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BC HYDRO – CPCN FOR DAWSON CREEK/CHETWYND AREA TRANSMISSION PROJECT EXHIBIT B-34

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July 6, 2012

Ms. Erica Hamilton
Commission Secretary
British Columbia Utilities Commission
Sixth Floor – 900 Howe Street
Vancouver, BC V6Z 2N3

Dear Ms. Hamilton:

RE: Project No. 3698640
British Columbia Utilities Commission (BCUC)
British Columbia Hydro and Power Authority (BC Hydro)
Application for a Certificate of Public Convenience and Necessity (CPCN) for the Dawson Creek/Chetwynd Area Transmission (DCAT) Project
Evidentiary Update - July 6, 2012

BC Hydro encloses as Exhibit B-34 an evidentiary update concerning BC Hydro's consultation with West Moberly First Nations (**WMFN**) in respect of the DCAT Project. The evidence is responsive to some of the issues raised by the WMFN in a recent meeting and correspondence including their final Impact Assessment Study (**IAS**), and is part of BC Hydro's commitment to ongoing consultation throughout the life of the project. BC Hydro reserves the right to file further evidence in response to WMFN's final IAS, whether by direct oral evidence or filed written evidence.

For further information, please contact Geoff Higgins at 604-623-4121 or by e-mail at bchydroregulatorygroup@bchydro.com.

Yours sincerely,

(for) Janet Fraser
Chief Regulatory Officer

gh/af

Enclosures (2)

Copy to: BCUC Project No. 3698640 (DCAT) Registered Intervener Distribution List.

Application for a Certificate of Public Convenience and Necessity (CPCN) for the Dawson Creek/Chetwynd Area Transmission (DCAT) Project

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Evidentiary Update

July 6, 2012

Please describe when West Moberly First Nation (WMFN) first advised BC Hydro that the overhead Pine River crossing should be avoided and the steps BC Hydro has taken since then to address this concern.

WMFN first identified to BC Hydro its desire that consideration be given to alternative means for crossing the Pine River during a teleconference on June 25, 2012 and in a letter of the same date.

WMFN identified to BC Hydro in a letter dated July 18, 2011, that the “East Pine” area is important to WMFN for the continued exercise of Treaty rights by their members. In a letter dated September 8, 2011, BC Hydro sought to clarify the boundaries of the “East Pine” area and the nature and location of WMFN’s exercise of Treaty rights in this area. WMFN responded to BC Hydro’s request for additional information on October 17, 2011 by indicating that such information could only be provided by conducting a community-based study, the terms of which were the subject of ongoing discussions between the parties.

Nonetheless, as discussed below, BC Hydro sought to minimize the footprint and associated environmental impacts of the Project in the Pine River area through Project through subsequent clearing plans.

In a meeting of November 25, 2011, WMFN again identified the “East Pine” area as an area of particular interest to WMFN for the continued exercise of Treaty rights. BC Hydro sought to determine whether WMFN was aware of any potential impacts from the Project in this area, to which WMFN’s Chief responded that they were not aware of any impacts but that the purpose of the Impact Assessment Study (**IAS**) was to determine this. The parties reached agreement in principle on the terms of reference for the IAS at the meeting.

At a meeting on February 8, 2012, WMFN indicated to BC Hydro that the potential significant issue concerning the Project of which they were aware was in relation to a sacred site located along the Pine River, and that the community interviews to be undertaken as part of the IAS would determine if this was in fact an issue.

BC Hydro and WMFN had a telephone call on March 29, 2012, the purpose of which was for WMFN to provide an update to BC Hydro on the status of the IAS and to indicate if there were any “showstopper” issues that could potentially have significant impacts on the Project. During that call, WMFN’s Land Use Manager stated that community interviews concluded that the sacred site in the Pine River area was located south of Highway 97 and therefore the proposed DCAT Pine River crossing was not a “showstopper” as long as it remained north of Highway 97. WMFN’s Land Use Manager also indicated that there were no other showstoppers and any other impacts that might be identified in the IAS could be mitigated with more typical measures. General discussion of the community interviews then ensued and WMFN’s Land Use Manager mentioned to BC Hydro that during the initial interviews for the IAS, one of the WMFN’s community members had mentioned that the proposed DCAT transmission line should cross the Pine River underground instead of overhead. WMFN’s Land Use Manager further advised that this was only the suggestion of one community member and that it was not necessarily the position of the WMFN. There was no request for BC Hydro to consider this alternative.

During a phone call on June 5, 2012, WMFN indicated to BC Hydro that the draft IAS report to be delivered the following day would identify potential impacts from the Project to traditional trails in the Pine River area.

BC Hydro was provided with a copy of the draft IAS on June 6, 2012. The draft report included only a general reference to traditional trails in the Pine River area and did not include any mention or request that undergrounding of the line be investigated by BC Hydro as an alternative to overhead crossing of the Pine River.

Leading up to and upon receipt of the draft IAS, BC Hydro made several attempts to arrange meetings with WMFN to review the report. A meeting was eventually arranged

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for June 22, 2012. The issue of the Pine River crossing and possible alternatives were not raised by the WMFN during that meeting. BC Hydro was prepared to discuss the clearing requirements in regards to the Pine River crossing at the June 22 meeting, but WMFN did not wish to discuss project specifics at the meeting.

The parties met again by teleconference on June 25, 2012. Prior to the teleconference, WMFN sent a letter to BC Hydro. The letter referred to the Pine River Valley as the only Crown land WMFN has left in the Project area. The letter went on to state that BC Hydro was not considering ways to avoid crossing the Pine River altogether, and that community members preferred that the transmission line be directionally drilled under the river. WMFN raised this issue during the teleconference. This was the first time WMFN had expressly requested that BC Hydro consider undergrounding the line at the Pine River Crossing. No specific information about the nature of their concern regarding the crossing was provided (i.e., whether their concerns related to the location of the crossing, potential impacts to riparian areas, amount of clearing required in the crossing area, etc.). Nor did WMFN provide any information regarding the nature of the exercise of their Treaty rights in this area. At the conclusion of the teleconference, BC Hydro advised that it would provide a further response to the WMFN on this issue in writing once it had had a chance to further consider WMFN's letter.

Shortly after the June 25, 2012 teleconference the DCAT Project Manager made inquiries with technical staff (including BC Hydro Engineering) as to whether directional drilling of the DCAT transmission line under the Pine River was feasible. In particular, on June 26, 2012, the DCAT Project Manager contacted AMEC Environmental to obtain advice regarding the feasibility of HDD drilling under the Pine River. On that same day, the Project Manager also contacted BC Hydro Engineering to obtain information about the feasibility of Horizontal Direct Drilling (**HDD**) for the Pine River crossing of the DCAT Project.

On June 28, 2012, BC Hydro wrote WMFN as follow up to the June 22, 2012 meeting and June 25, 2012 teleconference. With respect to the Pine River crossing issue, BC Hydro advised that it would be prepared to discuss considerations and technical requirements that pertain to alternative means for crossing the Pine River such as underground or alignment changes. Further, BC Hydro requested that WMFN provide information regarding the nature of WMFN's concerns, in particular specifics on the potential impacts of the Project on WMFN's exercise of Treaty rights in the Pine River area, beyond those issues already identified in the draft IAS report.

WMFN responded by way of letter dated July 3, 2012. In its letter, WMFN states that their concern relates to the footprint of the Project in the Pine River area, and also makes reference to a historic trail system. WMFN also states in their letter that it had on several previous occasions prior to the June 22, 2012 meeting asked it BC Hydro was willing to study alternative means for crossing the Pine River.

WMFN's version of the facts in this regard is not consistent with BC Hydro's facts as described above.

On July 5, 2012, the DCAT Project Manager received the following responses to her inquires.

The depth of the canyon is a major issue in the case of crossing the Pine River. The depth of the canyon itself is approximately 200 m, and the HDD boreholes must be drilled a further 200 m below the riverbed in order to provide a balance of mud pressure against vertical confining stress to reduce the potential for hydrofracturing and mud loss to the river. This results in an overall depth of about 400 m. The slope limitation of the electrical cables is typically about 15 degrees, which is based on a 400 m depth, results in a total drill length of over 3 km. The only feasible HDD option would be to drill six separate boreholes, one for each phase of the circuits.

It should be noted that there are appreciable risks with respect to the rock formations present at the site. D.F. Stott (*Lower Cretaceous Fort St. John Group and Upper Cretaceous Dunvegan Formation of the Foothills and Plains of Alberta, British Columbia, District of Mackenzie and Yukon Territory,* Bull 328, Geological Survey of Canada) indicates that the rock at the proposed crossing consists of Dunvegan Formation sandstone overlying Cruiser Formation shale and siltstone. A thrust fault is shown approximately parallel to the proposed crossing. Observations in the canyon indicate closely jointed rock which is consistent with this geology. Circulation problems resulting in hole failure have occurred several times during directional drilling in the region and have resulted in major problems including failure of the directional drill. Hole stability is a concern with respect to the rock conditions and also due to the high horizontal stress conditions that likely exist below the bottom of the canyon. Drilling investigations would be required to further examine these issues and the characteristics and depth of the overburden. Overall, based on the existing information, there would be a significant probability of major problems.

Even assuming favourable rock and overburden conditions the length and depth of the holes would make them among the longest and deepest holes ever attempted. The strengths and elastic characteristics of the HDPE plastic pipes required to be pulled through the holes may not be sufficient to support the extremely long lengths.

Assuming all of the above risks and concerns are overcome, and if directional drilling was confirmed to be technically feasible through more comprehensive geotechnical studies, the costs of such an endeavor would be enormous. Horizontal directional drilling under the Pine River for the DCAT Project including cables, would cost approximately $120 million or more (direct costs), increasing the Project cost by over 50 per cent Therefore, installing the DCAT transmission lines under the Pine River is not considered feasible. BC Hydro is open to meeting WMFN to further explain its findings.

BC Hydro has designed the Pine River crossing in order to minimize impacts through a number of measures. The location of the crossing is approximately 250 m north of the existing 138 kV transmission line 1L358. BC Hydro is also proposing to remove the existing 138 kV line. Approximately 2 ha of ROW within the Pine River crossing area would be allowed to grow back after that line is dismantled.

Investigations and design work occurred during 2011 to determine the best location to cross the Pine River. Factors considered in finalizing the crossing location included terrain stability, avoidance of drainage areas, and the placement of structures on either side of the river crossing. The crossing structures were also shifted back away from the break on either side of the Pine River due to the potential for soil creep that can occur on slopes with fine textured soils characteristic of this area.

Following the siting of the crossing location, BC Hydro's team continued to discuss the design of the structures on either side of the Pine River crossing and in particular options that could minimize the amount of clearing through the crossing. Options included splitting the circuits onto two single steel poles on either side, switching to a single 500 kV lattice structure on either side, and using seven individual steel poles on either side (one for each conductor). This last option was the one ultimately selected as it resulted in the narrowest corridor.

Clearing width calculations were completed based on BC Hydro's clearing tables with consideration for conductor swing, the ground profile, current vegetation height and growth rate, culmination height and the conductor profile for the hot curve, and the clearing boundaries were marked in the field to provide full security to the line. Please refer to Appendix A for a preliminary map of the clearing boundaries on the Pine River crossing.

The clearing on the west side of the Pine River below the break is planned for hand falling and helicopter removal under winter conditions to minimize ground disturbance. The clearing below the break on the east side of the Pine River is planned for hand falling and hand removal/hand piling of waste. No stumping/grubbing will be permitted within the clearing corridor through the Pine River crossing area to protect the soils. No trails or access structures will be constructed below the top of break on either side and a 5 m machine free zone will be maintained along the edge of the break and no burning of waste/debris will be permitted within the clearing corridor below the break at top of bank on either side of the Pine River.

Regrowth of vegetation within the SRW will be monitored through BC Hydro's vegetation maintenance program and the frequency of treatments will be determined based on the requirement to maintain security to the line. BC Hydro will avoid using herbicides as a vegetation treatment tool in this area in order to maintain vegetation cover and promote active root systems. Brushing treatments will be limited to manual hand treatment options.

The total area to be cleared on Crown land between private parcels either side of the Pine River crossing is 3.2 ha (1.3 ha on the west side and 1.9 ha on the east side.) The remainder of the right of way in that area will not be cleared is about 10.8 ha.

Please describe how the Valued Ecosystem Components used in the Environmental Overview Assessment were identified, and in particular, how were moose considered as part of this process.

As part of the assessment of the Dawson Creek/Chetwynd Area Transmission (**DCAT**) Project, BC Hydro contracted AMEC Americas Limited (**AMEC**) to undertake an Environmental Overview Assessment (**EOA**). AMEC's general methodology with respect to an environmental overview assessment is set out in Exhibit B-1, Appendix F, section 3.2. It describes the development of an appropriate baseline and the identification of Valued Ecosystem Components (**VECs**) for assessment of effects. This is consistent with other environmental assessments practices for projects of this size.

