	Lack of Specialists
	Fire Program Support	

CHAPTER 6: CONCLUSIONS

6.1 Main Findings and Discussion

This research represents the first phase of a biocultural design process that looks at two case studies of prescribed fire: one on Lake of the Woods and one in Wabaseemong Independent Nation. The conceptual framework of biocultural design was used as tool for gathering and evaluating the elements that influenced the design and outcomes of these prescribed burns. The data identified through this research represent the outcome of the divergent phase of design and provide options for the next choice-making stage of the design process. The potential for innovative design solutions for prescribed burning can come from design elements, such as those presented in this research.

In order to achieve the purpose of evaluating the past used of prescribed burning and identifying the design elements that comprise the use of prescribed fire, three questions were used to guide this research:

1. What are the design elements that influenced the planning, implementation, and outcome of the prescribed burns on Lake of the Woods and in Wabaseemong?

2. What are the enabling and constraining factors of prescribed burning that affect its ability in achieving multiple outcomes?

3. What outcomes did managers hope to achieve through the use of prescribed burning on the LOW islands and in Wabaseemong and has the use of prescribed burning met those goals? Were these goals and outcomes consistent with the values set out in OMNRF guiding policies and documents?

The following three sections will cover the findings for each of these questions, followed by theoretical research implications, limitations and suggestions for future research, and concluding thoughts.

6.1.1 WIN and LOW PB Design Elements

The themes that populated the design elements in this research- demonstrated the knowledge and values specific to community members and the capabilities of the prescribed burn teams. The benefit of the conceptual framework used in this research is that it identifies capabilities, values, and knowledge particular to the place in which the design project is taking place. The separation of design elements into community and operational considerations allowed for clear distinctions in where opportunities and barriers lie and in which realm specific considerations need to be made.

At this phase of the design process, all design elements are given equal weight and thus a full picture is available of the elements at play in these prescribed burn projects. The value of this biocultural design perspective for prescribed burning is that it provides insights or choices, in the form of the design elements and their relevant themes, for future prescribed burn designs.

The contribution that community members, PB specialists, fire crew members, and district planners made to the design elements gathered in this research also demonstrates how biocultural design can support the capabilities of design participants. Biocultural design is premised on the idea that design can be a compositional process that brings together the "knowledge, values, and skills" of its participants and in this way draw upon and support local capabilities (Davidson-Hunt et al., 2012). The knowledge and values that were expressed by WIN community members and OMNRF staff, demonstrate two realms of knowledge, capabilities, and values that can be brought together into a design process.

6.1.2 Enabling and Constraining Factors of the WIN and LOW PBs

Enabling and constraining factors are linked to the desirability, feasibility, and viability of the LOW and WIN PBs. Enabling and constraining factors were identified by two methods. Firstly, interview participants explicitly pointed out how certain factors either limited or supported the desirability, feasibility, or viability of the PBs. Secondly, as data was gathered from interviews and grouped into themes related to the design elements, it became clear that certain themes would either enable or constrain the PBs. In some cases, solutions to the enabling and constraining factors were already present in the design elements, but there also remain gaps in these elements where future design and planning may be necessary to overcome constraints.

The identification of enabling and constraining factors also demonstrates the value of biocultural design and the role that a designer plays within the biocultural design framework. Acting less as an expert designer, the designer(s) involved in biocultural design facilitate the implementation of the biocultural design process. However, the designer/researcher, being in the unique position of gathering, organizing, and laying out the design element data, can identify opportunities or problems in the form of enabling and constraining factors. It follows that, with the collaborative characteristic of the biocultural designing process, these enabling and constraining factors should be presented to the design team for consideration in the development of a working solution.

6.1.3 Outcomes of the WIN and LOW PBs

The outcomes of the WIN and LOW PBs have largely met the objectives set out in these projects. Evaluating the outcomes of these PBs can be accomplished by analyzing the

desirability, feasibility, and viability of each PB program as well as by looking at whether the outcomes met the objectives and goals laid out for the PBs in OMNRF planning documents.

The WIN PBs were designed to reduce the number of human-caused wildfires through the use of prescribed fire and thus provide protection to the community. Based on the interviews conducted for this study, it appears that the WIN PBs are meeting the *Wildfire Management Strategy's* goals and objectives. In addition, the enabling factors influencing desirability, feasibility, and viability provide opportunities to further support the effectiveness and value of the WIN PB program. However, some of the constraining factors affecting the WIN PB's desirability, feasibility, and viability are complex and will require further research into solutions that will work for the community.

