NORTH SLAVE MÉTIS ALLIANCE
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October 11, 2017

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Dear Mr. Cliffe-Phillips,

RE: EA-1617-01 Tlicho All Season Road - North Slave Métis Alliance Technical Report

The Department of Infrastructure of the Government of the Northwest Territories (GNWT-DOI) submitted an application for a Type A Land Use Permit ("LUP") and Type B Water Licence ("WL") to the Wek'èezhìi Land and Water Board (WLWB or the Board) on March 31, 2016. The Tlicho All Season Road (TASR) project was subsequently referred to the Environmental Assessment (EA) by the Mackenzie Valley Environmental Impact Review Board (MVEIRB), on July 21, 2016.

The North Slave Métis Alliance (NSMA) has been actively participating in the MVEIRB's EA process; and presently the MVEIRB is inviting interested parties to submit a Technical Report by October 11, 2017. NSMA understands that the purpose of the Technical Report is to present our views on the TASR project's environmental and socio-economic impacts as well as our conclusion on the magnitude of the impacts.

To the extent we could, the NSMA reviewed relevant materials on the MVEIRB Public Registry and is pleased to present to the MVEIRB our Technical Report as attached below.

We look forward to the further discussion during the Public Hearing in Whati from November 15-17, 2017.

Sincerely,
Shin Shiga
Manager, Environment

CC: Michael Conway, GNWT-DOI
Attachment: Appendix A

1. Background

NSMA members are Métis people of the Great Slave Lake area of the Northwest Territories (NWT) with asserted Aboriginal harvesting rights recognized and affirmed under section 35(1) of the *Constitution Act*, 1982. The Minister of Aboriginal Affairs and Northern Development Canada (Minister), and the Supreme Court of the NWT, have both acknowledged that NSMA members have a good *prima facie* claim to the Aboriginal right to hunt caribou on their traditional territories in the area north of Great Slave Lake, NWT (North Slave Region), and are entitled to be consulted when those asserted rights may potentially be adversely impacted by a Crown decision.[1]

The GNWT has copies of the evidence before the Minister and the Supreme Court of the NWT that support this acknowledgement as well as further material supplied during consultations in 2013 and 2014.

The proposed TASR will be constructed in the region where both the Minister and the Supreme Court of the NWT found NSMA members exercise their Aboriginal rights as Métis.

Since July 21, 2016, the NSMA submitted comments (October 13, 2016), Information Requests (July 14, 2017), and attended the Technical Session in Behchoko from August 15-17, 2017. The NSMA has also received a funding from the GNWT-DOI to conduct a Traditional Knowledge (TK) Study. The TK Study is ongoing.

2. Outstanding Issues

2.1. NSMA members' Traditional Knowledge

The NSMA entered into a Contribution Agreement with the GNWT-DOI in June 2017 to conduct the TK Study on TASR. The NSMA is still in the process of conducting the TK Study. We anticipate that the final report will be ready in early 2018.

NSMA believes that the result of the TK Study would have benefited both NSMA and the Developer in furthering the understanding of potential project impacts on the environment and NSMA members. In that sense, it is unfortunate that the study will not be finalized before the Public Hearing.

Having that in mind, given the perpetual nature of the proposed Project, and ongoing dialogue between the GNWT and NSMA respecting NSMA members' s.35 Aboriginal rights, it is our view that the TK Study should, once completed, inform any future conversation related to the Project and other related matters.

Recommendations:

The Developer should, once completed, accept the NSMA TK Study, and consider it in future regulatory discussions and decisions (e.g. WMMP and LUP).

[1] See: *Enge v. Mandeville*, 2013 NWTSC 33, paras 230 and 236

2.2. Continued Consultation with NSMA

In the Draft Wildlife Monitoring and Mitigation Plan (WMMP) (September 2017), the Developer makes a number of commitments to ongoing work with the Tlicho Government (e.g. 5.2.3. p.38&39, 6.2.2. p.49). As previously stated, the NSMA represents our members who assert s.35 Aboriginal rights in the project area. In that respect, we request that NSMA should also be included in the ongoing monitoring and management of wildlife in the project area.

Specifically, in 5.2.3 (p.38) of the WMMP the GNWT commits to working with Tlicho TK holders and reflecting their findings in the next version of WMMP. As we commented above, NSMA requests the same considerations be given to NSMA's TK Study results, once completed.

In the same section, on page thirty-nine, the GNWT commits to distributing the boreal caribou collar monitoring results to co-management partners. NSMA is a frequent participant in wildlife co-management forums in the NWT, and on that basis, as well as based on our members' asserted Aboriginal rights, we request that the NSMA be specifically included as a co-management partner who receives collar monitoring results and data.

Lastly, on page forty-nine of the WMMP, the GNWT commits to initiating discussions with "TG, WRRB and other relevant Aboriginal government organizations", should there be evidence or concerns about unsustainable levels of wildlife harvest in the project area. As this may have direct implications on NSMA members' asserted Aboriginal right to harvest caribou, NSMA strongly recommends that the NSMA specifically included in the list of relevant Aboriginal government organizations.

Recommendations:

1. NSMA should be included in the ongoing monitoring and management of wildlife in the project area.
2. NSMA should be included as a co-management partner who receives boreal caribou collar monitoring result and data.
3. NSMA should be included in the list of relevant Aboriginal government organizations (WMMP p.49).

2.3. Technical Comments on WMMP

The NSMA contracted Zoetica Environmental Consulting Services (Zoetica) to review and comment on the technical aspects of the WMMP. Zoetica's comments are attached to form a part of NSMA's submission, and attached as "Appendix A".

Appendix A

Technical Review

TECHNICAL REVIEW OF THE TŁI CHǪ ALL SEASON ROAD PROJECT

SUBMITTED TO

Shin Shiga
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1.0 EXECUTIVE SUMMARY

The Tłįchǫ All- Season Road (TASR) is a proposed road that will connect Highway 3 to Whati. The potential effects of this project on the regional sustainability of ungulates (e.g., caribou, moose) and bovids (wood bison) are of interest to the North Slave Métis Alliance (NSMA). The NSMA seeks to ensure that the environmental assessment for this project has objectively considered all likely effect pathways, while ensuring optimal mitigation and monitoring plans are implemented. The NSMA retained Zoetica Environmental Consulting Services (Zoetica) to conduct a technical review of the Developer's Adequacy Statement Response (DASR; April 2017), and associated mitigation and monitoring plans for the proposed TASR; these included Version 1 of the draft Wildlife Mitigation and Management Plan (V.1 WMMP, March 2016), Version 1 of the draft Conceptual Wildlife Effects Management Plan (V.1 WEMP, July 2017), and Version 2 of these plans, which were consolidated into one document (V.2 WMMP, September 2017). The scope of our review focused on potential impacts of the TASR on boreal caribou, barren-ground caribou, wood bison, and moose. All numbers included in this executive summary refer to sections within this technical review, where additional detail can be found.

Our review revealed that the DASR has some deficiencies requiring further consideration to ensure that all potential impacts have been fully considered. We also disagree with some of the methods used, and conclusions arrived at within the DASR. For instance, we question whether the NT1 range was an adequate area for assessing regional impacts to boreal caribou. This is because the use of a regional study area that is disproportionately large compared to the project will render the prediction of significant impacts impossible (Section 3.3). On the other hand, if a smaller regional area was selected, which may be more relevant to hunters, or for considering impacts to gene flow and population rescue effects, significant effects may be predicted. Further, we suggest that the residual impacts of the road on boreal caribou or wood bison that will occur *via* indirect pathways, caused by interactions between apparent competition and predator road use, may be underestimated in the effects assessment (Sections 3.3 and 4.0).

We also found that several mitigation plans could benefit from refinement. Project impacts could be further reduced by compensating for habitat loss and increased predator access to prey via functional restoration of habitat along existing corridors (Section 4.3). Mitigation plans relying on sensitive seasons could be improved by including the rut and post-calving periods for caribou, and by extending the sensitive season for wood bison (Section 6.0). We also recommend further discussion about optimizing access and harvest monitoring plan to ensure that sufficient effort will be applied to preventing harvest impacts (Section 3.0) to Species at Risk (SAR). We note that select mitigation plans could be strengthened in a variety of ways (Sections 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0), or that clarity of mitigation could be improved (e.g., Section 11.0). We also recommend that additional wildlife habitat features, beyond dens and nests, be included during pre-constructive surveys and setback planning (Section 17.0, 19.0). Several mitigation items were removed between V.1 and V.2 that render the WMMP less protective (Sections 5.0, 8.0, 9.0, 10.0, 15.0) which we discuss.