One of the initial steps in the EOA was for AMEC to undertake a desktop environmental overview of the Project area. This occurred in April through August 2010. The desktop environmental overview was intended to summarise existing environmental and socio-economic resources in the study area to ultimately assist BC Hydro in project planning.

A VEC may be defined as an environmental element of an ecosystem that is identified as having scientific, social, cultural, economic, historical, archaeological or aesthetic importance. During the summer field program and through fall 2010, AMEC began identifying the VECs to validate and refine the information ascertained through the desktop study. Through this process VECs were identified. The process used is described on a discipline by discipline basis in the EOA (refer to Exhibit B-1, Appendix F, sections 4.2, 5.2, and 6.2). The methodology used in identifying VECs was consistent with environmental assessment methods and appropriate.

In selecting VEC's for the DCAT project, consideration was given to a wide range of organisms that are of concern in the region, and that might impact or be impacted by the project. These are described in the EOA. Wetlands, which are an important habitat component for moose, were included as a VEC in both the Vegetation (Sensitive ecosystems) and Wildlife (critical habitat for wildlife and invertebrates) sections. Not every species in the region was considered as some were either not likely to be effected, or would not raise habitat concerns beyond those raised by other VEC's.

The resources reviewed as part of the desktop environmental overview noted the presence of ungulate species occurring in the study area including moose. It further noted that moose were abundant and that riparian habitats within river valleys were likely important areas for this species. Habitat fragmentation and increased accessibility in this area were noted as potential impacts to ungulates. Further, stream crossings were noted as having the potential to reduce connectivity of movement corridors and result in loss of riparian habitat. As to considerations specific to the DCAT Project, AMEC noted that the limited number and distribution of wetlands in the area should make avoidance of wetland habitat possible, resulting in minor impacts to wetland associated species.

The extent of wetlands in the study area (~3.5 ha) was defined in the Vegetation section of the EOA. Potential impacts were assessed in both the Vegetation and Wildlife sections. It was concluded that, from a wildlife perspective, residual effects would be low as long as mitigation measures were implemented.

In or around the same time the desktop environmental overview was being undertaken, BC Hydro was meeting with WMFN to discuss the DCAT Project. During a meeting held in the summer of 2010, WMFN identified a number of concerns to BC Hydro including potential impacts to wildlife and specifically a wetland area used by moose. BC Hydro responded that it was in the process of beginning route investigations and was hopeful that the DCAT Project could run parallel to existing transmission lines where possible. It also explained that it would be undertaking an EOA to identify and assess potential environmental impacts arising from the DCAT Project. WMFN indicated that it wanted the opportunity to review the results of the EOA once completed.

In March 2011, BC Hydro provided WMFN with a copy of the draft EOA and requested that First Nations provide their comments within 30 days of receiving the draft report.

BC Hydro did not receive any comments from WMFN on the draft EOA, or the field study information that was sent out in spring 2010 and 2011. In particular, WMFN did not provide any indication that potential impacts on moose were not adequately dealt with in the EOA.

In or about July 2011, BC Hydro and AMEC finalized the EOA. A final copy of the EOA was included with the CPCN Application provided to WMFN on July 14, 2011. WMFN wrote to BC Hydro on July 18, 2011. In its letter, WMFN included a quote from a report authored in part by WMFN's Land Use Manager, which identifies moose as important to its community. The letter did not raise any concerns regarding the consideration given to moose or moose habitat in the EOA.

Nor did WMFN raise any such concerns during meetings with BC Hydro on November 25, 2011 or February 8, 2012. On March 29, 2012, BC Hydro and WMFN held a teleconference to allow WMFN to update BC Hydro on the initial feedback received from WMFN community members as part of the interviews undertaken for the WMFN's Impacts Assessment Study (**IAS**). During that meeting, WMFN's Land Use Manager advised that although to date only informal interviews had been conducted, WMFN did not expect any major issues to arise out of the formal community interviews.

On May 8, 2012, BC Hydro provided WMFN with a copy of the draft Construction Environmental Management Plan (**EMP**) and requested that First Nations provide their comments within 30 days of receiving the draft EMP. At no time did WMFN express any concern that the Construction EMP did not adequately address any potential impacts to moose.

On June 6, 2012, WMFN provided BC Hydro with a copy of the draft IAS. In it, several WMFN community members identified potential impacts to moose from development in general and the DCAT project specifically as being a concern. On June 15, 2012, BC Hydro provided WMFN with its initial response to the draft IAS report, including identifying measures planned to mitigate potential impacts of the DCAT project on moose. BC Hydro also invited further information from WMFN regarding their concerns, as well as WMFN's feedback on the planned mitigation measures as described in the draft EMP.

A meeting was held on June 22, 2012 to discuss the draft IAS. During the meeting, WMFN raised a concern that moose had not been included as a VEC in the EOA. This was the first time that BC Hydro had heard this concern from WMFN. BC Hydro asked WMFN why it had not previously identified this specific concern to BC Hydro given that WMFN had been given the chance to review and comment on the draft EOA prior to it being finalized. WMFN replied that BC Hydro should have known how important moose are to WMFN for hunting. WMFN proposed that a moose study be conducted to inform additional consultation on this issue.

A follow up teleconference between the parties was held on June 25, 2012. The issue of moose was not specifically discussed during that teleconference call.

Having learnt in the June 22, 2012 meeting that WMFN felt the EOA did not adequately address the issue of moose, BC Hydro inquired with AMEC whether this was indeed the case. AMEC advised that the EOA was adequate to address any potential adverse effects on moose arising from the DCAT Project. In particular,

- The EOA covered and considered important moose habitat elements;
- The construction Environmental Management Plan addressed large game animals including moose and provides measures to mitigate the potential affects on these animals;

- The DCAT Project involves little new corridor, less that 7 per cent of the route; and
- BC Hydro has committed to allowing the unused portions of the old line to grow back.

BC Hydro inquired as to whether any further review could be done to address WMFN's concern about moose. AMEC provided that they could prepare a "Habitat Management and Mitigation Plan for the DCAT Project (the **Moose Habitat Report**). BC Hydro requested that AMEC undertake this report.

The purpose of the report was to respond to WMFN's concerns by reviewing the available information on moose in the study area, and assessing potential effects from the DCAT Project on moose and their habitat.

The Moose Habitat Report reviewed the available information on moose in the DCAT project area as well as the habitat requirements of moose and some of the common problems associated with linear corridors. Potential project effects during construction, and ongoing operations and maintenance were considered. Mitigation measures were recommended. It was concluded that moose are expected to be present in the area during all activities of the project. However, residual (post mitigation) effects are not considered significant. Most of the recommended mitigation measures suggested have already been included in BC Hydro's draft construction EMP (which was sent to WMFN on May 8, 2012 for review and comment), but a few additional measures have also been identified.

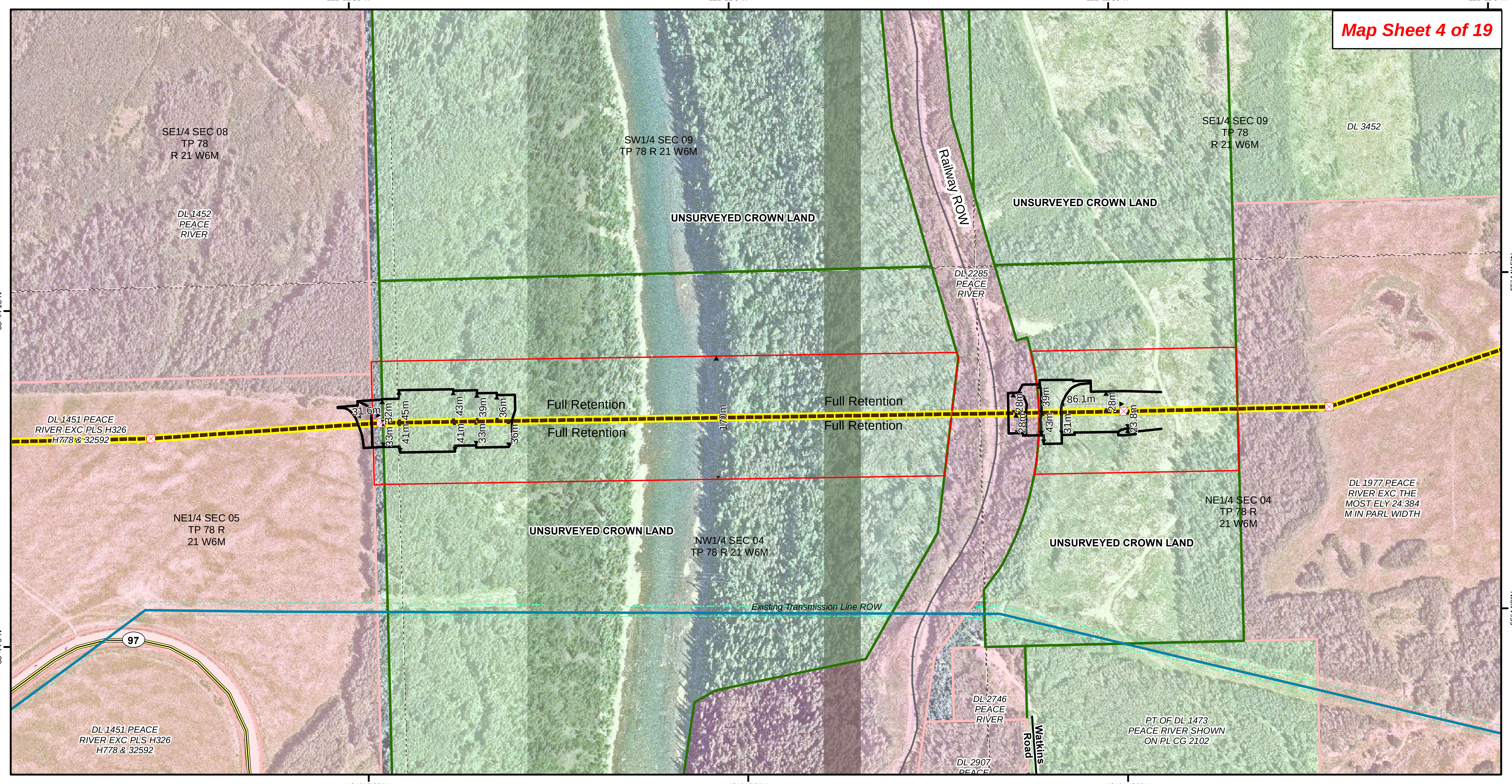
A copy of the Moose Habitat Report is attached as Appendix B.

Application for a Certificate of Public Convenience and Necessity (CPCN) for the Dawson Creek/Chetwynd Area Transmission (DCAT) Project Evidentiary Update – July 6, 2012

Appendix

A

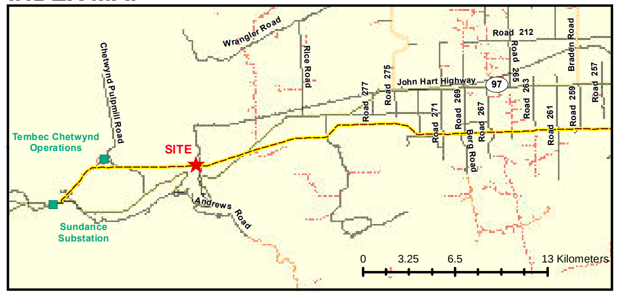
Pine River Crossing Map



Legend

- Proposed Stucture
- Proposed Transmission Line
- Licence Of Occupation Area
- Existing Transmission Line (138 kV)
- Existing Right of Way
- Railway
- Highway
- Other Roads
- Quarter Section Boundary
- Unsurveyed Crown Lands
- Private Lands
- Clearing Boundary W34-W35

INDEX MAP



NOTE:

1. All distances are expressed in metres and are preliminary values only. Distance and areas shown on this map are subject to field survey

2. Total Licence Of Occupation Area = 18.30 ha

N

SCALE 1:5,000

0 125 250 500 Feet

0 50 100 200 Meters

Drawn : HM | Approved : MK

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SNC·LAVALIN T&D

PRELIMINARY

DCAT – EAST PINE RIVER "PROPOSED CLEARING BOUNDARY"
DAWSON CREEK / CHETWYND AREA TRANSMISSION (DCAT) PROJECT
NORTH WEST/EAST QUARTER, SECTION 04, TOWNSHIP 78, RANGE 21,
WEST OF THE 6TH MERIDIAN
PEACE RIVER DISTRICT

May 31, 2012 | 2L329-T11-B0004 Rev. C

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Application for a Certificate of Public Convenience and Necessity (CPCN) for the Dawson Creek/Chetwynd Area Transmission (DCAT) Project Evidentiary Update – July 6, 2012

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Appendix

B

Moose Habitat Management and Mitigation Plan for the Dawson Creek/Chetwynd Area Transmission (DCAT) Project - Draft Report

Moose Habitat Management and Mitigation Plan for the Dawson Creek /Chetwynd Area Transmission (DCAT) Project

Prepared for AMEC by Sean Sharpe, RPBio., M.Sc.
June 30, 2012

DRAFT

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1 INTRODUCTION

Moose (*Alces alces*) are considered an important species for First Nations sustenance, sport hunting and as a valued ecosystem component in predator – prey systems in western and northern Canada (Rowe 2008). The ecology and habitat requirements of moose are well understood and documented (Appendix A). In the South Peace region moose populations are affected by human development and access as well as by populations of alternate prey (elk, deer) and predators (wolves and bears). Moose (*Alces alces*) within the Peace Region of British Columbia (Region 7B) are a high priority species. As the most abundant cervid (member of the deer family) within the region, moose play an important role. Firstly, moose are of principal importance to the First Nation people of the Peace Region for both food and cultural purposes. Secondly, non-First Nation people including resident and non-resident hunters prize the moose as a hunted species and over the past 10 years, the Peace Region has contributed about 22% to the total provincial moose harvest. In addition, moose are also valued for appeal to wildlife observers, naturalists, and others. Finally, moose play a key role within their ecosystems as a major prey species for large carnivores and as a keystone browser (Rowe 2008).