The OMNRF's *Old Growth Policy for Ontario's Crown Forests* (2003) and *Wildland Fire Management Strategy* (2014) both lay out the desire and procedure for learning from the process of implementation. These documents outline steps for improving fire management strategies and policy by gathering information regarding the implementation of policy directives and by engaging local communities in order to identify "values, opportunities, and objectives" (Ontario Ministry of Natural Resources, 2014b). The built-in learning-through-implementation aspect of biocultural design lends itself to the adaptive management approach outlined in the *Old Growth Strategy for Ontario's Crown Forests*. The lessons learned from this research can be used to inform and direct future prescribed burn planning and design, thus meeting the adaptive management requirements laid out in the *Old Growth Policy*.

This research was meant to provide insight into the recent prescribed burns and thus contribute to the learning and engagement process laid out in these documents. However, in

performing this research, it became clear that the OMNRF had not begun an organized process for learning from these prescribed burns, other than the vegetation plot sampling conducted on Lake of the Woods. The desire for greater public engagement in the WIN PBs and the lack of an assessment of public opinions following the LOW burns indicates that more effort is needed in meeting policy objectives. By using a framework like biocultural design, the OMNRF can evaluate the outcomes of their prescribed burns and use that information to guide their adaptive policy approach. In addition, the collaborative aspect of biocultural design can help achieve the objectives of community engagement and the consideration of local values.

The LOW PB was consistent with the goals of the *Lake of the Woods Conservation Reserve Prescribed Burn Pilot Study* (Ontario Ministry of Natural Resources, 2010) in that the goals and objectives to reintroduce fire in a manner that emulates natural disturbance, protects human lives and safety, is scientifically rigorous, and allowed for the study of the effects of fire were met. Other documents that underpinned the LOW PB program were the *Lake of the Woods Forest Fire Response Plan* (Ontario Ministry of Natural Resources, 2012) and the *Lake of the Woods Conservation Reserve Resource Management Plan* (Ontario Ministry of Natural Resources, 2006).

The *Lake of the Woods Conservation Reserve Resource Management Plan* states that "fire [is] an important ecosystem process, fundamental to restoring and maintaining the ecological integrity of the natural environment represented within this Conservation Reserve." (Ontario Ministry of Natural Resources, 2006). The *Lake of the Woods Conservation Reserve Prescribed Burning Pilot Study* is an attempt to meet this management directive by implementing prescribed burns in a controlled way in order to understand their impact on the

landscape. The *Prescribed Burning Pilot Study* and the *Resource Management Plan* refer to ecological integrity as the desired outcome of prescribed fire. Ecological integrity is defined as:

> A condition in which biotic and abiotic components of ecosystems and the composition and abundance of native species and biological communities are characteristic of their natural regions and rates of change and ecosystem processes are unimpeded (Ontario Ministry of Natural Resources, 2010)

Based on the objectives and goals laid out in the *Fire Response Plan*, the *Prescribed Burning Pilot Study*, and the *Resource Management Plan*, it appears that the LOW PB project's outcomes has met those goals. The additional benefits of the PB program, such as *PB capacity building* and *OMNRF capacity building* add additional justification for future projects like this one.

Old growth red and white pine receive particular attention in the *Old Growth Policy* (2003) and *Lake of the Woods Conservation Reserve Resource Management Plan* (2006), but this research has shown that red and white pine trees and old growth forests do not receive special consideration in the current management of the LOW Conservation reserve. Precautions were taken to prevent mortality in pine trees on the islands that were burned, but the management objective of managing according to natural or ecological processes does not favour one tree type or successional stage over another.

Given the high concentration of people in the Lake of the Woods area, the cultural values that have been associated with white pine may play a role in how the public responds to prescribed burns on the landscape. The relationship between public acceptance of prescribed fire and the context in which they take place suggests that aesthetics and other local values should be considered in prescribed burn design (McCaffrey, 2006). If a prescribed burn program

were to continue on Lake of the Woods, the cultural value of white pine will have to play a role in how islands are selected and the techniques used for burning them.

It has also been shown that white pine require regular, low intensity fires in order to remove competitive species and re-seed (Beverly & Martell, 2003; Waldrop et al., 1992). The low intensity prescribed fires used in prescribed burn project on Lake of the Woods meet the criteria of fire prescribed for white pine stand maintenance (Mcrae et al., 1994). However, it has been asserted that the prevalence of white pine in the Lake of the Woods region is largely influenced by the presence of historic anthropogenic fire (Mcrae et al., 1994; Waldrop et al., 1992). Given that the presence of white pine on the landscape is a result of human fire, it follows that a prescribed burn program that does not take into account anthropogenic fire and the intentional burning of specific islands will produce a landscape that does not resemble the historical or current one.