In terms of monitoring plans, we found that some aspects of these plans improved greatly between versions, while others need further consideration. For example, the traffic monitoring plans have improved, and we agree with the traffic threshold of 200 vehicles during the sensitive seasons (Section 22). However, we consider additional sensitive periods pertinent for the protection of boreal caribou and wood bison (Section 6.0), and recommend that these traffic thresholds be examined during those periods as well. The monitoring plan for boreal caribou likely requires additional work, as it may not work as intended when operationalized. These plans are highly reliant on caribou collar data for triggering mitigation at a distance. However, collars will represent a small proportion of the population, and boreal caribou are highly solitary for much of the year (Section 18); for instance, collar locations during the calving period may only depict the locations of one or two animals, while most animals are missed. The invasive plant monitoring plan could also be improved by including monitoring 10 years following construction, recognizing slow colonization rates of invasive plant species in the NWT (Section 21). Finally, as spot treatment of sodium chloride may occasionally be used on the road, which can attract ungulates, it will be important to track locations of use and include them alongside wildlife incidents within annual monitoring reports (Section 25.4).

We acknowledge the work done to date by the GNWT as well as Golder. We hope that the feedback found within this report serves to present our outstanding concerns, and ultimately to aid in the improvement of the final DASR effects assessment, as well as mitigation and monitoring plans to ensure appropriate wildlife protections.

2.0 ACKNOWLEDGEMENTS

This report was written and researched by Heather Bears (MSc, PhD, R.P. Bio), Megan Rogers (BSc, Cert. Env. Lit, B.I.T), and Celia Chui (BSc, MSc). Shin Shiga provided valuable information and feedback that was important in determining key issues for the NSMA.

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Concerns and Recommendations Related to The Effects Assessment

3.0 DIRECT AND INDIRECT EFFECTS ON BOREAL CARIBOU

The NSMA expressed concern during the technical meeting that the proposed TASR could have numerous direct and indirect effects on boreal caribou that could be underestimated. Further, they noted that the lack of data within the region for this species renders it difficult to be confident in the magnitude and reversibility of impacts. Here, we summarize our concerns about potential direct and indirect effects of on boreal caribou. We also comment on the answers provided by the GNWT in response to questions posed by the NSMA related to these topics, and provide recommendations to help better consider, enumerate, and mitigate potential effects resulting from these pathways.

3.1 Increased Hunting Access

The TASR will allow easier access to boreal caribou by hunters. Within questions submitted (Topic 1, q. 3-4), and at the technical hearing, the NSMA requested more information about monitoring program(s) and enforcement of hunting restrictions for the project's operational phase. In the answer provided by the GNWT, they refer to the draft WEMP which outlines the GNWT's proposed approach for Access and Harvest Monitoring. As the WEMP was later combined with V.2 of the WMMP, we also reviewed Section 5.2.2 of this document., which contained the latest iteration of the plan. Of relevance to caribou harvest, this plan includes: i) creating a new ENR Officer position in Whatì, ii) increasing patrols along the TASR, year-round, iii) increasing length of winter monitoring and move the checkpoint station south of Whatì, iv) expanding Whatì community-based monitoring, v) increasing aerial surveys (GNWT INF and ENR, 2017). While these monitoring efforts are generally thorough, the patrolling that will be needed to eliminate this effect may not be financially or logistically feasible. Increased harvesting activities due to the Project may have irreparable impacts to boreal caribou[1] in the NWT.

Within the NWT Boreal Caribou Recovery Strategy, objective #2 is to: "*ensure that harvest of boreal caribou is sustainable*" by: 1) obtaining accurate and reliable harvest data, and 2) managing sustainable harvest levels *via* community outreach and regulations (CMA, 2017). Management of boreal caribou in the NWT is currently based on the idea that Aboriginal people and resident hunters harvest boreal caribou opportunistically, with annual harvest numbers between 80-200 (1-3% of the population, roughly estimated at 6000-7000 animals) (CMA, 2017). However, significant concerns about harvest underestimation for boreal caribou have been raised by community members and biologists. Within Tłı̨chǫ lands, harvested caribou[2] were identified as animals from the Bluenose-East and Bathurst herds based on the distribution of radio-collared females (Croft and Rabesca, 2009). However, barren-ground caribou winter ranges

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[1] We have similar concerns about the impacts of hunting on wood bison because they are listed as Threatened, the Mackenzie subpopulation is already in decline, and there is virtually no probability of dispersal from elsewhere to re-populate this population (NWT Species at Risk Committee, 2016).

[2] There was an increasing trend in harvesting activities from the 2007/2008 to the 2008/2009 winter seasons (from 1,690 to 2,712 animals) (Croft and Rabesca, 2009). Reported harvest of barren-ground caribou increased from 1,451 to 1,658 animals from the 2011/2012 to the 2012/2013 seasons, but remained about the same during the 2013/2014 season (BGTWG, 2015).

overlap with boreal caribou north of the Project Area (where no collars have been deployed for boreal caribou), so it is possible that some of these harvested animals are boreal caribou. We note that hunting restrictions to manage the Bathurst herd that were implemented in 2010 may have led to increased hunting pressure on boreal caribou; however, harvest data for the period before and after restrictions are not available for analysis.

Evaluating the potential impacts of access and harvesting on a population requires accurate population estimates, for which there are little for boreal caribou in this region. There are limited data on boreal caribou population trends in the NWT; however, traditional knowledge suggests that caribou may be declining in Wek'èezhìı and the North Slave region (CMA, 2017). While the cause(s) of these declines are uncertain, increased hunting access due to the TASR would contribute to higher mortality rates. Studies have shown that ungulate species, including caribou, are more vulnerable to hunting in areas of high visibility and accessibility, such as roads (Plante *et al.*, 2017; Lebel *et al.*, 2012; Proffitt *et al.*, 2013). Tłıchǫ harvest maps showed that hunting activities were concentrated around Lac la Martre/Whatì, Gamètì, and Wekweètì (Croft and Rabesca, 2009), presumably in areas that were more accessible. Construction of an all-season road would further increase access to boreal caribou.

3.2 Recommendations

The Access and Harvest Monitoring methodology proposed in the draft WEMP is generally supported by the NSMA. The amount of patrolling, which is not stated within the WEMP, will be vital to the success of this plan. We request the following to ensure that the plan is as effective:

1. Rather than move the harvest check station, which may render a "blind spot" for harvest north of Whati (potentially moreso for barren-ground caribou herds), add a second check station
2. We recommend working with interested and knowledgeable stakeholders to help further guide effective monitoring and patrolling methods for access and harvest along the TASR. Incredible care will be needed to ensure that access and harvesting do not significantly impact boreal caribou in the NWT.

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3.3 Apparent Competition Between Caribou and Other Ungulates

Within their written questions submitted prior to the technical meeting, the NSMA requested information about moose and wolf densities in the Project Area and the rationale behind not assessing or proposing mitigation for the potential impact of increasing moose densities (and associated increase in wolf densities) on caribou populations (Topic 35, q. 1 and 2). This request was made because of studies that have demonstrated the phenomenon of apparent competition between boreal caribou and other ungulates. Apparent competition occurs when two species, one rare and one more common, are eaten by the same predator. If the common species is abundant, or grows in abundance, the rare species can become locally extirpated because predator numbers are “propped up” by these other more common species. This process is called "apparent competition" because, superficially, it appears that the more common and rare prey species directly compete for habitat. In reality, it is the shared predator that links the dynamics of the prey species.

Studies on predator-prey dynamics have revealed that caribou experience apparent competition with moose (James *et al.*, 2004; Courbin *et al.*, 2014) and white-tailed deer (Latham *et al.*, 2011a), which favour early seral stage vegetation in disturbed habitats. Due to recent fires, a high percentage of the area overlapping and surrounding the road is comprised of early seral stage habitat, which could increase apparent competition. Recently, some authors have demonstrated that experimental moose reductions can lower wolf densities and stop the declines of endangered caribou (Serrouya *et al.,* 2017), which adds strength to the magnitude of the impact that apparent competition can have on caribou. In addition to the “base case” for this project, which includes apparent competition, is the impact of increased predation risk to boreal caribou along linear features, as these provide ease of travel and hunting access for wolves (Latham *et al.*, 2011b; Ehlers *et al.*, 2014; Dickie *et al.*, 2017) and other predators. The multiplicative effect of both the increasing apparently competition in the base case and the predator phenomenon as part of the application case, could result in moderate to high magnitude impacts experienced by boreal caribou.

The GNWT, in answering questions posed by the NSMA on this topic, indicated that they recognize that moose abundance may increase in areas of regenerating vegetation that have been affected by recent burns. Approximately 60% (2,725 ha) of the Project footprint has already been disturbed by fire (DASR, page 4-170), and 41% (1,117 ha) of this area contains burns that are older than 5 years (DASR, page 4-170), which moose preferentially occupy for browsing (Maier *et al.*, 2005). The GNWT argued that apparent competition effects due to the large abundance of recently burned, preferred habitat for other ungulate prey species are unrelated to the project, which we agree with. However, these baseline conditions are emphasized because they may affect the resiliency of boreal caribou in the region and lead to a stronger interaction with the road. If boreal caribou have a low resilience due to existing increases in apparent competition, propping up predator numbers, they may be less able to cope with additional predation pressure that may result from the construction and maintenance of a year-round linear corridor, which will facilitate predator travel and hunting efficiency (Topic 39, q. 1). This may, in turn increase the magnitude of effects to caribou beyond base case conditions. The GNWT, in their written responses to the NSMA's questions in Topic 39, suggested that an increase in predators could be balanced by the increase in traffic volumes and possibly harvesting on the route. However, we provide a detailed review in Section 4.0 on this topic, suggesting that road attraction will likely outweigh deterrence.