Within the Peace Region, moose are managed at the wildlife management unit (WMU) scale. There are 27 WMU's within the Peace Region, and all are known to support moose populations (Figure 1). Often, collections of WMU's referred to as Game Management Zones (GMZ's) are used to manage species at a broader scale. There are five GMZ's in the Peace including the South Peace, the North Peace, the Northeast Rockies, Liard, and Fort Nelson. Subdividing the 5 GMZ's based on general habitat type results in a better approximation of the actual moose populations within the region. This has been done in the Peace Region resulting in eight moose game management subzones (Figure 1).

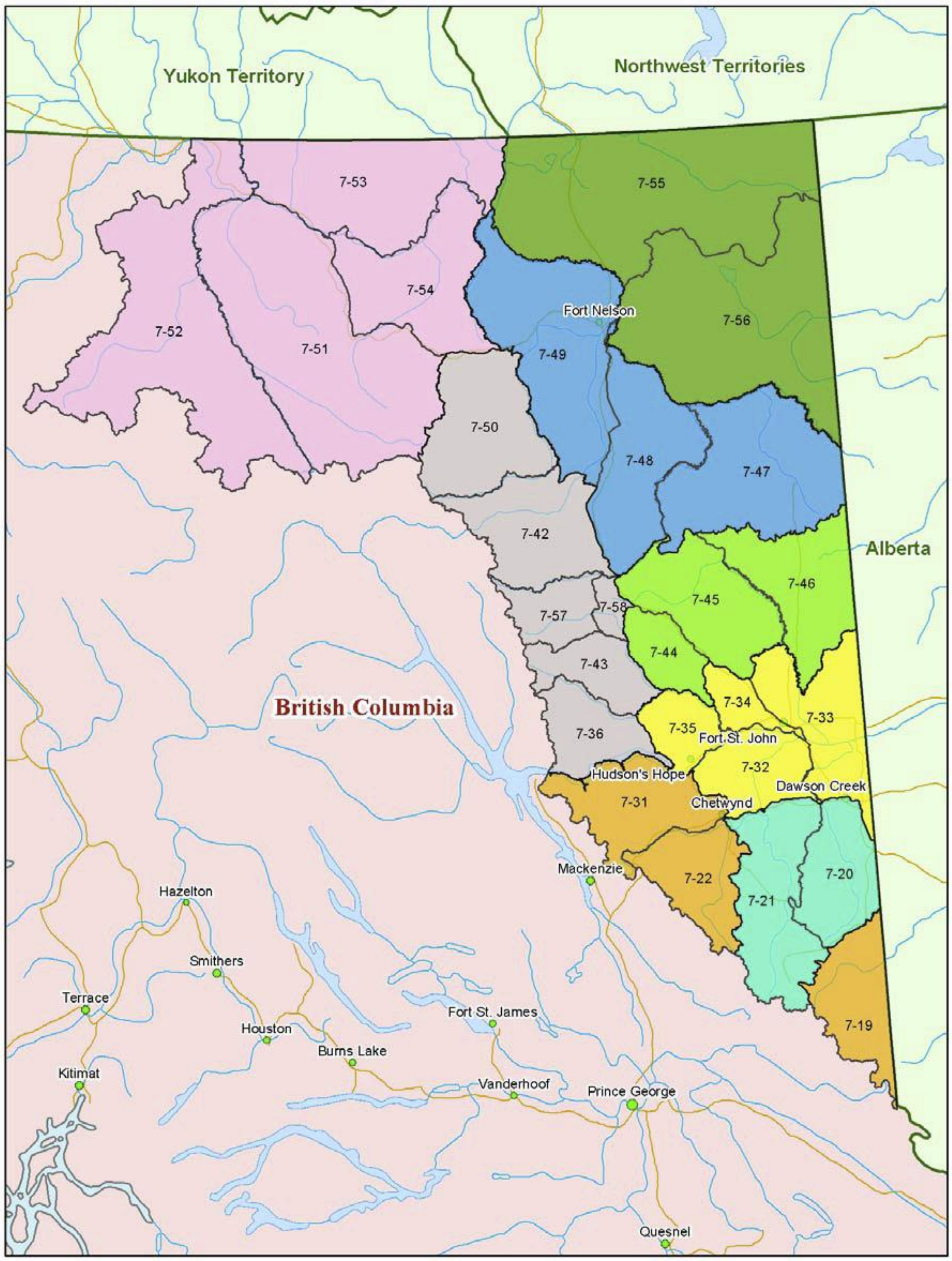

Figure 1: **Map of Peace Region wildlife management units (numbers) and their associated moose game management subzones (A to H).**

1.1 Moose Habitat

Moose rely heavily on a combination of habitat types ranging from early successional deciduous stands to mature conifer dominated closed canopy stands. Thermal cover and snow interception are particularly important in winter, when snow depths may effectively isolate groups of moose resulting in greater predation or risks from starvation. Moose are known to avoid areas with snow depth greater than 1-2 m and rely heavily on conifer dominated stands to allow movement among forage patches in northeastern BC. Long term management of moose habitat for this project where vegetation is proposed to be removed and revegetated will have stands cleared that are deciduous leading and the one-time clearing area within the Crown portions will be allowed to regenerate naturally. These areas will likely re-establish quickly to windfirm deciduous leading stands as BC Hydro typically doesn't under-plant and manage these areas to conifer. Natural seeding of conifer will occur in the one-time clearing areas, especially where there is a heavier conifer component to the stand being removed. Other than the riparian vegetation management areas (RVMA's) within the stream right-of-way (SRW) the entire SRW will be maintained to prevent significant regrowth that could encroach on the lines. While small conifers within the RVMA's on classified waterbodies may be left at the initial clearing phase, over time they may need to be selectively removed as they grow taller and encroach on conductors prolonged exposure zone. The RVMA's are managed in accordance with BCH's vegetation management protocols for right-of-way management.

1.2 Predation Risk

Increased corridor width can not only reduce available habitat, it may result in increase efficiency for predators (wolves in winter and bears preying on calves in early summer). Because of this, a narrower corridor provides greater security to moose; however a variable width likely would be effective in maintaining movement and security. New clearing for right-of-way increases the visual line of sight for predators and may increase efficiency of hunting by predators and increased predation risk to moose.

1.3 Moose Research

Rowe (2008), states that an abundance of research and management has been invested into this species by biologists with the Ministry of Environment. Some of that research has been captured and summarized in a report entitled “Moose conservation and harvest management in central and northern British Columbia” (Hatter 1998). Further, a number of other documents have been produced that related to moose management within the Peace Region (Hatter 1994, MELP 1995). Recent work has not been summarized (Rowe 2008) and a comprehensive report describing the status of moose populations within the Peace Region has been requested by a number of user groups in recent years. It is understood that the Rowe (2008) report currently serves as a summary of recent moose inventory for the Peace region (Rowe 2008).

Subzone B is south of Dawson Creek and roughly centred on the Tumbler Ridge area and covers the majority of the DCAT route. Stratified counts were conducted for both WMU's 7-20 and 7-21 in 1998 and repeated for WMU 7-21 in 2006 (Rowe 2006). The 1998 counts did not classify bulls and cows, instead focusing on total density and only classifying moose to adult or calf. In 2006, the number of moose in 7-21 was considered to be either unchanged or slightly higher than the 1998 estimate. Both bull and calf ratios were considered to be well within population objectives at 51 bulls/100 cows +/- 19% and 34 calves/100 cows +/- 21%. The density estimate was 0.30 moose/km^2 +/- 19% in 2006 compared to 0.24 +/- 19% in 1998. Transect counts carried out in the subzone in December of 2003 resulted in similar bull and calf numbers. There were 195 moose classified and ratios of 47.2 bulls/100 cows and 36.8 calves/100 cows were observed.

Rowe (2008), state that resident harvest has averaged 149 moose within this subzone since 1976. The number of kills dipped sharply in 1996, as in other subzones, but has recovered to levels similar to those in the 1980's. The number of hunters in this subzone looks to have been declining since about 1990. In contrast, the number of days per kill has been decreasing and hunter success has been increasing since 1996. This appears to be a situation of a stable or slowly increasing moose population and a declining hunter population. It is unclear what the ultimate cause of declining hunter numbers in this subzone is. (Rowe 2008)

Population surveys south of Fort St. John indicate a small decline in moose density since the 2004 survey. However the population trend is stable over the long term, considering surveys previous to 2004. Surveys in the areas of the far northeast indicate a stable, low density population typical of that land area. The population appears to be stable in agriculture zones (FLNRO factsheet May 2012).

The Peace area has been greatly influenced by invading mountain pine beetles over recent years. With increasing infestation has come an increased rate of conversion from mature pine stands to early seral populations through cut and burn programs. This may have an indirect effect on caribou populations since a larger moose population supports a larger predator base (Seip 1992). A moose inventory within this subzone in the next 5 to 7 years may aid researchers in determining how moose populations respond to changing habitat conditions with the 7-21 inventory used as a baseline. Consistently strong bull to cow ratios have been observed in recent years, but additional research such as early winter transects counts could be used to determine bull age structures and availability of harvestable moose. (Rowe 2008).

1.4 Access

Human access via snowmobile in the winter or ATV trails in the summer may lead to increased hunting and poaching pressure of moose. Habitat patches of less than 100 m with adjacent roads have significantly greater hunter success than areas with less access. If habitat patches of less than 400 m are present, human access to the moose along the right-of-way must be managed to limit hunting impacts.

1.5 Linear Corridor Effects

The literature provides many references to linear disturbance barriers to wildlife, particularly carnivores and sensitive species such as caribou. Highways and railways can function as barriers to moose populations both physically and in terms of predation sinks. Raised grades of roads 2 m above surrounding terrain were found to reduce crossings of roads by ungulates, but in these studies they examined use of structures to direct wildlife into man-made crossings. Although road crossings by moose are a combination of indirect effects (traffic noise and movement) and grade of roadsides, reductions in movement can be significant. Laurian *et al.* (2008) found that moose crossed highways 16 times less than expected by chance and forest roads 10 times less often. Since the existing corridor is in place, the proposed transmission right-of-way is not expected to cause these effects due to closure to frequent motorized access.

A more practical measure of terrain barriers to moose movement can be inferred from studies looking at reducing wildlife – vehicle collisions. Fences, guard rails and embankments of 2 m or greater discourage ungulates from crossing roads (Barnum 2003, Cain *et al.* 2003, Malo *et al.* 2004, Clevenger *et al.* 2003). In Sweden (Olsson and Widen 2008) found that GPS collared moose were significantly deterred from crossing an approximately 2.7 m fence. Clevenger and Walthro (2000) and Clevenger *et al.* (2001) found that 8 foot fences (2.44 m) were extremely effective in excluding large ungulates including moose, elk and deer. In Quebec, Leblanc (Yves Leblanc, pers. Comm. 2009) confirmed that they have found 2.4 m fencing and natural features such as boulders, steep ditches and road cuts formed an effective barrier to moose movement. Sielecki (2005) documented in BC that over 470 km of continuous fencing with 30 crossings for the Coquihalla and Okanagan connector highway system excluded moose from accessing the highway, but permitted migration movements. In addition, Sielecki (2005) noted that natural terrain features such as steep road cuts and cliff faces were used in place of fencing in many road sections with equal success in providing barriers to moose movements. Dunne *et al.* (2007) and Dunne (2007) illustrated that pipelines (1.5-2 m in height) formed barriers to moose, unless elevated greater than 2 m above ground or had crossing structures of 6:1 slopes built over the pipeline every 400 m of length. The proposed transmission corridor does not introduce any features that could be considered a barrier to moose movements.