The Lake of the Woods prescribed burn project was guided by a desire to emulate natural fire and this approach influenced the island selection process, which was mostly random. The justification for this approach was premised on the idea of managing according to natural processes. The OMNRF wanted to learn how island vegetation would respond to fire and decided that the best way to introduce fire to these islands was through a randomized selection process, which assumes that the distribution of fires on islands in the past was a result of random ignition from natural sources. However, two key factors suggest that a random process of island selection may not accurately represent the historical distribution of fire on islands 1) human caused fires have historically burned on islands in the area (Davidson-Hunt, 2003a) and 2) interview participants indicated that some islands were susceptible to burning,

while others were not, which means that some islands may not burn, regardless of the source of ignition.

If Lake of the Woods Conservation Reserve managers aim to manage fire according to a definition of 'natural' that excludes anthropogenic fire, then the historic use of fire on the landscape by people would play no role in understanding the history that influenced the current composition of the landscape and contemporary prescribed burning should play no role in current management practices. If anthropogenic fire is considered in the history and management of the landscape, then prescribed burning can be justified to meet management goals and the selection of islands should be guided by principles that include criteria such as susceptibility to fire. Islands that are capable of being burned, which are likely the islands that burn after natural or human ignition, are the ones that should be prioritized in a prescribed burn project.

The OMNRF district planners prefer to manage the LOW Conservation reserve according to 'natural' disturbance and successional patterns, allowing the forest to change with little to no human intervention, but this concept of 'nature' ignores the cultural legacy that humans and fire have had on the landscape. The forest that currently exists is a product of both human and non-human disturbances. Thinking about this forest in terms of 'natural' verse human misses the interconnected relationship between anthropogenic fire and a landscape, the biocultural heritage of the Lake of the Woods.

6.2 Contributions of this Research

This research is the first use of biocultural design as a tool for evaluating and learning from past projects. Conducting and analysing this research involved developing the conceptual framework of biocultural design into a tool that could be used in the first phase of a design process. Biocultural design has hitherto been conceptually framed, but its use as a tool for relevant projects has been limited and this research has demonstrated the use of the framework within the restrictions of the initial design phase of a biocultural design project. This research has shown that the biocultural design framework can be used to guide research and generate compositional and evaluative data from which later design phases can draw on.

The tools developed in this research for analysing and evaluating bicultural projects can be applied to case studies other than those related to prescribed burning. The process described here provides an opportunity for learning during the research and design process. The biocultural design process provides a voice to communities and allows for marginalized people and perspectives to contribute to planning and design that has a potential impact on their lives and communities.

As a tool for prescribed burn management, biocultural design provides contextual information that can serve to inform and support prescribed burns or identify boundaries and constraints that should be respected or that require careful design in order to account for. This research does not provide results that suggest prescribed burning is distinctly good or bad. Instead, the implication of this research is that the acceptability or effectiveness of prescribed burning as a management tool is contextual. A prescribed burn's desirability, feasibility, and viability is dependent on where it is being applied, who is applying and how, and who and what

it affects. These evaluative design elements will fluctuate between places and across time and they must be accounted for if prescribed burns are intended to be done safely, respectfully, and with diverse human goals and values in mind.

The literature relating to public perceptions of prescribed burning suggest that people are accepting of prescribed fire if they understand the purpose of its use, trust those who are planning and implementing the burns, and feel satisfied as to the safety and impacts of the burns (Bright & Newman, 2006; McCaffrey, 2006). The use of biocultural design in this project provided a means for evaluating local community concerns regarding the use of prescribed fire. Participants in this project were in favour of the use of prescribed fire but voiced concerns about safety, smoke, and the level of community involvement. These finding support the conclusions of Bright and Newman (2006) and McCaffrey (2006) and emphasize the need for recognizing these concerns, and continuing trust building and engagement with communities involved with prescribed burning.

A further advantage of biocultural design is its inclusion of community members in the development of prescribed and other fire management designs and strategies. In *The Science of Firescapes: Achieving Fire Resilient Communities,* Smith et al. (2016) recommends that communities become more involved as active partners in managing wildfire risk and tackling the wicked problem of wildfire management. Biocultural design is a step in this direction, as it requires the input of community members in the development of working solutions on local landscapes.

The advantage of a biocultural design framework for evaluating prescribed fire is its focus on social/cultural elements, technical elements, and material/biological elements. The

evaluative process of the biocultural design framework provides social and ecological feedback that Armitage et al. (2009) and Berkes (2009) describe as necessary for assessing past actions and modifying future plans in order to achieve appropriate social and ecological strategies for a community. This research has shown that the biocultural design framework can be used as an evaluative lens capable of forming the foundation of a collaborative management process that can be used to address the trust and public engagement issues present in the use of prescribed fire. Future prescribed burning projects could benefit from a collaborative management approach, informed by a biocultural design process. As prescribed fires are implemented, their impacts and outcomes can be explored, evaluated, and modified using the biocultural design framework, beginning with the divergent and exploratory phase represented by this research. This process can serve to inform contextual solutions or designs that will help to increase public engagement and support, while meeting the goals and capabilities of those implementing the burns.