Within Section 4.2.3.1 of the DASR, the GNWT suggests that, even with a potential increase in moose abundance due to the Project, moose densities in the North Slave region (0.02-0.04 moose/km^2; Cluff, 2005) are too low to support a significant increase in wolf numbers. Wolf density estimates in the NWT are extremely limited; however, a recent study in the Hay River Lowlands reported 1.6 wolves/1000 km^2 (Serrouya *et al.*, 2016). Within the DASR, the GNWT also cites a study by Bergerud and Elliot (1986), conducted in the late 1970s to early 1980s, in northwestern BC. These authors found that densities of 0.11 moose/km^2 would be needed to support wolf densities (6.5 wolves/1,000 km^2) that could destabilize that particular caribou population. However, these population dynamics derived from northern BC, 25-47 years, ago may not be applicable to the NWT at present. This is especially true because apparent competition effects depend strongly on the triad of densities of each of: caribou, more common prey species that support wolves (such as moose, bison, and potentially mule deer as they expand their range northward), and wolves. This density triad will likely differ between BC and the NWT, and between time periods considered. There are not accurate estimates of boreal caribou densities within the NT1 range of the NWT or a smaller, more relevant area. However, if boreal caribou are less dense within the NWT than within Bergerud and Elliot's (1986) study area in BC (during the 1970s and 1980s), the risk of apparent competition destabilizing boreal caribou in the NWT remains. Existing information, though limited, already suggests that the triad of densities for key players in apparent competition with boreal caribou are much different in the NWT compared to those measured by Bergerud and Elliot (1986).

Accurate information is extremely limited about boreal caribou, ungulate prey species involved in apparent competition, and wolf and other predator densities (e.g., black bear) within the TASR study area. The population of boreal caribou in the NWT is roughly estimated at 6000-7000 animals based on local and scientific knowledge, and extrapolations from caribou densities within study areas of various sizes (SARC, 2012). Traditional knowledge suggests that most boreal caribou inhabit the southern areas of the NWT and NT1 range, where greater declines (e.g., in Wek'èezhìı and the North Slave region) are occurring (CMA, 2017). Boreal caribou densities within the NWT are estimated to be low (0.013 caribou/km^2), with 500-1000 the North Slave region (SARC, 2012). Within Bergerud and Elliot's (1986) study, they note that there could have been 5,000 caribou within 15, 000 km^2 of the Spatsizi-Lawyers range in the late 1960's to 1970's (0.33/km^2), and an average of 0.11 caribou/km^2 were measured in that area from 1977 to 1984 during the time of their study (Table 3; Bergerud and Elliot, 1986). These densities from northwest BC are orders of magnitude greater than cursory estimates for boreal caribou within the NWT, meaning that a much lower density of moose and wolves would be required to destabilize caribou in NWT compared to in BC. The GWT's attempts to extrapolate moose and wolf densities needed to cause caribou population destabilizations from Bergerud and Elliot's (1986) BC system to the context of the NWT is not advised.

Finally, it requires acknowledgement that, despite our disagreement with the GNWT about the potential magnitude that the project may have on boreal caribou *via* the interaction between the linear corridor, fire/vegetation dynamics, and apparent competition, we agree with the GNWT, in their answer to the NSMA's q. 1, Topic 35, that it is "*unlikely that a local increase in moose and wolf densities will destabilize boreal caribou at the scale of the NT1 range".* This is primarily true because the Project Area occupies such a small proportion of the extremely large NT1 range. In this vein, we feel that scaling the regional study area to the NT1 range is inappropriate. Regional effects, no matter how large, cannot be predicted when the regional study area represents an excessively large spatial area. Removal of entire National or Provincial parks would not have conceivably significant effects for many species if assessed at the provincial, territorial, or Canada-wide spatial scale; yet we can recognize that such an activity would have very tangible regional impacts. We do believe that, with the selection of a more reasonable regional assessment area (e.g., watershed boundaries) that better represents a regional landscape unit (e.g., watershed boundary) the TASR could potentially have a significant impact on boreal caribou *via* the aforementioned pathway.

3.4 Recommendations

We request the following, based on our review:

1. Revise the spatial scale of the regional study area to a smaller and more relevant area for boreal caribou, rather than examining potential effects relative to the entire NT1 range. One suggested unit for consideration is the watershed scale.
2. Provide a more fulsome consideration of the baseline resiliency of local boreal caribou populations, and their current and future apparent competition with moose and other prey (wood bison), in an update to the effects assessment. Using updated baseline information, and considering information presented in Section 3.0, make new inferences

about the magnitude of changes in predator-prey relationships due to direct or indirect effects of the road on apparent competition.

3. Due to uncertainty, collect ongoing data on boreal caribou in the regional study area and Project Area, to improve knowledge of population size, distribution, and trends. Include monitoring for the project's effect on other prey species that could interact via apparent competition (e.g., wood bison), and wolf densities in relation to caribou survival and reproduction. We note that the updated V.2 of the WMMP (September 2017) already includes helicopter-based monitoring for moose populations. The balance of such numbers may be crucial in determining adaptive management programs to aid in boreal caribou recovery and to prevent declines.
4. Include adaptive management and mitigation measures in the WMMP, should monitoring results indicate negative effects on the boreal caribou population.

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4.0 ROAD EFFECTS ON PREDATOR DETERRENCE

The NSMA remains concerned that, within the DASR (and resulting mitigation plans) the GNWT has not paid sufficient attention to the ways in which the project will facilitate increased hunting and hunting efficiencies of wolves, which will interact with apparent competition to affect survival and reproduction of prey species such as caribou. In questions submitted prior to the technical meeting, the NSMA asked if such effects were expected, and what mitigation had been considered for those effects (q.1, Topic 39). The GNWT's response acknowledged that increased predation could result in measurable, minor environmental changes relative to existing conditions, but that they would have a negligible residual effect on the population. To help justify this rationale, they also suggest that the potential of an increase in predator numbers due to the road acting as a travel corridor, would be balanced by the increase in traffic volumes and possibly harvesting along the route (acting to deter predators). Yet, they did not provide weight of evidence for this opinion. Hence, there is no mitigation proposed, aside from route selection. To determine how the road will likely affect predators, and hence their prey, we conducted a literature review on the impacts of roads on predator-prey relationships.

Predator Attraction to Roads

One important consequence of roads is that they impact roadside vegetation, which can attract predators and increased predation on boreal caribou (especially calves). Dussault *et al.* (2012) found that high road densities increased the mortality risk for caribou calves in Quebec. The majority of depredated caribou in this study were due to black bear, which used roadside habitat that offered a relatively high biomass of appropriate vegetation. These authors did not indicate that bears would be deterred by traffic, but rather would prefer these areas due to their adjacent, attractive vegetation used as food. In this study, less than 50 per cent of the caribou calves survived more than two months. Increasing the road density in the Tlicho project area will therefore likely increase mortality risk for caribou calves with resulting fitness consequences. The added change of an all-weather road, would allow this vegetation to be maintained year-round and the effect would also become long term and irreversible, which is distinct from a winter road which has the potential of being decommissioned and restored.

Bastille-Rousseau *et al.* (2011) also conducted a study of black bear predation on caribou calves in Quebec. In this study, black bears showed a stronger preference for high quality vegetation over searching for calves as prey, even though bears represent the largest cause of mortality for young ungulates. Bears in this study tended to use roadsides, as such areas were the best source of preferred early seral stage vegetation (forbs, graminoids, and new tree leaves). Then, *via* frequent movements between habitat patches, black bears encounter and opportunistically feed on ungulate calves. As a result, these authors suggested a management approach to conserve caribou, which included the protection of large uncut blocks of conifer forest, while ensuring that vegetation-rich feeding areas for black bears (e.g. roadsides) are present in different parts of the landscape (Bastille-Rousseau *et al.,* 2011).

The second well-documented impact that of roads can have on predator-prey dynamics, is the ability of predators to use roads as travel corridors and increase adult ungulate mortality through predation. Leblond *et al.* (2013) studied this impact by focusing on caribou in Quebec, where all confirmed predation events were caused by wolves. Leblond *et al.* (2013) found that in areas of low total road density, the probability of boreal caribou dying increased with increasing active road density. In areas of high total road density, the effects were reversed, *i.e.*, the probability of caribou dying decreased with increasing active road density. Active roads were defined as those that are 35–90 m wide including right-of-ways, maintained in winter, with a road life expectancy of over 10 years. The Tlicho project area has very low road density relative to these studies; therefore, increasing active road density would likely increase the probability of caribou mortality. In terms of the significance of this effect, Leblond *et al.* (2013) found that "*an increase of 0.25 km/km^2 (i.e., the equivalent of a 1-unit increase in standardized density) of active roads in the annual home range of a caribou would increase its risk of dying by 88%*". The DASR should present such information and determine the risk caused by this issue, given the existing road density, and typical home range size. The conclusion that there would be little change from the previous winter road is also not supported by Leblond *et al.* (2013) as they found that derelict roads had the opposite effect of a larger, active road; in areas with low total road density, increasing derelict roads decreased the risk of caribou predation.

