A Critical Evaluation of Winter Archaeological Impact Assessments for Proposed Oil and Gas Developments in Northeast British Columbia

by

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Abstract

Consulting archaeologists in northeast British Columbia have employed winter testing for archaeological impact assessments for over a decade. This thesis compares archaeological impact assessments carried out during summer and winter conditions to determine if snow cover effects the rate of site identification. To do so, this thesis first discusses the environmental and cultural history of northeast British Columbia. The unique regulatory environment that has developed around the oil and gas industry, which led to the introduction of winter testing, is also examined. The requirements for consulting archaeologists carrying out winter assessments are introduced and reviewed. Data, in the form of archaeological impact assessments reports, are presented and analyzed to compare reports produced during summer and winter conditions. Finally, potential avenues of new research and regulatory improvements are discussed. The report data examined in this thesis reveal that the rate at which archaeological resources are identified does not differ substantially between summer and winter conditions. This suggests that the continued use of winter testing in northeast British Columbia is an appropriate tool to meet regulatory requirements and ensures that impacts to heritage resources from development are minimized.

Keywords: northeast British Columbia; archaeological impact assessments; BC Oil and Gas Commission; Archaeology Branch

To Vera, for her guidance;

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List of Acronyms

AIA	Archaeological Impact Assessment
AOA	Archaeological Overview Assessment
BC	British Columbia
BP	Before Present
BPE	Boreal Plains Ecoprovince
CMT	Culturally Modified Tree
EAO	Environmental Assessment Office
HCA	*Heritage Conservation Act*
LiDAR	Light Detection and Ranging
NEB	National Energy Board
OGAA	Oil and Gas Activities Act
OGC	BC Oil and Gas Commission
PARL	Provincial Archaeological Report Library
PFR	Preliminary Field Reconnaissance
RAAD	Remote Access for Archaeological Data
TPE	Taiga Plains Ecoprovince
UNDRIP	United Nations Declaration on the Rights of Indigenous Peoples

Glossary

Archaeological Impact Assessment	In-field assessment to conduct subsurface testing and identify archaeological sites
Archaeological Overview Assessment	Desktop assessment to predict archaeological potential
BC Archaeology Branch	Provincial regulator for archaeologists, oversees implementation of the Heritage Conservation Act, and provincial registry
BC Oil and Gas Commission	Provincial regulator for oil and gas developments
Environmental Assessment Office	Regulator for projects meeting provincial review requirements
Heritage Conservation Act	Legislation protecting archaeological resources and outlining permitting requirements
National Energy Board	Regulator for projects meeting federal review requirements
Oil and Gas Activities Act	Legislation regulating oil and gas developments
Preliminary Field Reconnaissance	In-field assessment to determine and document areas archaeological potential
Section 12 permit	Site alteration permit issued under section 12 of the Heritage Conservation Act
Section 14 permit	Inspection permit issued under section 14 of the Heritage Conservation Act

Figure 1. Pipeline Right of Way in Northeast British Columbia

Photo: Author, 2017.

Chapter 1.

Introduction

The British Columbia (BC) *Heritage Conservation Act* (HCA) ensures the regulation of archaeological resources within the province (Heritage Conservation Act 1996). This legislated protection of archaeological resources ensures that industries throughout the province properly assess and mitigate developments to prevent disturbance of archaeological resources. Responsibility for the implementation of regulatory components of the HCA is delegated to the Archaeology Branch. Due to the intensity of exploration and drilling in the oil and gas industry in northeast BC, the Archaeology Branch has allocated regulatory responsibility to the BC Oil and Gas Commission (Commission) with effective delegations through legislation for compliance and enforcement of the HCA (BC Archaeology Branch 2004). With this responsibility, the Commission is accountable for ensuring that the oil and gas industry is managing heritage resources protected under the HCA as well as monitoring the standards and impact assessments of archaeologists in northeast BC (BC Oil and Gas Commission 2017a).

Archaeologists working in the northeast BC oil and gas industry have conducted archaeological impact assessments under snow cover and in below freezing temperatures for over a decade (BC Archaeology Branch 2016). There are several significant archaeological sites in northeast BC but the vast majority of recorded sites are isolated lithic finds or small lithic scatters. The winter testing strategies developed and employed by archaeologists for the oil and gas industry are well suited to this type of site discovery. Proponents of winter impact assessments advocate for their continued implementation; critics are concerned about the success of site identification under winter conditions including snow cover.

James Cotter, writing to American Antiquity in 1955, might have expressed it best in his letter “Winter Archaeology: To Freeze or Not to Freeze”. Cotter notes that while winter archaeology results in “healthier working conditions” due to the lack of mosquitoes and pests, the weather may result in work stoppages and slower field work (Cotter 1956). Considerable data now exists to closely scrutinize the success or failure of winter testing in northeast BC. In order to compare winter and summer testing, the overall results in site identification, feature identification and subsurface testing must be contrasted. Determining if there is significant difference in site discovery between summer and winter results is straightforward through comparison of field results. Examination of a representative sample from a decade long series of assessments in northeast BC provides a critical review of winter archaeological impact assessments. Weaknesses identified within the sample, where winter testing results do not match the expectations set by snow-free results, require analysis to ensure that appropriate changes are applied and any additional regulatory oversight is given.

Winter archaeological impact assessments involve archaeologists identifying areas of potential under snow cover, conducting accurate ground truths, removing frozen or unfrozen samples from the tests areas, and finally thawing and screening the samples to identify any artifacts. Archaeologists must accurately define features of archaeological potential under adverse conditions. Winter impact assessments were developed to assist the oil and gas industry in completing regulatory requirements when the assessments could not be postponed until snow-free, or summer conditions, were available. Prior to the implementation of winter testing, assessments that could not be postponed were conducted in a post-construction context (BC Archaeology Branch 2016).

There has yet to be a substantial study examining the success of winter archaeological impact assessments in determining areas of archaeological potential and identifying sites. The BC Archaeology Branch's has recently decided to allow winter testing to be utilized outside of the oil and gas industry across northeast BC. Winter archaeological impact assessments are being recognized as an appropriate and viable option when summer fieldwork is unable to occur (BC Archaeology Branch 2016). Winter fieldwork is costly but it has been embraced by the oil and gas industry as an alternative that does not restrict production and construction timelines, while ensuring legislative requirements are met. The completion of archaeological assessments by the oil and gas industry results in thousands of interim reports and compiled data covering northeast BC.

Archaeology in northeast BC, in a relative sense to the remainder of the province, is sometimes viewed as the poor sibling within professional consulting and academic circles. In 2008, while discussing problems with the HCA, Quentin Mackie proposed that the Commission "write off 10% of all impact assessments in the Northeast in return for the money to go into a pool to do actual research-based archaeology" (Mackie and Dady 2008:9). The regulatory requirement of the Commission is to enforce the HCA and ensure that the industry is following best practices for heritage management (BC Oil and Gas Commission 2017a). As a regulator, the Commission can only enforce legislation and provide best management practices (BC Oil and Gas Commission 2017a). The introduction and support of winter assessments as a required alternative to post-impact assessments is a significant way that a regulator has enforced and increased the quality of archaeological work and certainly prevented the destruction of countless archaeological sites (BC Archaeology Branch 2016).

The ultimate goal of winter testing, and by extension heritage management in British Columbia, is the identification and avoidance of archaeological resources. Mackie's comments reflect the lack of knowledge that, while millions of dollars have been spent on archaeological work in northeast BC, there may have been critically important and regionally significant sites saved as a result of heritage resource management. While oil and gas companies are required to fund the costs associated with the identification and avoidance of archaeological resources, they are currently not required to fund any additional research. The identification of archaeological sites with a single flake and limited subsurface testing does not necessarily illustrate the full research potential of the site, as the aim is to identify and avoid to allow future research or almost complete preservation of the site. There is currently little research into the archaeological resources that have been identified and saved from destruction, but that is not to say that researchers, First Nations communities, or the greater public will not at a later date support further investigations and research into the identified sites.

Winter archaeological impact assessments can face criticism from First Nations groups and archaeologists throughout the province. There has been a general perception in the academic and consulting archaeological community that the work being conducted in the winter suffers from decreased precision (Vera Brandzin, personal communication 2018[1]). The regulatory bodies, the Archaeology Branch and the

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[1] Vera Brandzin has been the Heritage Conservation Program Manager at the BC Oil and Gas Commission for over sixteen years and was instrumental in developing the current policies and regulations.

Commission, believe that quality archaeological fieldwork is being conducted in the region during both summer and winter conditions (BC Archaeology Branch 2017). The broader archaeology community, however, has yet to access these results through dissemination of accurate, reliable, and replicable data.

The implementation of winter archaeological impact assessments can be placed within the broader discussions surrounding cultural resource management and heritage conservation in BC. Cultural resource management frameworks have been in place for several decades, with the wide involvement of many key players including consulting archaeologists, academic archaeologists, government regulators, First Nations communities, and industry (Apland 1993; Klassen 2008). Heritage management has expanded to include not only artifacts, but landscapes, and spiritual places. There is increasing involvement and ownership of management decisions by Indigenous groups (Watkins and Beaver 2008). Regulatory bodies in BC are currently held within their mandate to the implementation and restrictions of the HCA (Apland 1993; BC Archaeology Branch 2004). It is the responsibility of those delegated with enforcement of the act to ensure that appropriate methods are being utilized and that results and fieldwork is upheld to consistently high standard (Apland 1993). With the cultural resource paradigm in BC and the increasing involvement of First Nations communities in their own heritage resources, any policy or direction from regulatory bodies should reflect the ever-increasing standard to manage impact of development, including the oil and gas industry. Concerns have been voiced that decolonizing archaeology and cultural heritage management aims are separate and excluded from the views of archaeologists working for industry, including the oil and gas industry (Connaughton and Herbert 2017:308). It is hopeful that further merging of discussions surrounding the limitations of heritage management and the opportunity for consulting archaeologists to be involved in those discussions can educate and bridge the gap between academic and consultants (Welch et al. 2007).

The growth of cultural heritage management in the province has not only significantly increased the involvement of First Nations communities, but increases the accountability of archaeologists and regulators for assessments and mitigation direction, as well as engagement and collaboration (Welch et al. 2007). Heritage management, from a regulatory perspective, has never been more important. It is vital that the impact assessment strategy is endorsed by regulatory bodies and enforced on archaeologists, and by extension proponents, be credible and viable in terms of increasing identification and protection of heritage resources from development. Regulators must be visible, in terms of policy direction, and accountable for that which they endorse, while working within the mandated role of the agency (Apland 1993). There are many significant critiques to the overarching legislation and regulatory framework for heritage in BC as archaeological work continues to be undertaken to enable development (Dady 2008). It is vital to the interests of all parties involved in heritage management that when archaeological assessments are undertaken sound methodology is used.

With the introduction of the current iteration of the HCA, and an increasing “proponent-pays” mindset outlined in government policy, First Nations management and their involvement in managing resources was severely limited (Klassen et al. 2009). Only with substantive court decisions has more First Nations involvement, including consultation on archaeology permits, been introduced (Connaughton and Herbert 2017; Klassen et al. 2009). Endorsement of the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) by the federal government in 2017 has resulted in mandate letters to government agencies across the country insisting on the implementation of UNDRIP supported policies (Ministry of Energy, Mines and Petroleum Resources 2017). The development of new archaeological methods to support heritage management, while meeting legislative requirements, will make First Nations involvement essential (Ministry of Energy, Mines and Petroleum Resources 2017; United Nations General Assembly 2008). Consequently a review of archaeological impact assessment results to ensure that the goals of identifying and protecting archaeological resources are met is timely. Furthermore, reviewing the wealth of information resulting from assessments gives regulatory bodies a response to questions from industry on what happens to the archaeology information collected.

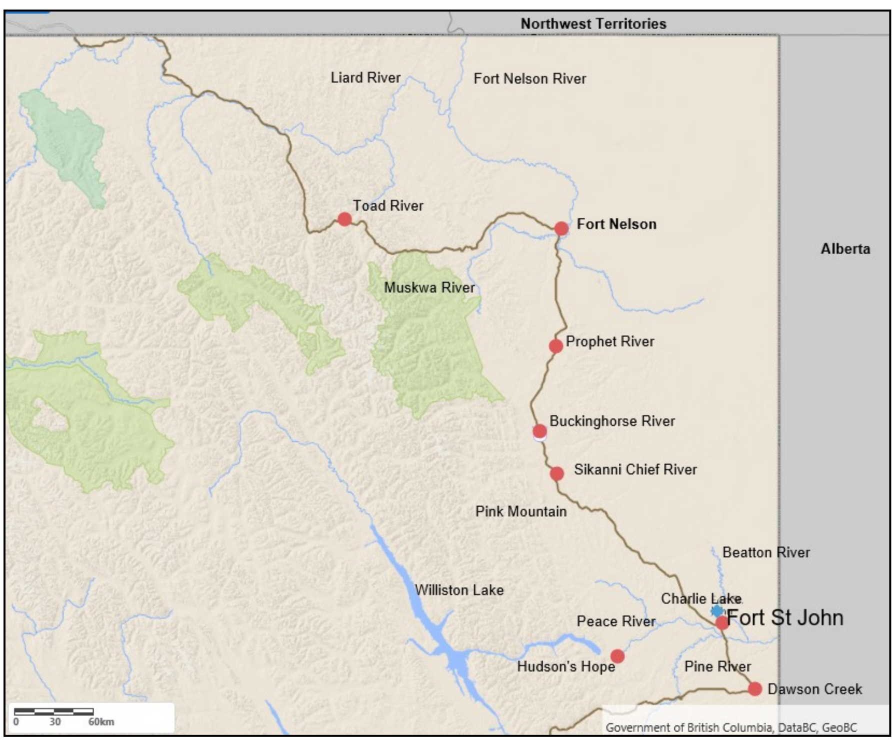
In this chapter I have outlined my objectives and their importance. Chapter 2 provides an overview of archaeological fieldwork being conducted in northeast British Columbia, including site types, environmental characteristics, and the nature of the oil and gas industry operating in the region. Chapter 3 covers regulatory jurisdictions and applicable legislation, while Chapter 4 discusses the accepted winter testing impact assessment requirements and regulatory standards. Chapters 5 and 6 compare the results of data collection and draw conclusions to the effectiveness of winter archaeological impact assessments.

Chapter 2.

Northeast British Columbia

Winter impact assessments are a tool used by consulting archaeologists working in northeast BC to assess proposed oil and gas activities. As a context to assess and critique this tool, four key areas must be examined: regional archaeology; the northeast BC environment; First Nations traditions, both pre and post-contact; and the oil and gas industry for which winter testing was developed. Figure 2 illustrates the area of BC where winter methodology is practiced. To be successful, winter fieldwork must be able to identify regionally common sites and uncommon sites. The impact assessment must also appropriately assess current and paleo-features on the landscape, provide reassurances to First Nations and answer their concerns, and effectively support the industry for which winter work is being carried out.

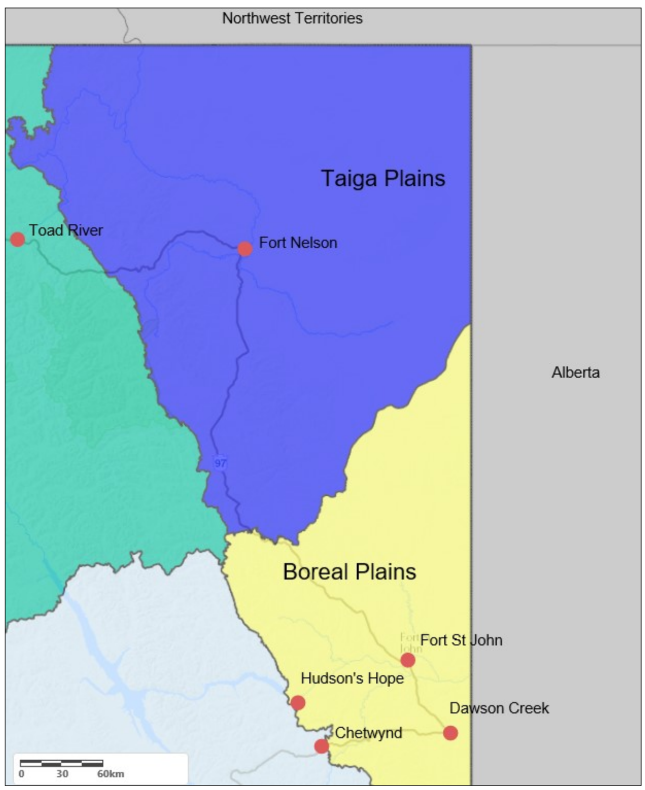
Figure 2. Northeast BC



Environment

Understanding regional environments within northeast BC is valuable when comparing the frequency of site identification within different ecoprovinces by multiple archaeologists and projects. Specific ecoprovinces may allow for more appropriate survey and site identification in winter while others are more constrained. Forest cover and the amount of snow impacts the ability of archaeologists to accurately survey and properly identify landscape features with high archaeological potential. Figure 3 illustrates the Boreal Plains and Taiga Plains Ecoprovinces where the majority of oil and gas development has occurred over the previous decade.

Figure 3. Northeast BC Ecoprovinces



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The northern continental climate of northeast BC generally is defined by long, cold winters with short, wet, and warm summers (DeLong et al. 1990:1). The terrain is characterized by mainly poorly drained muskeg areas with stands of lodgepole pine and aspen, with some areas of mature white and black spruce (DeLong et al. 1990:1). The dominant biogeoclimatic zones are described in Table 1. The boreal forest is particularly lacking in sediment, making the identification of significantly distinct occupational layers in archaeological sites and deep stratigraphy unlikely (Driver et al. 1996:267).

Table 1. Northeast BC Biogeoclimatic Zones and Characteristics

Zone	Characteristics
Boreal White and Black Spruce (BWBS) (Alldritt-McDowell 1998a; DeLong et al. 2011)	-majority of northeast BC -forest fires are common -least volume of snowfall in comparison to other northern zones -harsh, long winter -warm, short summer -mixture of upland forests and muskeg -extensive muskeg located in the northeast lowlands -well drained areas of pine and aspen
Engelmann-Spruce Subalpine Fir Zone (ESSF) (Alldritt-McDowell 1998b)	-south of Dawson Creek, mainly within the Tumbler Ridge area -above 1200m -common for snowpack as deep as two to three meters found in the forest -in drier areas, the ground freezes and stays frozen until July -subalpine meadows common
Spruce-Willow-Birch Zone (SWB) (Alldritt-McDowell 1998c)	-west of Fort St. John -above 1050m -harsh climate -black spruce is common in nutrient-poor, saturated locations -permafrost may be found in valleys above 1,200m-1,400m

Table 2 illustrates the ecoprovinces in northeast BC (Demarchi 1996).