The decision to display the results of this research (the design elements, themes, and the demonstrative quotes) as visual tables was to facilitate the use of these results of the design process. In their *Field guide to Human-Centered Design* (2015a) the design company IDEO emphasizes the need for visualizing the conceptual frameworks used for gathering data and connecting related concepts. Visualizing, for IDEO, is how patterns are recognized and concepts are absorbed (IDEO, 2015a). The design element tables presented in this research are the first step in visualising the design elements and their constituent themes and how they interact and influence the prescribed burn programs. If this biocultural design project were to

continue into the next phases of the design process, these tables would be used visualize the factors that compose, enable, and constrain prescribed burning.

Visualizing these design elements can allow for brainstorming and concept mapping sessions to identify opportunities and insights. The process that IDEO describes for human-centered design begins with inspiration, followed by ideation, and ends with implementation (IDEO, 2015a). This research is situated in the inspiration and ideation phases of this process. The next steps involve brainstorming, storyboarding, and prototyping. These steps utilize the themes, lessons, and frameworks developed in the inspiration and ideation phase demonstrated through this research project. This research has shown that the conceptual framework of biocultural design can be used to gather information and lessons that can be used in the inspiration and ideation phases of human-centered design.

Figure 12: Biocultural Design Solution Prototype

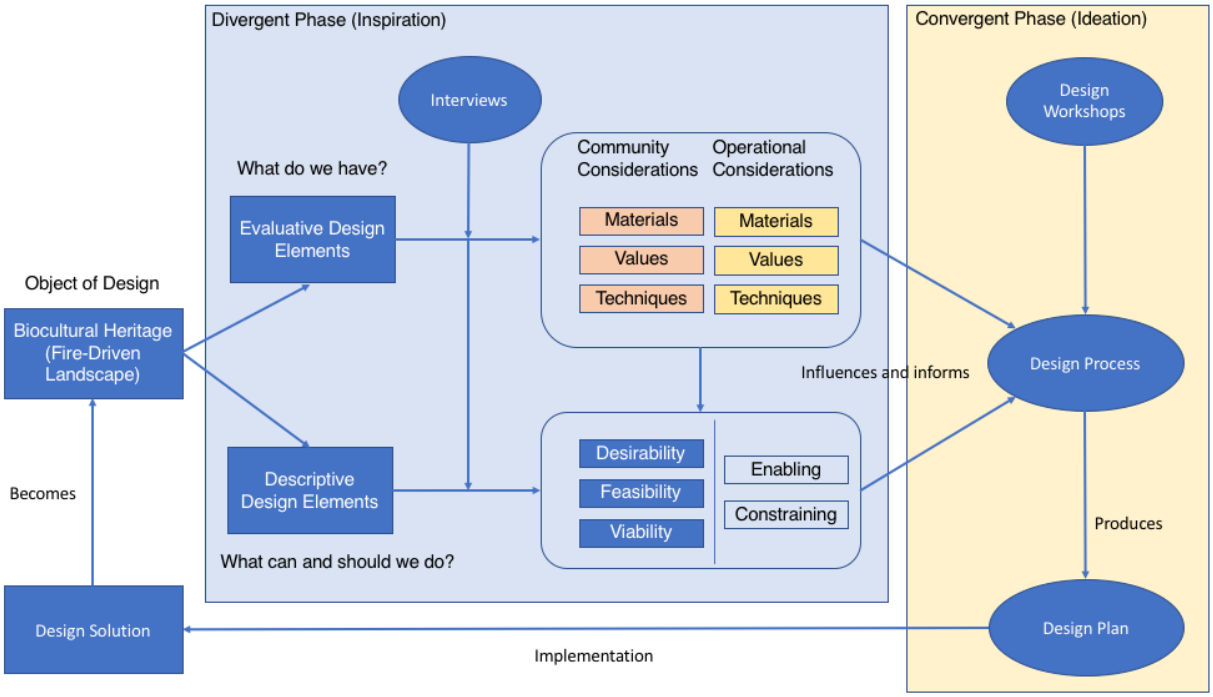


Figure 12 is a visual representation of the prototype biocultural design solution process used in this research. This research is represented by the divergent phase of this process. The process displayed here is a tool that can be used elsewhere by researchers for back-casting onto biocultural projects for the purpose of evaluation or beginning the divergent phase of a biocultural design project.

6.3 Limitations and Suggestions for Future Research

One of the primary limitations in this study was the lack of community input from the Lake of the Woods case study area. There was a difficulty in finding potential participants who were aware of the prescribed burns that had taken place on Lake of the Woods. Future research into prescribed burns in the Lake of the Woods region should look into public values concerning prescribed and wild fire in the landscape of Lake of the Woods.