James and Stuart-Smith (2000) found that in northern Alberta, woodland caribou were typically further from linear corridors, wolves were closer to linear corridors than random, and caribou mortalities attributed to wolf predation occurred closer to linear corridors compared to live telemetry locations from each caribou. This indicates that caribou that are close to linear corridors are at a higher risk of predation. Thus, the authors recommend that the "development of new corridors within caribou habitat should be minimized and existing corridors should be made unsuitable as travel routes to reduce the impacts […] on caribou populations" (James and Stuart-Smith, 2000). This study also makes an important point that in areas with many roads, wolves are less abundant (Thiel, 1985; Jensen *et al*., 1986; Mech *et al*., 1988; Fuller, 1989; Fuller *et al*., 1992), but in areas with little human use, roads and other corridors are attractive to wolves (Horejsi, 1979; Edmonds and Bloomfield, 1984; Eccles and Duncan, 1986; Thurber *et a*l., 1994). Given that there is relatively low human use of the project area, and there are few roads, it is quite likely that predators would also be attracted to this road as a travel corridor.

The effect of predators using roads to increase predation has also been shown to affect other prey species such as moose. For example, Gurarie *et al.* (2011) found that wolves in Finland preferred to use forest roads (gravel roads) as these open corridors offered minimal traffic disturbance where prey were almost entirely moose and caribou. Similarly, Erikson *et al.* (2009) determined that wolves showed a preference for travelling on gravel forest roads, which may be a convenient and efficient strategy to patrol their large territories to locate areas with moose.

Predator avoidance of roads

Predator avoidance of roads, and a potential protective effect associated with human infrastructure, as mentioned in the GNWT's response to Topic 39, most likely occurs only in areas with high total road density at the landscape level. This was demonstrated by Leblond *et al.* (2013) that in areas with high total road density, probability of caribou dying by wolf predation decreased with increasing active roads. This is likely because the areas were too developed and so wolves avoided using roads, to avoid humans, creating a shielding effect for prey species.

The Muhly *et al.* (2011) study, referenced in GNWT's response to Topic 39, also highlights this "avoidance of humans" effect phenomenon. However, this is only one potential outcome of such interactions between humans and predator-prey relationships. In this case, predators were shown to be less abundant on roads and trails where people were observed while prey displayed more spatial overlap with people. However, this study was in southern Alberta, so it could be that the higher level of human development and high road density at this location contributes to this relationship. The Leblond *et al.* (2013) study was conducted in a boreal habitat more similar to the Tlicho road project, and showed that different, sometimes opposite relationships appear in areas of high and low road densities. It could be that both relationships are possible, but the detrimental impact of predators at low overall road densities is a more likely outcome for the Tlicho AWR area (boreal forest with low road densities). Muhly *et al.* (2011) also included different species of less relevance (*e.g.* cattle) and only focused on the summer period over 4 years, while Leblond *et al*. (2013), focused on wolves and caribou and used data collected over 10 years. Muhly *et al.* (2011) also acknowledged that "*relative density and distribution of each species may potentially change during the winter*", as "*predators may favour roads and trails during the winter for ease of travel*". Overall the Muhly *et al.* (2011) study illustrates that predators avoid humans in some situations; however, we do not expect a similar pattern in our study area, which is relatively less developed and has low road densities.

Some studies have shown thresholds at which vehicle traffic rates affect predators and cause road avoidance (e.g., Northrup *et al.* 2012, 20-100 vehicles per day causing avoidance). However, those studies tended to focus on grizzly bears and brown bears, which seem particularly wary of roads and traffic and which are expected rarely or not at all within the study area. These relationships may also differ in the project area as the Northrup *et al*. (2012) study occurred in a more southern environment that had road densities of 0.73 km/km^2 overall, which differs in context from the TASR project area in NWT.

A study by Berger (2007), also documented the behaviour of moose during calving, along with brown bears, in proximity to roads in Grand Teton National Park (GTNP) (in the Yellowstone Ecosystem). Moose cows in this study selected birth sites closer to roads compared to non-mothers and compared to mothers in areas absent of brown bears (Berger, 2007). This suggests that moose were using human infrastructure to buffer against predation risk (Berger, 2007). The important distinction to be made about this study is that these carnivores were absent from the park for 60 years, in contrast to Alaska and other northern environments where they have been continually present (Berger, 2007). Hunting is also not permitted in National Parks, which may explain some of the protection received from calving or spending post-calving periods near roads. Other studies have shown that in these northern locations moose do not tend to give birth near roads and grizzly bears do not avoid roads (Berger, 2007), meaning that the effect was context specific. This highlights the fact that the effect of roads on the predator-prey relationship is situationally dependent.

It is important to emphasize that the aforementioned studies were included in our review for the sake of objectivity, as they do act as examples of where roads can deter predators. However, it became clear during our review that there are a paucity of examples and studies whereby relevant predator species avoid roads at traffic rates (and landscapes) comparable to the Tlicho AWR project area. When considering road densities, habitat, and the main prey species of relevance, the weight of evidence supports the hypothesis that predators would use the TASR for hunting. For the main predators that are present within the Tlicho road area, there were more examples, in stronger studies, wherein roads acted more as an attractive corridor, rather than a deterring feature.

Effect of Hunting on Predators

The relationship between roads, predators, and prey is also complicated by hunting. Kunkel and Pletsher (2000) found that wolf kill sites for moose were characterized by lower road densities. However, Kunkel also observed that "*wolves certainly used roads, probably owing to the ease of travel and because roads likely increased their hunting efficiency*". They suggest that this contradiction is due to the risk of mortality resulting from the human presence, because snowmobilers used the primary roads extensively throughout the winter, and hunting was the primary source of mortality for wolves in this area. Moose were, however, more vulnerable to wolves at sites closer to trails and streams. These non-road linear corridors provided an increase in hunting efficiency for moose, similar to roads, but they were safer (as snowmobilers used them less often). This suggests that wolves use roads when possible, but it depends on their previous experience. In NWT and Nunavut, hunting and trapping of wolves is estimated at 200 wolves per year, which accounts for approximately 2% of the estimated 10,000 wolf population. If hunting from the road itself is minimal or prohibited, or if wolves are rarely targeted, then the effects on prey via wolves (that hunt more efficiently along roads) is likely.

4.1 Conclusions

In conclusion, the relationship between ungulates, prey, and roads is complex. Predictions regarding whether predators will use roads for hunting their prey appear to be mediated by several factors including: overall level of development in the area, total road density, the predator species' tolerance for traffic, and the predators' prior experience with human hunting. Local effects on populations of ungulates may occur, should growing numbers of wolves (supported via apparently competition, Section 3.3) hunt more efficiently along roads. More often than not, adult and calf survival is strongly affected by predators when road densities increase in low road density areas (Dussault *et al.,* 2012; Leblond *et al.,* 2013) and predation, primarily by wolves, is recognised as the main factor limiting boreal caribou populations (DASR). Overall, whether higher predation impacts are experienced by boreal caribou (as well as moose, bison, and barren ground caribou), will depend largely on whether the predation benefits outweigh the predator mortality risks due to hunting.

While our review mainly focused primarily on studies of boreal caribou (supplemented with some studies on moose), the impact of the roads on predators would likely also affect barren-ground caribou (if they enter the project area). There would also likely be an effect on wood bison, although no relevant studies on the three-way interaction between bison, predators, and humans hunting predators were found during our review. Wood Bison are known to travel long distances and frequently use established trails between favoured places, even congregating along roads and becoming traffic hazards in some areas (NWT Species at Risk Committee, 2016). Hence, this species may be particularly susceptible to roads that bring them into greater contact with hunting predators.

4.2 Recommendations

Based on our review, we recommend that additional attention be paid to this issue and that further information be presented in the DASR (results, residual effects, mitigation). More specifically, we would like to see the following additions made to the effects assessment within the DASR:

1. Provided a careful weighing of this information within the DASR, along with a strong illustration of the uncertainty associated with this predation pathway (alongside apparent competition, discussed in Section 3.3).
2. It should also be possible to estimate the extent of the effect given information presented in, for example, Leblond *et al.*, 2013.
3. As noted in Section 3.0, reduce the regional study area for boreal caribou to arrive at more realistic regional impact predictions.
4. As needed, present additional monitoring and adaptive management triggers that could be introduced in response to the interaction with the road as a travel corridor for wolves and black bears, and predation related mortality increases to boreal caribou, barren-ground caribou, or wood bison.