Movement corridor width can vary for species, depending on the length of the corridor section and on the behaviour and predation risk to the species. An excellent example of this can be inferred from numerous studies where wildlife overpasses or underpasses have been constructed. In Banff National Park, corridors as narrow as 50 m are functional to small species while corridors of 100-200 m are most functional for ungulates such as deer and moose (Clevenger and Waltho 2005). In the Oil Sands work associated with the SEWG process, moose survival and persistence on the landscape relative to various Oil Sands development scenarios was assessed (Silvatech 2007) using ALCES as a modeling tool. In these cases, effective barriers ranging from 50 to 100 m adjacent to Oil Sand developments (SAGD and open pit) were assessed. In most cases, a 100 m buffer was sufficient due to homogeneity of the terrain and habitat types although other factors such as predation, hunting and forage also impact moose populations. However, numerous studies of wildlife at a landscape level suggest that long distance movements through corridors may not be as effective in narrow corridors. Berger (2004) examined corridor use by ungulates in the Greater Yellowstone ecosystem and suggested that corridors of 100-400m width over stretches of 5 km were effective for use by pronghorns and other ungulates. He suggested that bottlenecks of 100 – 300m in some circumstances where no alternative habitat was accessible (e.g. bounded by cliffs, hard line edges like cities, etc) need to be monitored for potential impacts to movements. In river valley corridors comparable in width to the DCAT waterway crossings, Sandgren and Sweanor (1998) assessed moose movements in natural river corridors and found that linear migration movements along river drainages ranged from 40 to 310 km. In the case of the proposed project, known wildlife movement corridors are not expected to be disrupted and measures are proposed to maintain movement corridors and mitigate potential impacts in this document and the prepared Environmental Management Plan (EMP).

2 DCAT PROJECT

BC Hydro is planning the construction of new transmission infrastructure, the Dawson Creek / Chetwynd Area Transmission (DCAT) Project (Project), in north-eastern British Columbia (BC) (Figure 2). The electrical load is expected to increase substantially over the next ten years, and BC Hydro is proposing the DCAT Project to increase the electrical capacity to the Dawson Creek area.

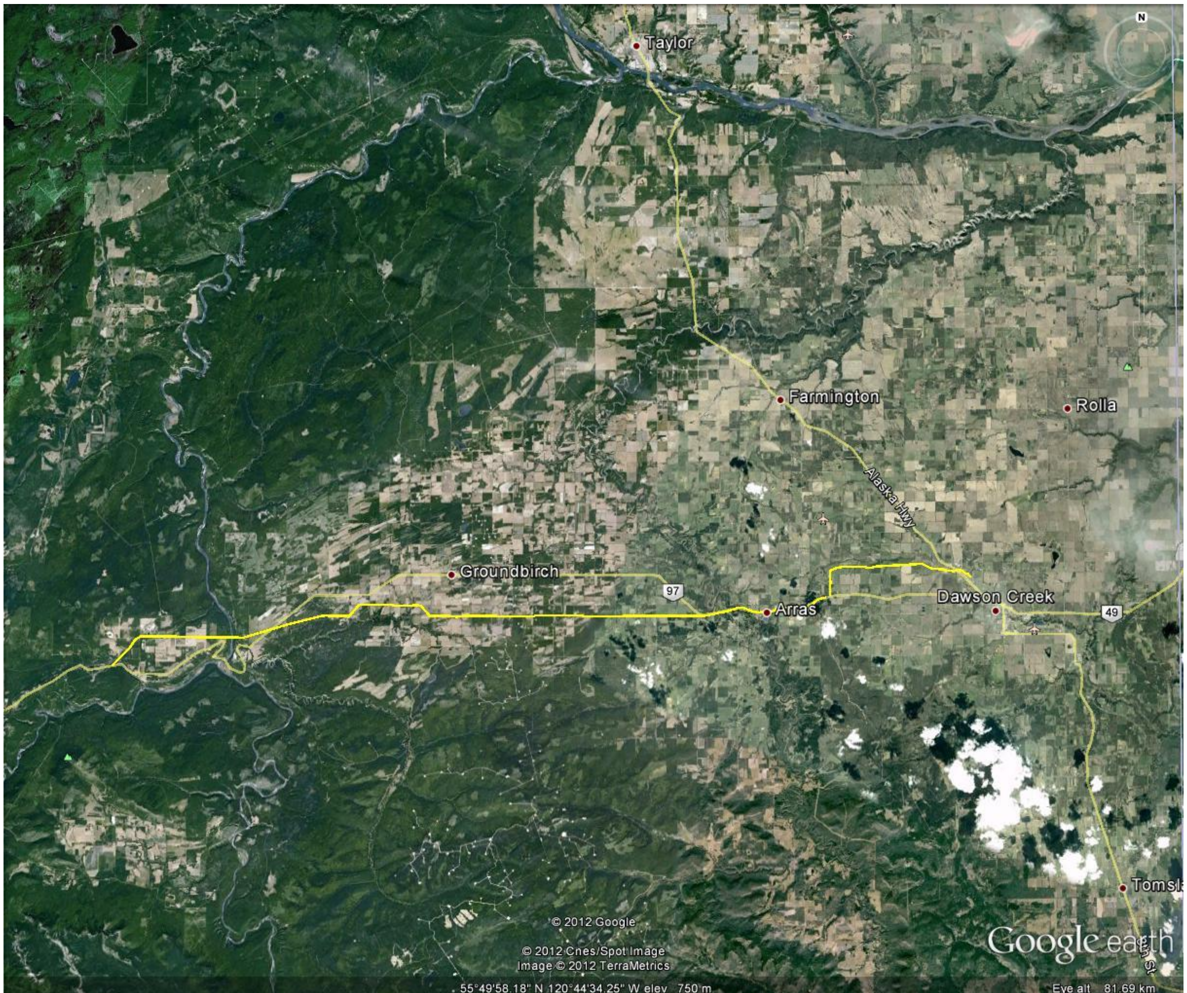

Figure 2: DCAT transmission corridor.

The proposed DCAT Project includes:

- A new substation (Sundance (SLS)) that would be located about 19 kilometres (km) east of Chetwynd, near Highway (Hwy) 97;
- A new 230 kilovolt (kV) double circuit transmission line, approximately 60 km long, from SLS to Bear Mountain Terminal (BMT); BMT is an existing station located about 12 km west of the City of Dawson Creek;
- Expansion of BMT; and
- A new 230 kV double circuit transmission line approximately 12 km long, between BMT and the existing Dawson Creek Substation (DAW).

At a landscape scale, the proposed DCAT project parallels the existing Hydro highway and rail right-of - ways for approximately 80% of its length. The remaining 20% that requires a new right-of-way passes through agricultural land for most of the route; a total of approximately 7.3 ha loss of fragmented woodlots. New corridor constitutes approximately 6.7% of the route (Table 1).

Table 1: Estimated New Corridor

Land	Length (km)	%
Crown	1.02	1.4
Private	3.90	5.3
Total Project Length	**72.90**	

Although the proposed hydro corridor is going to be placed through some areas of fragmented woodlot, the primary areas of concern, with respect to the regional moose population include:

- Wetland areas;
- Forest patches / corridors that provide cover and movement corridors; and
- Riparian crossings which typically consist of excellent shrub / food cover for moose.

Other key considerations at a landscape scale include the potential change in motorized access for hunting and poaching of moose and increased predator efficiency (wolves) due to cleared right-of-ways.

3 OBJECTIVE

The objective of this overview moose assessment is to respond to West Moberly First Nation concerns and identify whether, taking into account mitigation, developing the DCAT Project route option or the two substation sites (i.e., Bear Mountain and Sundance) would result in significant adverse effects on moose and their habitat in the project area.

4 ENVIRONMENTAL MANAGEMENT PLAN COMPONENTS THAT RELATE TO MOOSE

BC Hydro's standard procedure is to prepare a construction Environmental Management Plan once detailed design of the project begins. In addition, the contractor is required to write site specific Environmental Protection Plans (EPP) prior to the start of construction. The construction EMP for DCAT (AMEC 2012) has been prepared and details the permitting requirements and Best Management Practices (BMPs) to be implemented during Project construction. The purpose of the construction EMP is to:

- Identify environmental aspects and effects of the construction period;

- Investigate, and communicate potential effects of the works to staff, contractors, regulatory authorities, communities, and stakeholders;
- Provide safeguards to effectively minimize environmental effects during construction;
- Address conditions outlined in planning and environmental approvals, relevant regulations, guidelines, and policies; and
- Identify and define responsibilities for environmental management for the Project so they are clearly defined and understood.

The construction EMP provides:

- A prescription for completing on-site work in an environmentally sound way;
- A mechanism for incorporating environmental issues into contract documents; and
- A framework for discussion of environmental issues at Project tender briefings with the contractor.

The details of the construction EMP are specific and the level of detail depends on:

- The scale and complexity of the Project;
- Environmental issues and approvals identified in the Project planning phase;
- Any additional environmental and social issues identified following Project planning; and
- Issues raised by the community, regulatory authorities, and key stakeholders.

Generally, the BC Hydro Project Manager, or delegate (e.g., BC Hydro Environmental Officer), BC Hydro Field Construction Manager and the Contractor will be responsible for ensuring that the construction EMP has been reviewed and understood by all personnel involved with the Project. The construction contractor will be issued a copy of the construction EMP, asked to read and understand the content, and confirm that they understand their roles and responsibilities in environmental protection to the designated Environmental Monitor. The construction contractor will then be responsible for implementing the construction EMP by preparing and implementing site specific EPPs.

As a response to concern about potential project effects to moose, this moose habitat management plan has been written to address issues that may arise due to the project. The purpose of the Moose Habitat Management Plan (MHMP) is to identify important habitats and minimize potential adverse impacts to moose, moose habitat, and related vegetation resources that are potentially affected by construction of the DCAT Project an important to the moose.

More specific objectives of the MHMP include:

- Minimizing disturbance and loss of vegetation through avoidance where possible;
- Protecting moose, moose habitat and related vegetation; and

- Providing enhancement and compensation measures where impacts cannot be avoided or minimized.

4.1 Cross-Reference to Other Relevant Component Plans

A number of related plans pertinent to the moose are found in the BC Hydro Environmental Management Plan (AMEC 2012):

- Air Quality and Dust Control Plan – e.g., wildlife and wildlife habitat are potentially subject to adverse air quality effects;
- Archaeological Mitigation / Monitoring Plan – e.g., Culturally Modified Trees may represent wildlife habitat;
- Environmental Training Plan – the training Plan will include content on wildlife and vegetation;
- Fisheries Habitat Management Plan – fish and wildlife habitat typically overlap, such as in riparian areas;
- Contaminated Sites Management Plan – e.g., contaminated soils and groundwater may be harmful to wildlife and may adversely impact terrestrial habitat;
- Emergency Spill Response, Containment and Management Plan – e.g., spills of harmful substances may contaminate terrestrial habitat;
- Noise Management Plan – e.g., wildlife is potentially subject to adverse noise effects;
- Site Restoration Plan – e.g., restoration of disturbed areas back to natural conditions;
- Surface Water Quality and Sediment Control Plan – e.g., adverse water quality can be harmful to wildlife and may adversely impact terrestrial habitat; and
- Waste Management Plan – e.g., the storage and disposal of waste may be harmful to wildlife or terrestrial habitat.

Baseline terrestrial values assessed in the Environmental Overview Assessment (AMEC 2011) included habitat (i.e., movement corridors/wildlife corridors) for moose including three large watersheds (i.e., Pine and Kiskatinaw Rivers, and Dawson Creek).

The terrestrial area is biogeoclimatically classified as the Boreal White and Black Spruce Zone (BWBS) and includes one subzone moist warm (BWBSmw). Ecosystems within a 500 m wide corridor (250 m on each side transmission line) of the transmission line are a mix of:

- Urban vegetated and forest fragmented areas (industrial and commercial areas);
- Agricultural lands (pasture, crops and fallow fields);
- Wetlands (natural and modified); and
- Fragmented forest (upland and wetland, Figure 2).