Further research that can support the *materials* and *values* component of this research would be participatory mapping of harvesting areas with the types of plants being harvested in each area. This information could inform the desirability of burning in certain areas based on the detrimental or beneficial effects of fire.

This research has been a biocultural design influenced exploration into the design elements influencing prescribed burns in WIN and LOW. The next step in a biocultural design project would be to take the information gathered in these studies and begin a collaborative design process, in which key participants from the communities involved, the operations branch, and the planning branch of the prescribed burning program would discuss the enabling and constraining factors outlined in this research. Based on the information gathered in this

study and the collaborative design workshops, working solutions would be developed, implemented, and evaluated. The exploratory and evaluative phase of biocultural design used in this research can be used on future iterations of prescribed burn implementations to determine the effectiveness of the biocultural design process. The advantage of the evaluative aspect of biocultural design is the ability to test and learn from the outcomes as well as the process.

Implementation, evaluation, and redesign are core principles of biocultural design. The design process does not end once a solution or product has been created, involvement in design continues as the clients or participants interact with the solution and develop new capabilities or recognize new opportunities through it (Davidson-Hunt et al., 2012). The iteration inherent in biocultural design is premised on Nelson & Stolterman's (2003) idea that design is a process of composition; the creation of working solutions, not permanent ones, is the natural outcome of a living design process (Davidson-Hunt et al., 2012). This requires continued engagement in biocultural designing as the planners, implementers, stakeholders, and landscape that is involved in prescribed burning is altered. Reassessment or correspondence and another round of design follows each implementation. Therefore, future research would involve a constant re-evaluation of the prescribed burns in order to adapt their design to suit any change in the evaluative design elements.

Lastly, more studies using biocultural design as a framework for design element identification and evaluation would be beneficial in testing the biocultural design framework. Biocultural design is new practise and further studies would help to develop the conceptual lens and practise for its use in evaluating and designing projects similar to the prescribed burns

described in this research. A full test of the biocultural design framework and process would include a research and design project that included the divergent phase, convergent phase, implementation, and re-evaluation.

6.4 Concluding Thoughts

This study is not meant to provide a solution to any of the issues that may arise or may have arisen from the prescribed burn projects on LOW and WIN. What is provided here is a framework of how future prescribed burning can be evaluated in a way that contributes to a design process. The people who are involved in the planning and implementation of prescribed burns are specialists in their field and community members have intimate knowledge and experience within the landscapes around their homes; this research is meant to provide a link between these groups and offer a collaborative design-based perspective into prescribed burning.

The use of a biocultural design framework provides an alternative analysis for the role of fire in a cultural landscape. As discussed in chapter 2, there is strong evidence of long-term anthropogenic fire in the landscape of Lake of the Woods. Anthropogenic forest fires are one factor that makes Lake of the Woods a cultural landscape. However, as the *Prescribed Burning Pilot Study* and the interviews in the Lake of the Woods case study has shown, the reintroduction of fire on the landscape of Lake of the Woods focused on the natural or ecological processes that drove disturbance in the area; human-caused fire was not considered as a process that drove plant distribution and landscape ecology. By only considering Lake of the Woods as a natural landscape, driven and shaped by ecological processes, the OMNRF may

be missing some of the factors that originally shaped the plant type and distribution on the landscape. The plant communities and habitats on LOW are a result of both human and natural disturbance. By only managing according to natural disturbance, the OMNRF will not be able to achieve the landscape and ecosystem types that traditionally formed the Lake of the Woods. Or at the very least, the current values that guide the landscape of the management of the LOW Conservation Reserve will lack the design elements that can be derived from a cultural landscape.

The advantage of using a biocultural design framework in studying and managing a landscape is that it intentionally brings culture into the design process. This cultural perspective informs values and outcomes, which in turn inform our understanding of the role of fire on the landscape. The presence of certain plant species, distribution patterns, disturbance cycles, and ecosystems are the result of a fire regime that included cultural fire. From a biocultural design perspective, the role of fire on the landscape would be both ecological and cultural; maintaining ecological processes and cultural values at the same time. This is especially relevant as the desire to maintain or conserve certain ecological processes or communities is inextricably entwined with cultural values. Biocultural design's use of biology and culture allow for designers to be transparent and intentional in their designs. It forces designers to consider how values, such as ecological or natural objectives, influence their decisions and ultimately result in a landscape shaped by those values.