Table 2. Ecoprovinces within Northeast BC

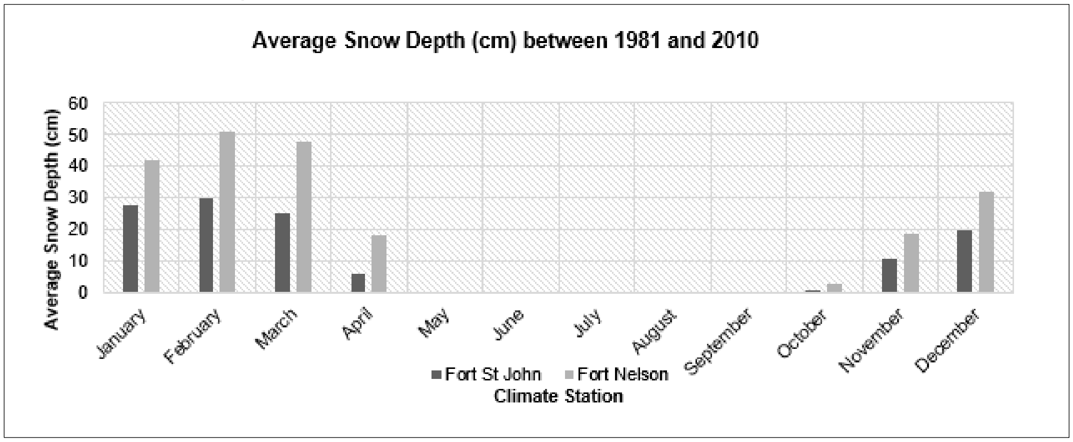
Ecoprovinces within Northeast BC	Characteristics
Boreal Plains (Demarchi 1996)	-extends from where the Rocky Mountains meet Alberta to the Beatton River -part of the Boreal Ecodivision -portions of agricultural land -areas of aspen, balsam, and poplar -numerous wetlands -habitat for moose, elk, grizzly, black bears, mule and white-tailed deer, various waterfowl -warmer, wet winters -dominated by Boreal White and Black Spruce Zone
Taiga Plains (Demarchi 1996)	-from Beatton River to border with the Northwest Territories and Yukon -part of the Sub-Arctic Ecodivision -white spruce in well drained areas -black spruce in poorly drained areas -balsam and spruce on floodplains -wintering habitat for caribou, moose, black bear, and furbearing carnivores -mountain goat, Stone's sheep, and mule deer can be found in the Sikanni River canyons

An overview of glaciation and paleo-environment is beneficial for field identification of past landscapes. The landscapes in northeast BC, including forest cover and waterways, have significantly changed since the first arrival of peoples into the area. Northeast BC was impacted by the Laurentide, Cordilleran, and Montane glaciations, resulting in variable interpretations on the nature of an ice-free corridor or areas in the region. Laurentide glacier ice covered the region between 22,000 and 14,000 BP; Montane ice was located only in the western area of the region between 15,000 and 10,000 BP (Catto et al. 1996:21). The environment of any ice-free areas would have been extremely harsh and tundra-like between 14,000-10,000 BP (Catto et al. 1996:30). There are substantial Quaternary sediments exposed along the Peace River and tributaries (Hartman and Clague 2008:550). A large meltwater lake, Glacial Lake Peace, was formed during the retreat of the Laurentide ice and covered most of the present Peace River drainage system (Fladmark 1981:124). The lake can still be identified by its distinctive lacustrine sediments, with varying shorelines and deltas easily recognizable (Hartman and Clague 2008:556). Wood samples have been recovered from Glacial Lake Peace sediments dating to 14,000 BP (Catto et al. 1996; Hebda et al. 2008:612).

The subalpine-boreal forest regions of western Canada have had continued vegetation change through time (Macdonald 1987:303). Around 11,700 BP the region contained open shrub, similar to modern tundra (Wilson 1989:53). The spruce forests did not appear to reach the Peace River region until 10,000 BP (Driver and Vallieres 2008:251). Further to the east, along the foothills of the Rocky Mountains, the region would have been shrubby, with open grassland (Driver and Vallieres 2008:251). It is debated whether the ice-free corridor was responsible for first peopling of North America. The Peace River region, nevertheless, has some of the oldest documented sites in BC (Driver 1999:289). The immediate post-glacial environment of northeast BC has not been reconstructed (Driver and Vallieres 2008:251). With paucity of academic research in the northeast of the province, there is an argument for the assessment and protection of areas associated with paleo-topography potentially having sites dating upwards of 9,000 BP (Fladmark 1979:55).

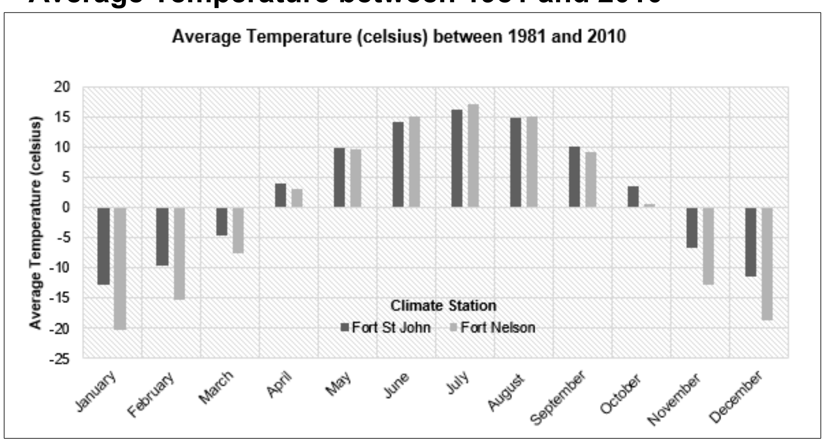
A potential argument against the implementation of winter archaeological impact assessments is concern with the difficulties of conducting fieldwork under snow and winter temperature conditions. Figures 4 and 5 provide monthly average snowfall depth and winter temperature data from 1981 to 2010. The Fort Nelson area is of particular note since it generally features lower temperatures and greater snowfall than Fort St John. Also notable is the amount of snowfall where between January and March there is an average of 40-50 cm of snow cover from 1981-2010. With blowing and shifting snow there is a significant risk of missing landforms during survey. Beyond access and obfuscation of site features by snow, cold temperatures as well as the need to remove large amounts of snow prior to testing create difficult working conditions for archaeologists and may result in physical strain. Figures 4 and 5 also illustrate winter conditions in northeast BC are present from November through April.

Figure 4. Average Snow Depth between 1981 and 2010



*data - Environment Canada (http://climate.weather.gc.ca/historical_data/search_historic_data_e.html), accessed September 2, 2017

Figure 5. Average Temperature between 1981 and 2010



*data - Environment Canada (http://climate.weather.gc.ca/historical_data/search_historic_data_e.html), accessed September 2, 2017

First Nations

First Nations history in northeast BC is complex. At the time of Alexander Mackenzie's arrival to the Peace River region, several established First Nation groups occupied the land north to the Liard River, west to the Rocky Mountains, and to the south of what is now Dawson Creek. These groups included the Dane-zaa (comprising the Beaver and Sekani peoples), the Cree, the Saulteaux, and the Slavey (Napoleon 1998:2; Robinson 1982:16). Europeans moving into the area recorded three-pole tipis, with a covering of moose or caribou hide as the common house form. The tipi poles would be left standing, indicating defined and persistent camping areas throughout the region (Goddard 1916:212). Above-ground caches were commonly used for food storage (Goddard 1916:210-213). The First Nations were dependent upon larger game hunting, small game snaring and trapping, with harvesting of vegetal resources including berries. There was no agricultural subsistence base (Goddard 1916:213). Burials were placed in trees, or on platforms built into trees. By the twentieth century, this practice had largely been replaced with below-ground burials (Goddard 1916:222). Into the late 1990s, many elders throughout the region were still strongly connected to the spiritual world, with many having grown up in a nomadic lifestyle (Napoleon 1998:2). First Nations in northeast BC signed and now adhere to Treaty 8, with the first groups signing in 1899 and the last, the McLeod Lake Indian Band, adhering in 2000 (Leonard and Whalen 1998; McLeod Lake Indian Band 2017).

First Nation areas of cultural significance most often are considered within Traditional Land Use studies. While many cultural sites are not protected under the HCA, these may be no less valuable to First Nations than those that are regulated. Important cultural sites are most often tied to spiritual, ritual, mythological or burial places (Nicholas 2006). Also important in Traditional Land Use studies, however, are subsistence and resource exploitation sites, including hunting locations, mineral licks and berry picking locations. These attest to First Nations claims to the traditional landscape. Traditional use studies are most often funded by First Nations communities themselves. Often due to the expense and cultural sensitivity of the information, the data may be protected with restricted access imposed by First Nation groups. Many communities are concerned that government or industry will misuse this data in support of development proposals (Nicholas 2006). Many archaeological consultants, however, have participated in this type of research and their experience and knowledge may be integrated within an impact assessment (Vera Brandzin, personal communication 2018).

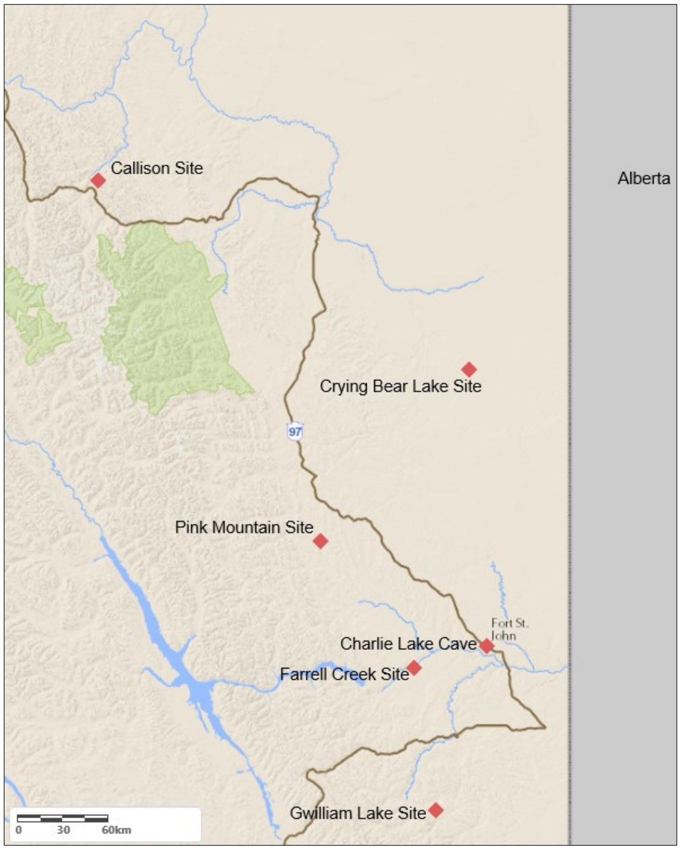
Archaeological impact assessments on Crown land often involve First Nations participants with interest in the area. There is no legislation or regulation pertaining to archaeologists to ensure First Nation participation during assessments. Notification of this work to First Nations groups is required prior to permit issuance and this does provide an opportunity for First Nations to express comments or concerns. Oil and Gas companies often voluntarily fund First Nation participation during archaeological fieldwork in the interest of building relationships. The majority of oil and gas companies address First Nations traditional use concerns separately from archaeology concerns (Budhwa 2005:24-25).

Archaeology

Academic archaeological research has been carried out in northeast British Columbia for over sixty years (MacNeish 1954). The work has been sporadic but it has illustrated that First Nations history in the region extends back 11,000 or so years. Unfortunately, the majority of fieldwork has either concentrated on the earliest sites of the paleoindian period (Howe and Brolly 2008; Driver et al. 1996) or, alternatively, on the later historic era with arrival of the European fur trade (Burley et al. 1996). Consequently the intervening archaeological sequence is poorly documented. As well, the majority of archaeological studies in the region have been recorded within a cultural resource management context (Howe and Brolly 2008). Thus, when sites are discovered, they typically are avoided rather than being excavated.

Howe and Brolly (2008) have presented a projectile point sequence for northeast BC integrating the research conducted at major archaeological sites. This sequence accounts for over 10,500 years of human occupation in the region. They note that the lack of stratified archaeological sites in northeast BC results in the requirement to compare radiocarbon dates and projectile points with neighbouring sequences to determine a cultural context for the region (Howe and Brolly 2008). It is hopeful that this research will be expanded and built upon by future research and excavation of sites in the region. Howe and Brolly (2008) outline a three-period division for the region: the Early Prehistoric (10,500-7,500 BP), the Middle Prehistoric (7,500/7,000 to 3,500/2,500 BP) and the Late Prehistoric (3,500/2,500 to contact). This three period division integrates not only northeast BC but also as the Rocky Mountain Trench and Omineca Mountains. Howe and Brolly (2008) base their synthesis on data from several sites including the Callison site, the Pink Mountain site, Gutah Creek, Farrell Creek, Charlie Lake Cave, and the Gwilliam Lake Site (Howe and Brolly 2008:304). Site locations are identified on Figure 6.

Figure 6. Map Illustrating Major Archaeological Sites in Northeast BC



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The most notable archaeological site in northeast BC is Charlie Lake Cave (HbRf-39), a rock shelter site located 10 km north of Fort St John. Excavated by Fladmark (Fladmark et al.1988) and Driver (Driver et al. 1996), the earliest occupation is dated to 10,500 years ago. Much of the research emphasis thus far has focused upon the nature of the early landscape including Glacial Lake Peace to the south and the incising of the Peace River valley (Driver and Vallieres 2008:242). While early human occupation in the area was associated with a glacial lake environment, modern fauna began to appear by 9,000 BP (Driver 1988:1545; Fladmark et al. 1988:371). Human occupation and the archaeological sequence at Charlie Lake Cave is continuous into the later period (Driver et al. 1996:256).

The Early Prehistoric Period is defined at Charlie Lake Cave by a small type of paleoindian fluted point associated with bison bones and dated to 10,700+/-120 and 9990+/-150 BP (Howe and Brolly 2008; Driver et al. 1996). The projectile point is described as a “lanceolate, extensively resharpened point of black chert” (Fladmark 1996:14). The Middle Prehistoric Period is characterized by side-notched projectile points found at the Farrell Creek Site, as well as a similar point identified at Charlie Lake Cave. Howe and Brolly (2008) characterize the projectile points associated with this period as “broadly leaf-shaped, with a shallow side-notches and a convex base” (Howe and Brolly 2008:307). The projectile points are similar to Oxbow types identified on the plains. The Late Prehistoric Period is demarcated by “small projectile points with shallow side-notches and convex bases” (Howe and Brolly 2008:307-308).

The Callison site (IeSh-1), located near Toad River, is one of the first investigated sites in the region, with fieldwork conducted in 1957 (Howe and Brolly 2008; MacNeish 1954, 1960). MacNeish dated the site occupation from 7,000 to 2,000 BP (MacNeish 1960). The projectile points recovered a small lanceolate point, a side notched point with convex-base, and a side-notched point with concave-base were placed between 4,000-2,500 BP and compared with other sites in the southern Yukon (Howe and Brolly 2008; MacNeish 1960).

Much of the archaeological work over the past forty years around Fort St John and the Peace River has been undertaken to facilitate the construction of mega-hydro projects, including BC Hydro’s Site C Dam. One report (Hutchcroft 2009) published in 2009 identified 337 archaeological sites in conflict with the Site C study area, many being recorded over the decades-long fieldwork in the region (Hutchcroft 2009; Spurling 1980). Of the 337 sites, 299 consisted of lithic material, mainly scatters. An additional 27 historic sites, including Old Fort and Rocky Mountain Fort, are in conflict with the proposed dam impact footprint (Hutchcroft 2009). Significant archaeological work has also been completed at several historic forts along the Peace River in conflict with the damn (Burley et al. 1996; Fladmark 1985).

Heritage North identified two sites, HjRr-10 and HjRr-11, in 2015 approximately 250 km north of Fort St John (Heritage North 2015). The fluted points, based on the regionally accepted fluted point tradition, have been attributed to paleoindian occupations (Heritage North 2015). Significant for this thesis, HjRr-10 and HjRr-11 are examples of paleoindian sites that have been identified under winter conditions during an archaeological impact assessment for an oil and gas development (Heritage North 2015).

The Gutah Research Project, 160 km north of Fort St John, was funded by the BC Oil and Gas Commission's Science and Community Environmental Knowledge Fund in the early 2000s. A major site recorded on this project, HkRe-1, sometimes referred to as the Gutah Creek site or Crying Bear Lake site, was referenced in traditional use studies of Dane-zaa peoples (Heritage North 2004:2). Work at this site by the consultant company Heritage North recovered over 7,000 artifacts. Projectile points recovered from the site have been attributed to the Late Prehistoric period based on similarities to the Fisherman Lake complex (Howe and Brolly 2008). A study of Holocene environments was also conducted as part of this project (Heritage North 2004).

Another long-term occupation site, the Pink Mountain site (HhRr-1), was recorded during an archaeological assessment for Westcoast Transmission Company Ltd. The Pink Mountain site is significant for its inclusion of archaeological materials from the paleoindian era to historic period (Wilson 1989:51). Wilson (1996) argues that the earliest projectile points, with only recovered basal portions, resemble the paleoindian point from Charlie Lake (Howe and Brolly 2008; Wilson 1996:32). A later paleoindian projectile point with Scottsbluff features and a microblade core were also recovered (Howe and Brolly 2008).

The Gwillim Lake site, attributed to the Middle Prehistoric period, is located between Tumbler Ridge and Chetwynd. The site contained two projectile points, with similarities to the Oxbow complex as defined for the northern Plains (Howe and Brolly 2008). The site was radiocarbon dated to 3,427 +/- 100 BP (Spurling and Ball 1981; Howe and Brolly 2008).

The Farrell Creek site (HaRk-1), west of Fort St John, is unique in that it contains deeply buried and stratified deposits within an aeolian cliff-edge dune (Spurling 1978, 1980). It is located at the confluence of the Peace River and Farrell Creek (Howe and Brolly 2008; Spurling 1980). The site was excavated in the 1970s by Knut Fladmark of Simon Fraser University (Spurling 1980). Four separate and distinct occupations, are present with three of these characterized by projectile point types (Spurling 1980). The Farrell Creek Site was occupied between the Middle and Lake Prehistoric periods as outlined above (Howe and Brolly 2008). The earliest projectile point recovered is similar stylistically to Salmon River side-notched points, dating 4,365 +/-100BP (Spurling 1980:211). Later projectile points, similar to Oxbow types, have been radiocarbon dated to 2,485+/-130 BP (Spurling 1978:267). Finally a smaller late prehistoric side-notched point was radiocarbon dated to between 500 and 1000 BP (Howe and Brolly 2008; Spurling 1980)

Howe and Brolly (2008) discuss common side-notched and corner-notched points being regularly encountered during archaeological impact assessments for oil and gas developments (Howe and Brolly 2008). The points are described as “ubiquitous throughout British Columbia and the Northern Plains in the later period” (Howe and Brolly 2008:311). That notwithstanding, rarely is further investigation or excavation undertaken if development is altered to avoid the site. As well, the vast majority of identified archaeological sites in northeast BC are limited to small lithic scatters, likely hunting sites or campsites, utilized for a brief period of time. Virtually all of these remain undated or lack diagnostic artifacts to position them within regional culture history. It is assumed that these lithic scatters generally reflect the nature of First Nations settlement pattern in the region; they also reflect the regulatory focus for much of the work where studies are concentrated in specific areas, often with low potential for human occupation. Subterranean features, including cache pits and pithouses are also almost entirely absent in regional archaeological contexts. This limits easy recognition of village locales or special use sites. Alternatively archaeologists writing overview assessments in northeast BC emphasize features such as knolls, rises, low ridges, and terrace edges as being land forms where high potential for site identification exists (Dady et al. 2005).