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4.3 Habitat Loss

In their written submission prior to the technical hearing, the NSMA had requested more information about project impacts on undeveloped boreal caribou habitat (Topic 27, q 2). The answer provided by the GNWT refer to the DASR, Section 4.4.2.1, which presents their predicted direct and indirect loss estimates of suitable, undisturbed boreal caribou habitat, due to the project. The TASR was assessed to have negligible effects at the scale of the NT1 range, thus maintaining 66.8% undisturbed habitat at the time of analysis. The GNWT concluded that the boreal caribou population will be self-sustaining and ecologically effective because the amount of undisturbed habitat, at the NT1 scale, will be above the 65% threshold outlined by the Federal Boreal Caribou Recovery Strategy (EC, 2012).

The NSMA questioned the numbers presented in the DASR for undisturbed habitat remaining in the NT1 range, and calculated that approximately 613,300 ha of undisturbed habitat, above the 65% threshold, would remain if the TASR and reasonably foreseeable developments proceed (Topic 33, q. 1). The answer provided by the GNWT to Topic 33, q. 1 indicates that forest fires are the primary determinant of the amount of undisturbed habitat; they argued that the timing, location, and size of future forest fires cannot be predicted with certainty. The GNWT also indicated that they would not consider habitat compensation for the NT1 range because fire effects are unrelated to the Project (Topic 33, q. 2).

However, the NWT wildland fire statistics show that 252 fires have been reported during the 2017 fire season (May 1 – Sep 21). Sixty-six of these fires are still burning, and a total of 1,029,000 ha of forested land have been affected (ENR, 2017). In the North Slave region, 102,614 ha have been affected by forest fires during the 2017 fire season (ENR, 2017). While not all of those fires will have occurred in the boreal caribou NT1 range, these numbers represent the reality of forest fires in the NWT, which is expected to worsen with climate change (Flannigan *et al.*, 2005; Wotton *et al.*, 2010; Abatzoglou and Williams, 2016). For example, Wotton *et al.* (2010) projected that, in comparison to baseline data from 1980-1999, annual forest fire occurrence rates in the NWT will increase by 30-43% by the end of the 21st century.

4.4 Recommendations

We recommend that the GNWT re-calculate and re-assess the amount of continuous boreal caribou habitat within the NT1 range, prior to TASR construction. Further, we recommend that mitigation or habitat compensation measures be clearly articulated, if the updated "base case" of undisturbed habitat is found to be below the 65% threshold required for a self-sustaining boreal caribou population (or slightly above it, whereby the project could drop it below the threshold). In such a scenario, the GNWT should commit to compensating for habitat loss due to the Project. If the regional study area is modified to a smaller area, as per the NSMA's suggestion (Section 3.3), the same exercise should be done within the reduced regional study area.

The NSMA also requested that the GNWT consider habitat compensation in the Wek'èezhìı portion of the NT1 range to offset Project impacts (Topic 34, q.1), as the amount of undisturbed habitat in this region is estimated at 55% (CMA, 2017), well below the 65% threshold. The answer provided by the GNWT indicates that they would consider feasible options, depending on the Tłįchǫ Government. We recommend that the GNWT continue discussions with the Tłįchǫ Government, NSMA, interested stakeholders, managers, and communities to develop a suitable habitat compensation plan, which ideally restores functional habitat along of existing linear corridors to offset habitat loss and predation impacts of the proposed road project for boreal caribou.

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Concerns and Recommendations for Mitigation and Management

5.0 WILDLIFE GROUP SIZES FOR INFORMING MITIGATION

In written questions submitted prior to the technical meeting (Topic 20, q. 1; Topic 24, q. 1), the NSMA requested information from the GNWT about the scientific rationale for deciding that work stoppage mitigation should be applied to groups of 10 or more caribou or bison, which was included in V. 1 of the WMMP. The answer provided by the GNWT indicated that this number was not informed by data, but that the GNWT planned to rely on monitoring and adaptive management to refine the group size. After reviewing V.2 of the WMMP, it appears that the concept of group size triggering work stoppage was eliminated, and that the decision to modify work now relies on the distance of animals from activities during sensitive seasons. However, we still provide a review of group sizes for caribou, moose and bison in sections below, as there is utility in understanding seasonal patterns of density and clustering of species for the design of mitigation and monitoring plans (Section 6.0, 11.0), and in case the concept of group size is reintroduced in subsequent iterations of the WMMP. In the absence of data on group sizes for ungulate and bovid species of interest, we performed a literature review from other systems to derive an educated prediction for appropriate group size changes among seasons.

5.1.1 **Boreal Caribou**

NWT: Boreal caribou group sizes vary depending on season. The smallest groups tend to occur during calving and summer periods, while the largest groups occur during the rut and post-rut periods (late fall and winter) (MOE, 2010). In the NWT, most of the existing information on boreal caribou group sizes have been collected from traditional knowledge in the Dehcho and Gwich'in study areas (SARC, 2012). In these regions, boreal caribou are most commonly observed in groups of 2-3 animals. Groups of 5-8 boreal caribou are also not uncommon in the fall/rut period. Larger groups of greater than 10 animals (typically 10-20, and up to 40) are occasionally observed in late winter (March to April), but we do not know how common such occurrences are.

British Columbia: Data from northeastern BC also support the idea that boreal caribou are typically found in groups of fewer than 10 animals. During calving and summer periods, females are typically documented alone or with a calf (Culling *et al.*, 2006). In late winter, the mean group size is 7 animals (ranging from 1-27), based on data from 107 groups (Culling and Culling, 2014). Similar group sizes have been documented in the fall rut period (Culling *et al.*, 2006). Although these studies were conducted in BC, the boreal caribou range in the southern NWT is continuous with northern BC and Alberta, and populations are known to interact (SARC, 2012). Mountain woodland caribou follow a similar pattern. Bergerud and Page (1987), found a mean group size of 2.4 (excluding calves), and the distribution of group sizes (excluding calves) that they recorded, was: 60% 1 adult, 17% 2 adults, 4% 3 adults, 4% 4 adults, 5% 5 adults, 10% >5 adults (where there was at least one calf present).

Ontario: Berger (1985) studied group sizes in a woodland (boreal) caribou near Lake Superior, Ontario. The mean group size determined from this study was 2.9 +/- 0.16 in winter, and 1.5 +/-

0.13 in summer (including calves). The most frequent group size was two, usually a cow with a calf, while the largest was 12.

5.1.2 **Barren-ground Caribou**

The seasonal variation in barren-ground caribou group sizes tends to be the opposite to that of boreal caribou. Barren-ground caribou typically disperse into groups of 15-100 animals during the winter. In addition, wolf predation may cause barren-ground caribou to disperse further, into groups of 30-50 individuals (SARC, 2017). A winter survey of Bathurst caribou found that most groups consisted of 1-23 individuals, with a mean group size of 33 (Mattson *et al.*, 2009). We emphasize that seasonal group sizes move in opposite directs for barren-ground and boreal caribou; barren-ground caribou form large herds during the calving and post-calving periods (strength in numbers), while boreal caribou become quite solitary and space out (to avoid detection by predators). Groups of barren-ground caribou disperse into relatively smaller groups in the rut and winter, while these are the only times of year when boreal caribou increase their group sizes. Finally, while group sizes of more than 10 are common for barren-ground caribou, these group sizes are rare for boreal caribou.

5.1.3 **Wood Bison**

Wood bison group sizes vary with population size, with smaller groups occurring as populations decline (SARC, 2016). Bison within the Wentzel herd (199 bison in 2015), outside Wood Buffalo National Park, form small family groups of 6-15 individuals (GOA, 2017). The most recent population estimate for the Mackenzie herd, which overlaps with the proposed project, was 714 in 2013 (SARC 2016). Therefore, it is possible that Mackenzie bison are found in larger groups. Seasonally, bison aggregate during the post-calving period (June and July), then disperse into smaller groups during the rut in late summer and fall. Small groups may coalesce in the winter, and groups of up to 100 animals are "occasionally" observed. Cold temperatures and wind may incentivise bison to move into forested areas and disperse into smaller groups.

5.1.4 **Moose**

While moose are not at-risk in the NWT, they are important to harvesters and are susceptible to impacts due to construction and roads (Bartzke *et al.*, 2015, Laurian *et al.*, 2012). Moose are generally found as individuals, or cows with calves (Forsyth, 1985; Miquelle *et al.*, 1992). Despite being recognized as a wildlife VC due to their importance to First Nations hunters and interactions with other species (DASR, Table 4.1-1), no moose-specific mitigation measures (e.g., setback distances, work stoppages) were explicitly articulated in either the DASR or V.1 of the WMMP. During technical hearings, the NSMA requested that setback mitigation be added for moose due to their importance to harvesters (Topic 15, q. 2). The September 2017 (V.2) of the WMMP now includes some mitigation for moose within Section 4.3. More care should generally be exercised around cow:calf pairs, but as moose rarely cluster into groups, and consideration of moose numbers in devising mitigation is less relevant.