Biocultural design's focus on design elements that influence composition and evaluation of a landscape-scale project provides a unique perspective into the interaction of materials values and techniques, and desirability, feasibility, and viability. This perspective allows for an

understanding of a design situation in which capabilities are assessed and enabling and constraining factors are considered in relation to the desired outcomes. Certain outcomes or desired solutions can be evaluated according to the values that surround the landscape being designed and the feasibility of the solutions presented can be assessed according to the technical capabilities or materials available. The multi-faceted approach of biocultural design drives the creation of working solutions that consider the complexity of a design problem and the real-world limitations to a design's implementation. Lastly, the evaluative component of biocultural design is a process built into the framework. This evaluative aspect allows for a process of ongoing evaluation over the course of planning, implementing, assessing, and re-designing. As working solutions and designs are implemented on a landscape, the landscape will alter; the materials, capabilities, and values change in response to the acting out of a design. The ever-changing nature of cultural landscapes means that evaluation and design must continue in order to ensure that the outcomes still meet the criteria of those involved.

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APPENDIX 1

UNIVERSITY OF MANITOBA | Research Ethics and Compliance
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APPROVAL CERTIFICATE

November 22, 2016

TO: **Kurtis Ulrich** **(Advisor: Iain Davidson-Hunt)**
Principal Investigator

FROM: **Kevin Russell, Chair**
Joint-Faculty Research Ethics Board (JFREB)

Re: **Protocol #J2016:091 (HS20210)**
"Learning from Prescribed Burns: A Biocultural Design Case Study from Lake of the Woods, Ontario"

Please be advised that your above-referenced protocol has received human ethics approval by the **Joint-Faculty Research Ethics Board**, which is organized and operates according to the Tri-Council Policy Statement (2). **This approval is valid for one year only and will expire on November 22, 2017.**

Any significant changes of the protocol and/or informed consent form should be reported to the Human Ethics Coordinator in advance of implementation of such changes.

Please note:

- **If you have funds pending human ethics approval, please mail/e-mail/fax (261-0325) a copy of this Approval (identifying the related UM Project Number) to the Research Grants Officer in ORS in order to initiate fund setup. (How to find your UM Project Number: http://umanitoba.ca/research/ors/mrt-faq.html#pr0)**

- **if you have received multi-year funding for this research, responsibility lies with you to apply for and obtain Renewal Approval at the expiry of the initial one-year approval; otherwise the account will be locked.**

The University of Manitoba may request to review research documentation from this project to demonstrate compliance with this approved protocol and the University of Manitoba *Ethics of Research Involving Humans*.

The Research Ethics Board requests a final report for your study (available at: http://umanitoba.ca/research/orec/ethics/human_ethics_REB_forms_guidelines.html) **in order to be in compliance with Tri-Council Guidelines.**

APPENDIX 2

Sample Consent Form for Wabaseemong Case Study

UNIVERSITY OF MANITOBA

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Designing Prescribed Burns: Two Biocultural Design Case Studies from Northwestern Ontario

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This consent form, a copy of which will be left with you for your records and reference, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

Project Summary: This project is being conducted as a part of my Master's degree in Natural Resource Management at the University of Manitoba. The purpose of this research will be to analyse the recent prescribed burn program in Wabaseemong through the lens of biocultural design and facilitate a collaborative landscape design conversation in order to learn from the recent burns conducted and provide information that can be used by managers for future prescribed burn planning in Wabaseemong Independent Nation. This project will focus on the process of prescribed burning, what can be learned from its implementation, and its use in designing and managing a landscape, utilizing the conceptual framework of biocultural design. Biocultural design is a framework that considers how materials, values, and techniques interact in the management of cultural landscapes. Community members, resource

planners, and fire managers will be included in this project in order to explore the biocultural design principles of desirability, feasibility, and viability and their relation to prescribed burning outcomes.

Nature of Participation: As a research participant, you will be involved in individual semi-structured interviews. The interview will be in person and take approximately 40 minutes. Participation in this interview is voluntary and no economic compensation will be provided. You may decline to answer any questions and/or withdraw from the study at any time without any loss or negative consequences. You may withdraw from the study even after the interview is over by contacting the researcher via email or telephone. If you choose to withdraw from the study, all of your recordings and transcripts will be immediately destroyed. Once your data has been incorporated into the thesis analysis, making it impossible to be excluded, and after the thesis has been submitted to the Faculty of Graduate Studies, it will no longer be possible to withdraw from the study. It will be impossible to withdraw from the study after December 31, 2017. I will request that you permit me to digitally record our conversation for the process of data analysis, but if you object, I will transcribe it by hand. Immediately after the interview, you will be debriefed, in which the researcher will verbally summarize the information you have provided. The University of Manitoba may look at your research records to see that the research in being done in a safe and proper way.

Data Gathering and Storage: Interviews will be documented through note taking and the use of a digital recording device. All recordings, notes and transcripts will be stored in password protected computer files and any hard copies will be stored in a locked cabinet. No digital recording devices will be used or photographs taken during interviews without written consent from you the participants involved in the interview session.