Muskeg covers large areas of northeast BC and northern Alberta. Archaeological impact assessments frequently record sites on knolls or other types of raised terrain within these bogs, clearly illustrating widespread human use (Ives 1993:20-21). The raised terrain, including knoll features, is covered by a mix of pine and aspen, indicating dry ground (DeLong et al. 1990). These locales reflect past hunting spots, areas where deadfalls or traps could be set as well as sheltered areas for temporary camps. It is postulated that based on site positioning relative to prevailing winds many of the sites identified in the muskeg were visited and occupied during the winter (Ives 1993:20-25).

Advances in airborne light detection and ranging (LiDAR) technology have improved the identification of subtle terrain features prior to fieldwork through the creation of images that accurately map topography. Even subtle features under forest cover are now visible through LiDAR digital elevation models (Schindling and Gibbes

2014). In northeast BC, the employment of LiDAR has become a unique tool for mitigation of the perceived shortcomings of winter fieldwork (Schindling and Gibbes 2014). It allows for areas and features with high archaeological potential to be identified prior to fieldwork. This gives the industry proponent an opportunity to better plan, alter or postpone archaeological field work to reduce costs.

Archaeological Site Types in Northeast BC

Winter archaeological impact assessments must effectively identify common sites in the region. As illustrated in Table 1, over 95% of sites thus far recorded in northeast BC are comprised exclusively of lithic material. The lithic site types recorded are almost wholly designated as isolated scatters. The most common lithic sites contain between 1 to 100 artifacts, although some sites greatly exceed this number. The goal of archaeological impact assessments is to identify the presence of archaeological sites, determine the site dimensions, and review the potential impacts that could occur. In northeast BC, the standard approach by industry has been to avoid recorded sites, meaning further evaluation of site context/content is rarely done. Site classifications are affected accordingly.

Table 3. Archaeological Site Type Distribution by Mapsheet

Mapsheet	Number of Recorded Sites	Exclusively Reported as Lithic	Other*	Percentage (%)
94P	149	145	4	97% lithic
94N	13	10	3	77% lithic
94O	227	213	14	94% lithic
94I	127	124	3	98% lithic
94J	359	350	9	97% lithic
94K	60	51	9	85% lithic
94G	772	729	43	94% lithic
94H	570	549	21	96% lithic
94A	2,128	2,102	26	99% lithic
94B	414	363	49	88% lithic
94C	891	850	41	95% lithic
93P	800	765	35	96% lithic
93I	196	181	15	92% lithic
93O	146	121	25	83% lithic
Total	6,852	6,555	297	95.6% lithic

*includes any recorded site that is not exclusively categorized as lithic
*compiled utilizing the Remote Access for Archaeological Data database on September 14, 2017.

The high percentage of lithic sites in northeast BC does not mean that other sites types can be ignored; rather a desktop review needs to be completed prior to fieldwork for their possible identification as well. The sites categorized as “other” in Table 3 contain a wide variety of features including culturally modified trees (CMTs) (pre and post 1846), trails, paleontological sites, fur trade forts and other types of historic sites, as well as possible cultural depressions, cache pits, and historic burials. With almost 7000 recorded sites in the region and continued recording of sites through on-going resource management projects, a substantial volume of site type data is being compiled. That the majority of sites in the region are small campsites forms part of the rationale for winter testing in impact assessment work. The compiled assessment result data set, a large archive of consultant’s reports and survey work done under summer conditions, provides the basis to evaluate the efficacy of winter archaeology.

Oil and Gas Industry

Northeast BC is the second highest producer of natural gas in Canada. In 2016, 4.6 billion cubic feet of natural gas was produced per day in northeast BC (Canadian Association of Petroleum Producers 2017). In 2016, $2.5 billion was spent by industry on development and exploration of oil and gas here, and an additional $186 million was paid by industry to the province (Canadian Association of Petroleum Producers 2017). There is an estimated 349 trillion cubic feet of natural gas resources within northeast BC which is anticipated to last 300 years at current levels of demand (Canadian Association of Petroleum Producers 2017).

In 2015, the Oil and Gas Commission received 1,768 applications for exploration/drilling permits and 1,552 amendments to existing permits (BC Oil and Gas Commission 2016). An archaeology review is completed for each application where there is anticipated land disturbance to ensure that archaeological resources are not impacted (BC Oil and Gas Commission 2016). The amount and type of archaeological work occurring in northeast BC reflects the nature of the oil and gas industry. Sites that cannot be avoided and require site alteration permits can lead to excavation as mitigation, though this is rarely the case.

The oil and gas industry is motivated by current prices for oil and gas, and acts responsively to demands (BC Oil and Gas Commission 2014). Oil and gas industry work occurs across the year, with breaks in the spring and fall for break-up and freeze-up respectively. Archaeological impact assessments undertaken in the winter provide faster timelines when industry proponents are carrying out winter programs. In the northernmost regions of the project some oil and gas fields are not accessible during the summer due to saturated terrain, and winter ice roads are required to access well sites and pipelines for servicing. It is the responsibility of oil and gas companies to follow provincial and federal legislation while completing and operating facilities and related infrastructure, including pipeline, well sites and access corridors (BC Oil and Gas Commission 2014).

As I have described, the majority of sites presently recorded in northeast BC are small lithic scatters incorporated within a shallow soil horizon. Factors affecting fieldwork that must be taken into account include variable biogeoclimatic zones, and the influence of past paleo-environments. Fieldwork in the winter has developed appropriate methods to find sites or, through use of LiDAR, avoid areas with high potential for site presence. Winter impact assessments must be able to identify environmental features during deep snow conditions that account for both common and uncommon site types. Before reviewing field methods and requirements, I provide the regulatory context in which winter testing was developed and has operated within for ten years. The next chapter examines the shift from a post-impact assessment focus to the more proactive winter testing strategy utilized today.

Chapter 3.

Regulatory Environment

A history of the regulatory environment in which winter archaeological impact assessments have developed and evolved must be analyzed as part of a review of the assessment process itself. The regional context for archaeological fieldwork was established in the previous chapter. Here I review the various regulatory responsibilities and participants involved in the implementation and maintenance of heritage resource management in northeast BC, particularly as it relates to winter fieldwork and the methods by which it is undertaken. An agreement between the Archaeology Branch and the Oil and Gas Commission allowed archaeologists to implement winter fieldwork in northeast BC in 2003 (BC Archaeology Branch 2016). The oil and gas industry, until recently, has been the only industry in the province where winter impact assessments have been allowed (BC Archaeology Branch 2016). The unique regulatory relationship between the Archaeology Branch and the Commission allows for greater oversight of the oil and gas industry through a single-window regulatory system, where the regulator manages both the archaeologist and the proponent under appropriate legislation.

BC Archaeology Branch

The Archaeology Branch, currently operating under the Ministry of Forests, Lands Natural Resource Operations, and Rural Development, the provincial regulator for archaeological permitting, is responsible for the provincial heritage registry, and facilitates implementation of the HCA (BC Archaeology Branch 1998a). The Archaeology Branch is uniquely tied to the Environmental Assessment Office (EAO), participating in the referral period and review of large provincial projects (Gibson and Day 1995). The relationship with the Commission is not unique. The Archaeology Branch previously had set a precedent by developing a separate Protocol Agreement with the Ministry of Forests, requiring overview assessments from forestry licensees to ensure no sites are impacted during forestry activities (Klimko, Moon, and Glaum 1998:31).

One mandate of the Archaeology Branch is to develop guidelines and standards for the regulation of archaeologists and archaeological inventories throughout BC. The Archaeology Branch involves First Nations in the comment period for applications. A provincial heritage registry reviews and records site locations and distributions spatially. The archaeological data is housed within an online database, the Remote Access to Archaeological Data (RAAD). This allows archaeologists and First Nations to access and share data across the province. Regulatory oversight for archaeology operates through a three-permit system in the province. Under section 14 of the HCA, two options for permits, either investigative or inspection types, are available for archaeologists engaged in impact assessment work. An inspection permit allows archaeologists to survey and identify sites within a given boundary. Investigative permits allow for more thorough investigation through excavations to be completed. Both permit types are referred to as section 14 permits, and it is under these that winter testing is allowed in the northeast. Section 14 permits utilize a general permit template, requiring archaeologists to explain and provide rationale when permit methods will vary from the provincial standard (BC Archaeology Branch 1998a; 1998b; 2000; 2004). The third permit type is issued under section 12 of the HCA. This allows for the alteration of known sites, with any number of additional conditions (BC Archaeology Branch 2004). Table 4 summarizes the permit types that are outlined in the HCA.

Table 4. Heritage Conservation Act Sections

Heritage Conservation Act Section	Section 14		Section 12
Permit Type	Investigative	Inspection	Alteration
Characteristics	-generally for research projects -excavation of a known site for the purposes of academic study	-required to conduct fieldwork in BC where areas of potential are tested and sites are identified -common in northeast BC -allows for an assessment of the potential of a proposed area -allows for testing within a site to determine site significance	-issued to a proponent to allow for the alteration, including complete destruction, of a protected archaeological site -application must specify exactly how the site will be altered, as well as a rationale for the alteration

BC Archaeology Branch 1998a, 1998b, 2000, 2004

There are three main types of work conducted under a section 14 inspection permit: an archaeological overview assessment (AOA), a preliminary field reconnaissance (PFR), and an archaeological impact assessment (AIA). An archaeological overview assessment is a summary of the archaeological potential of a proposed development or area. There is no fieldwork conducted under an archaeological overview assessment, and it is research-focused and utilizes many of the resources, such as RAAD and Provincial Archaeological Report Library (PARL), which are managed by the Archaeology Branch. A preliminary field reconnaissance is a field visit to the proposed development or area which results in either areas of potential being recorded or no areas of potential identified. There is no subsurface testing conducted under a preliminary field reconnaissance. An archaeological impact assessment is when areas of potential are tested in an effort to determine the archaeological resources within a given area, a surface inspection may also be completed. Archaeological sites may or may not be identified during an archaeological impact assessment (BC Archaeology Branch 1998a; 1998b; 2000; 2004). Table 5 summarizes the types of archaeological reviews that may be undertaken for a development.

Table 5. Types of Archaeological Assessments

	Archaeological Overview Assessment (AOA)	Preliminary Field Reconnaissance (PFR)	Archaeological Impact Assessment (AIA)
Characteristics	-background study -research of previous sites and assessments -may not require a permit issued under the Heritage Conservation Act	-field visit without any testing -identify if the proposed location contains archaeological potential -further work may be required if areas of potential are in conflict with proposed location	-surface inspection and subsurface testing of archaeological potential landforms -aim is to survey and identify archaeological resources within a proposed location

BC Archaeology Branch 1998a, 1998b, 2000, 2004

The permitting legislation of the HCA allows for the Archaeology Branch to issue what are termed "blanket permits". Blanket permits allow archaeologists to receive section 14 permits covering a wide geographic area, such as northeast BC, using consistent methods. Blanket permits allow consultants to add multiple oil and gas proponents to their permit. Blanket permits are common in northeast BC, and many permits have upwards of a hundred assessments completed prior to them being closed. Blanket permits ensure consistency in applied archaeological assessments across the region (BC Archaeology Branch 2017).

BC Oil and Gas Commission

The BC Oil and Gas Commission was created as a Crown Corporation in 1998 (BC Oil and Gas Commission 2017a). The Commission operates with the goal of being a single-window regulator, having a wide variety of specialists on staff to assist in the review of permit applications, consultations with First Nations, liaising with the public, and compliance and enforcement activities (BC Oil and Gas Commission 2017a). The Commission's mandate is to regulate the oil and gas industry, protect public safety, conserve the environment, and support resource development (BC Oil and Gas Commission 2017a). The Commission is also required to make timely decisions within regulations and act in a transparent and accountable manner. The archaeology review at the Commission is extensive and it is based on regulating the entire lifecycle of a development, from application to restoration. Archaeological information, provided by archaeologists permitted under section 14 of the HCA, is reviewed in relation to permit decisions and the creation of permit conditions. The Commission is responsible for the review of interim reports and subsequent acceptance of the final report. The Commission is responsible for determining best management practices for oil and gas proponents and regularly conducts meetings and inspections to determine the success of these strategies (BC Oil and Gas Commission 2017b).

The application system at the Commission is unique in BC in terms of archaeological information. For every oil and gas development application with ground disturbance, the proponent must engage an archaeologist to enter information, similar to what would be collected under an archaeological overview assessment. Previously identified sites, previous work, and a map overview must be completed and the information is entered into the Commission application system. A Commission archaeologist then reviews the information for accuracy, quality, adherence to section 14 permit requirements, and appropriately adds conditions to the proponent's oil and gas development permit. This system ensures that an archaeologist reviews every aspect of development (BC Oil and Gas Commission 2017b). Commission staff are also aware of the projects that are "written off", or considered to have low potential for archaeological impact. Any concerns with the archaeologist's assessment of potential, can be handled locally, in the field, and prior to any development taking place. This process has proven to be extremely effective in the northeast, and timelines are less of an impediment, as only a short, two-page form is required at the permitting stage; fieldwork reporting can then be submitted subsequent to the proponent receiving their oil and gas development permit. All interim reports are reviewed by Commission staff to ensure that not only is the oil and gas development assessed, but that the archaeological work was appropriate for the region. Every newly identified site within northeast BC as part of an assessment for an oil and gas development is reviewed by the Commission. All mitigation strategies, including avoidance measures, are approved prior to construction. The Commission is appropriately situated to be the regulatory expert within the province, and Commission archaeology staff act as subject matter experts (BC Oil and Gas Commission 2017b).

The Commission has an annual archaeology audit program, auditing oil and gas proponents to determine the effectiveness of their heritage management systems. The annual archaeology audit program then ensures that proponents are appropriately conducting assessments and reporting efficiently to the regulator. The audit program is formal, with written protocols and reports (BC Oil and Gas Commission 2017c). The archaeology group at the Commission annually inspects projects to ensure archaeological resources are not impacted by proponents and are being appropriately defined and tested by archaeologists. Archaeologists at the Commission are regularly involved in compliance inspections, First Nations consultation, and public information sessions (BC Oil and Gas Commission 2017b).

Regulatory Jurisdictions

The Protocol Agreement with the Archaeology Branch and the specified enactment included in Oil and Gas Activities Act (OGAA) enable the Commission to effectively regulate the oil and gas industry. Operating as a single window regulator in the northeast, the Commission has the ability to manage archaeology requirements, with an understanding of the limitations and requirements of the oil and gas industry (BC Archaeology Branch 2004). Permitting of winter archaeology initially was stimulated by industry limitations (BC Archaeology Branch 2016). The Protocol Agreement currently excludes projects that fall under an EAO review, which are projects that meet provincial thresholds for additional review, separate from the Commission (BC Archaeology Branch 2004).

The Commission has a specified enactment under OGAA to issue site alteration permits under section 12 of the HCA to sites that cannot be avoided during construction.

The specified enactment applies to the entire province, with the only exclusion being projects which require a National Energy Board (NEB) review. An NEB review involves pipelines or projects which cross provincial borders and/or reach thresholds set out by the federal government. By legislating the Commission to be the authority to make decisions on site alterations, decision makers are involved in the entire process, and have a greater understanding of any rationale provided for the alteration of the site (BC Archaeology Branch 2004; BC Oil and Gas Activities Act 2008).

The Commission has a unique perspective and ability to manage and regulate both oil and gas proponents and archaeologists in northeast BC. This integration allows the Commission to manage heritage resources while ensuring that archaeological work conducted in northeast BC follows appropriate methods and takes into consideration any unique regional significance (BC Archaeology Branch 2017; BC Oil and Gas Commission 2017b). Table 6 outlines the responsibilities of the regulators involved in oil and gas projects throughout the province.

Table 6. BC Regulatory Responsibilities

	Protocol Agreement	Specified Enactment
Archaeology Branch Responsibilities	-reviews applications and issues section 14 (inspection) permits to qualified archaeologists -manages section 14 permits of archaeologists working outside northeast BC and Environmental Assessment Office (EAO) projects -manages archaeological site inventory of the province	-issues section 12 (alteration) permits to National Energy Board (NEB) Projects
BC Oil and Gas Commission Responsibilities	-manages oil and gas section 14 permits of archaeologists working within northeast BC -reviews site mitigation strategies -develops best practice standards for oil and gas proponents -conducts inspections of archaeologist's work under section 14 permits -reviews and accepts section 14 final permit reports	-issues section 12 permits to any oil and gas project in the province, including EAO approval projects -specifically excludes NEB projects

BC Archaeology Branch 2004, BC Oil and Gas Activities Act 2008, and BC Oil and Gas Commission 2017b

Part of an effective regulatory framework is the implementation of enforcement and compliance measures. The Commission has an extensive compliance framework, from employment of a team of enforcement officers, to the legislative powers outlined in OGAA. In 2016, the Commission completed over 4,500 inspections of oil and gas developments (BC Oil and Gas Commission 2017d). The Commission also responds to complaints from the public and First Nations regarding any incidents. Commission staff are delegated as officers to enforce legislation and implement collaboration with other ministries, including the Archaeology Branch, being part of the Ministry of Forests, Lands, Natural Resource Operations, and Rural Development. Contraventions of OGAA can be prosecuted in BC Provincial Court. The strong legislative power of the Commission ensures that permit conditions and direction are complied with by oil and gas proponents (BC Oil and Gas Commission 2017d).

Oil and Gas Developments

There are a variety of oil and development project types subject to Commission review and regulatory oversight. Geophysical programs, roads, borrow pits, workspaces, and campsites are areas of ground disturbance in addition to the impact of wells, pipelines, facilities, and roads (BC Oil and Gas Commission 2016). The developments in unconventional gas recovery in the last decade resulted in an increase in the size of wellsites and multiple wells are drilled directionally from a single well pad rather than a single wellhead on each well pad (BC Oil and Gas Commission 2017e). Unconventional gas recovery results in more flexibility in well pad placement, as well as an overall lower surface impact (BC Oil and Gas Commission 2017e). In order to effectively regulate the industry, a knowledge of the restrictions during construction, safety standards, as well as effective and trusted mitigation strategies, in terms of archaeology, is required (BC Oil and Gas Commission 2017b; 2017c; 2017d).