Areas of potentially important moose habitat (i.e., wildlife corridors) were identified in 2011 (AMEC 2011). Wetlands, riparian and upland forest habitats all warrant protection and mitigation from impacts to avoid potential damage to vegetation. Wildlife movement corridors are identified on the study area maps. (Appendix B).

5 POTENTIAL CONSTRUCTION IMPACTS

DCAT Project impacts to the moose will mostly be confined to the area surrounding the transmission line and the substation sites, however, in some cases additional roadways may need to be created for access to the transmission corridor for tower erection. The main impacts expected of the DCAT Project on terrestrial habitat include:

- Mortality of species: either directly related to clearing, collisions with vehicles, or increases in hunting accessibility;
- Potential damage to or loss of listed plant species due to the construction footprint;
- Loss or degradation of wetlands due to direct construction activities such as clearing and grading, or indirect loss due to pesticide use, drainage or water quality changes;
- The spread or introduction of invasive species;
- Loss, alteration, fragmentation, disturbance, of wildlife habitat;
- Wildlife sensory disturbance or displacement caused by an increase or change in the amount of light or noise; and
- Disruption of wildlife movement.

Many of the above issues have already been addressed in the Construction Environmental Management Plan (AMEC 2012) for all species groups as well as ungulates (which includes moose, Section 3.12 and specifically Section 3.12.5.6).

5.1 Effects Assessment

Potential effects of the Project on moose can be divided into direct effects (i.e., mortality, habitat loss) and indirect effects (disturbance from construction noise and increased human presence). Effects are more likely and expected to occur during construction than during operation and maintenance. During construction potential impacts may result from: direct habitat alteration, direct mortality, noise disturbance, and odours causing attraction (i.e., predators). During operation and maintenance, potential impacts may result from direct habitat alteration, direct mortality, disturbance and indirect mortality (e.g., increased predator access, increased alternate prey).

BC Hydro's BMPs include practices to deal with identified concerns including:

- Potential effects from herbicide use (*Integrated Pest Management Regulation* 2009);

- Potential effects from electromagnetic fields (EMF). Research has shown that exposure to EMF from power lines has no known adverse effects on animals (Fernie and Bird 2000; Steenhof, Kochert, and Roppe 1993)*;* and
- Vegetation maintenance along ROW would follow BC Hydro's "Integrated Vegetation Management Plan for Control of Vegetation within Transmission Rights-of-Way" (BC Hydro 2010).

5.1.1 Construction Effects

Alteration of Land – Vegetative cover is expected be reduced through the clearing of vegetation in some sections of the existing ROW and in small areas of fragmented wooded areas (Appendix A). The result of this is expected to include potential effects on wildlife (including moose) from vegetation clearing for transmission line and structure assembly / placement, potential laydown areas, and access road footprints. These issues have been addressed and assessed in the Environmental Overview Assessment (AMEC 2011a).

A summary of potential Project-related effects from the alteration of land cover during construction which were considered in the wildlife and wildlife habitat effects assessment and addressed in the Construction EMP (AMEC 2012) include:

- **Habitat alteration and fragmentation:** This generally involves direct effects of habitat loss that include vegetation removal, fragmentation of larger patches of contiguous habitat for a road or transmission ROW (Appendix B). Indirect Project effects include effects on moose and moose habitat from the creation of wildlife movement barriers or corridors (i.e., habitat alteration / modification), thus negatively fragmenting habitats and creating edge effects;
- **Disturbance and / or displacement:** Noise disturbance is a potential effect on moose and moose habitat; avoidance by wildlife species, especially from construction machinery, vehicles, and human activity is likely;
- **Access management:** Increased road use can lead to an increase in disturbance or possibly an increase in vehicle-related wildlife effect. Road upgrades and new road construction can create or improve access into previously inaccessible areas. This in turn can have indirect effects such as an increase in hunting and poaching, and recreational activity; and
- **Mortality:** While smaller, less mobile species (small mammals, reptiles, some invertebrates and amphibians), and species with very small home ranges may suffer direct mortality related to construction equipment and clearing this is not expected for moose as they are able to avoid equipment.

Sensory Disturbance - Noise, visual, kinaesthetic (i.e., vibrations), or olfactory (scent), endocrine (acute or chronic stress reaction), or energetic responses. Potential sources of disturbance during the construction phase on moose and other ungulates of the Project include noise and vibration from traffic, construction equipment, human activity, and odours of food wastes from construction crews.

5.1.2 Operations and Maintenance

Potential Project-related effects from the management of a ROW and the ongoing presence of transmission infrastructure during the operations phase of the Project include the following:

- **Indirect habitat alteration**: creating wildlife movement barriers or corridors, causing habitat fragmentation, edge effects, and invasive species establishment; and
- **Direct mortality**: transmission line electrocution or collision. This is not expected for moose.

Potential Project-related effects to moose from increased human access include disturbance and indirect mortality as well as associated human presence (recreational) and / or hunting.

5.2 Construction Environmental Management Plan (AMEC 2012)

Mitigation strategies are intended to minimize potential adverse impacts from construction activities on terrestrial habitat, vegetation resources, wildlife (e.g., furbearers and large mammals) and will follow EFP's 11, 19, and 20 (Appendix 6.4.3 and 6.4.5) of the Environmental Management Plan (AMEC 2012). The environmental management plan focuses on five main elements with a focus on the protection of wildlife, namely furbearers and ungulates (i.e., moose, deer and elk) along the transmission corridor. They include:

- Habitat avoidance;
- Pre-construction confirmatory surveys;
- Timing of construction;
- Wildlife salvage; and
- Environmental monitoring.

Habitat avoidance entails demarcating environmentally sensitive areas (ESAs, i.e., significant wildlife areas and watercourses) on construction drawings where they intersect DCAT Project activities. ESAs mapped to date are shown in Appendix 6.1 of the Environmental Management Plan (BC Hydro 2012). They include:

- Areas of known or potential rare wildlife occurrences as listed in the Detailed Field Studies – Wildlife Report (2011) including moderate or high suitability habitat for species-at-risk; and
- Areas of known sensitive wildlife habitat areas (i.e., areas of high biodiversity, ungulate wildlife corridors) as listed in the Wildlife Report appendix (also Appendix B of this report).

Additional ESA's may be identified before or during construction. Prior to clearing vegetation or beginning construction activities, ESAs will be delineated in the field with signage, flagging, or fencing. This will provide a visual **"No Work Zone"** to the construction crews and combined with environmental training / briefings, it is expected that this will minimize the potential for unnecessary incidental impact to the surrounding terrestrial habitat. The environmental monitor and, as warranted, the Environmental Officer, will field check the flagging / signage. Previously unidentified ESAs values that are encountered during construction (e.g., identified through confirmatory assessment) or that become ESAs as a result of a change in conservation status, will be demarcated in the field and relevant information communicated to the BC Hydro Environmental Program Manager.

As required, pre-construction surveys will be undertaken by the contractor to ensure that up-to-date data are used to refine wildlife / vegetation mitigation strategies e.g., to minimize adverse impacts to ungulate and furbearer movement corridors, breeding raptors and their nest sites, active migratory birds, breeding and migratory areas for amphibians and identified species at risk.

Moose are of concern in the study area and protection of habitat (i.e., travel corridor integrity, foraging and overwintering) is critical to maintaining local populations. Characteristic species of the area such as white-tailed deer (*Odocoileus virginianus*), elk (*Cervus canadensis*) and moose thrive on edge habitat and the proposed transmission corridor traverses through an agricultural landscape that contains large areas of edge habitat (Hamilton *et al.* 1980). Human activities that fragment a natural environment create ideal habitat for moose (*ibid.*). Ravines, creek draws, natural areas, and wooded parks create natural bedding areas and cover, open park land, fertilized lawns and flowering or vegetable gardens provide ample and varied forage opportunities for ungulates (Tomm *et al.* 1981). Deer, moose and elk also find the combination of excellent habitat with abundant refuge (forest blocks) areas highly attractive. However, loss of critical habitat for forage and shelter may reduce local ungulate populations.

In order to protect ungulates and smaller mammal populations the following DCAT Project mitigation will be implemented for moose as described for ungulates in (AMEC 2012, Section 3.12.5.6):

- Clearing will be restricted to those areas required for construction and the safe and reliable operation of the transmission line, except where danger or hazard tree removal is required. Areas to be cleared will be flagged to minimize permanent habitat loss.
- Identified important habitat areas outside the DCAT Project footprint will be marked with flagging, signage, fencing and/or other measures. Construction activity will be avoided in these areas.
- Disturbed areas including identified wildlife corridors cleared for construction of the transmission line will be re-vegetated as soon as possible after disturbance with appropriate native shrub or grass species.
- There will be no hunting by BC Hydro or contractor work crews.

Construction crews will not place salt on access roads that may attract ungulates or the moose to a work site nor discard garbage, particularly food, along the right-of-ways and any access roads as it attracts mammals to roadside areas.

- The Peace Region Selected Terrestrial and Aquatic Wildlife Least-Risk Windows' document (MFLNRO 2011) contains information on the least-risk windows for a number of terrestrial animals within the Peace Region, including, elk and moose. As defined within the document, the critical period for elk and moose occurs between May 15th and July 15th, corresponding to the calving period during spring. Spring calving sites are similar to those described for moose and tend to be within protected areas with abundant food, nearby water and security (especially dense shrub) cover. So, to the extent possible, between May 15th and July 15th, BC Hydro crews should avoid disruptive construction activities within, or adjacent to riparian and contiguous forests.
- Construction duration will be minimized, especially during sensitive times for wildlife such as dawn and dusk and during breeding periods, to reduce the potential for sensory disturbance to wildlife.
- Wildlife / human interactions during and post construction will be monitored. Mitigation measures will be implemented, as required.
- Any new temporary roads required for construction and laydown areas located in forested Crown land areas will be de-activated and replanted with unpalatable native vegetation when they are no longer needed. Any new temporary roads required on forested private lands will be revegetated in accordance to landowner wishes however, attempts will be made to plant unpalatable moose forage species with the acceptance to the land owner.
- If possible, construction timing will avoid clearing and erection of infrastructure during the critical winter period for ungulates around riparian corridors.
- BC Hydro crews will be provided information on local wildlife species and / or management strategies. Where deemed applicable, basic wildlife awareness training materials will be provided to employees and sub-contractors, including tracking forms to document sightings / encounters within the DCAT Project Area.
- Crews will avoid the creation of roadside barriers (e.g., laydown areas) that could impede wildlife passage across roads and trails.
- Human presence in the DCAT Project footprint will be managed (e.g. through signage). Gates may be used to restrict road access and may require further permits or approvals.
- Fencing will be used to prevent wildlife from entering areas containing hazardous materials.
- Crews will follow procedures within EFP 19 and will provide overall protection to mammal habitat and procedures within EFP 20. This will provide protection to wetlands which will protect habitat for game species such as beaver and moose.
- Avoid disturbance or destruction of breeding wildlife to ensure compliance with Section 35 of the *Wildlife Act 2004.* If land-clearing is necessary within the breeding period of

mammals (early summer), crews will proceed only once an on-site survey is conducted immediately prior to land-clearing activities to ensure that breeding wildlife Project effects are assessed.

- Temporary roads required for construction, and laydown areas will be deactivated and replanted with native vegetation when they are no longer needed.
- Crews will deactivate and replant track roads and laydown areas not required for ongoing access to the line. Efforts wil be made to plant unpalatable native vegetation when replanting cleared roadsides so that moose and bears are not attracted to areas with active roads.
- BC Hydro will work with the MFLNRO and Canadian Wildlife Service (CWS) wildlife biologists as necessary through discussions and consultation to minimize Project effects to moose populations and address human interaction issues as they arise.
- Maintenance and retention of wildlife corridors (Appendix B) through the Project area will be maintained where possible, in order to facilitate wildlife movement.

In addition to the above recommended management mitigations already in the CEMP, the following should be applied for moose in the Project area:

- BC Hydro will review construction plans and schedules with local First Nations to minimize potential conflicts between the DCAT Project and Aboriginal activities.
- Human presence in the DCAT Project footprint will be managed (e.g. through signage). Gates may be used to restrict road access and may require further permits or approvals.
- The Project will follow guidelines as defined in the provincial document “Develop With Care: Environmental Guidelines for Urban and Rural Land Development in British Columbia” (British Columbia 2006d).
- Critical crossing locations will be identified along the DCAT route and signage will be erected indicating sensitive areas. In these areas reduce vehicle speed limits to reduce potential for moose and other ungulate impacts. Warning signs or lighted/animated warning signs have minimal effect on reducing accident rates or vehicle speed (Romin and Bissonette 1996). A system of temporary warning signs associated with reduced speed limits, erected during the period of maximum collision potential, might reduce the frequency and seventy of ungulate collisions. These signs should be changed on a regular basis so that motorists do not become habituated to the same signs and reduce their awareness. New signage may provide greater awareness.
- Temporary Fencing of highway right-of-ways will be used to prevent impacts with moose or other ungulates. This is generally acknowledged as the most effective way to reduce or prevent animal-vehicle collisions, despite the high initial capital investment.