Confidentiality: I will keep any information gathered in this research strictly confidential. All data will be identified only by code number with the code key stored separately to ensure to direct linkage can be made between individuals and the raw data. Data will be kept in a locked cabinet. Confidential personal information will be stored in password protected electronic files and destroyed (permanently deleted) no later than December 31, 2018. Only my advisor and I will have access to the data. You will not be named or identifiable in any reports of this study. If any statement you made during this interview is used in a research report it will be attributed to an anonymous source, unless you request otherwise. Full masking, however, may not be possible. Others may speculate or make inferences as to the identity of research participants and who said what. A copy of the interview transcript will be given to you after the interview in order for you to review the transcripts for any inaccuracies or details that you feel to be compromising to your anonymity.

Risk and Benefits: This research does not present any risks to participants or third parties beyond that experienced in day-to-day life. The possible benefits of your participation in this research include increased collaborative management in land use planning in the study area, opportunities to learn from recent management initiatives, and prescribed fire outcomes that meet the values of local communities. No information will be used in a way that puts your integrity or safety at risk. It is possible the interview

questions will evoke negative emotions related to land use issues. If this occurs, you may skip a question without negative consequences and/or withdraw participation at any time.

Feedback and Dissemination: Results from this research will be disseminated at academic conferences, by publication in academic journals and a Master's thesis. A brief summary of the results (1-3 pages) will be made available to organizations and community members that request them by December, 2018. Please indicate how you wish to receive this summary:

□ sent to e-mail address: _____.

□ sent through regular mail to the following address: _____.

□ sent to a community organization: _____.

□ not interested in receiving the summary of results.

Consent: Please indicate the following

Yes /No	1. I agree that the researcher may use a digital recording device during this interview.
Yes /No	2. I agree that the researcher may cite my name and directly quote me in future publications. I understand that as a result it will be possible for others to recognize me. (Please, feel free to answer this item at the end of the interview)
Yes /No	3. I agree that the researcher may directly quote me using pseudonym rather than my real name (Please feel free to answer this item at the end of the interview)
Yes /No	4. I agree that photographs of myself taken during my participation in this study may be taken and used in presentations, reports and publications connected to this research.

Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to participate as a subject. In no way does this waive your legal rights nor release the researchers, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time, and/or refrain from answering any questions you prefer to omit, without prejudice or consequence. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation.

Participant's Signature Date

Researcher's Signature Date

This research has been approved Joint Faculty Research Ethics Board. If you have any concerns or complaints about this project you may contact any of the above-named persons or the Human Ethics Coordinator at the University of Manitoba at (204) 474-7122 or humanethics@umanitoba.ca. A copy of this consent form has been given to you to keep for your records and reference.

APPENDIX 3

Interview Schedule for Wabaseemong Case Study

A3.1 Semi-structured interview schedule for community members

Personal History of Participant	1. Name, extent of familiarity with the study area 2. occupation/activity in the study area 3. Length of residency/experience in the study area
The Cultural Landscape of Wabaseemong	1. What is your experience with prescribed fire in Wabaseemoong? 2. What role do you see prescribed fire playing in the community? 3. Has your perception of fire changed after prescribed fire has been introduced in the community? Why? 4. What outcomes of the prescribed fire do you value and disvalue? Why? 5. Has prescribed burning affected the community or landscape in a significant way for you? How? 6. How important to you are the areas that have been burned? Why? 7. What aspects of these areas do you value? Why? 8. If prescribed fire were to be continued in the area, what outcomes would you like to see? Why?

Prescribed burn site selection and purpose in Wabaseemong	1. What was the purpose/goals of the recent implementation of prescribed fire in Wabaseemoong? Were the goals achieved? 2. How were the sites selected for prescribed burning and what was the justification for that selection criteria? 3. What were the outcomes/results of the prescribed burns? Were the results consistent with the goals/values of the PB program? 4. Were there documents or policies that guided the recent prescribed burns? If so, did the prescribed burns achieve the objectives set out in these documents? 5. Was there any public/stakeholder consultation before or after the prescribed burns and how might public consultation affect the planning and implementation of prescribed burning? 6. How were the outcomes of the recent prescribed burns evaluated? 7. Based on the outcomes of this PB program, are there any future plans for prescribed fire in Wabaseemoong? Why or why not? 8. What is the long term viability of prescribed burning in Wabaseemoong and what factors influence its continued use?