All archaeological site mitigation is reviewed by the Commission to ensure it not only protects the archaeological resource, but that is the mitigation procedures required to protect the site are understood and followed by the oil and gas industry proponent (BC Oil and Gas Commission 2017b; 2017c; 2017d). Archaeologists can employ several strategies in a site mitigation approach – including the fencing or flagging of sites for avoidance in the field, monitoring during construction, and the recommendation of directional drills or alignment shifts to avoid archaeological areas (Charlton 1976:136). Any mitigation recommendations agreed upon are outlined in the oil and gas permits. This is then reviewed by Commission compliance and enforcement staff to ensure the sites are avoided in the field. Mitigation measures may vary depending upon the development type. Smaller diameter pipelines are considered easier to realign and avoid areas of potential and/or recorded sites (Charlton 1976). Pipelines can also be directionally drilled beneath archaeological resources to avoid surface disturbance (Charlton 1976:136). Apart from legislation and permit conditions, the most important aspect of ensuring site avoidance is the communication from the archaeological consultant to the construction crews and contractors (Charlton 1976:137). Not only placement of the pipeline or wellsite needs to be reviewed, but so does the construction of ancillary developments including borrow pits, sumps, and campsites (Charlton 1976:138). Mitigation strategies vary depending on the site type and terrain, but reflect the limited stratigraphic depth of many sites. Strategies such as matting over the site with rig matting to allow access would likely remove the top duff layer along with most of the cultural layer, severely impacting the site. Matting mitigation strategies have been allowed in the past, when environmental conditions such as sufficient snow depth and frozen ground as well as communication and monitoring conditions have been met. The Commission, situated in the middle of the region, and involved in the decision-making process for projects, is better prepared and informed to discuss viable mitigation strategies with consultants (BC Oil and Gas Commission 2017b; 2017c; 2017d).

Archaeological Impact Assessments in the Winter - Beginnings

In the 1980s, the Archaeology Branch and the Ministry of Energy and Mines developed a process to accommodate the required short turnaround times needed for the oil and gas industry and the necessity of winter construction. Oil and gas proponents were receiving construction permits from the province and any work being conducted in the winter was allowed to continue with the proponent promising to complete a post-impact assessment review. Post-construction archaeological impact assessments were implemented, as there was no other technique to support the oil and gas industry. The hope was that the negative impact of constructing over archaeological sites would be offset by systematic data recovery (BC Archaeology Branch 2016).

Unfortunately, oil and gas companies were less likely to support and fund archaeological assessments in a post-construction context as the permit was already issued to them (BC Archaeology Branch 2005). Oil and gas proponents would receive their permit with a condition requiring the submission of a post-impact assessment. Post-impact assessments would involve a permitted archaeologist visiting the constructed development, walking around and collecting any artifacts that were on the surface of the lease or pipeline right of way. Any potential for recording the provenience of the site would be lost, as well as any testing of potential models or furthering the development of testing strategies for the northeast. The hoped for systematic data recovery and excavations did not come to fruition and more and more sites were being identified in a post-impact context. As previously discussed, the nature of the shallow stratigraphic depth of most sites in northeast BC resulted in limited information, with lithic material being collected and sent to repositories, rather than protected *in situ* (BC Archaeology Branch 2016).

Environmental limitations also restricted pre-construction assessments. Due to the environment in northeast British Columbia, some areas with heavy muskeg are unable to be accessed under thawed conditions, requiring all construction and maintenance of wells and pipelines to occur in the winter. Many developments are located in remote areas, accessed only by helicopter, and require the construction of snow or ice roads for access. The environmental restrictions along with the shortened turnaround time were the rationale behind the original acceptance of post-impact assessments in the oil and gas industry (BC Archaeology Branch 2005; 2016).

There are several problems with allowing post-impact assessments as opposed to those undertaken before a project begins. The shallow stratigraphic depth of sites in northeast BC often meant that they were entirely destroyed or heavily impacted during construction with even minimal disturbance activities, such as the tracking of equipment over a field or the placement of camp equipment. Additionally, information presented to First Nations during the permit application consultation period was essentially incomplete in terms of archaeological information. Sites and areas of potential were being impacted without consultation and assessment by an archaeologist. Unless a recorded site was in conflict, a post-impact assessment would be allowed. Site mitigation is a more effective regulatory tool. Oil and gas proponents are forced through development permit conditions to avoid any areas of archaeological concern. Allowing post-impact assessments made the management of archaeological resources extremely difficult in northeast BC. Finally, post-impact assessments were sometimes used simply as a reason to avoid the identification of archaeological concerns prior to project construction by proponents. Proponents would apply for a permit, citing construction during the winter as a reason for a post-impact assessment, but the project would not be constructed until the summer (BC Archaeology Branch 2005; 2016).

Implementation of Winter Impact Assessments

Until 2004, all oil and gas projects constructed under winter conditions were subject to a post-impact assessment. With the introduction of winter fieldwork in 2004, post-impact assessments were replaced with requirements to complete archaeological assessments prior to construction (BC Archaeology Branch 2005). No further post-impact archaeological assessments are permitted by the Commission, apart from emergency situations. Emergency situations occur when human life and/or environmental features are in danger, and access to an area is immediately required. Winter impact assessments are considered a preferable approach to the post-impact assessments that were previously employed (BC Archaeology Branch 2016). Currently, approval for winter impact assessments does not extend south of Tumbler Ridge or west of Williston Lake. Beyond these areas it is more likely that subsurface archaeological features, such as storage pits, may be identified (BC Archaeology Branch 2005; 2016).

The Protocol Agreement between the Oil and Gas Commission and the Archaeology Branch is often compared to other agreements between the Archaeology Branch and the forestry industry. The forestry industry often features five-year cutting plans whereas the oil and gas industry is characterized by shorter planning cycles that are driven by fluctuating global commodity prices (BC Archaeology Branch 2016). Forestry archaeology reviews are managed not by archaeologists (like the Commission), but by forest district managers. Forest district managers do not regulate the archaeologists working in their region, and do not issue site alteration permits (Klimko, Moon, and Glaum 1998). Winter fieldwork has only recently been extended to industries outside of oil and gas (BC Archaeology Branch 2016). With the increased cost of conducting winter archaeology, as well as the longer planning timeframe, it is unlikely that many forestry projects will be completing archaeology reviews utilizing winter programs. Winter survey and subsurface testing is most appropriate when there is a shortened turn-around time and an area needs to be reviewed prior to the spring. Most, if not all, of the archaeologists holding permits in northeast BC are familiar with winter fieldwork requirements. It should, therefore, be possible to extend standards of work now required by the Commission into requirements for other industries in northeast BC (BC Archaeology Branch 2016).

No formal study has been completed on the effectiveness of winter impact assessments and their implementation in northeast BC. From the onset, however, sites were able to be identified and mitigation measures applied prior to construction activities taking place. In this, the Commission has been able to oversee and manage the resource effectively, and First Nations were often given a more complete picture of the archaeological resources that they were being asked to comment on. The Commission can also withhold a decision on the oil and gas development permit until all the information on the identified archaeological site is received (BC Oil and Gas Commission 2017b; 2017c). This aspect gives the regulator greater power and flexibility in managing and working with the proponents to ensure that archaeological resources are not being impacted.

Prior to 2004, many parties argued that there needed to be a better option for the management of archaeological resources other than the post-impact assessment strategy (Vera Brandzin, personal communication 2018). Companies were not being held accountable for report submissions and archaeologists were identifying large, regionally significant sites in a post-impact context (Vera Brandzin, personal communication 2018). Archaeologists throughout the province have stated that oil and gas proponents should be forced to only conduct archaeological work during the summer (Vera Brandzin, personal communication 2018). With the oil and gas sector forming a large sector of the BC economy, it would be difficult if not impossible to convince government to impede its progress. If anything it would probably lead to a return of post-impact assessment resource management projects (BC Archaeology Branch 2005; 2016).

Provincial Impact Assessment Comparisons

Winter testing originally was not to be employed outside of northeast BC. While not explicitly stated in policy, archaeologists and regulators relate this to the greater diversity of site types (house pits, storage caches), depth of site burial and complexity of the archaeological record elsewhere. The possibilities that these types of sites may be missed in snow conditions or under evaluated in their extent and content seems high. Winter survey sometimes has been allowed outside of northeast BC when the archaeologist is conducting culturally modified tree (CMT) surveys or where winter site excavations are being undertaken. Winter archaeology viewpoints vary within Canada from province to province. The position for provincial regulatory bodies is dependent on heritage legislation and the type of industry it is being applied to (BC Archaeology Branch 2005; 2016).

The Yukon Heritage Resources Unit accepts applications for winter linear access, with limited ground disturbance; such as for a snow or ice road (Yukon Heritage Resources Unit 2015). Any archaeological inspections in the Territory are completed in the summer months and must be carried out in frost-free conditions (Yukon Heritage Resources Unit 2015). Additional 30 m and 200 m buffers prevent development activities from impacting known sites. While the Yukon Heritage Resources Unit is prescriptive for avoidance measures, there is no precedent for where winter survey and subsurface testing would be acceptable (Yukon Heritage Resources Unit 2006, 2015).

The Ontario Ministry of Tourism, Culture and Sport, the regulator for archaeologists and assessments, supports snow excavation using heated blankets to thaw the ground but restricts winter survey; snow cover reduces ground visibility and the identification of topography, surface features or ruins (Ontario Ministry of Tourism, Culture and Sport 2013:15). As a consequence surveys can only occur when snow is absent and ground conditions are thawed. The Ontario regulator also believes that crews working in the cold are less likely to work carefully and be able to make detailed observations. Working conditions considered inappropriate by the Ontario regulator are not described in detail in the manuals.

The Archaeological Survey of Alberta, Alberta's regulatory agency for heritage, utilizes a standard permitting template that requires fieldwork to only be conducted in frost and snow-free conditions. Any deviation from the standard permit condition requires consultation and discussion with the agency. The Archaeological Survey does not prescribe conditions where winter archaeological work will be acceptable or unacceptable. It does, however, state that the completion of an impact assessment prior to construction outweighs assessment done in a post-impact context. Winter field work may be allowed but on a case by case basis with the approval and involvement of Archaeological Survey staff. The Archaeological Survey also states that the quality of work conducted under any type of winter conditions needs to meet regulatory standards regardless of the time of year (Archaeological Survey, Heritage Resource Management Branch 2006).

Comparisons of the BC situation to other provincial regulators is valuable for consideration of winter testing efficacy. However, variation in archaeological site types and landscapes across the country makes these types of comparisons difficult. The type of impact assessments and restrictions in Alberta, Yukon or Ontario cannot be copied into BC, and BC regulatory programs may be inappropriate for each of those jurisdictions. Each jurisdiction must respond to and develop policies and protocols to fit individual circumstances.

This chapter has provided an account of the regulatory context for heritage conservation in BC, a history for Commission involvement in regulatory archaeology in the province's northeast and a timeline as well as discussion of winter testing both in BC and elsewhere. In the next chapter I will discuss winter testing in detail, as well as provincial standards that have been recently set for implementation.

Chapter 4.

Winter Archaeological Impact Assessments

Winter impact assessments have been conducted in northeast BC for over a decade with relatively few changes to the original requirements. Winter archaeological impact assessment requirements were first developed in partnership between the Commission and Keary Walde, owner of Heritage North - an archaeological consulting company in Fort St John. One of the main concerns with winter fieldwork is the ability to distinguish landforms and areas of potential under potentially deep snow cover (Vera Brandzin, personal communication 2018). There also is the potential of incorrectly identifying the extent of a landform, as well as the natural boundaries of an identified site. Based on Archaeology Branch and Commission requirements, there is no difference in the subsurface testing strategy employed during winter and summer conditions (BC Archaeology Branch 2017). Archaeologists working under winter conditions must be able to identify and define landforms to the same level of accuracy as during summer conditions.

Accepted Provincial Standard

As of 2016, there is a provincial standard for winter fieldwork methods that is provided to archaeologists working in northeast BC. The provincial standard is included in the section 14 permit template published by the Archaeology Branch (BC Archaeology Branch 2017). Prior to 2016, archaeologists would include their own methodology in the permit application, which then would be reviewed by project officers at the Archaeology Branch and subsequently the Oil and Gas Commission and First Nations during the permit application comment period. While the permit application is still distributed for comment, archaeologists are able to select and confirm adherence to the provincial standard, or provide their own (BC Archaeology Branch 2017). The Commission Section 14 permit application outlines eight requirements:

- the removal of snow to expose the ground when required;
- permitted use of concrete saws to cut frozen ground;

- excavation of tests using shovel or pick-axe to the sterile layer;
- each sample must be individually bagged;
- each sample must be numbered and mapped;
- samples must be thawed and screened through 1/4” mesh;
- the collection screen must be visually inspected;
- Evaluative units may be excavated once the ground is heated and no longer frozen.

The permit application further requires systematically-spaced subsurface testing if the topography cannot be observed (i.e. the snow is too deep to discern features) (BC Archaeology Branch 2017). The eight standard requirements reflect the overall methodology that has been employed in the region since 2004. The permit application wording and requirements were developed in cooperation between the Archaeology Branch and the Commission to reflect the unique northeast BC and oil and gas requirements (BC Archaeology Branch 2016, 2017). The provincial requirements can be separated into three parts: survey and landform identification, subsurface testing, and evaluative assessment with controlled excavation units. The survey methodology is vital to the success of winter fieldwork. The number of tests and determining the landform size and dimensions need to be completed under winter conditions, with the aid of LiDAR and pre-field work review. The methodology standards are focused on maintaining the provenience of the samples during movement from the field into the office for thawing. The permit requirements also support the use of concrete saws and pickaxes to help remove samples from the frozen ground. The ground is cut, removed and the frozen pieces are bagged. To undertake evaluative units within a site, the ground must be thawed. Heating blankets are often used to accomplish this, as well as heated tents for the comfort of the fieldworkers (BC Archaeology Branch 2017).

The standard winter impact assessments requirements are supported and integrated into overall testing and survey requirements that are outlined in the permit application. The Archaeology Branch provides testing schemes based on landform size, with the expectation that testing strategies utilized in the field will reflect site density assumptions (BC Archaeology Branch 2017). Areas of potential should be tested on the basis of previous work but not at the expense of ignoring potentially unique features of the area or landform. If the area is surveyed accurately, then the testing regime across the region should be relatively uniform across consultants in the field regardless of weather conditions. The risks associated with maintaining sample provenience, such as mislabeling, misplacing, and missing samples, would be similar to the risks in summer conditions. Table 7 provides a summary of the requirements for archaeological impact assessments as outlined in the Archaeology Branch permit methodology (BC Archaeology Branch 2017).

Table 7. BC Archaeology Branch Requirements for Archaeological Impact Assessments

	Archaeological Impact Assessments	
Survey Transects	Permit applicants are able to choose applicable survey transect spacing regardless of snow cover: 10 m or less in high potential, 25 m or less in moderate potential, and 10-40 m in areas of low potential; Entire development spaced less than 5 m intervals; Areas with high potential for surface artifacts surveyed at 1-5 m intervals; Areas with low potential (other than CMTs) surveyed at 5-50 m intervals; Areas of low potential may not be surveyed	
Mesh Sizing	¼” mesh or smaller in summer conditions	¼” mesh in winter conditions
Subsurface Testing	Areas of high potential tested at 1-5 m intervals	
Field Director Requirements	Must meet required number of days of experience in the boreal forest region	

BC Archaeology Branch 2015, 2017

Survey

Conditions for archaeological survey in northeast BC can range from staggeringly hot to brutally frigid. Temperatures can significantly impact everything from specific types of field methods to selection of trucks and snowmobiles. Consulting companies often face a high employee turnover rate, resulting in crews with less overall experience in winter survey and familiarity with the northeast BC landscape. Winter access can become extremely difficult. Full-sized test pit samples must also be transported to the truck and lab for processing, adding considerable time to the process. For oil and gas proponents, winter archaeology can extend permitting and construction timelines and become costly to employ. Winter conditions are not considered a rationale for insufficient testing or inaccurate site boundaries. The field director is held accountable for under evaluated development sites or where inadequate information is present to document site boundaries (BC Archaeology Branch 2015, 2017).

While the environmental conditions vary throughout the year, and with some degree of flexibility, there is a standard survey methodology that the Archaeology Branch has endorsed for winter impact assessments. Apart from initial desktop survey, permit applicants design their field approach through selection of traverse spacing for test pit excavation prior to permit issuance. The overall position for survey spacing is dependent upon the field director’s assessment of the area. Traverse spacing will vary significantly depending upon the snow depth and eco-region that the development is located in. The Archaeology Branch supports spacing at 10 m intervals or less for areas that are projected to be high potential. Less than 25 m intervals are approved for moderate potential, with the prescribed range of between 10-40 m intervals for low potential areas. The Archaeology Branch also allows field directors to employ traverse spacing at less than 5 m for areas defined as high potential (BC Archaeology Branch 2017). Traverse spacing is a significant aspect of the impact assessment that can result in missed areas of potential, without the implementation of environmental condition-appropriate spacing, field director experience, and a solid desktop review.

The accurate identification of landform size and type is vital in winter fieldwork for evaluating area potential and for the correct placement and amount of subsurface testing. Misidentification of landforms potentially results in insufficient or no testing leading to inadequate reports or archaeological site destruction. Often a crew will visit a development site once and the number of tests per feature must be determined in the field. The field director needs to be comfortable and experienced with the landforms that exhibit potential. The number of tests placed on the feature should be similar and consistent with the amount of tests that would be placed on that same feature under summer conditions (BC Archaeology Branch 2017).

The Archaeology Branch requires subsurface testing at 1-5 m intervals or less on areas of high archaeological potential. There is no discussion or requirements listed in the permit application for areas of moderate or low potential, where archaeological resources may still be encountered (BC Archaeology Branch 2017). Testing strategies are left to qualified field directors to determine the appropriate density and spacing of samples that should be taken. The regulatory office may conduct audits of assessments to determine if sufficient testing was undertaken and may require additional work where deficiencies are determined (BC Archaeology Branch 2017).

Site Boundaries

Determining the extent of a site is critical when artifacts are recovered. Regardless of snow depth, the surrounding area and landform must be accurately mapped with nearby drainages or other terrain features described and reported (BC Archaeology Branch 2017). In many cases, landforms from which cultural materials are recovered are limited in size and can be mapped as the archaeological site per se. Determination and mapping of site boundaries also involves substantial cost when project access is difficult, where snow depth obscures landform features, and where site crews have already moved away from the area and need to return. Inappropriate identification of site boundaries can result in the destruction of sites by a development project even after a project redesign has been made to avoid a recorded site. Accurate site documentation also allows for proactive management of area resources in advance of further development. It is vital that additional testing to determine the site boundaries is completed when necessary.