5.3 Access Management

- The majority of the corridor is proposed on private lands, thus no additional access will be created in these areas an only minor clearing is proposed along the existing right-of-way areas where moose have become habituated (Appendix B).

- A management plan for corridor access (e.g., for hunting) should be adhered to as defined in the Environmental Assessment Overview document (pages 16, 17, 112 and 158) as well as the EMP document (AMEC 2012).
- Construction of the transmission line will require access roads. Where possible, existing public and resource roads would be used. Additional access will be constructed as necessary and adhere to the recommendations of this report and the Construction EMP (AMEC 2012).
- Long term access to new roads are expected to be managed with consideration of environmental issues, as well as First Nations and community interests.
- The amount of access to remain open to the public post-construction will be decided in consultation with land-owners, regulatory agencies and resource users.
- An access management plan should be developed to manage access by the public through areas within the Project sites and ROWs.

5.4 Demarcating Known Sensitive Wildlife Sites

- Crews will demarcate sensitive moose and wildlife sites prior to initiating construction (e.g. mineral licks, calving areas).
- Prior to starting work in sensitive moose and wildlife areas, crews will delineate these areas in the field using signage, flagging, fencing or other method to guide construction crews (these markings will reduce the potential for unnecessary incidental impact to the surrounding terrestrial habitat).
- As warranted, the Environmental Officer or their designate will check the flagging / signage / fencing in the field.

5.5 Reduce Interaction between Construction and Wildlife

- In order to reduce predator interactions with moose and ungulates crews will maintain all construction sites free of wildlife attractants such as food, garbage, petroleum products or other materials with a strong odor.
- Where garbage containers are required, ensure containers are inaccessible to wildlife.

5.6 Equipment Operation in Environmentally Sensitive Areas

- Construction equipment will only be operated within the designated construction site and access roads unless otherwise approved by relevant regulatory agencies.
- In order to protect moose habitat refueling procedures outlined in section 9 Emergency Spill Response, Containment, and Management Plan; and Construction zones in or near environmentally sensitive areas will be clearly marked and flagged prior to construction activities.

5.7 Vegetation

- Crews will minimize the limits of clearing to those areas necessary for the safe operation of the transmission line.

- Crews will retain and protect native trees and understory plants, to the extent possible, in areas outside of the construction area where safety or infrastructure requirements are not a concern.
- A close cut (i.e. cut close to the actual root system without disturbing the root zone) will be used by crews or no grubbing techniques where clearing must occur outside the immediate footprint will be conducted.
- Re-vegetation will use native species or an approved seed mix and/or crop species to assist in the control of noxious and invasive species.
- Sensitive vegetation areas on construction drawings that are critical for moose and ungulates will be delineated.
- Sensitive vegetation areas prior to clearing and grubbing activities will be marked.

5.8 Monitoring Strategy

Environmental monitors and / or wildlife specialists will monitor construction in or near sensitive vegetation / wildlife habitats or features. Monitoring will include:

- General construction monitoring to track compliance with applicable sections of the CEMP and with area specific or activity specific work plans.

6 RESIDUAL EFFECTS

Based on the evaluation of baseline data and desktop analyses for moose, there are expected to be two key residual effects of the Project on this species during construction and operations:

- Direct and indirect changes to moose habitat, such as loss, alteration, fragmentation, habitat avoidance due to sensory disturbance.
- Access to moose habitat with a potential to have higher rates of moose mortality through hunting.

Significance of potential residual effects (after mitigation discussed above) is assessed for environmental and social effects by analysing the following factors:

- Magnitude - Magnitude describes the nature and extent of the environmental effect. The magnitude of an effect is quantified in terms of the amount of change in a parameter or variable from an appropriate threshold value, which may be represented by a guideline or baseline conditions.
- Geographic Extent - Geographic extents are similar to the spatial boundaries of the assessment (e.g., Study Area).
- Duration - Duration is defined as a measure of the length of time that the potential effect could last. It is closely related to the Project phases or activities that could cause the effect.

- Frequency - Frequency is associated with duration and defines the number of occurrences that can be expected during each phase (i.e., construction and operations) of the proposed Project.
- Reversibility - Reversibility is the ability of the physical parameter, biological or social community to return to conditions that existed prior to the adverse environmental effect. The prediction of reversibility can be difficult because environmental effects may, or may not, be reversible. It is important to ascertain reversibility because it has an important influence on the significance of an effect.
- Ecological Context (Biophysical Environment Only) - Ecological context is a measure of the relative importance of the affected ecological component to the ecosystem, or the sensitivity of the ecosystem to disturbance. It indicates the degree to which an effect on the component would affect the ecosystem.
- Level of Confidence - Using the previously described rating criteria, the significance of adverse environmental effects is evaluated based on a review of project-specific data, relevant literature, and professional opinion. To this is added the level of confidence in the prediction.
- Certainty - To arrive at a high level of confidence for a significance rating, it is usually desirable to apply rigorous scientific and / or statistical methods (quantitative approach). Where such methods are not feasible, professional judgement is usually employed (qualitative approach). Rating the certainty of the significance rating is an additional step that can be used to justify or substantiate the level of confidence in the evaluation; and
- Probability of Occurrence - The probability of effects is the likelihood that the effect would occur.

Table 2 presents the Residual Effects Assessment for the moose and the ratings applied (Table 3).

Table 2: Residual Effects Assessment By Project Development Phase For Moose

Parameter	**Stage of Development Rating**	
Stage of Project Development	Construction	Operations
Residual effect	**Habitat loss/Change in habitat availability**	
Effect attribute		
Magnitude	Low	Low
Geographic extent	Point	Point
Duration	Short-term	Short-term
Frequency	Once	Once
Reversibility	Yes	Yes
Ecological context	Low	Nil
Direction	Neutral	Neutral
Certainty	High	High
Level of confidence	High	High
Residual effects significance	Not significant (minor)	Not significant (minor)
Residual effect	**Hunting**	
Magnitude	Nil	Nil
Geographic extent	Point	Point
Duration	Short-term	Chronic
Frequency	n/a	n/a
Reversibility	n/a	n/a
Ecological context	n/a	Low
Direction	n/a	Negative
Certainty	High	High
Level of confidence	High	High
Residual effects significance	Not significant (minor)	Not significant (minor)

Note: n/a (not applicable)

Table 3: Biophysical Environment Rating Criteria for Evaluating Significance of Effects

Rating Criteria	Description
Significance	
Not significant (negligible)	Impacts are point-like or local in scope, short-term or chronic, low frequency (once or intermittent), and their effects are indistinguishable from the natural range of variability in physical, chemical and biological characteristics and processes.
Not significant (minor)	Impacts are local in scope, short-term to chronic, low frequency, and their effects can be distinguished from the natural range of variability in physical, chemical and biological characteristics and processes.
Not significant (moderate)	Impacts are local to regional in scope, medium-term to chronic, occur at all frequencies, and their effects and consequences are distinguishable at the level of moose populations.
Significant	Impacts are local to regional in scope, long-term to chronic, occur at all frequencies, and are consequential in structural and functional changes in moose populations.
Direction	
Negative	Effect is worsening or is not desirable.
Positive	Effect is improving or is desirable.
Neutral	Effect is neither worsening nor improving.
Magnitude Scale	
Nil or none	Effects are not measurable.
Low	1 to 10% change, depending on the parameter.
Medium	5 to 20% change, depending on the parameter.
High	>5 to >20% change, depending on the parameter.
Geographic Extent	
Point	Effect generally does not exceed 100 m^2 or distance from the source is less than 5 m.
Local	Effect is confined to the Project site.
Regional	Effect extends to the Project site.
Duration	
Short-term	From less than one day to one year.
Medium-term	Construction phase.
Long-term	Throughout.
Chronic (permanent)	Beyond Project time.
Frequency	
Once	Impact occurs on one occasion.
Intermittent	Impact occurs several times.
Continuous	Impact occurs continuously.

Rating Criteria	Description
Reversibility	
Yes	Effect is reversible over one to a few cycles of the physical event after the impact ceases (Physical). Effect is reversible over one to a few life cycles after the impact ceases (Biological).
No	Effect is not reversible over the Project.
Ecological Context Biological Environment and specific to each effect (categories given are general)	
None or nil	The impact has no effect, i.e., the linkage is invalid.
Low	Affects some population and community functioning.
Medium	Affects 10 to 50% of population and community components functioning to some extent.
High	Affects most population and community functioning or a critical population or community component.
Level of Confidence Subjectively based on professional opinion	
Low	Low to moderate correlation of data and single or few lines of evidence supporting the conclusion.
Medium	Moderate correlation of data and a moderate number of lines of evidence, at least some of which are quantitative; alternately a relatively high amount of corroboration from qualitative data sets.
High	High correlation of data and multiple lines of evidence supporting the conclusion, some or all of which are quantitative.
Certainty	
Low	Based on third-party professional judgment (literature, comparison to other sites).
Medium	Based on personal professional judgment from firsthand experience at the site and similar sites within the same or very similar contexts.
High	Based on quantitative evaluation of reliable site-specific data.
Probability of Occurrence	
Low	The effect on the moose is well understood and there is a low probability of effect on the moose as predicted.
High	The effect on the moose is well understood and there is a high probability of effect on the moose as predicted.
Unknown	The effect on the moose is not well understood and based on potential risk to the moose, effects will be monitored and adaptive management measures taken as appropriate.

Following applied mitigations for Project effects identified above, residual effects are expected to be 'Not Significant (minor)[1]. Overall the Project is expected to have a low impact on trapping and hunting activities. After mitigation residual effects are expected to be between minor to low magnitude, local, short term, of continuous frequency, and reversible.

Moose are expected to be present in the area during all activities of the Project. Residual effects are not considered significant. Project activities related the substations are also not expected to have any measurable effect on hunting (AMEC 2011a).

7 CONCLUSION

Moose are an important species for First Nations sustenance, sport hunting and as a valued ecosystem component in predator – prey systems in western and northern Canada. The ecology and habitat requirements of moose are well understood and documented. In the South Peace region moose populations are affected by human development and access as well as by populations of alternate prey (elk, deer) and predators (wolves and bears). They are the most abundant cervid (member of the deer family) within the region.

As much of the proposed DCAT project is on areas that are already significantly altered by agriculture, residential development and existing right-of-ways, little additional impact is anticipated on moose numbers and movement. Best management practices and vegetation management plans for moose habitat are expected to mitigate any potential negative effects due to temporary habitat loss and predation risk as outlined in the EMP and this document. Access control may also help limit potential increases in hunting or poaching risk to moose as defined in the EMP.

Based on the evaluation of baseline data and desktop analyses for moose, there are expected to be two key residual effects of the Project on this species during construction and operations:

- Direct and indirect changes to moose habitat, such as loss, alteration, fragmentation, habitat avoidance due to sensory disturbance; and
- Increased access to moose habitat with a potential to have higher rates of moose mortality through hunting.

However, following applied mitigations of this document and the EMP for Project effects, residual effects are expected to be 'Not Significant (minor) for moose for this Project.

[1] Impacts are expected to be point-like or local in scope, low frequency (once or intermittent), and their effects are indistinguishable from the natural range of variability in physical, chemical and biological characteristics and processes.

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APPENDIX A: MOOSE SPECIES ACCOUNT

MOOSE ECOLOGY AND KEY HABITAT REQUIREMENTS

General

The moose is the largest cervid in North America and lives mostly within forested, shrubland and wetland habitat types. Kelsall and Telfer (1974) provide a summary of the biogeography of moose, outlining the expansion of moose populations in North America since the last ice-age. During the Wisconsin glaciation (approximately 12,000 to 8,000 years ago) moose were restricted to areas south of the ice-sheets (*A. a. shirasi* in the mountains and *A. a. andersonni* to the east) and an ice-free refuge in Alaska (*A. a. gigas*). Following the retreat of the ice-sheets, boreal forests grew northward and moose (*A. a andersonni* and *A. a. shirasi*) followed. Moose from Alaska (*A. a. gigas*) moved eastward and south with the retreat of the ice-sheets. Currently Shiras moose (*A. a. shirasi*) are found in the mountainous regions of southeastern British Columbia, Montana, Utah, Washington and Wyoming. In northern British Columbia and Alberta, *A. a. gigas* have moved into coastal areas and expanded south and east to overlap with *A. a. andersonni,* which migrated from the eastern portions of the province.