5.2 Recommendations

We request that the GNWT do the following for the next iteration of the WMMP:

1. Consider group size information and seasonal changes in group sizes presented herein in the next iteration of the WMMP. For instance, we show in Section 6.0 that the use of collar information to trigger mitigation is not very useful during seasons where boreal caribou are more solitary (such as during calving), but may be more useful during times of year when they are found in larger groups. Having a strong prediction of seasonal clustering patterns is critical for designating effort towards selecting appropriate seasonal monitoring and mitigation plans that protect the most animals.

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6.0 MITIGATION IN SENSITIVE SEASONS (GENERAL)

Prior to the technical meeting, the NSMA submitted questions pertaining to enhanced mitigation during sensitive periods for wildlife (*e.g.*, Topic 13, q. 1, 2; Topic 14, q.1). V.2 of the WMMP now partially addresses this issue in Appendix E for boreal caribou. Pages 98-99 state that "*ENR considers there to be two key periods when boreal caribou should receive additional protection from sensory disturbance*", the two key periods being late winter (16 Mar – 4 Apr) and calving (5 Apr – 6 Jun). The GNWT does not include the sensitive rut period (late Sep – Oct) or the post-calving period, which we suggest are also sensitive periods. Regarding blasting activities during sensitive periods, Table 1 in Appendix E specifies 2 km and 3 km "cautionary zones" during late winter and calving periods, respectively, compared to "*the danger zone of the blast area, as determined by the blast manager*" during summer, fall, and early to mid-winter (7 Jun – 15 Mar). Table 1 in Appendix E also states that: "*If the caribou is calving, suspend blasting until an ENR biologist indicates that calving is complete*."

For boreal caribou and wood bison, both of which are SAR with a high probability of occurring within the project footprint, sensitive seasonal periods related to life-history periods, should be recognized, and mitigation adjusted during these periods. Currently, V.2 of the WMMP recognizes two sensitive periods for boreal caribou: calving (5 Apr to 6 June) and late winter (16 Mar to 4 Apr). For wood bison, the calving period, alone, is recognized as sensitive (15 Apr to 15

Jul). However, the sensitive period for wood bison is defined by AANDC *et al*. (2012) guidelines as occurring from 1 March to 15 July, which is 1.5 months longer than the sensitive period proposed by the GNWT.

While we agree that the life-history periods identified are biologically sensitive, some periods appear to be missing. We disagree with the exclusion of the post-calving and rut periods for caribou due to unique biological considerations that make caribou more susceptible to disturbance effects during these periods. During the post-calving period, females have increased energy demands due to lactation and their need to be hyper-vigilant to keep calves safe from predators; yet being alarmed by disturbances and running more frequently during this period makes calves more susceptible to being seen and caught by predators (discussed further in Section 7.0). The fall rutting period is when boreal caribou form larger mixed-sex groups and reproduce (Thiessen, 2009), and a time when their hormonal and behavioural changes can lead to them reacting more strongly to stressful stimuli (Romero and Butler, 2007). Finally, it is unclear as to why the entire period, from 1 March to 15 April, was not all included as a sensitive season for wood bison.

While most of the mitigation suggested for sensitive periods in Appendix E (Operating Procedure for use of Boreal Caribou Collar Data to Mitigate Impacts from Construction of the TASR) of the WMMP (V.2) seem reasonable, additional changes are requested. For example, Table 1 within Appendix E suggests that mitigation during the calving period for boreal caribou will be triggered mainly based on collar locations, while mitigation during the late winter period will utilize both collar data and ground-based wildlife surveys. This seems conceptually backwards, however. Boreal caribou are quite solitary during the calving period (Section 5.0), and collars will, on average, only show the locations of one or two individuals. This would be similar for the post-calving period. Hence collar data alone, will not be very informative, as a small proportion of the population will be collared. It is during the seasonal period where animals are more solitary that ground-based surveys would be most beneficial. The reliance on collar data may, in fact, be relatively more effective during the rut and winter periods, when boreal caribou are in larger groups (see Section 5.0 for additional discussion on group sizes). It is also during the late winter period when collar locations would represent the most animals, and when ground-based surveys are less effective with dark conditions.

6.1 Recommendations

We request the following be modified within the next version of the WMMP:

1. Alter sensitive periods for boreal caribou to include post-calving and rut periods;
2. Wherever possible, avoid construction during sensitive seasons for boreal caribou and wood bison.
3. Along with the use of collar data, include ground-based wildlife surveys (in Appendix E) prior to vegetation clearing, blasting, and other construction activities during the calving and post-calving periods, and rutting season in the next WMMP. Ground-based surveys should enable visibility to at least the distance of the exclusion area around the planned activity.

4. While both collar and ground-based monitoring should be used during sensitive seasons, we suggest that the GNWT rely more heavily on collar data during the late winter and rut seasons, as collar locations will likely represent the largest and second largest groups of boreal caribou during this season (*i.e*., one collar will demarcate a cluster of individuals; Section 5.0). Inversely, we highly recommend relying more heavily on ground-based monitoring, supplemented with collar data, during the calving, post-calving, and other periods when boreal caribou are far more solitary (and when collars will usually only represent collared individuals or pairs).
5. During sensitive seasons for boreal caribou and wood bison, when safety allows, alter the flight mitigation to include stricter mitigation of aircraft use during sensitive seasons. We recommend that flight altitudes be at least 300 m (1,000 ft) above ground level (AGL) during less sensitive periods. During sensitive times of the year for ungulate SAR (boreal caribou and bison), however, we support the maintenance of over-flight altitudes of at least 600 m (2,000 ft) AGL. These mitigation recommendations for sensitive seasons are taken from "Flying in Caribou Country", which was produced by the Government of Yukon for protection of barren-ground and boreal caribou in the Yukon (EDI, 2010) after extensive research.
6. Include a table (similar to Table 1, Appendix E) summarizing mitigation and monitoring for wood bison during the sensitive calving season.
7. Please provide references for and explain why the AANDC *et al*. (2012) guidelines were not followed for wood bison sensitive seasons (which state that a setback of 0.5 km should be used between 1 March to 16 July)? Please correct in next iteration to match sensitive season to guidelines if there is no biological reason for the GNWT to have shortened this period by 1.5 months.

6.2 Literature Cited

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7.0 UNGULATE AND BOVID RESPONSES TO DISTURBANCES AND MITIGATION

The NSMA submitted written questions prior to the technical meeting, requesting information about the scientific rationale considered by the GNWT when designing the 'danger zone' of 500m for blasting, and if the resulting noise level would cause undue stress to ungulates (Topic 2, q. 6). The GNWT's response offered that barren-ground caribou do react to stressors but are only affected for up to one minute. However, their response did not include a reference, the type of stressor being spoken about, the magnitude of stressor, or the distance from which animals reacted to the stressor. It is also unclear if boreal caribou and wood bison, which are SAR and more likely to interact with the site, can be expected to have the same reaction as barren-ground caribou. After completing a literature review, we found that behavioural responses can last greater than one minute for a variety of disturbance stimuli, such as loud noises, and there is the potential for long-term costs for caribou. While studying wildlife reactions to stressors is challenging, it is possible to measure heart rate changes, behavioural responses, daily movements and reproductive outcomes that demonstrate the energetic costs of various types and magnitudes of disturbances. We explore some of those well-documented responses to disturbances below.

Harrington and Veitch (1991) studied the short-term effect of jet overflights that created noise levels of 115 dB on woodland caribou in eastern Canada. Active caribou (feeding, standing or walking) disturbed by overflights ran for 9 seconds, with a return to normal behaviour within a minute. Resting caribou (lying down), on the other hand, reacted by running for 9 seconds, remaining standing for at least a minute, and returning to pre-flight behaviours by 5-10 min post-disturbance. Hence, behavioural impacts to stressors (though the stressor was large in this case) can last for up to 10 minutes, and disturbance effects can differ based on prior activity. These authors also reported that, for low flights (at 30 m agl), there were a range of responses at different distances from the flight path. In this study, a noise threshold of 90 dB (assumed to be less aversive) was reached at 250 m.

There are also longer-term effects of disturbances documented in other studies. Startle reactions use energy (particularly if they occur repeatedly), but they also increase the risk of injury due to running in rugged topography, cows and calves becoming separated, and animals becoming stranded in deep snow (Harrington and Veitch, 1991). Maier *et al.* (1998), studying free-ranging caribou in Alaska, reported that low level overflights by jets, producing Sound Exposure Levels of 98 dBA (46-127 dBA), caused caribou to spend more time active and to move greater distances. They measured these movements to calculate the total time spent active versus resting during each 24-hour period, which allowed them to show that disturbance caused increased daily activity. This trend toward increasing activity was stronger for post-calving caribou, a seasonal period not yet included as sensitive within the September 2017 WMMP (Section 6.0), and resulted in a significant decrease in daily time spent resting and a resulting 2.8-hr increase in daily time spent active. Jets were at altitudes of 33m, and the mean diagonal distance from caribou (hypotenuse) for all flights was 756 m.