Winter Archaeological Impact Assessment Processes

Properly mitigating high risk components ensures that fieldwork is completed to an acceptable threshold and improves confidence in the methodology. Table 8 identifies the stages of an assessment, as well as providing ways that regulators and archaeologists mitigate high-risk activities. Stages in which winter methods differ from summer practice require discussion and rationale to validate the replacement techniques. There is the potential for winter testing to increase the probability of recovering an artifact when entire samples are removed for inspection and mesh screens are inspected in the lab utilizing water screening, rather than in the field. Water screening melts the frozen sediments and better facilitates close inspection of removed sediments caught in the mesh.

Table 8. Winter Field Methodology Process

	Winter Fieldwork Process
Pre-field Desktop Review	-Commission requires overview document to review all recommendations, including those of no field work required -LiDAR and previous archaeological reports form basis of knowledge for consultants to draw on
Transect Spacing and Survey	-Archaeology Branch requires standard transect spacing -Regulators acknowledge and anticipate field directors will determine appropriate spacing based on experience, snow conditions, and region
Identification of Landform Size	-Archaeology Branch requires standard testing intervals -LiDAR and geo-photos are helpful to consider landform size and definition
Site Boundary Definition	-Archaeology Branch policy, outlining requirements for determining site boundaries utilizing natural or arbitrary boundaries, including required amounts of negative testing -Commission conducts reviews and visits sites in summer conditions to review site boundaries determined under snow cover

BC Archaeology Branch 2017; BC Oil and Gas Commission 2017b

Permit Requirements

There are several additional concerns and issues that are unique to winter fieldwork that are not addressed in the permit methodology approved by the Archaeology Branch. These issues include depth of test units, potential impacts on a site or cultural materials from winter excavation methods, the disposition of tested matrices, and winter testing experience requirements for field directors.

Maintaining stratigraphic control of samples recovered in winter excavation can be extremely difficult. Also important is a determination of the maximum depth for test units, ensuring that tests reach culturally sterile soils. Test unit depths need to be discussed in the impact assessment report for proper evaluation by the regulator. The actual depth of a test unit is based on previous work in the area, the depth and characteristics of soil horizons defined in summer work as well as site specific contexts. With samples needing to be removed for screening, determination of appropriate depth for test excavation is critical (BC Archaeology Branch 2017).

The impact of concrete saws or pickaxes on cultural materials is another potential concern. It is possible that artifacts will be broken during sample removal but the limited nature of site assemblages in the boreal forest, and the fact that virtually all artifacts are lithic, ensures this will be minimal. It is likely the use of shovels in summer conditions would pose a similar risk to increase artifact breakage. When a site is in an unavoidable conflict with a development, and additional tests are required under a site alteration permit, this may be of greater concern and subject to additional permit requirements.

If a project is being undertaken on cultivated land, lithics exposed in plowed fields in the summer potentially will be missed in winter survey. Assessments and subsequent testing is required on cultivated fields regardless of snow cover. Without discrete landforms for direct testing then a grid system or some other systematic testing methodology is employed to accurately test the area. There are several recorded sites in the region located on agricultural land where dispersed scatters of lithics are present, albeit the overall density of artifacts is low for the size of the area under investigation. Testing is required for ploughed fields in the region, and often they are located within areas of high archaeological potential – along rivers and terraces (Vera Brandzin, personal communication 2018).

A final issue related to winter fieldwork practice relates to the experience of a field director in identifying features and landforms under snow cover conditions. Currently field directors are typically assigned to projects based upon experience within a particular region. In northeast BC a permit holder is required to have sub-arctic-boreal forest experience, as defined by the Archaeology Branch. There is no requirement to have experience working under winter conditions (BC Archaeology Branch 2015). Permit holders, who are not required to be in the field, need to employ field directors with appropriate skills and experience. The field director also needs to be able to determine when snow depth reaches a threshold where it is no longer possible to accurately identify and define features in the field.

Snow Cover Threshold

The field director, as outlined in the section 14 permit, determines the snow cover threshold where landforms can no longer be accurately defined during the assessment as the Archaeology Branch is not prescriptive, and does not assign a depth that would require all assessments to be halted (BC Archaeology Branch 2017). Depending on snow drifts and the location of the assessment, the depth of snow that would require testing to be halted can vary considerably. Similar to testing strategies, the Archaeology Branch relies upon the field director's experience to dictate when the snow cover is too deep (BC Archaeology Branch 2017). Snow cover threshold also significantly impacts development access and project timelines. If accurate LiDAR is available for the development project, landforms may be identifiable for evaluation when snow cover recedes.

Defining Site Boundaries

Site boundaries are commonly defined by landforms and other natural features in the oil and gas industry. Proponents treat archaeological features similar to protected environmental features like mineral licks or streams; the sites are to be identified and avoided without spending significant time and resources on extensive excavations. The goal is to have accurate site boundaries that provide protection for the site and landform integrity (BC Archaeology Branch 1998a). When minimal testing occurs, the landform on which an archaeological site is located becomes the potential site boundary for avoidance. In the planning stages of a development project, some proponents employ consultants to identify areas of lower archaeological potential. Without accurate LiDAR, however, ground-truthing an area may still be required.

Methods and Testing Strategy Based on Environmental Area

The eco-region greatly influences the appropriate testing strategy for the area. Agricultural lands must be evaluated prior to survey to determine if any landscaping, ground disturbance or cultivation, has occurred over the area. Areas of heavy muskeg must also be assessed to determine if any areas of potential, including knolls, are located within the survey area. Knolls located within the muskeg, especially further north are considered areas of high potential, likely used for hunting or camping (Dady et al. 2005). There cannot be a prescriptive requirement by the regulator that applies to the entirety of northeast BC, as sampling should depend upon eco-regions, context of landscapes, and any areas of microtopographic or paleo-features (BC Archaeology Branch 2017). To ensure that areas which may exhibit potential are not ignored, the Commission requires consultants to provide a rationale when recommending that no further archaeological work is required for a development (BC Oil and Gas Commission 2017b).

Archaeological Potential Models

Archaeological potential models are desktop-based applications that attempt to identify areas of potential based on set criteria within a region. The limits of potential models for northeast BC are acknowledged and addressed in oil and gas development regulations. Oil and gas developments within BC require an archaeologist to be involved prior to permitting and construction of developments taking up new lands. EAO and NEB requirements vary from Commission requirements slightly, but still require an archaeologist to review the project. Every permit application must include archaeological information, not only for Commission review, but also to be included in First Nations consultation packages. The consultant must provide an overview of the project, reference to previous work in the area, and an assessment of archaeological potential for the project area. The pre-field overview is required to review a broad range of information (construction plans, LIDAR, previous work), beyond the initial assessment of archaeological potential by an archaeologist. Archaeology-specific conditions are then added to development permits to ensure compliance to legislation by oil and gas companies (BC Oil and Gas Commission 2017b).

Several attempts have been made to develop a model of archaeological potential for different areas in northeast BC to aid in the identification of archaeological sites and industrial planning. Mackie (1997:2) for example, has attempted this for the Dawson Creek Forest District. As he observes, existing archaeological data in this area has been recovered largely through industrial development providing a skewed picture of site distributions (Mackie 1997:3). Alternatively, he employs landscape variables in his model including proximity to larger transportation rivers, slope aspect, and forest type. Efforts to develop a representative archaeological assessment model for the Fort Nelson Forest District were ultimately unsuccessful due to the inability to predict microtopography within muskeg. There is a significantly high archaeological potential associated with microtopography in these areas, and the lack of inclusion in the potential model severely limits its use (Mackie 1998:4).

The Millennia model, developed over five years from 2001 to 2006 integrated terrain modeling based on field verification (Eldridge and Anaya-Hernandez 2005). A combination of orthophoto review and field work was utilized to test the model's predictive ability. At the time, LiDAR was not readily available for integration into the model. A noted gap in the model is aboriginal trails, with the inability to obtain additional data on traditional use areas from First Nations. While the model is in use today, the model lacks the ability to accurately predict "one-fifth to one-quarter of all known sites" (Eldridge and Anaya-Hernandez 2005:79). Integration of LiDAR data would be expected to greatly increase the reliability of the model (Eldridge and Anaya-Hernandez 2005).

It is necessary to compare a sample of archaeological assessments between winter and summer conditions to determine the effectiveness of winter impact assessments. While the majority of the assessment is left to the professional discretion of the field director, any trends or differences between the assessments should be reviewed. Comparing the data objectively and identifying any deficiencies will allow for valid regulations, requirements, and potentially the development of an audit program to ensure that winter and summer methodology are accurate and there is a similar standard in northeast BC. The following chapter will present data collected and analyzed to determine the success of winter testing in northeast BC over the past ten years.

Chapter 5.

Data Presentation and Analysis

Data was collected from projects undertaken by a wide variety of consulting companies and throughout the period from the introduction of winter methodology to the implementation of current methods. Reports on file at the Commission office in Fort St. John and the Provincial Archaeological Report Library (PARL) in Victoria were utilized for data collection. Only government approved reports were considered, ensuring that the Archaeology Branch and the Commission had completed project reviews and accepted the data. The reports were chosen from blanket final permit reports, with the archaeologist completing multiple assessments under the permit for multiple clients. Each report selected contained the archaeological impact assessment results from a single oil and gas project.

Data was collected from 20 assessments per permit issuance year, from 2006 to 2015. Assessments post-dating 2015 were minimal and therefore not included in the sample. Reports from these more recent projects had not yet been completed or had yet to be reviewed and/or accepted by the regulatory bodies. Within each permit year, ten summer and ten winter interim reports were randomly selected from approved blanket final permit reports; if an extra summer assessment appeared in the sample, it was not used until a winter assessment was collected. Each permit was assigned a separate number so the consulting company could not be identified. The goal of the research is to assess the overall results of winter impact assessments, rather than the results of individual companies. The random sample of 100 reports from each summer and winter assessments is based on the assumption that the sample would be representative. Blanket permit reports can contain as few as a single report to upwards of 500 interim reports. Blanket reports are particularly useful for this study, as they allow for consistency in methodology by the same consultant, while applying their methodologies across different terrains. The complete dataset can be found in Appendix A.

For each report, the following data was collected:

- Permit year
- Ecoprovince (Boreal Plains or Taiga Plains)

- Terrain (forest, agricultural, muskeg, or a mix)
- Vegetation cover
- Landform type
- Mapsheet
- Winter or summer impact assessment
- Snow cover
- Snow cover depth
- Number of archaeology sites identified
- Number of areas of potential identified
- Number of subsurface tests completed
- Year work was conducted
- Site type
- Site dimensions

Environmental area type was recorded to identify the types of vegetation or other environmental factors associated with each project assessment. The dominant oil and gas fields are located in the Boreal Plains and the Taiga Plains Ecoprovinces. The terrain information collected was to give a general impression of the study area, whether it was forested, agricultural land, or muskeg, as well as possibly mixed terrain. The goal for collection of these data was to determine if general terrain types create discrepancies in site identification or in application of overall impact assessment testing strategies between summer and winter. Vegetation cover was recorded as well to address the same issues. Landform type pertains to the archaeological potential for test excavations and site recognition on different terrains. If there were multiple landform types these were listed in sample data.

The type of impact assessment for individual assessments was recorded as winter or summer; no assessment in the sample incorporated projects with both. If snow cover was present, winter impact assessments were identified as having frozen or unfrozen ground where regular subsurface testing was implemented. This was done to ensure that all areas of potential surveyed under snow cover were reviewed as a single sample, as opposed to a grouping of the latter under summer conditions for test excavations. If provided in the report, the depth of snow cover was documented. Where snow depth was given as a range, the midpoint was used. Additionally, snow cover depth was rounded up/or down to the nearest 5 cm interval.

The number of areas of archaeological potential identified for each project and the total number of subsurface tests was also collected. Since blanket permits span multiple field seasons and years, the year of work was defined. Only information resulting from the identification of new archaeological sites was collected. This includes the number of documented sites for each project as well as type. Notably all site types were identified as lithic in categorization meaning at least one lithic flake/core or artifact was recovered. Estimates for site dimensions were identified and used to calculate site area.

Data Trends

As a beginning point in data analysis, I examined overall trends and comparative results. A total sample of 100 winter and 100 summer projects was employed as stated previously. The Boreal Plains and Taiga Plains Ecoprovinces encompassed the data collection area. Table 9 provides a breakdown of projects undertaken in these regions by winter versus summer fieldwork.

Table 9. A Comparison of the Projects Separated into Boreal Plains and Taiga Plains Ecoprovinces

AIA Type	Number and Percentage of Boreal Plains Ecoprovince Projects	Number and Percentage of Taiga Plains Ecoprovince Projects	Total
Winter AIA	86 (52%)	14 (40%)	100
Summer AIA	79 (48%)	21 (60%)	100
Total	165	35	200

A total of 165 projects were examined for the Boreal Plains Ecoprovince representing 82.5% of the sample recorded. The number of assessments for the Taiga Plains Ecoprovince was considerably lower. This discrepancy is not unexpected, as considerably more oil and gas development, especially in the last decade, has occurred in the former region. Winter versus summer projects are relatively even in the Boreal Plains area with 60% of the Taiga Plains project assessments completed under summer conditions. While some discrepancy exists between the two areas, the variation between summer versus winter work seems limited.

In terms of success, 54 (27%) of the projects identified the discovery of at least one archaeological site as presented in Table 10. The results were fairly evenly split, with 28 of the projects assessments conducted under summer conditions and 26 assessments conducted winter conditions.

Table 10. A Comparison of the Projects with Archaeology Sites Identified by Ecoprovince

	Winter AIA	Summer AIA	Total
Boreal Plains Ecoprovince	20 (23% of all winter BPE projects)	23 (29% of all summer BPE projects)	43
Taiga Plains Ecoprovince	6 (42% of all winter TPE projects)	5 (23% of all summer TPE projects)	11
Total	26	28	54

While the overall results of projects can be compared as above, multiple archaeology sites are recorded in some of the assessments. Within the overall data set, a total of 75 sites were identified. Table 11 provides the number of sites reported for winter and summer projects, as well as area in which they found. Again, site discovery results are relatively equal between summer and winter conditions. The greater number of sites in the Boreal Plains Ecoprovince reflects on the greater number of assessments being completed in the region.

Table 11. A Comparison of the Total Number of Archaeological Sites Identified by Ecoprovince and AIA Type

	Archaeology Sites – Winter	Archaeology Sites – Summer	Total
Boreal Plains Ecoprovince	27 (47% of all BPE identified sites)	31 (53% of all BPE identified sites)	58
Taiga Plains Ecoprovince	7 (41% of all TPE identified sites)	10 (59% of all TPE identified sites)	17
Total	34	41	75

Beyond discovered sites, it also is possible to compare the number of areas assigned as having high archaeological potential for site location identified under winter and summer conditions. Table 12 outlines this data. Notably the data illustrate disproportionate numbers of high potential areas identified in the summer as opposed to the winter in both the Boreal Plains and Taiga Plains Ecoprovinces. This seemingly indicates that areas with potential are being missed under snow cover, or more discrete landforms are being tested under summer conditions. If the former, then it is possible that sites are being lost from high potential landforms that are being missed in winter conditions.

Table 12. A Comparison of the Total Number of Areas of Archaeological Potential Identified by AIA Type and Ecoprovince

	Areas of Potential – Winter	Areas of Potential – Summer	Total
Boreal Plains Ecoprovince	294 (40% of all BPE areas of potential)	439 (60% of all BPE areas of potential)	733
Taiga Plains Ecoprovince	51 (25% of all TPE areas of potential)	150 (75% of all TPE areas of potential)	201
Total	345	589	934

The number of subsurface test excavations conducted in summer versus winter projects is provided in Table 13. Table 14 provides the mean number of tests completed per project. As illustrated there is a substantial difference in the amount of test units being excavated in summer and winter. In both the Boreal Plains and the Taiga Plains Ecoprovinces almost twice as many subsurface tests are completed in the summer compared to the winter. There are several potential explanations for this discrepancy. There may be more reliance upon subsurface testing in the summer to determine site boundaries as opposed to an assumption that landform size is equivalent to site size in the winter. Further research, looking at specific site boundaries identified in winter and summer conditions would be required to identify this. Another explanation would be that landforms identified and tested in the winter are more likely to result in the identification of archaeological resources, as they are distinct and more easily identifiable, in such that more discrete features are not tested in the winter but also are not producing archaeological materials when these discrete features are tested under summer conditions. Summer archaeological impact assessments may also incorporate more subsurface testing of features with lower potential.

Table 13. A Comparison of Subsurface Testing Completed by AIA Type and Ecoprovince

	Subsurface Testing – Winter	Subsurface Testing – Summer	Total
Boreal Plains Ecoprovince	5,779 (34% of BPE subsurface tests)	11,368 (66% of BPE subsurface tests)	17,147
Taiga Plains Ecoprovince	686 (15% of TPE subsurface tests)	3,760 (85% of TPE subsurface tests)	4,446
Total	6,465	15,128	21,593

There is substantially more subsurface testing being completed in the summer in the Taiga Plains Ecoprovince but the site identification rate is more even than the volume of testing would seem to indicate. The Boreal Plains data illustrates a similar trend to the Taiga Plains, with less drastic differences between the identification of areas of potential and subsurface testing amounts.

Table 14. A Comparison of the Average Number of Subsurface Tests Completed by AIA Type and Ecoprovince

	Subsurface Testing – Winter	Subsurface Testing - Summer
Boreal Plains Ecoprovince	67 tests per project	144 tests per project
Taiga Plains Ecoprovince	49 tests per project	179 tests per project
Overall Total	66 tests per project	151 tests per project

Comparing the relative success rate in terms of site discovery from shovel testing, with 6,465 test holes in winter and 34 sites, the test success rate is 0.5% or 1 site discovered approximately every 190 tests. In the summer, it is 0.27% with one site discovered approximately every 369 tests. This indicates that winter shovel tests are more efficient at identifying sites than summer tests. Potentially this is due to greater scrutiny to removed sediments, or a large volume of summer testing being used to determine site boundaries.

Identified areas of high potential and overall subsurface testing occur in much greater numbers in the summer compared to the winter. The data, however, do not indicate that increased testing equals increased site identification. It is necessary to further explore the data based on the different variables recorded in the data set.

Environmental and Forest Cover

Data was sorted into overall landscape categories of forested, agricultural, muskeg, forest-muskeg and agricultural-partial forest. The latter two mixed environments accounted for only 3 and 6 of the projects respectively and are omitted from further discussion here. Data for the first three, comprising over 95% of the sample, are incorporated in Tables 15, 16, and 17.