Kelsall and Telfer (1974) attribute climate as the most likely limiting factor to moose expansion, with high winter snowfalls and high summer temperatures determining the extent of moose range. Moose are adapted for high snowfall areas, having long legs and low foot loads (Kelsall and Telfer 1974, Coady 1974), and can usually use areas where snow depths are less than 70cm (Kelsall and Prescott 1971, Kelsall and Telfer 1974 and Coady 1974). Snow density and crusting has an effect on the depth of snow that a moose can use, with higher density snow allowing for deeper snow use (Kelsall and Prescott 1971, Coady 1974). High summer temperatures have been shown by a number of researchers to affect moose behaviour and habitat use. Moose will seek to avoid heat stress by inhabiting cool areas under closed canopy forests and in aquatic environments such as lakes, rivers and ponds (Kelsall and Telfer 1974, Schwab 1985, Renecker and Hudson 1986, Demarchi and Bunnell 1993, 1995).

Home Range

Seasonal home ranges for moose are generally small, with the maximum size usually ranging from 5 to 10 km^2 (LeResche 1974). Winter home range sizes are usually smaller than other seasonal home ranges and vary substantially (0.01 to 2 km^2) due to snow conditions (Coady 1974 and LeResche 1974). Home ranges during the growing season (spring, summer and fall) are larger than winter home ranges but are variable and dependent on the sex, age and reproductive status of the moose. Female moose with calves tend to have smaller home ranges than other moose during the spring, likely due to lack of mobility by the calf (LeReche 1974, Cederland and Sand 1994). Male moose tend to have larger home ranges than females in all seasons with the largest differences occurring in the fall during the rut (LeResche 1974, Cederland and Sand 1994). Fall home ranges of younger males are highly variable, with most studies showing larger home ranges than older males (LeResche 1974, Lynch and Morgantini 1984 *In* Cedarland and Sand 1994). Some findings show no difference (Saunders and Williams 1972 *In* LeResche 1974) whereas other findings show smaller home ranges (Cedarland and

Sand 1994). Seasonal home ranges can be relatively small while the distances between the seasonal ranges can be quite large depending on the population migration type as outlined by LeResche (1974) (see below). Annual home ranges therefore can be highly variable and have been reported in the literature ranging from 15 to 150 km^2 (LeResche 1974).

Moose migration patterns are variable over their range in North America. LeResche (1974) reviews these variations, and suggested three migration patterns based on numerous studies of moose populations. He classified moose migrations patterns into Type A: short distance movements between two seasonal ranges with little elevation change; Type B: medium to long distance movements between two seasonal ranges with large elevation differences; and Type C: medium to long distance movements between three seasonal ranges with large elevation differences between the winter/spring and summer/fall habitats. All of these patterns can be expressed within the same general area by different segments of the same population, and may be dependent on factors such as age, sex, social status and reproductive status (LeResche 1974). In his review of numerous moose studies, LeResche (1974) found that Type A populations were found in areas of low elevational relief and high habitat diversity so that movements between winter and growing season habitats were relatively small (0-10 km). His review of other work suggested that Type B populations have a low elevation winter range and a higher elevation spring/summer/fall range separated by 500 – 1000m vertically and 2 to 60 km horizontally. Type C populations were identified where migrations occur from winter areas at low elevations to other low elevation spring areas approximately 20 km away followed by a movement to higher elevation (+ 500m) summer/fall areas 30 to 50 km from the spring areas. Although LeResche (1974) distinguishes three migration patterns, he acknowledges that they are points upon a continuum of possible moose movement patterns within North America.

Moose seasonal habitat use varies depending on the area studied, sex, age, social status and reproductive status of the animal. General seasonal use patterns are difficult to predict and quantify due to the differences in migratory patterns (LeResche 1974) and food preferences (Peek 1974) described by various authors. During the winter, moose are severely restricted in their movements when snow levels are greater than 90 cm, are relatively mobile if the snow levels are less than 60 cm, and prefer areas where snow depths are less than 40 cm (Coady 1974). In general, more open habitats such as burns, shrublands and cutblocks are used during early winter or when snow levels are low and more closed canopy coniferous forests are used when snow levels increase (Coady 1974, Eastman 1974 and 1977, LeResche *et al.* 1974, Peek *et al.* 1976, MacCracken *et al.* 1997). Spring, summer and fall habitats tend to be open types such as cutblocks, burns, shrublands and wetlands that have abundant browse species and aquatic habitats such as ponds, which provide aquatic browse plants (Peek 1974, Peek *et al.* 1976, Doer 1983, MacCracken *et al.* 1997).

Reproduction

Moose mate in late September to early October during the rutting period, which is a time of intense social interaction between males and between males and females (Lent 1974). Usually one calf is born in late May and early June although two calves are not uncommon, especially when habitat quality is high (Franzmann and Schwartz 1985 *In* MacCracken *et al.* 1997). Calves stay with the female moose until the next spring and sometimes on into the fall (Stringham 1974). Female moose can become sexually mature after the first year but consistent reproductive success is not usually established until they are over 2.5 years (Simkin 1974).

Feeding Habitats

Moose are found in a wide variety of habitats and browse on a wide variety of plant species over their range in North America. Moose consume different plants in different parts of the continent and in different seasons (Peek 1974). In his review of 41 moose browse studies in North America, Peek (1974) cautioned against generalizations in food habits due to these wide variations and suggested that local information be used wherever possible. In the west, seasonal differences in browse species have been documented for British Columbia, Alberta, Alaska, and the western states of Montana, Utah, Washington and Wyoming (Peek 1974 and Eastman 1977). In general, the main winter browse species in moose diets in British Columbia are willows (*Salix spp.*), birches (*Betula spp.*), and aspens (*Populus spp.*) (Kelsall and Telfer 1974). Other species such as red osier dogwood (*Cornus sericea*), and sub-alpine fir (*Abies lasiocarpa*) have also been found to be important during the winter (Eastman 1977). By late spring, the above species are still used along with alders (*Alnus spp.*), maples (*Acer spp.*), grasses, ferns,

Moose typically only use foraging habitats that are within a certain proximity to thermal and/or security cover; this is especially true during the winter season. The distance between thermal/security cover habitats and used feeding habitats has been reported differently for various study areas (Table 1).

Table 1: Proximity distances reported between moose feeding and cover habitats from a review of the literature.

Distance (m)	Season	Details	Study Area Location	Citation
530	All	Maximum distance to cover in boreal forest	Alberta	Eastman 1974
40	Winter	Beyond 40 m from cover, frequency of use decreased and became zero at approximately 100 m from cover	Ontario	Hamilton and Drysdale 1975
200	All	< 75 m is considered optimal	Alberta	Tomm et al. 1981
80	Winter	95% of browse activity within 80 m of cover	Ontario	Hamilton et al. 1980
60	Winter	Cow/calf groups ranged 3-60 m from cover (mean of 27 m) in early winter and 0-30 (mean12 m) in late winter, distance decreased with increasing snow depth	Ontario	Thompson and Vukelich 1981
N/A	Summer	No difference in browsing at varying distances from edge; authors note that no predators exist in study area	Sweden	Andren and Angelstam 1993

Distance (m)	Season	Details	Study Area Location	Citation
100	Spring	Female moose with calves	Alberta	Penner 1997 in Higgelke and Macleod 2000
100	Winter	Maximum distance from cover habitat	Alberta	Higgelke and Macleod 2000

Winter

During the winter, moose feed primarily on browse plants found in open areas and in the boreal forests of British Columbia. Early winter foods include willows (*Salix spp*.), red osier dogwood (*Cornus sericea*), and paper birch (*Betula papyrifera*) while late winter diets include willows, paper birch and subalpine fir (*Abies lasiocarpa*) (Eastman 1977). Other winter foods described in the literature for north-central British Columbia include falsebox (*Pachistima spp.*) (Ritcey 1965 *In* Peek 1974), high bush cranberry (*Viburnum edule*), saskatoon (*Amelanchier alnifolia)*, trembling aspen (*Populus tremuloides*), and mountain ash (*Sorbus sitchensis*) (Westworth *et al.* 1989). Bark stripping in late winter by moose has been reported by various authors (e.g. Miquelle and van Bullenburghe 1989, MacCracken *et al.* 1997) and occurs primarily on deciduous trees such as willow, trembling aspen and cottonwood.

Various researchers have looked at winter habitat use by moose in North America and have found that moose use a number of habitat types such as coniferous forests (e.g. Peek *et al.* 1976, Forbes and Theberge 1993), riparian areas (e.g. LeResche *et al.* 1974, MacCracken *et al.* 1997), shrublands (e.g. LeResche *et al.* 1974), burns and harvested areas (e.g. Eastman 1974, Forbes and Theberge 1993), open and closed coniferous wetlands (Osko et al 2004) and mixed forests (e.g. Hundertmark *et al.* 1990). The reason for such differences in findings appears to be related to the region studied (e.g. Alaska, Ontario, Minnesota, Alberta, British Columbia, etc.), sampling methods used (e.g. track counts, pellet counts, radio-telemetry, aerial surveys, etc.), sampling period (i.e. early winter vs. late winter), snow characteristics (e.g. depth, density, layers, etc.), life requisite function (foraging vs. bedding) and the delineation of the habitats (i.e. map scale, classification method).

One factor that could be influencing the delineation of winter habitat types could be the scale of the measurements. For example, a study by Forbes and Theberge (1993) in Ontario found that moose selected closed canopy forest habitats at the stand level but mosaics of 33% harvested areas at the landscape level. Another factor that could influence winter habitat selection is moose density, as moose were found to feed within 80m of cutblock edges when moose densities were low and up to 260m from edges when moose densities were higher in northern Ontario (Hamilton *et al.* 1980).

Most researchers agree, however, that snow characteristics and canopy closure have the greatest influence on moose winter habitat use (Kelsall and Prescott 1971, Coady 1974, Peek *et* *al.* 1976, McNichol and Gilbert 1980, Thompson and Vukelich 1981, Hundertmark *et al.* 1990, MacCracken *et al.* 1997). When snow levels are low (<60cm), in early winter or during mild winters, moose are able to browse in open habitat types such as shrublands, burns and cutblocks (Eastman 1974, LeResche *et al.* 1974, Peek *et al.* 1976, Schwab 1985, MacCracken *et al.* 1997). As snow levels increase (> 60cm), foraging in open habitat types decreased and use of closed canopy forests and edge habitats between open and closed canopy areas increased (Eastman 1974, Peek *et al.* 1976, McNicol and Gilbert 1980, Schwab 1985, Hundertmark *et al.* 1990). Use of open areas is limited to distances ranging from 30 to 80m from forested edges when snow levels are more than 60cm (Hamilton and Drysdale 1975, Hamilton *et al.* 1980, Thompson and Vukelich 1981).

Spring

Peek *et al.* (1976) and MacCracken *et al.* (1997) provide plant protein analysis data that show spring browse provides the highest value food for moose and suggest that spring feeding is critical for moose replenishment of fat reserves. Moose spring foraging areas consists primarily of open areas that provide early green browse such herbs and new leaf buds of woody plants. Spring foods in north-central British Columbia include deciduous shrubs such as Sitka alder (*Alnus viridis spp. sinuata*), Douglas maple (*Acer glabrum*), willows and paper birch (Eastman 1977). Important herbaceous plants eaten in spring in Alaska include horsetails *(Equisitem spp.*), buckbean (*Menyanthes trifoliata*), and marsh cinquefoil (*Potentilla palustris*) (MacCracken *et al.* 1997). Moose have also been reported to strip bark from willow, aspen and cottonwood trees during spring (Miquelle and Van Ballenberghe 1989, MacCracken *et al.* 1997).

Movement from winter areas to spring feeding areas occurs as soon as snow depth declines and green-up of plants starts (LeResche 1974). Spring habitat types used for foraging include wetlands, shrublands, riparian areas, recent burns and cutblocks (Eastman 1977, Schwab 1985, Simpson *et al.* 1988). Moose that exhibit type B and C migration patterns (LeResche 1974), will follow the receding snow levels to upper elevation wetlands, meadows and sub-alpine forest parklands during the latter part of the spring (Edwards and Ritcey 1956, Simpson *et al.* 1988).

Summer/Fall

During the summer and fall, moose continue to feed on willow and herbaceous plants found in open areas as well as aquatic plants in the early part of the summer (Peek 1974, Peek *et al.* 1976, MacCracken *et al.* 1997). Sedges (*Carex* spp.), grasses and reedgrasses (*Calamagrostis* spp.) are reported as forage species for moose but usually make up very low percentages (1 to 5%) of their summer diet (see Peek 1974, MacCracken *et al.* 1997). Aquatic plants used by moose include burreed (*Sparganium* spp.), pondweed *(Potamogeton* spp.), horsetails, (Ritcey and Verbeek 1969 *In* Peek *et al.* 1974, Peek *et al.* 1976), buckbean (MacCracken *et al.* 1997), water arum *(Calla palustris)*, yellow water lily (*Nuphar lutea)*, and sedges (*Carex* spp.) (Peek *et al.* 1976). The use of aquatic plants has been hypothesized to be a response to the increased amounts of minerals, especially sodium in these plants (Belovsky and Jordan 1981), making them an important food source in the early summer. Red-osier dogwood was found by Eastman (1977) to be an important fall food for moose in north-central British Columbia.