Other acute and chronic impacts of ungulates disturbed by aircraft have also been measured, including: panic running (Calef *et al.,* 1976), changes in habitat use (Krausman *et al.,* 1986), decreased foraging efficiency (Stockwell *et al.,* 1991), decreased nursing frequency (Gunn *et al.,* 1985), and lower calf survival (Harrington and Veitch, 1992). Continued or repeated exposure to stressors can have energetic consequences in seasons when animals are already energetically stressed such as when they are trying to maintain their body condition during harsh winter conditions (when food is less abundant and nutritious and movement through snow requires more energy), avoiding insects, or during calving, post-calving, and rutting periods, or years with harsh conditions.

Similar results have been found, with regards to disturbances due to seismic blasting, as reviewed by Webster (1997). For example, Kuck *et al.* (1985) found that loud noises associated with mining and seismic activity negatively impacted elk. Simulated mine noise recordings (100 decibels) caused elk calves to move greater daily distances, use larger areas than undisturbed calves, and some individuals abandoned their traditional calving area entirely (Kuck *et al.,* 1985). Knight *et al*. (1981) also found that elk increased daily movements, moving about twice as much, in response to seismic activity. Similarly, Bradshaw (1997) who tested the effects of blasting noises (90-110 decibels), 331 m (279- 383m) from the test animal, to simulate exploration mining, found that affected woodland caribou were displaced from the area, increased movement rates, and moved between habitat patches more frequently (which increases their risk of encountering and being detected by predators).

Andersen *et al.* (1996) provided a more intense case of noise disturbance by studying the effect of military exercises and personnel on moose. They measured heart rate changes lasting on average 13.9 min after exposure to human disturbances (e.g. person on foot, skier, platoon of soldiers) and 9.3 min for mechanical stimuli (e.g., ATV, helicopter, jet, canon fire). The distance at which animals began running was 211 m for human, and 58 m for mechanical disturbances. They also measured variation in moose escape distance, with some running distances of 1,147 m from humans and 424 m from mechanical disturbances. It is important to note that hunting of moose in Andersen *et al*.'s (1986) study area is only allowed on foot, so humans are perhaps perceived as more dangerous than various machinery and vehicles.

7.1 Recommendations

Based on this review, and in the absence of information on the specific effects of blasting and construction activities on the physiological and behavioural responses of boreal caribou or bison, we recommend the following:

1. Set a preliminary blast sound effect threshold at 90 decibels. A distance threshold may then be devised based on noise modelling or testing of blast noises received at different distances. We expect the distance effect threshold to be in the range of 250 – 756 m based on literature. If the current blast distance of 500 m does not exceed 90 decibels, then 500 m, as suggested in the WMMP (V.2), is acceptable.
2. Adaptive management to enable the immediate adjustment of buffer distances between wildlife and construction activities, based on behavioural observations of ungulates and bovids, is recommended.

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8.0 SNOW CLEARING AND ESCAPE GAPS

In written questions submitted prior to the technical meeting, the NSMA requested additional information and rationale behind the GNWT's proposed snow crossings every 300 m (Topic 7, q. 2, 3). If snow depths along road verges cannot be retained to depths below the minimum known to impact ungulates in the area, wildlife may require more frequent gaps in the snowbanks. Appendix B of the WMMP, V.1, provided a list of typical gravel road maintenance requirements. For the winter months, this list includes snow removal, and snow fence installation, inspection, repair and maintenance. Now instead of committing to the creation of escape gaps every 300 m (as was included in V.1 of the WMMP), V.2 of the WMMP includes no escape gaps. V.2 of the WMMP takes a reactive, rather than proactive, approach to wildlife mitigation for an issue that is already predictable in advance of development.

Both movement and direct or indirect mortality of ungulates can be impacted by the creation of deep snowbanks or snow-filled depressions along roads. Ensuring that snow banks do not increase mortality risk or inhibit movement of animals important, as this will cause ongoing impacts to wildlife for the life of the road. As ungulates may preferentially travel along snow-cleared, low traffic roads in the winter due to the relative ease of movement compared to the surrounding landscape, they can be impacted by traffic via: 1. being struck by vehicles due to not being able to clear the road in sufficient time, 2. running along the road due to the noise or visual stimuli from an oncoming vehicle heard at a distance, leading to winter exhaustion, indirect mortality or later impacts on reproductive success due to energetic effects; or 3. the animal will attempt to clear the road into deep snowbanks that inhibit their motion and lead to higher rates of predation by wolves.

Crossings of barren-ground caribou are unimpeded by snow depths of < 0.5 m, but Rescan (2011) found that caribou deflected from roads when snow berms exceeded 1.6 m in depth. Boreal caribou, likewise, tend to move into areas with lower snow depths for ease of moving through, and feeding in, these areas (Fuller and Keith, 1981). Moose are affected at shallower depths, as they adjust their behaviour and move to avoid areas of snow deeper than 90 cm (Peek *et al*., 1982). While there is limited information on wood bison movements in relation to snowbanks, previous studies suggest a consensus on bison mobility through deep snow (NWT Species at Risk Committee, 2016). In general, 50-60 cm impedes calf movement (Van Camp, 1997; Reynolds and Peden, 1987), while 65-70 cm impedes adult movement (Van Camp, 1975). Studies from 1-25 cm (Rouys, 2003) and 27 cm (Fortin *et al*., 2003) posed no limitations on movement, and 38 cm caused some limitations (Fortin *et al.,* 2003). In another study, sites with snow depths that were up to 127 cm were avoided (Meagher, 1971) by wood bison. We suggest that 55 cm should be used as the maximum snow depth for wood bison, as adults should be able to move through these depths. Calves may have more difficulty moving through 55 cm of snow, but it is still within their range for movement.

V. 1 of the WMMP included a provision that snow banks within the proposed TASR footprint will be kept "low" and escape points will be ploughed out for wildlife crossing every 300 metres. However, the proponent had not provided any information on the anticipated depth of snow berms, or how various snow depths will impact the ungulate species assessed, or committed to snow bank management below those heights.

In response to questions raised by the NSMA during the technical meeting, the GNWT indicated that the "*value of clearing snow to provide wildlife crossings is being reviewed, through the updated WMMP*". We have now reviewed V.2 of the WMMP and our initial concern is not adequately addressed. Section 6.2.2 of this document now states that "*snow will be managed to maintain a slope on the side of the road… If there are reports of wildlife having difficulty crossing the TASR right of way or moving off the road due to the depth of cleared snow along the roadside, the GNWT will consider instructing Project Co. to clear escape routes at regular intervals along problematic sections of the TASR*". There will naturally be a slope to snow at the side of the road, as the road will be elevated above the surrounding ground level. It is not clear how the suggested mitigation will improve the unmitigated situation, unless that angle will be much stronger, to render snow much less deep. Such clarifying information was not provided.

8.1 Recommendation

As the GNWT has not yet provided a firm commitment to including necessary information for, or dealing with this issue via mitigation, we would like the GNWT to ensure that appropriate snowbank mitigation is included within the next WMMP (V.3). We request the following be added back in, and enhanced, as mitigation:

1. Creating escape gaps every 200 m near high quality habitat and 300 m around lower quality habitat (V.1 of the WMMP stated gaps would be created every 300 m). The GNWT can later modify gap frequency in problem areas.
2. Ensure that snow within escape gaps are maintained at generally less than 55 cm.

9.0 BISON PROTECTION FOR LARGE GROUPS

In their written submissions preceding the technical meeting, the NSMA questioned the rationale used in developing setbacks for large groups of bison (Topic 24, q. 2, 3) within V.1 of the WMMP. Namely, the NSMA was looking for rationale to support the use of wood bison group sizes (10) and distances. In V.1 of the WMMP, work stoppages were noted as being required if observations indicate large numbers of bison (>10) were in the vicinity of the road alignment or winter access routes. Activities would be allowed to resume after these groups had moved >200 m from the activity or were no longer visible. Vehicle speeds during construction were noted to be 50 km/h to reduce the potential of bison mortality due to collisions.

In response to our requests for clarity/scientific rationale, the GNWT indicated that "*setbacks will be revisited in the next version of the WMMP*". We have now reviewed the V.2 of the WMMP and the requested information could not be located. Mitigation for large groups of bison have seemingly been removed from V.2 of the WMMP. The most relevant section is now Section 4.3.1 which refers to mitigation for sensory disturbances during construction. Mitigation wording now states that "*if any big game species are observed within the cleared right of way adjacent to active construction areas, speed limits will be reduced to 30 km/h within 1 km on either side of the sighting*". Further, "*if bison are present on roads, Environmental Monitors will be contacted*". The only statement referring to large groups of bison in the WMMP (V.2) is that "*Environmental*

Monitors should be aware that groups of bison with more than 5 individuals are likely to be nursery groups containing calves and juveniles".