Table 15. A Comparison of Winter versus Summer fieldwork as sorted with Forested being the Major Environmental Characteristic

	Winter AIA	Summer AIA	Total
Projects	67 Projects	61 Projects	128
Number of Sites Identified	23 (47%)	26 (53%)	49
Number of Areas of Potential	234 (43%)	312 (57%)	546
Subsurface Tests	4,671 (36%)	8,129 (64%)	12,800

Table 16. A Comparison of Winter versus Summer fieldwork as sorted with Muskeg being the Major Environmental Characteristic

	Winter AIA	Summer AIA	Total
Projects	10 Projects	15 Projects	25
Number of Sites Identified	7 (54%)	6 (46%)	13
Number of Areas of Potential	37 (24%)	116 (76%)	153
Subsurface Tests	673 (28%)	1,714 (72%)	2,387

Table 17. A Comparison of Winter versus Summer fieldwork as sorted with Agricultural Land being the Major Environmental Characteristic

	Winter AIA	Summer AIA	Total
Projects	20 Projects	18 Projects	38
Number of Sites Identified	4 (36%)	7 (64%)	11
Number of Areas of Potential	66 (34%)	129 (66%)	195
Subsurface Tests	996 (19%)	4,342 (81%)	5,338

Tables 15, 16 and 17 illustrate trends similar to those previously examined for the categorized landscape data but there are also dissimilarities with interesting connotations when landscape types are compared. For forested zones the pattern in Table 15 matches closely overall numbers presented in earlier discussions (see Tables 12 and 13). With forested area projects dominating the sample, this is as expected. One aspect of the muskeg terrain data, however, gave unexpected results. While considerably greater numbers of subsurface tests were conducted in the summer, and more areas with high potential were identified, slightly more sites were identified under winter conditions. Why this may be the case is unknown, albeit greater scrutiny of excavated sediments through thawing and sieving in the lab may result in greater numbers of artifact finds as opposed to expediently examined shovel test matrices in summer work. Data from agricultural land projects are similarly interesting. Approximately twice as many sites are identified on agricultural land in the summer as in the winter. This discrepancy cannot be based on the overall project numbers as more assessments were completed on agricultural lands in the winter than in the summer. Surface exposures in the summer, and the ease with which test excavations can be undertaken in this type of terrain, is no doubt responsible. The failure to identify sites in the winter on this type of terrain also suggests winter impact assessments may be inadequate here, possibly identifying a category of landscape to be excluded from winter project assessments.

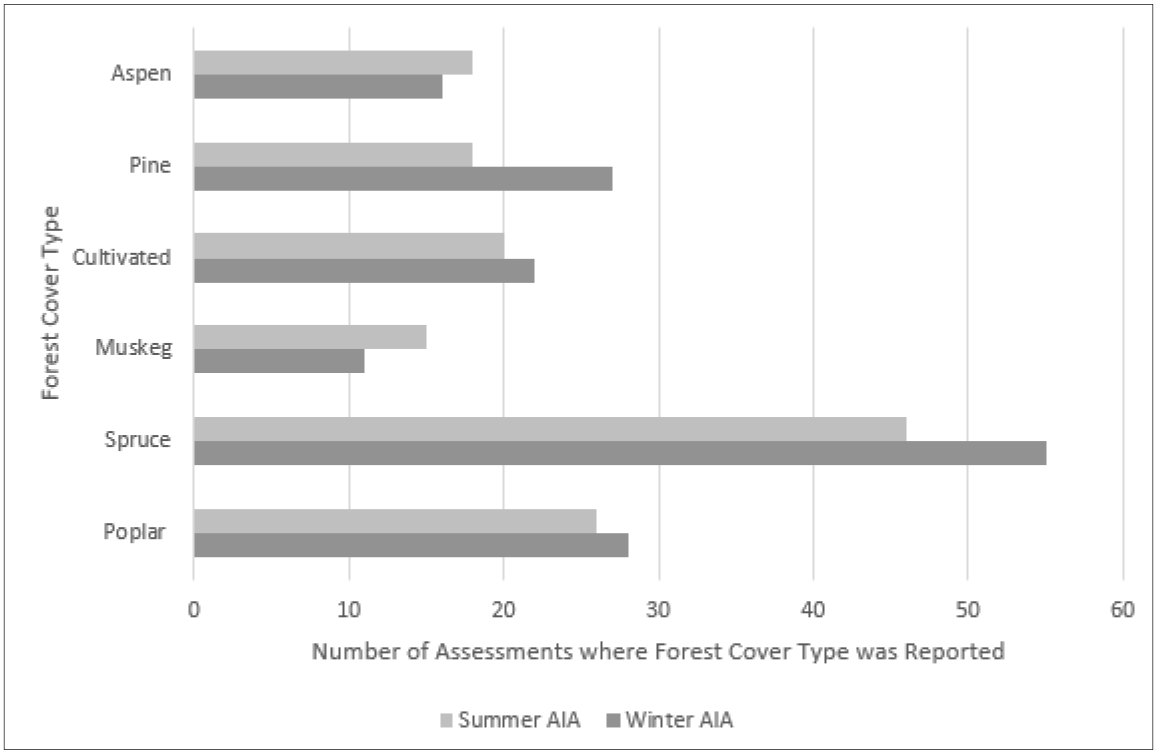
Specific types of forest cover were identified from projects and compared. When multiple vegetation types were listed, the major cover was documented. Spruce was reported as the dominant forest cover in 40% of project assessments. Illustrated in Table 18, project results in spruce forest cover were somewhat evenly split between winter and summer fieldwork with a similar split in numbers of sites identified, number of identified areas with potential as well as the intensity of subsurface testing. All of this suggests winter impact assessments have been effective and have roughly equal results to summer field work in spruce cover.

Table 18. A Comparison of Spruce Forest Cover As Reported Between AIA Type

	Winter AIA	Summer AIA
Site Identification	58% (18 archaeological sites)	42% (13 archaeological sites)
Areas of Potential	48% (192 areas of potential)	52% (205 areas of potential)
Subsurface Testing	44% (3,689 subsurface tests)	56% (4,700 subsurface tests)
Overall Total Distribution of Reported Spruce Cover in Projects	54% (55 projects)	46% (46 projects)

Figure 7 compares project results in terms of identified areas with high potential across all forest types, and similar to spruce, there is virtually no differences between summer and winter fieldwork reinforcing the preceding interpretation of winter test efficiency. Winter conditions appear to not influence the identification of forest cover, as would be expected.

Figure 7. Major Forest Cover Characterstics Reported based on AIA Type



Landforms and Identified Areas of Archaeological Potential

Different landform types were recorded and are compared in Table 19 for site identification and summer or winter conditions. Table 19 provides data for the five most common landform features identified in the data. These comparisons are interesting in so far as winter field projects consistently resulted in fewer site identifications and areas of potential across landform types. In the case of terraces, this was substantially so. These discrepancies are probably accounted for by the disproportionate number of shovel tests undertaken in summer work.

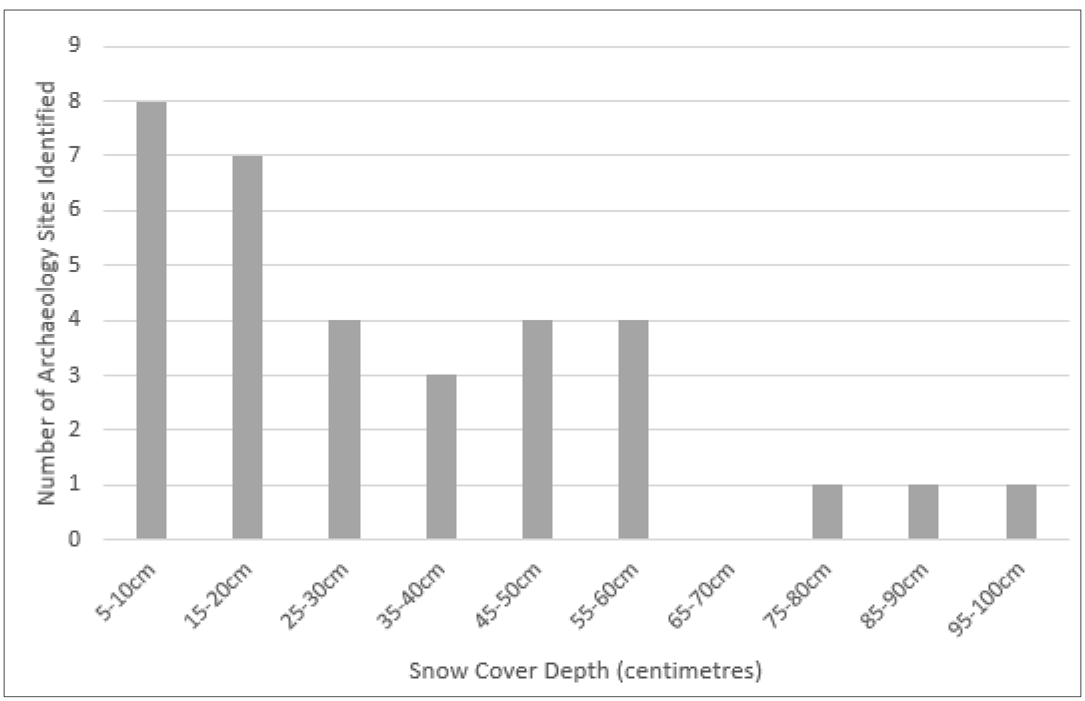
Table 19. Comparing Landform Feature Identification as Reported with AIA Type.

Feature Identified	Winter AIA	Summer AIA	Winter AIA project with Sites Recovered	Summer AIA project with Sites Recovered
Break In Slope	34 (53%)	30 (47%)	9 (43%)	12 (57%)
Knoll	37 (50%)	37 (50%)	13 (45%)	16 (55%)
Ridge	26 (41%)	37 (59%)	14 (44%)	18 (56%)
Terrace	17 (53%)	15 (47%)	6 (32%)	13 (68%)
Topographic High	24 (49%)	25 (51%)	8 (36%)	14 (64%)

Snow Cover

Snow cover and snow depth data was collected when provided in the impact assessment. Figure 8 illustrates the relationship between increasing snow depth and number of sites identified. Site discovery continues up to a depth of 100 cm. There is no indication that there is a threshold related to snow cover and site identification, but the limited data requires further verification, including where data is controlled for the number of projects per snow depth.

Figure 8. A Comparison of the Number of Sites Identified to the Reported Snow Depth



Chi-square Tests for Independence

In order to analyze the collected data and test for independence of the variables, a chi-square analysis was chosen. Chi-square allows us to see if differences between the observed value and expected values occur. It also provides us with the ability to test for significance with a p-value ≤ 0.05 required for rejection of the null hypothesis. This initially was run on sites discovered in winter versus summer projects (see Table 20).

Table 20. Chi-Square Contingency Table for Archaeological Sites Identified on Projects in Winter versus Summer Conditions

	Winter AIA	Summer AIA	Row Totals
Projects with Sites	26 (27)	28 (27)	54
Projects with No Sites	74 (73)	72 (73)	146
Column Totals	100	100	200 (Grand Total)

Observed versus expected (in parentheses) numbers are incorporated in the table

For the data in Table 20, the null hypothesis is that the number of sites recorded in summer versus winter fieldwork will be varied because of differential fieldwork conditions. The chi-square value is 0.1015 with a p-value of 0.750071. The result is not significant and the null hypothesis is rejected. This indicates that the variables, including site identification and season of documentation, are independent. The results of this analysis support the use of winter fieldwork as a whole, as site identification rates remain consistent throughout the year.

Data involving assessments completed in muskeg environmental areas was also tested (see Table 21).

Table 21. Chi-Square Contingency Table for Archaeology Sites Identified on Projects in Winter versus Summer in Muskeg Areas

	Winter AIA	Summer AIA	Row Totals
Projects with Sites in Muskeg	5 (3.60)	4 (5.40)	9
Projects with No Sites in Muskeg	5 (6.40)	11 (9.60)	16
Column Totals	10	15	25 (Grand Total)

Observed versus expected (in parentheses) numbers are incorporated in the table

For data in Table 21, the null hypothesis is that the number of sites recorded in muskeg environmental areas in summer versus winter fieldwork will be varied because of differential fieldwork conditions. The chi-square value is 1.4178 with a p-value of

0.233762. The result is not significant and the null hypothesis rejected. This result indicates that the variables of muskeg environment conditions and archaeological impact assessment season are independent.

Data involving assessments completed in forested environmental areas was tested (see Table 22).

Table 22. Chi-Square Contingency Table for Archaeology Sites Identified on Projects in Winter versus Summer in Forested Areas

	Winter AIA	Summer AIA	Row Totals
Projects with Sites in Forested Areas	18 (18.32)	17 (16.68)	35
Projects with No Sites in Forested Areas	49 (48.68)	44 (44.32)	93
Column Totals	67	61	128 (Grand Total)

Observed versus expected (in parentheses) numbers are incorporated in the table

For data in Table 22, the null hypothesis is that the number of sites recorded in forested environmental areas in summer versus winter fieldwork will be varied because of differential fieldwork conditions. The chi-square value is 0.0162 with a p-value of 0.8988. The result is not significant and the null hypothesis is rejected. This result indicates that the variables of forested environment conditions and archaeological impact assessment season are independent.

Data involving assessments completed on cultivated land was also tested (see Table 23).

Table 23. Chi-Square Contingency Table for Archaeology Sites Identified on Projects in Winter versus Summer in Cultivated Areas

	Winter AIA	Summer AIA	Row Totals
Projects with Sites in Cultivated Areas	3 (4.21)	5 (3.79)	8
Projects with No Sites in Cultivated Areas	17 (15.79)	13 (14.21)	30
Column Totals	20	18	38 (Grand Total)

Observed versus expected (in parentheses) numbers are incorporated in the table

For data in Table 23, the null hypothesis is that the number of sites recorded in cultivated areas in summer versus winter fieldwork will be varied because of differential fieldwork conditions. The chi-square value is 0.9306 with a p-value of 0.334695. The result is not significant and the null hypothesis rejected. This result indicates that the variables of cultivated conditions and archaeological impact assessment season are independent.

Finally data involving assessments completed where terraces were identified and where knolls were identified was also tested utilizing chi-square (see Table 24 and Table 25).

Table 24. Chi-Square Contingency Table for Archaeology Sites Identified on Projects in Winter versus Summer and Associated with Identified Terraces

	Winter AIA	Summer AIA	Row Totals
Projects with Sites and Terraces Identified	5 (6.38)	7 (5.62)	12
Projects with No Sites and Terraces Identified	12 (10.62)	8 (9.38)	20
Column Totals	17	15	32 (Grand Total)

Observed versus expected (in parentheses) numbers are incorporated in the table

For data in Table 24, the null hypothesis is that the number of sites recorded in association with terraces identified will be varied because of differing environmental conditions between winter and summer assessments. The chi-square value is 1.0123 with a p-value of 0.314355. The result is not significant and the null hypothesis is rejected. This indicates that the variables of site identification relating to terrace identification are independent from the variables surrounding environmental conditions for the assessment.

Table 25. Chi-Square Contingency Table for Archaeology Sites Identified on Projects in Winter versus Summer and Associated with Identified Knolls

	Winter AIA	Summer AIA	Row Totals
Projects with Sites and Knolls Identified	12 (11.84)	12 (12.16)	24
Projects with No Sites and Knolls Identified	25 (25.16)	26 (25.84)	51
Column Totals	37	38	75 (Grand Total)

Observed versus expected (in parentheses) numbers are incorporated in the table

For data in Table 25, the null hypothesis is that the number of sites recorded in association with knolls identified will be varied because of differing environmental conditions between winter and summer assessments. The chi-square value is 0.0063 with a p-value of 0.936859. The result is not significant and the null hypothesis is rejected. This indicates that the variables of site identification associated with knoll identification are independent from the variable of assessment season.

Several statements can be made with the results of the chi-square analysis. There is no dependency between site identification results and the methodology utilized. The variables relating to the identification of terraces and knolls was also independent to the assessment season. This supports winter testing, in that, site identification rates are not dependent upon the season that the fieldwork was completed. The results indicate relatively even site identification outcomes between winter and summer testing across a decade. This is supported by the earlier chi-square analysis of collected data presented in Table 20. There are potential problems surrounding subsurface testing discrepancies, as well as site identification on cultivated lands and ensuring the identification of areas of potential associated with paleo-features, such as terraces. The variables of cultivated fields, terraces, and knolls, are not dependent on the assessment season, but looking at the data trends indicates that there are additional variables influencing the increase subsurface testing amounts and identification of areas of potential during summer conditions.

The final chapter will discuss the significant difference in area of potential identification and subsurface testing that was identified in the data set, limitations of the study, as well as several areas where winter archaeological impact assessments could be improved. The chapter will also feature a discussion of potential modifications to ensure the continued success of winter impact assessments in northeast BC.

Chapter 6.

Discussion

There are several factors that appear to support efficacy of winter impact assessments compared to those undertaken in the summer in northeast BC. Since the majority of site are restricted to lithics located on identifiable features such as knolls, ridges, and terraces, there is little chance that significant subterranean features, such as cache pits or pit houses, are missed under snow cover. There is a substantial data set in terms of previous archaeological assessments in the region, and ever-increasing LiDAR development. The availability of resources for desktop reviews prior to survey, including First Nations traditional land use research, also aids in the identification of areas with high potential for archaeological sites. The regulatory oversight in place with the Commission allows for field visits, report reviews, and site identification tracking. The Commission's delegated responsibility also puts in place an organization with a mandate to ensure that archaeological work in the region is meeting standards set elsewhere and that the oil and gas industry is adhering to the requirements of the HCA (BC Oil and Gas Commission 2017a).

Limitations of the Data Set

The limitations of the study require acknowledgement, especially assumptions about subsurface testing variables, including variability in test size and spacing, as well as the limitations for area of potential analysis by project amount rather than the overall size. Suggested further research includes determining the area (in hectares) of areas of potential and the rate of subsurface tests performed in a per hectare measurement. The nature of the impact assessment reports means that gathering this information, within the context of this study, would have been challenging; the data would be better serviced in a stand-alone research project. While the data indicated a major variation between the identification of areas of potential and subsurface testing numbers between winter and summer conditions, this variable could have been better controlled by measuring and collecting data relating to the overall area, in hectares, that was defined as having potential. There is certainly space for further research and data collection to investigate the differences in subsurface testing and areas of potential identification between summer and winter assessments.