Habitats selected during the summer and fall are varied, with open areas such as burns, cutblocks, sub-alpine parklands, avalanche tracks, wetlands and shrublands used for foraging (LeReche *et al.* 1974, Peek *et al.* 1976, Tomm *et al.* 1981, Schwab 1985, MacCracken *et al.* 1997). Use of these open areas is dependent on factors such as temperature and distance from cover, with moose avoiding open areas during hot days (> 20^{o} C) (Schwab 1985) unless sufficient cover (e.g. alder > 5m tall) or water is present to reduce heat stress (Demarchi and Bunnell 1995). Use of open habitats during the summer and fall is also related to the proximity of forested habitat edges. Work in Alberta by Tomm *et al.* (1981) found that moose used edges extensively to provide forage and cover and seldom moved more than 60m from the edges into open areas when disturbed by road traffic. In central Alaska, moose preferred browsing on diamondleaf willows (*Salix planifolia pulchra*) in shaded areas on an edge over those in sunlight, possibly due to the higher protein content of the willows in the shade (Molvar *et al.* 1993). Wetland habitats are used if they provide the optimum feeding conditions that are usually found in small lakes (1 to 5ha) with organic bottoms, slow streams and beaver ponds (Adair *et al.* 1991, Fraser *et al.* 1984).

During the fall rutting period (late September to early October), moose generally select open wetland and shrubland habitat types or early seral stage burns and cutblocks (Lent 1974, Peek *et al.* 1976, MacCracken *et al.* 1997). Use of closed canopy forests also can be found in areas where hunting of moose occurs, possibly in response to this activity (Peek *et al.* 1976, Tomm *et al.* 1981, Schwab 1985). Male moose tend to aggregate more during the rut than females (Lent 1974), and have been shown to have smaller seasonal home ranges during this time (Cedarland and Sand 1994).

Security/Thermal Habitats

There are three main security and thermal cover requirements for moose: hiding cover for all seasons, winter thermal cover and summer thermal cover. Security from predators in the form of hiding cover is provided by shrubland and forested habitat types (Tomm *et al.* 1981, Schwartz and Franzmann 1983, MacCracken *et al.* 1997). Thermal cover in the winter for snow interception (Coady 1974, Thompson and Vukelich 1981) and shelter from wind (McNichol and Gilbert 1978) is provided by closed-canopy mature forests. Thermal cover in summer for heat relief can also be provided by closed-canopy mature forests (Schwab 1985, Demarchi and Bunnell 1993 and 1995) and by aquatic environments (Kelsall and Telfer 1974).

Winter

Moose are severely restricted in their movements when snow levels are greater than 90 cm, are relatively mobile if the snow levels are less than 60 cm, and prefer areas where snow depths are less than 40 cm (Coady 1974). Snow density and crusting has an effect on the depth of snow that moose can use, with higher density snow allowing for deeper snow use (Kelsall and

Prescott 1971, Coady 1974). Snow depth and duration were found to be the highest natural mortality factors for moose in Alaska over an eleven-year period (Modafferi and Becker 1997).

Although during very extreme winter weather moose may experience cold stress, heat stress may be a more important factor of moose habitat selection during moderate winter temperatures (Schwab 1985). However, Schwab (1985) also found moose using forests with high canopy closures when temperatures were less than –20°C. Mature closed canopy forests provide shelter from wind, with even residual stands of trees providing important wind shelter (McNichol and Gilbert 1978).

Thermal/snow interception cover habitats for moose in winter consist of closed-canopy coniferous forests, which intercept snow, provide shelter and minimize radiation of heat to the open sky (Coady 1974, Eastman 1974, Peek *et al.* 1976, McNicol and Gilbert 1980, Thompson and Vukelich 1981, Schwab 1985, Hundertmark *et al.* 1990). Open habitats such as burns, shrublands and cutblocks are used during early winter or during low snow winters and closed canopy coniferous forests are used during heavy snow winters or in late winter when snow levels increase (Coady 1974, Eastman 1974 and 1977, LeResche *et al.* 1974, Peek *et al.* 1976, MacCracken *et al.* 1997). In British Columbia, Schwab (1985) found moose using forests with high canopy closures when snow levels were greater than 90 cm. Also in British Columbia, Eastman (1974) found that forested habitats were used by moose for cover in winter rather than for feeding and that partially logged stands were the preferred habitat type due to the presence of forage and cover. In Alaska, Hundertmark *et al*. (1990) observed that coniferous stands lacked sufficient browse and were selectively used by moose with greatest use occurring in severe winters.

Spring

Security/thermal habitat required by moose during the spring is primarily security cover to provide protection from predators, especially for female moose during the calving and post-calving period. This security cover is required near foraging areas for activities such as bedding, ruminating and calving. Female moose will use dense cover in the spring to give birth to calves (Stringman 1974) and may leave calves in hiding cover in the first few hours after birth (Peterson 1955 *In* De Vos *et al.* 1967, Stringman 1974) or while feeding in the open (Altmann 1963 *In* De Vos *et al.* 1967). MacCracken *et al.* (1997) found that calving areas were most often located in open, tall alder-willow shrub habitats and that extensive feeding on willow and bark stripping occurred, probably due to the female remaining close to the calf for 7-10 days in these habitats. Another researcher in Alaska found that mature aspen spruce forests with a high canopy closure were used for calving (Miquelle 1990 *In* MacCracken *et al.* 1997). Canopy closure for 17 of 22 calving areas studied by MacCracken *et al.* (1997) had over 50% canopy closure. MacCracken *et al.* (1997) hypothesized that the tall alder-willow shrub and closed canopy mature forest habitats used for calving provide predator protection and thermoregulation advantages for moose. They also found that 50% of the collared females in their study showed high site fidelity for calving sites between years, using areas within 0.1 to 1km from each other in successive years.

No information is available for calving areas in Alberta and British Columbia, although it is expected that moose would select dense tall shrub, riparian or closed canopy mature forest habitats similar to those described in Alaska.

Summer/Fall

During the summer and early fall, thermal cover has been reported by many researchers to be an important habitat feature selected for by moose (Schwab 1985, Renecker and Hudson 1986, Demarchi and Bunnell 1995). Demarchi and Bunnell (1995) found that moose generally used habitats in proportion to their availability but modified habitat use in response to warmer temperatures, displaying increased use of forested habitats with greater than 55% crown closure. In north central BC, Schwab (1985) found that summer habitat use was directly related to avoidance of heat stress.

Moose have been found to select habitats such as lakes, rivers and ponds (Kelsall and Telfer 1974, Peek *et al.* 1976), closed-canopy tall shrublands (Demarchi and Bunnell 1995, MacCracken *et al.* 1997), and closed-canopy forests (Schwab 1985, Demarchi and Bunnell 1993 and 1995) during high temperature days (> 20-25^{o} C). Demarchi and Bunnell (1993) also provide a range of crown closure classes required for moose based on summer ambient temperatures. They suggest that moose will select forests with crown closures greater than 66% when temperatures are greater than 25^{o} C.

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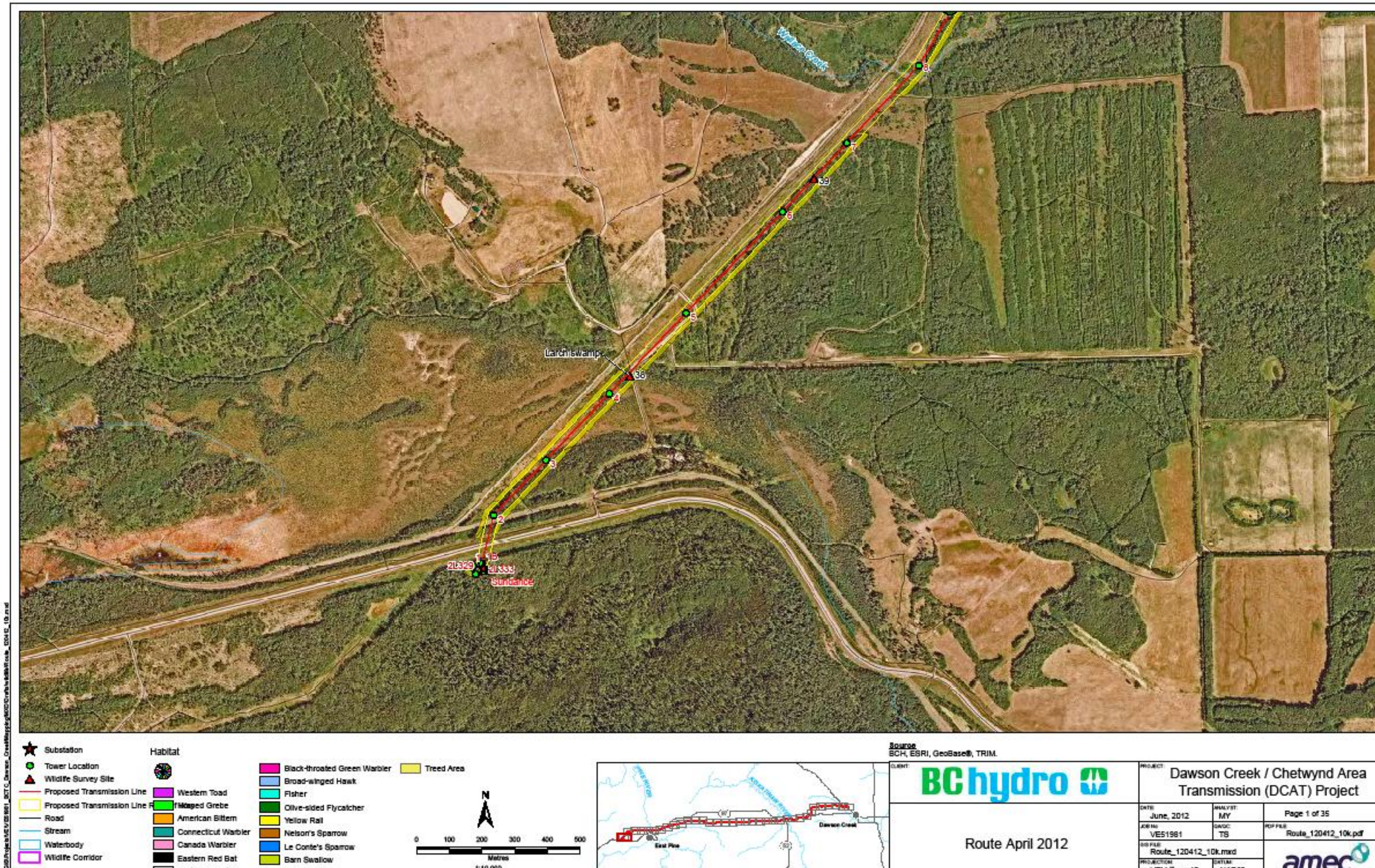
APPENDIX B: 1:10,000 MAPS FROM ENVIRONMENTAL OVERVIEW ASSESSMENT IDENTIFYING HABITAT CORRIDORS AND AREAS OF IMPORTANCE TO MOOSE (WETLANDS, SWAMPS, FORESTED PATCHES, RIPARIAN CROSSINGS)

Please insert route maps from 1:10000 wildlife surveys.


Larch swamp
Sundance
Substation
Tower Location
Wildlife Survey Site
Proposed Transmission Line
Road
Stream
Waterbody
Wildlife Corridor
Habitat
Western Toad
American Bittern
Connecticut Warbler
Canada Warbler
Eastern Red Bat
Northern Myotis
Black-throated Green Warbler
Broad-winged Hawk
Fisher
Olive-sided Flycatcher
Yellow Rail
Nelson's Sparrow
Le Conte's Sparrow
Barn Swallow
Treed Area
N
0 100 200 300 400 500
Metres
1:10,000
Source
BCH, ESRI, GeoBase®, TRIM.
CLIENT:
PROJECT:
Dawson Creek / Chetwynd Area Transmission (DCAT) Project
Route April 2012
DATE: June, 2012
ANALYST: MY
Page 1 of 35
JOB No: VE51981
QA/QC: TS
PDF FILE: Route_120412_10k.pdf
GIS FILE: Route_120412_10k.mxd
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DATUM: NAD83