Prescribed Fire technique in Wabaseemong	1. What were the outcomes/results of the PBs? Were these results consistent with the goals/values of the PB program? 2. What were the primary factors influencing the outcomes of the prescribed burns? 3. What were the primary factors considered when conducting the recent prescribed burns in the study area? 4. What methods of ignition were used when conducting the prescribed burns and what determined the methods used? 5. What different techniques, if any, could be used to achieve the desired outcomes? 6. How did ignition type influence fire behaviour and burn outcomes? 7. How did the forest type and age contribute to the outcomes of the prescribed burns? 8. Given the constraints of prescribed burning, what is the feasibility of conducting prescribed burns while achieving the goals of the Wabaseemoong PB program?
Collaborative Management	1. Were you aware of the purpose and goals of the recent prescribed burn program? 2. If future prescribed burning were to take place, how would you like to contribute to the outcomes achieved?

A3.2 Semi-structured interview schedule for OMNRF/AFFES fire staff

Prescribed burn site selection and purpose in Wabaseemong	1. What was the purpose/goals of the recent implementation of prescribed fire in Wabaseemoong? Were the goals achieved? 2. How were the sites selected for prescribed burning and what was the justification for that selection criteria? 3. What were the outcomes/results of the prescribed burns? Were the results consistent with the goals/values of the PB program? 4. Were there documents or policies that guided the recent prescribed burns? If so, did the prescribed burns achieve the objectives set out in these documents? 5. Was there any public/stakeholder consultation before or after the prescribed burns and how might public consultation affect the planning and implementation of prescribed burning? 6. How were the outcomes of the recent prescribed burns evaluated? 7. Based on the outcomes of this PB program, are there any future plans for prescribed fire in Wabaseemoong? Why or why not? 8. What is the long term viability of prescribed burning in Wabaseemoong and what factors influence its continued use?

Prescribed Fire technique in Wabaseemong	1. What were the outcomes/results of the PBs? Were these results consistent with the goals/values of the PB program? 2. What were the primary factors influencing the outcomes of the prescribed burns? 3. What were the primary factors considered when conducting the recent prescribed burns in the study area? 4. What methods of ignition were used when conducting the prescribed burns and what determined the methods used? 5. What different techniques, if any, could be used to achieve the desired outcomes? 6. How did ignition type influence fire behaviour and burn outcomes? 7. How did the forest type and age contribute to the outcomes of the prescribed burns? 8. Given the constraints of prescribed burning, what is the feasibility of conducting prescribed burns while achieving the goals of the Wabaseemoong PB program?

APPENDIX 4

Interview Schedule for Lake of the Woods Case Study

A4.1 Semi-structured interview for ignition specialists

Personal History of Participant	1. Name, occupation/role in prescribed burn team 2. Number of years conducting prescribed burns 3. Role/level of participation in conducting the recent prescribed burns in the study area
Prescribed burning	1. What were the outcomes/results of the PBs? Were these results consistent with the goals/values of the PB program? 2. What were the primary factors considered when conducting the recent prescribed burns in the study area? 3. What methods of ignition were used when conducting the prescribed burns and what determined the methods used? 4. What different techniques, if any, could be used to achieve desired outcomes? 5. How did ignition type influence fire behaviour and burn outcomes? 6. How did the forest type and age contribute to the outcomes of the prescribed burns? 7. Given the constraints of prescribed burning, what is the feasibility of conducting prescribed burns while achieving the goals regarding old growth white pine?

A4.2 Semi-structured interview schedule for conservation reserve planners

Personal History of Participant	1. Name, occupation/role in conservation reserve planning 2. Length of time spent working in position/study area 3. Familiarity with the study area 4. Familiarity with the communities in the study area
Lake of the Woods Conservation Reserve Planning/Management	1. What are the guiding documents/values that influence planning in the Lake of the Woods conservation reserve? 2. How is white pine considered in conservation reserve planning? What level of significance are they given? 3. Is the LOW conservation reserve considered a cultural landscape? If so, how does this influence management? (Does the evidence of historical human-caused fire play a role in the planning of prescribed burns?)
Prescribed Burning	1. What was the purpose/goals of the recent implementation of prescribed fire on the Islands of Lake of the Woods? Were the goals achieved? 2. What were the primary factors influencing the outcomes of the prescribed burns? 3. How were the Islands selected for prescribed burning and what was the justification for that selection criteria? 4. Were there documents or policies

	that guided the recent prescribed burns? If so, did the prescribed burns achieve the objectives set out in these documents? 5. Was there any public/stakeholder consultation before or after the prescribed burns and how might public consultation affect the planning and implementation of prescribed burning? 6. How could the values set out in the Lake of the Woods Conservation Reserve Management Plan and Old Growth Policy regarding white pine be considered in regards to prescribed burn planning? 7. How were the outcomes of the recent prescribed burns evaluated? 8. Based on the outcomes of this PB program, are there any future plans for prescribed fire in the conservation reserve? Why or why not?