Future research should also involve the differentiation of subsurface and surface artifact recoveries, in order to determine if surface finds are influencing the recovery rates between summer and winter assessments. The influence of forest cover is another area which could be further investigated, especially the link between pine and aspen indicating well-drained soils and high archaeological potential

Winter Impact Assessment – Potential Concerns

Based on the collected sample, there is no significant difference in the efficiency of site identification results between impact assessments completed in the winter versus the summer. However, some variability in the results from the sample data indicate the necessity for further research and tracking of the assessment data coming out of northeast BC. In particular, the data illustrates a significant discrepancy in the amount of subsurface tests excavated in winter versus summer work. The data also indicates that a greater number of areas with high archaeological potential are being identified in summer conditions. The greater amount of subsurface testing occurring in summer projects when compared to winter assessments may be related, in part, to the nature of the work being undertaken. For example, larger pipeline projects with an extensive shovel test survey design, are more likely to be undertaken in summer conditions. The relative ease with which shovel tests can be excavated in summer projects where site boundaries are being established may be another factor. The differences in recognition of high potential areas in survey is not so easily explained. The most logical explanation is the difficulty of recognizing subtle landform features in the winter when snow cover is obscuring the underlying terrain. If further investigation bears this out, it would appear to be a limitation and/or deficiency for winter impact assessment work. Perhaps this might even require every project being undertaken in the winter to utilize high resolution (>20 cm) LiDAR to aid in the identification of landforms.

Considerably more subsurface testing, areas of archaeological potential, and sites were identified in impact assessments on cultivated land in summer conditions. Due to this disparity, cultivated lands should be the first environmental factor that triggers additional consideration by archaeologists and regulatory oversight for assessments under snow cover. Snow drifting may explain why fewer areas of potential are identified in the winter, with knolls and higher terrain being misidentified or missed entirely. Exposure and wind chill for consultants working on cultivated land may also impact the subsurface testing regime, with fewer tests being placed on areas of potential, or a heavier reliance upon desktop review materials rather than survey. The data relating to cultivated land may also be impacted on the types of oil and gas developments being placed on these lands. While a pipeline may impact areas of potential only partially, a wellsite may encompass the entire area of potential, resulting in more testing and more sites being identified. Due to the variety of potential influences, further research is required to determine why cultivated land assessments conducted in the winter differ so significantly from those completed in the summer.

An enhanced regulatory review of assessments completed during winter months, combined with educating permit holders and field directors on the discrepancy in testing, could be used to improve testing rates. Engaging with practicing archaeologists in northeast BC may also identify potential explanations for the discrepancy and assist with the development of future methodological improvements. Winter assessments on cultivated lands in northeast BC certainly require further data analysis and field verification to determine if areas of potential are being missed under snow cover or this discrepancy can be explained by the overall terrain, type of work being completed, or another characteristic of cultivated lands that differs from forested or muskeg areas.

Other Regulatory Considerations

A useful consideration in regulatory policy would be inclusion of winter impact assessment experience as a requirement when delegating field directors in northeast BC. While the majority of individuals working in the region have ample experience, defining a minimum amount of time working under winter conditions would ensure that all field directors have a basic experience to make decisions on field methods and terrain potential for sites under snow cover. Currently there is no such requirement (BC Archaeology Branch 2015).

Additional policy revisions would focus on sampling methods under winter conditions. For example, regulatory reviewers, such as project officers, might require or request rationales for testing strategies in cultivated land to ensure that appropriate coverage is completed. With further research into winter methodology any future shortcomings or inconsistencies should become part of the regulatory review process of archaeological fieldwork, acting as a subsequent check to ensure the assessment was complete and appropriate. A policy for report review should be drafted and made available to consultants so there is an understanding of the expectations and additional requirements when working under winter conditions. A clear, consistent and transparent review of the archaeological work could help alleviate concerns from various groups, including the public, First Nations, and the greater archaeological community in British Columbia.

Auditing Program Recommendations

An effective safeguard to ensure the continued effectiveness of winter impact assessments would be to develop and employ a random audit program of archaeological projects completed under snow cover. Audits would be undertaken by the regulatory body with delegated authority (Archaeology Branch or Commission). Auditing programs allow increased oversight and evaluation of methodologies, as results are published and promoted (Dady 2008; Klassen et al. 2009). Audits would facilitate a study of subsurface testing as well as identification criteria for areas of archaeological potential in winter projects. Winter assessment auditing also would be a useful tool for consulting companies with newly appointed field directors, ensuring that they were minimizing risk to the company and completing a sufficient review of the project. Ongoing auditing by the regulator further ensures consistency throughout the region, as well as an on-the-ground presence.

Auditing of the means by which site boundaries are defined under snow cover is another tool that regulatory bodies could use to monitor results and assessments. The regulator might ensure that the site is appropriately defined, and the feature is appropriately flagged for avoidance. Invitations to participate in the auditing process could also be extended to First Nations communities with concerns relating to winter impact assessments. First Nations involvement and participation in an auditing framework would allow a strengthened relationship with the regulatory agency as well as provide insight into permit conditions and winter testing strategies being required.

Beyond their role in compliance, consultant companies might also be encouraged to carry out internal audits of their work. An internal audit could potentially consist of site re-visits by the permit holder, or a separate field director, under summer conditions, to ensure that areas of potential were appropriately defined and subsurface testing was sufficient. The audit report could then be either supplied to the regulator or kept on file by the archaeology company and form the basis of recommendations for areas of improvement within the company. It also would provide insight in the adeptness and expertise of project supervisors.

Conclusion

The results of this thesis can be utilized to not only inform and support the current archaeological work being conducted in northeast BC, but as a means to open further discussion and study of methodologies applied in consulting archaeology. With growing involvement from First Nations communities and all levels of government accepting policies outlined in UNDRIP, defining appropriate methodology will be invaluable from a regulatory stand-point (Ministry of Energy, Mines and Petroleum Resources 2017). Not only does the archaeological work inform development decisions, but it forms a central piece for consultation with First Nations (BC Oil and Gas Commission 2017a). Sound methodology is the responsibility of the regulator to ensure that methods being utilized within an industry or region produce results. It allows those making cultural heritage resource decisions, be they provincial government or First Nations government, to have confidence that the assessments have met the highest standards.

In conclusion, winter impact assessments employed in northeast BC appear to be as effective in the discovery of archaeological sites as projects undertaken in summer months. Indeed, as illustrated in Table 20, there is no statistically significant difference between project results. My analyses, nevertheless, anticipates limitations in specific areas. Discrepancies in the identification of archaeological potential and subsurface testing cannot be overlooked and present opportunities for more detailed study. Another is the lack of success in finding sites in winter conditions on agricultural lands in comparison to impact assessments carried out in the summer. Although the results of the chi-square indicate that these variables are not dependent upon the assessment season, further research and investigation of these variables specifically would be of significant value and inform future assessments. Further investigation may indicate assessments relating to cultivated land might require continued adjustments to ensure features and areas of potential are not missed. That being said, and based on a sample compiled from a decade-worth of archaeological assessments in the region, site identification rates from work in the winter are equivalent to those in warm weather months. The allowance for winter impact assessments with Commission regulatory oversight, thus, has had a measure of success. For oil and gas companies, it also has provided a high degree of flexibility in their exploration and development of this industry in northeast BC.

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Appendix A.

Assessment Data

BPE – Boreal Plains Ecoprovince   Y - Yes

TPE – Taiga Plains Ecoprovince   N - No

F – Forested   NP – Not Provided

M – Muskeg   NA – Not Applicable

A – Agricultural

W – Winter

S - Summer

Year	Ecoprovince	Terrain	Vegetation Cover	Landform Type	Mapsheet	Winter or Summer	Snow Cover	Depth of Snow Cover (cm)	Site Identified?	Number of Sites Identified	Number of areas of potential identified	Number of Subsurface Tests	Year Work was conducted	Site Type	Site Size (m)
2006	BPE	F	Black Spruce, Willow	Break In Slope, Topo High	94-B	W	Y	NP	N	0	3	30	2007	N/A	N/A
2006	BPE	F	Alder, Aspen	Knoll	94-H	W	Y	NP	N	0	2	20	2006	N/A	N/A
2006	BPE	F	Pine, Spruce	Knoll	94-G	W	Y	NP	N	0	1	10	2006	N/A	N/A
2006	BPE	F	Aspen, Pine, Spruce	Break In Slope, Topo High	94-H	W	Y	NP	Y	1	5	70	2007	Lithic	15m x 8m
2006	BPE	F	Black Spruce, Pine	Knoll	94-H	W	Y	NP	Y	2	3	55	2006	Lithic, Lithic	12m x 14m, 5m x 5m
2006	BPE	F	Aspen, Pine, Spruce	Topo High	94-A	W	Y	NP	N	0	3	30	2007	N/A	N/A
2006	TPE	M	Black Spruce Muskeg	Knoll	94-I	W	Y	NP	N	0	2	24	2006	N/A	N/A
2006	TPE	M	Black Spruce Muskeg	Break In Slope, Ridge	94-J	W	Y	NP	Y	1	6	98	2006	Lithic	10m x 4m
2006	BPE	F	Pine, White Spruce, Willow	Knoll, Topo High	93-I	S	N	N/A	N	0	8	117	2006	N/A	N/A
2006	BPE	F	Pine, White Spruce	Knoll, Ridge	93-I	W	Y	100	N	0	2	50	2006	N/A	N/A
2006	BPE	F	Pine, White Spruce	Ridge	93-I	W	Y	10	N	0	2	31	2006	N/A	N/A
2006	BPE	F/M	Black Spruce	Bench	94-G	S	N	N/A	N	0	2	20	2007	N/A	N/A
2006	TPE	M	Black Spruce Muskeg	Break In Slope, Terrace, Topo	94-J	S	N	N/A	N	0	7	137	2007	N/A	N/A
2006	TPE	F	Aspen, White Spruce	Ridge	94-J	S	N	N/A	N	0	3	65	2006	N/A	N/A
2006	BPE	F	Pine, Spruce	Topo High	94-H	S	N	N/A	N	0	1	20	2006	N/A	N/A
2006	BPE	F	Aspen, Willow	Knoll	94-A	S	N	N/A	N	0	1	10	2006	N/A	N/A
2006	BPE	F	Pine, Spruce, Willow	Terrace	94-B	S	N	N/A	N	0	4	85	2007	N/A	N/A
2006	BPE	F	Aspen, Poplar, Willow	Break In Slope, Terrace, Topo	94-B	S	N	N/A	Y	1	3	113	2006	Lithic	5m x 3m
2006	BPE	F	Pine, Spruce	Break In Slope, Topo High	94-G	S	N	N/A	Y	1	10	237	2007	Lithic	5m x 10m
2006	BPE	F	Aspen, Fir, Spruce	Ridge	93-P	S	N	N/A	N	0	1	20	2006	N/A	N/A
2007	BPE	F	Black Spruce, Pine	Ridge	93-P	W	Y	10	N	0	1	15	2007	N/A	N/A
2007	BPE	F	Pine, Spruce	Knoll	93-P	W	Y	5	Y	1	1	33	2007	Lithic	15m x 5m
2007	BPE	F	Pine, Spruce	Topo High	93-I	W	Y	10	N	0	2	21	2007	N/A	N/A
2007	BPE	F	Spruce	Break In Slope	94-A	S	N	N/A	N	0	1	20	2007	N/A	N/A
2007	BPE	F	Aspen, Birch	Knoll	93-P	S	N	N/A	Y	1	1	30	2007	Lithic	14m x 18m
2007	BPE	F	Pine	Break In Slope	94-H	S	N	N/A	N	0	1	60	2007	N/A	N/A
2007	BPE	F	Pine, Spruce	Break In Slope	94-B	W	Y	5	N	0	2	30	2007	N/A	N/A
2007	BPE	F	Pine, Spruce	Break In Slope	94-B	W	Y	10	Y	1	2	57	2007	Lithic	5m x 5m
2007	BPE	F	Poplar, Spruce	Ridge, Terrace	94-B	S	N	N/A	Y	2	23	435	2007	Lithic, Lithic	8m x 18m; 15m x 15m
2007	BPE	F	Pine, Spruce	Topo High	94-A	S	N	N/A	Y	1	1	72	2007	Lithic	20m x 15m
2007	BPE	F	Alder, Spruce	Break In Slope	94-J	S	N	N/A	N	0	1	29	2007	N/A	N/A
2007	BPE	M	Black Spruce Muskeg	Knoll	94-I	S	N	N/A	N	0	6	90	2007	N/A	N/A
2007	TPE	M	Black Spruce Muskeg	Knoll, Ridge	94-P	W	Y	15	N	0	8	65	2007	N/A	N/A
2007	TPE	M	Black Spruce Muskeg	Topo High	94-I	S	N	N/A	N	0	1	20	2007	N/A	N/A
2007	TPE	M	Black Spruce Muskeg	Break In Slope, Knoll, Ridge,	94-I	S	N	N/A	N	0	41	578	2007	N/A	N/A

Year	Ecoprovince	Terrain	Vegetation Cover	Landform Type	Mapsheet	Winter or Summer	Snow Cover	Depth of Snow Cover (cm)	Site Identified?	Number of Sites Identified	Number of areas of potential identified	Number of Subsurface Tests	Year Work was conducted	Site Type	Site Size (m)
2007	TPE	F	Aspen, Poplar, Spruce	Ridge, Terrace	94-O	S	N	N/A	Y	3	4	1092	2007	Lithic, Lithic,	10m x 10m; 70m x 20m; 10m x
2007	BPE	A	Cultivated	Break In Slope	93-P	W	Y	10	N	0	4	10	2008	N/A	N/A
2007	BPE	F	Aspen, Willow	Break In Slope	93-P	W	Y	10	N	0	2	20	2008	N/A	N/A
2007	BPE	F	Birch, Pine	Knoll	94-G	W	Y	10	Y	1	1	10	2007	Lithic	7m x 5m
2007	BPE	F	Black Spruce, Pine	Terrace	94-G	W	Y	10	N	0	2	50	2007	N/A	N/A
2008	BPE	M	Black Spruce, Poplar	Break In Slope	94-A	S	N	N/A	N	0	1	25	2008	N/A	N/A
2008	BPE	M	Black Spruce, Poplar	Ridge	94-A	S	N	N/A	N	0	5	45	2008	N/A	N/A
2008	BPE	M	Black Spruce Muskeg	Knoll	94-H	S	N	N/A	Y	1	2	41	2008	Lithic	5m x 20m
2008	BPE	M	Black Spruce Muskeg	Knoll, Topo High	94-A	W	Y	10	Y	2	11	163	2008	Lithic, Lithic	20m x 76m; 16m x 22m
2008	TPE	F	Aspen, Willow	Break In Slope, Knoll	94-I	S	N	N/A	N	0	6	52	2008	N/A	N/A
2008	TPE	F	Aspen, Black Spruce Muskeg,	Knoll, Ridge	94-P	S	N	N/A	Y	1	16	294	2008	Lithic	15m x 5m
2008	TPE	F	Poplar, Spruce	Knoll	94-I	S	N	N/A	N	0	1	8	2008	N/A	N/A
2008	BPE	F	Pine, Spruce	Knoll, Ridge	93-I	S	N	N/A	Y	1	14	151	2008	Lithic	75m x 25m
2008	BPE	F	Poplar, Spruce	Knoll, Topo High	94-G	S	N	N/A	N	0	7	125	2008	N/A	N/A
2008	BPE	F	Pine, Poplar, Spruce	Break In Slope, Knoll, Terrace	94-A	W	Y	5	N	0	13	182	2008	N/A	N/A
2008	BPE	F	Pine, Poplar, Spruce	Ridge	94-B	W	Y	15	N	0	3	55	2008	N/A	N/A
2008	BPE	F	Poplar, Spruce	Knoll, Ridge	94-B	W	Y	10	N	0	5	90	2008	N/A	N/A
2008	BPE	F	Poplar, Spruce	Knoll	94-B	W	Y	20	N	0	1	10	2008	N/A	N/A
2008	BPE	M	Black Spruce Muskeg	Terrace	94-B	W	Y	30	Y	1	1	140	2009	Lithic	40m x 65m
2008	BPE	F	Poplar, Spruce	Break In Slope, Knoll, Topo High	94-A	W	Y	20	N	0	15	299	2009	N/A	N/A
2008	BPE	F	Poplar, Spruce	Break In Slope	94-B	W	Y	5	N	0	1	10	2009	N/A	N/A
2008	BPE	F	Poplar, Spruce	Break In Slope	94-B	W	Y	15	N	0	3	48	2009	N/A	N/A
2008	TPE	M	Black Spruce Muskeg	Topo High	94-I	S	N	N/A	N	0	1	15	2008	N/A	N/A
2008	TPE	F	Poplar, Spruce	Knoll, Ridge	94-J	W	Y	15	Y	1	4	61	2009	Lithic	10m x 20m
2008	BPE	F	Spruce, Fir	Ridge	93-P	S	N	N/A	N	0	1	16	2009	N/A	N/A
2009	BPE	F	Pine, Spruce	Break In Slope, Topo High	94-G	W	Y	NP	Y	1	7	90	2009	Lithic	22m x18m
2009	BPE	F	Black Spruce, Pine	Break In Slope, Topo High	94-G	W	Y	NP	N	0	3	30	2009	N/A	N/A
2009	TPE	M	Black Spruce Muskeg	Knoll	94-O	W	Y	5	N	0	1	59	2009	N/A	N/A
2009	TPE	F	Aspen, White Spruce	Knoll	94-I	W	Y	10	N	0	1	13	2009	N/A	N/A
2009	TPE	F	Black Spruce, Poplar	Break In Slope, Ridge	94-O	W	Y	25	N	0	2	25	2009	N/A	N/A
2009	TPE	F	Black Spruce, Pine	Break In Slope, Knoll, Ridge	94-O	W	Y	35	Y	1	5	88	2009	Lithic	18m x 22m
2009	BPE	F	Black Poplar, White Poplar	Break In Slope, Knoll, Ridge	94-B	W	Y	60	N	0	7	104	2010	N/A	N/A
2009	BPE	A	Cultivated	Knoll, Ridge	94-A	W	Y	50	Y	2	6	235	2010	Lithic, Lithic	36m x 25m, 34m x 20m
2009	BPE	F	Aspen, Cutblock	Knoll	94-A	W	Y	NP	N	0	2	20	2009	N/A	N/A
2009	BPE	F	Pine, Spruce	Bank, Topo High	94-B	W	Y	NP	N	0	3	30	2009	N/A	N/A
2009	TPE	M	Muskeg	Topo High	94-O	S	N	N/A	Y	3	14	256	2009	Lithic, Lithic,	20m x 10m, 6m x8m, 6m x 10m
2009	TPE	F	Aspen, Black Spruce	Ridge	94-P	S	N	N/A	N	0	2	14	2009	N/A	N/A
2009	BPE	F	Regrowth	Ridge, Terrace, Topo High	94-B	S	N	N/A	N	0	5	81	2010	N/A	N/A
2009	TPE	F	Black Spruce Muskeg, Poplar	Knoll, Terrace	94-O	S	N	N/A	Y	2	12	708	2010	Lithic, Lithic	21m x 24m, 27m x 95m
2009	BPE	A	Cultivated	Topo High	94-A	S	N	N/A	N	0	17	338	2010	N/A	N/A
2009	BPE	F	Black Spruce, Poplar	Break In Slope, Knoll	93-I	S	N	N/A	N	0	5	73	2009	N/A	N/A
2009	BPE	F	Regrowth	Break In Slope	94-B	S	N	N/A	N	0	2	35	2009	N/A	N/A
2009	BPE	F	Pine, Spruce	Ridge	93-P	S	N	N/A	N	0	2	40	2010	N/A	N/A
2009	BPE	F	Pine, Spruce	Break In Slope, Topo High	93-I	S	N	N/A	N	0	3	52	2009	N/A	N/A
2009	BPE	M	Black Spruce Muskeg	Topo High	93-I	S	N	N/A	N	0	3	60	2009	N/A	N/A
2010	TPE	F	Aspen, Muskeg, Poplar	Topo High	94-O	W	Y	NP	Y	1	6	80	2010	Lithic	33m x 12m
2010	BPE	F	Aspen, Pine	Knoll	94-A	W	Y	NP	N	0	2	35	2010	N/A	N/A
2010	BPE	A	Cultivated	Topo High	94-A	W	Y	50	N	0	1	12	2011	N/A	N/A
2010	TPE	F	Black Spruce, Poplar	Ridge, Topo High	94-O	W	Y	45	N	0	6	26	2011	N/A	N/A
2010	BPE	F	Aspen, Spruce	Break In Slope	94-A	W	Y	NP	N	0	1	10	2011	N/A	N/A
2010	BPE	A	Cultivated	Bench	94-A	W	Y	5	N	0	2	22	2011	N/A	N/A
2010	BPE	A	Cultivated	Break In Slope, Terrace, Topo	94-A	W	Y	10	N	0	8	104	2011	N/A	N/A
2010	BPE	F	Aspen, Black Spruce, White	Knoll, Ridge, Terrace	93-P	W	Y	55	N	0	5	75	2010	N/A	N/A
2010	BPE	A	Cultivated	Topo High	93-P	W	Y	NP	N	0	5	55	2011	N/A	N/A
2010	BPE	F	Black Poplar, Pine, White	Knoll, Ridge	94-A	W	Y	30	Y	2	9	384	2011	Lithic, Lithic	26m x 65m, 36m x 55m
2010	BPE	F	Aspen, Poplar	Knoll, Ridge, Terrace	94-A	S	N	N/A	Y	3	10	297	2010	Lithic, Lithic,	127m x 10m, 30m x 15m, 33m x
2010	BPE	A	Cultivated	Break In Slope	94-A	S	N	N/A	N	0	1	40	2010	N/A	N/A
2010	BPE	F	Black Spruce, Pine	Knoll, Ridge	94-B	S	N	N/A	N	0	5	108	2010	N/A	N/A
2010	TPE	F	Black Spruce, White Spruce	Ridge	94-O	S	N	N/A	N	0	2	76	2010	N/A	N/A
2010	TPE	F	Pine, Poplar	Bench, Ridge	94-O	S	N	N/A	N	0	2	35	2010	N/A	N/A
2010	BPE	F	Pine, Spruce	Topo High	94-G	S	N	N/A	Y	1	2	70	2010	Lithic	20m x 20m
2010	BPE	F	Regrowth	Break In Slope	94-B	S	N	N/A	N	0	2	40	2011	N/A	N/A
2010	BPE	F	Aspen, White Spruce	Ridge	94-B	S	N	N/A	N	0	1	8	2010	N/A	N/A
2010	BPE	F	Spruce, White Poplar	Knoll	94-A	S	N	N/A	N	0	1	31	2011	N/A	N/A
2010	BPE	F	Black Poplar, White Poplar	Bench, Knoll, Ridge, Topo High	94-A	S	N	N/A	Y	2	26	997	2011	Lithic, Lithic	18m x 23m, 12m x 12m
2011	BPE	A	Regrowth	Terrace	94-B	S	N	N/A	Y	1	7	229	2011	Lithic	7m x 5m
2011	BPE	F	Poplar, Spruce	Knoll, Ridge, Topo High	94-B	S	N	N/A	N	0	24	238	2011	N/A	N/A
2011	BPE	F	Black Spruce, Pine	Knoll, Ridge	93-P	S	N	N/A	N	0	4	30	2011	N/A	N/A
2011	BPE	A	Cultivated	Bank, Knoll, Ridge	94-A	S	N	N/A	N	0	7	78	2011	N/A	N/A
2011	BPE	F	Aspen, White Spruce	Bench, Knoll	94-P	S	N	N/A	N	0	4	35	2012	N/A	N/A
2011	BPE	A	Cultivated	Knoll	94-A	S	N	N/A	N	0	1	13	2012	N/A	N/A

Year	Ecoprovince	Terrain	Vegetation Cover	Landform Type	Mapsheet	Winter or Summer	Snow Cover	Depth of Snow Cover (cm)	Site Identified?	Number of Sites Identified	Number of areas of potential identified	Number of Subsurface Tests	Year Work was conducted	Site Type	Site Size (m)
2011	BPE	F	Poplar, Spruce	Bank, Bench, Break In Slope	94-B	S	N	N/A	N	0	7	187	2012	N/A	N/A
2011	BPE	F	Poplar, Willow	Topo High	94-A	S	N	N/A	Y	1	3	162	2012	Lithic	13m x 24m
2011	BPE	F	Fir, Spruce	Topo High	94-B	S	N	N/A	N	0	2	40	2013	N/A	N/A
2011	BPE	F/M	Muskeg, Pine	Break In Slope	94-G	S	N	N/A	Y	1	2	90	2012	Lithic	12m x 10m
2011	BPE	F	Poplar, Spruce	Topo High	94-B	W	Y	20	N	0	5	59	2011	N/A	N/A
2011	BPE	F	Black Spruce, Pine	Knoll	93-P	W	Y	85	N	0	3	31	2011	N/A	N/A
2011	TPE	F	Poplar, Spruce	Knoll, Ridge	94-I	W	Y	10	N	0	5	53	2012	N/A	N/A
2011	BPE	F	Black Poplar, Cutblock, White	Bank	94-B	W	Y	5	Y	1	5	231	2012	Lithic	13m x 15m
2011	BPE	F	Black Poplar, Spruce, White	Break In Slope, Knoll, Ridge	94-B	W	Y	20	Y	3	13	713	2011	Lithic, Lithic,	16m x 19m, 13m x 14m, 12m x
2011	BPE	F	Black Spruce, Pine	Break In Slope	94-G	W	Y	NP	N	0	2	25	2013	N/A	N/A
2011	BPE	F	Black Spruce	Break In Slope	94-G	W	Y	20	N	0	1	10	2012	N/A	N/A
2011	BPE	F	Poplar, Spruce	Topo High	94-O	W	Y	10	N	0	1	12	2013	N/A	N/A
2011	BPE	F	Aspen, Black Spruce	Break In Slope, Topo High	94-A	W	Y	30	N	0	8	113	2013	N/A	N/A
2011	BPE	F	Aspen, Spruce, Willow	Topo High	94-A	W	Y	20	N	0	4	40	2012	N/A	N/A
2012	BPE	A	Cultivated	Knoll	93-P	S	N	N/A	N	0	1	24	2012	N/A	N/A
2012	BPE	A	Cultivated	Terrace	93-P	S	N	N/A	Y	1	2	111	2012	Lithic	10m x 10m
2012	BPE	F	Aspen, White Spruce	Terrace	94-B	S	N	N/A	N	0	14	267	2013	N/A	N/A
2012	BPE	F/A	Black Poplar, Cultivated, White	Break In Slope, Ridge	94-A	S	N	N/A	Y	1	13	616	2012	Lithic	31m x 32m
2012	BPE	A	Cultivated	Break In Slope	94-A	S	N	N/A	N	0	1	34	2012	N/A	N/A
2012	TPE	F	Black Spruce, Poplar	Knoll, Ridge	94-N	S	N	N/A	N	0	2	16	2012	N/A	N/A
2012	TPE	F	Black Spruce, Tamarack	Ridge	94-O	S	N	N/a	N	0	3	34	2013	N/A	N/A
2012	BPE	F	Black Poplar, Spruce, White	Bank, Ridge	94-A	S	N	N/A	N	0	2	36	2012	N/A	N/A
2012	BPE	A	Cultivated	Ridge	94-A	S	N	N/A	N	0	1	10	2013	N/A	N/A
2012	BPE	F	Aspen, Spruce	Break In Slope, Ridge, Topo High	94-B	S	N	N/A	N	0	8	45	2012	N/A	N/A
2012	BPE	A	Cultivated	Relict Dune	93-P	W	Y	75	Y	1	1	51	2012	Lithic	18m x 41m
2012	BPE	A	Cultivated	Break In Slope	93-P	W	Y	20	N	0	1	20	2013	N/A	N/A
2012	BPE	A	Poplar, Willow	Break In Slope, Knoll, Ridge	94-A	W	Y	10	N	0	4	26	2013	N/A	N/A
2012	BPE	A	Cultivated	Ridge	93-P	W	Y	5	N	0	1	45	2013	N/A	N/A
2012	BPE	F	Black Spruce, White Poplar	Bank, Knoll	94-B	W	Y	55	N	0	5	71	2013	N/A	N/A
2012	TPE	M	Black Spruce Muskeg	Knoll, Ridge	94-O	W	Y	100	Y	1	2	22	2013	Lithic	5m x 16m
2012	BPE	A	Cultivated	Terrace	94-A	W	Y	10	N	0	1	29	2014	N/A	N/A
2012	BPE	A	Cultivated	Knoll	93-P	W	Y	75	N	0	3	58	2013	N/A	N/A
2012	BPE	F	Regrowth	Knoll, Ridge	94-B	W	Y	10	N	0	2	18	2013	N/A	N/A
2012	BPE	F	Poplar, Spruce	Break In Slope	94-G	W	Y	15	N	0	1	8	2014	N/A	N/A
2013	TPE	M	Black Spruce Muskeg	Break In Slope, Knoll, Ridge	94-I	S	N	N/A	Y	1	11	122	2013	Lithic	17m x 27m
2013	BPE	F	Black Spruce, Pine	Break In Slope	94-G	S	N	N/A	N	0	1	12	2013	N/A	N/A
2013	BPE	F	Black Spruce, Poplar	Ridge	94-A	S	N	N/A	N	0	2	19	2014	N/A	N/A
2013	BPE	F	Poplar, Spruce	Bank, Break In Slope, Knoll	94-B	S	N	N/A	N	0	4	35	2013	N/A	N/A
2013	BPE	F	Poplar, Spruce	Knoll, Ridge	94-B	S	N	N/A	Y	2	4	496	2013	Lithic, Lithic	52m x 80m, 59m x 83m
2013	BPE	A	Cultivated	Break In Slope, Knoll	94-A	S	N	N/A	N	0	2	30	2013	N/A	N/A
2013	BPE	A	Cultivated	Bank, Knoll	94-A	S	N	N/A	N	0	5	58	2014	N/A	N/A
2013	TPE	F/M	Aspen, Muskeg, Pine	Ridge	94-I	S	N	N/A	N	0	1	16	2014	N/A	N/A
2013	TPE	M	Black Spruce Muskeg	Bench, Ridge	94-N	S	N	N/A	N	0	16	142	2014	N/A	N/A
2013	BPE	M	Black Spruce Muskeg	Break In Slope	94-G	S	N	N/A	Y	1	3	103	2013	Lithic	42m x 32m
2013	BPE	A	Cultivated	Level (systematic testing)	94-A	W	Y	25	Y	1	1	50	2013	Lithic	2m x 2m
2013	BPE	F	Black Spruce, Pine	Ridge	94-G	W	Y	50	N	0	1	14	2014	N/A	N/A
2013	BPE	M	Black Spruce Muskeg	Ridge	94-G	W	Y	55	N	0	3	30	2014	N/A	N/A
2013	BPE	F	Alder, Willow	Topo High	94-G	W	Y	35	N	0	1	21	2014	N/A	N/A
2013	BPE	F	Black Spruce, Poplar, White	Break In Slope, Terrace	94-B	W	Y	5	N	0	3	41	2013	N/A	N/A
2013	BPE	F	Regrowth	Break In Slope, Terrace, Topo	94-B	W	Y	20	N	0	3	39	2013	N/A	N/A
2013	BPE	F	Regrowth	Knoll	94-A	W	Y	30	N	0	1	20	2014	N/A	N/A
2013	BPE	A	Cultivated	Break In Slope	94-A	W	Y	20	N	0	1	8	2013	N/A	N/A
2013	BPE	F	Aspen, Pine, White Spruce	Terrace	94-B	W	Y	15	Y	1	1	39	2014	Lithic	10m x 13m
2013	TPE	M	Black Spruce Muskeg	Break In Slope	94-O	W	Y	20	N	0	1	10	2014	N/A	N/A
2014	BPE	A	Cultivated	Knoll	93-P	W	Y	30	N	0	2	22	2015	N/A	N/A
2014	BPE	F	Aspen, White Spruce	Break In Slope	94-A	W	Y	10	N	0	2	31	2014	N/A	N/A
2014	BPE	F	Pine, White Spruce	Bench, Ridge	94-A	W	Y	50	Y	1	2	22	2014	Lithic	4m x 15m
2014	TPE	M	Black Spruce Muskeg	Ridge, Topo High	94-O	W	Y	20	Y	2	2	62	2014	Lithic, Lithic	61m x 28m, 137m x 30m
2014	BPE	A	Cultivated	Break In Slope	93-P	W	Y	10	N	0	2	20	2014	N/A	N/A
2014	BPE	F	Black Poplar, White Spruce	Break In Slope	94-B	W	Y	5	N	0	1	10	2015	N/A	N/A
2014	BPE	F/A	Cultivated, White Spruce	Terrace	93-P	W	Y	NP	N	0	1	20	2015	N/A	N/A
2014	BPE	F	Black Spruce, Fir, White	Ridge	93-P	W	Y	NP	N	0	1	8	2014	N/A	N/A
2014	BPE	F	Aspen, White Spruce	Knoll, Terrace	93-P	W	Y	50	Y	1	5	51	2015	Lithic	44m x 27m
2014	BPE	F/A	Alder, Cultivated, Poplar	Break In Slope, Terrace	93-P	W	Y	30	N	0	6	97	2015	N/A	N/A
2014	BPE	A	Cultivated	Topo High	93-P	S	N	N/A	N	0	1	8	2014	N/A	N/A
2014	BPE	A	Cultivated	Knoll	93-P	S	N	N/A	N	0	2	21	2014	N/A	N/A
2014	BPE	F	Black Spruce, Pine	Break In Slope, Knoll, Topo High	94-G	S	N	N/A	Y	2	5	75	2014	Lithic, Lithic	5m x 5m, 18m x 19m
2014	BPE	F	Regrowth	Bench, Ridge	94-A	S	N	N/A	N	0	2	22	2014	N/A	N/A
2014	TPE	M	Black Spruce Muskeg	Knoll, Ridge	94-O	S	N	N/A	N	0	3	53	2014	N/A	N/A
2014	BPE	A	Cultivated	Break In Slope	93-P	S	N	N/A	N	0	1	8	2014	N/A	N/A
2014	BPE	A	Cultivated	Break In Slope, Knoll, Relict	93-P	S	N	N/A	Y	3	66	2579	2015	Lithic, Lithic,	19m x 59m, 17m x 23m, 13m x

Year	Ecoprovince	Terrain	Vegetation Cover	Landform Type	Mapsheet	Winter or Summer	Snow Cover	Depth of Snow Cover (cm)	Site Identified?	Number of Sites Identified	Number of areas of potential identified	Number of Subsurface Tests	Year Work was conducted	Site Type	Site Size (m)
2014	BPE	F	White Spruce, Willow	Ridge	93-P	S	N	N/A	N	0	1	6	2014	N/A	N/A
2014	BPE	A	Cultivated	Break In Slope	94-A	S	N	N/A	Y	1	2	48	2015	Lithic	8m x 16m
2014	BPE	A	Cultivated	Break In Slope	93-P	S	N	N/A	N	0	7	165	2016	N/A	N/A
2015	TPE	M	Black Spruce Muskeg	Knoll	94-O	S	N	N/A	N	0	2	27	2015	N/A	N/A
2015	BPE	F/A	Aspen, Cultivated, Spruce	Break In Slope, Terrace	93-P	S	N	N/A	N	0	4	45	2015	N/A	N/A
2015	BPE	F	Pine, Spruce	Terrace	94-A	S	N	N/A	N	0	1	6	2016	N/A	N/A
2015	BPE	F	Black Spruce, White Poplar	Knoll	94-G	S	N	N/A	N	0	2	24	2016	N/A	N/A
2015	BPE	F	Alder, White Poplar	Knoll	94-B	S	N	N/A	N	0	6	68	2015	N/A	N/A
2015	BPE	F	Aspen, Pine	Ridge, Topo High	94-H	S	N	N/A	Y	1	6	170	2016	Lithic	15m x 15m
2015	BPE	F	Alder, Aspen, Willow	Topo High	94-A	S	N	N/A	Y	1	14	379	2015	Lithic	12m x 11m
2015	BPE	F/A	Cultivated, Poplar, Willow	Knoll, Terrace	93-P	S	N	N/A	N	0	10	156	2016	N/A	N/A
2015	BPE	A	Cultivated	Knoll, Ridge	93-P	S	N	N/A	Y	1	5	548	2016	Lithic	71m x 161m
2015	BPE	F	Black Poplar, White Poplar	Topo High	93-P	S	N	N/A	N	0	1	11	2016	N/A	N/A
2015	BPE	F	Aspen, Pine, Spruce	Break In Slope, Topo High	94-B	W	Y	10	Y	1	7	110	2015	Lithic	24m x 10m
2015	BPE	A	Cultivated	Knoll	93-P	W	Y	10	N	0	3	35	2016	N/A	N/A
2015	BPE	F	Black Poplar, Spruce	Terrace	94-B	W	Y	10	N	0	1	10	2015	N/A	N/A
2015	BPE	F	Black Spruce, White Spruce	Terrace	94-B	W	Y	5	Y	1	6	324	2016	Lithic	12m x 18m
2015	BPE	F	Black Spruce, White Poplar	Topo High	94-B	W	Y	20	N	0	1	10	2016	N/A	N/A
2015	BPE	F	Spruce, White Poplar	Knoll, Terrace	94-B	W	Y	35	Y	2	5	240	2016	Lithic, Lithic	9m x 10.5m, 7m x 8m
2015	BPE	A	Cultivated	Knoll	93-P	W	Y	5	N	0	14	79	2015	N/A	N/A
2015	BPE	A	Cultivated	Relict Dune, Terrace	93-P	W	Y	10	N	0	4	81	2016	N/A	N/A
2015	BPE	A	Cultivated	Terrace	93-P	W	Y	5	N	0	2	34	2015	N/A	N/A
2015	BPE	F/A	Cultivated, Poplar, Willow	Topo High	93-P	W	Y	20	N	0	1	8	2016	N/A	N/A