9.1 Recommendations

We recommend the following:

1. That the GNWT revisit their mitigation for large groups of bison, but use more protective trigger numbers for large groups, informed by scientific literature (See Section 5.1.3). While, it will ultimately be the Environmental Monitors to make the call, including a provision for enhanced measures for large groups can be used to guide monitors.
2. Clarify work stoppage distances for bison or groups of bison (rather than just distances to invoke lower speed limits), as was present in V.1 of the WMMP.

10.0 SENSORY DISTURBANCES EFFECT ON MOOSE AND OTHER LARGE MAMMALS

The NSMA submitted questions prior to the technical meeting about why, within V.1 of the WMMP, there was no mitigation to protect certain species of large mammals, like moose, from severe sensory disturbances (Topic 15, q. 1, 2 and 3). V.1 of the WMMP included some basic protections against sensory disturbances for ungulate SAR (species at risk and barren-ground caribou) and bovid SAR (wood bison). However, other species of management concern such as moose, which are of importance to local harvesters but not SAR, had no protection. Likewise, there were also no setback distances for moose (and other large mammals in general) indicated in Appendix B (in V.1 WMMP). The NSMA felt that a broad mitigation measure to suspend construction and/or blasting when *any* large mammal is observed within a minimum of 250 m should also be used to prevent injury or excessive distress to these important species. In the guidelines for sensitive periods provided by AANDC *et al.* (2012), a setback of at least 0.25 km is recommended for all wildlife and birds during the general breeding and birthing seasons. For moose, the rut occurs in late September to mid-October and calving typically occurs in May. During these times, a setback of 250 m would be important.

In response to these concerns raised by the NSMA, he GNWT indicated that "*this mitigation will be considered in the next version of the WMMP*" and that "setbacks will be revisited in the next version of the WMMP". We have now reviewed the September 2017 version of the WMMP (V.2) and mitigation for sensory disturbance for moose and other large mammals is partially addressed in Section 4.3.1, which states that "*blasting may only proceed if no large mammals (e.g. caribou, moose, bison) are detected…*" and "*construction will be temporarily suspended by the Project Supervisor, or speed limits on the road temporarily reduced, when moose, caribou, bison or any other wildlife valued component that may be at imminent risk of injury or mortality, are known to be near the active construction site"*.

The NSMA's Topic 15, q. 3 has been addressed in Section 2.9, as moose are now included in the table of sensitive periods (calving: 15 May - 15 Jul). While moose have been included in construction stoppage mitigation, the revised WMMP (V.2) uses "*imminent risk of injury or mortality*" instead of the original 500 m setback distance used for caribou and bison, or the general 250 m setback suggested by AANDC for all large mammals. The wording for mitigation for moose is therefore more subjective and open to interpretation, as there are no setback distances listed.

10.1 Recommendations

The GNWT has improved the WMMP by acknowledging an important sensitive season for moose. However, the GNWT has not yet provided a firm commitment to using setback distances for moose and other large mammals. We would like the GNWT, within the next iteration of the WMMP, to produce a similar table of mitigation measures that will be applied to moose and other large mammals within sensitive and less sensitive seasons (similar to that provided in Appendix E, for boreal caribou) with these minimum protective distances recognized.

11.0 WILDLIFE TRAFFIC PROTECTION SPEED REDUCTION

The NSMA submitted questions to clarify speed limits and expectations of drivers prior to the technical meeting (Topic 18, q. 2). The NSMA asked GNWT to clarify and set clear limits for drivers and construction vehicles to reduce speeds to a predetermined level when caribou or bison were within a certain trigger 'zone' and to set another, shorter distance, for vehicles to stop (such as when caribou or bison are within 10 m of the road). The NSMA sought clarity about cases where vehicles should stop versus reduce speed.

V.1 of the WMMP included mitigation which stipulates that the presence of caribou and wood bison in areas of construction and access roads will be communicated to other drivers and all construction vehicles will stop or reduce speeds when caribou are within 500 m of the road. The mitigation could still be more specific; for example, what will speeds be reduced to? At what point would traffic stop? What will be the deciding factor about whether a vehicle stops or reduces its speed?

Wood bison are listed as Threatened in NWT, the Mackenzie subpopulation is already in decline, and there is virtually no probability of dispersal from elsewhere to re-populate this population (NWT Species at Risk Committee, 2016), making this group particularly vulnerable. As vehicle collisions with wood bison have been identified as one of the major threats to the species (NWT Species at Risk Committee, 2016), we need clear guidance for drivers.

In response to these concerns raised by the NSMA, the GNWT indicated that "*refinement of this mitigation will be considered during the update of the next version of the WMMP*". We have now reviewed the September 2017 version of the WMMP (V.2) and this is partially addressed in Section 4.4.1, which states that "*speed limits may be lowered to 30 km/h for construction vehicles within 1 km of wildlife sighted on or adjacent to the road*." While distance from wildlife triggering a reduced speed limit has been doubled, the revised WMMP no longer stipulates any stoppage of construction vehicles. Further the strength of the commitment language has been modified between document versions. V.1 used prescriptive language ("speed limits will be followed") while V. 2 used non-committal language (i.e., speed limits <u>may</u> be lowered"). We recommend reverting to the more committal language regarding speed limits.

11.1 Recommendations

As the GNWT has not yet provided a firm commitment to dealing with wildlife traffic protection, we would like the GNWT to ensure that construction vehicle stoppage mitigation, at clearly defined wildlife distances, are included within the next WMMP (V.3).

12.0 PUSHING CARIBOU AND BISON

In our written submission preceding the technical hearing, the NSMA has asked for clarification on the methods used to direct wildlife away from the project area and to standardize this process (Topic 22, q. 1, 2). V.1 of the WMMP noted that: "*If it is clear that caribou will likely remain in the development area for extended periods the Wildlife Monitor may gently encourage individual or small numbers of caribou to move away from the area using methods pre-approved by ENR*". The same mitigation is proposed for bison. However, this practice needs further clarification as it has the risk of potential for misuse. The phrase "*will likely remain in the development area*" could easily be misinterpreted and should be replaced with "*have been in the development area*". This will remove the need to guess how long caribou will be present, and the ushering method can then be used with confidence after some given time interval of excessive loitering at the site. The term "extended periods" also needs further clarification.

As noted in Appendix A, the NWT Wildlife Act, section 52, states that "subject to section 17, no person shall, unless authorized by a licence or permit to do so, (a) engage in an activity that is likely to result in a significant disturbance to big game or other prescribed wildlife; or (b) unnecessarily chase, fatigue, disturb, torment or otherwise harass game or other prescribed wildlife". Mitigation states that pushing methods will be preapproved by the ENR; however, it will be important to avoid chasing or disturbing caribou, making it extremely difficult to move them. The use of this method could violate section 52 of the NWT Wildlife Act.

In response to these concerns raised by the NSMA, the GNWT indicated that "*this can be considered during the revisions of the WMMP*". We have now reviewed the September 2017 WMMP (V.2) and this is addressed in Section 4.4.1. As the GNWT has provided a firm commitment that "if bison, caribou or moose are observed within construction areas and are at risk, operations at that particular work site will be temporarily suspended by the Project Supervisor to allow wildlife to move away from the area of their own accord". GNWT has also clarified that wildlife movement will only occur after "15 minutes". Further, they have clarified that "pushing" activities "will involve the slow approach of Environmental Monitors towards the caribou/moose/bison to encourage them to move". If applied correctly, this approach is mostly sufficient to protect the wellbeing of wildlife.

12.1 Recommendations

The NSMA recommends that the GNWT should provide flexibility in the WMMP, to allow for additional time above the 15 minute period (up to 2 hours) for animals to clear the area naturally before they are approached on foot after 15 minutes. This is because reluctance in such individuals to move away from areas of human activity may be due to their knowledge of nearby predators.

13.0 AIRCRAFT MITIGATION FOR WILDLIFE

In questions submitted by the NSMA prior to the technical hearing, they requested clarity over how flight paths would be developed (Topic 25, q. 2), as practical actions to design and successfully alter flight paths were not described in V.1 of the WMMP. Project mitigation indicates that flight paths will be altered as necessary to avoid important areas, especially during sensitive periods (for caribou and bison). But, it is unclear where these paths are and how effective they will be.

Although the startle response of caribou may appear to be temporary, flights can have population level consequences. For example, calf survival has been negatively correlated with a female's average level of exposure to overflights (Harrington and Veitch, 1992). Female caribou are most sensitive to stimuli associated with threats during the calving period (Harrington, 2001). If a female becomes stressed by an aerial overflight, the noise may signal to the female that she has to move to avoid a predator that is a threat to her young. As a result, her avoidance movements increase. This movement, particularly fast movement, increases her calf's risk of predation as they are more likely to be noticed the more they move around. This is particularly a concern for boreal environments, where predator density can be relatively high. Potentially adverse impacts can be minimized by avoiding flying over specific areas during the calving period (Harrington and Veitch, 1991). For these reasons, flight altitude guidelines also suggest that "caribou calving grounds should be avoided whenever possible" (Environmental Impact Screening Committee (EISC), 2012).

In response to concerns raised by the NSMA over flight paths, and if flight paths/altitudes logs would be assessed for compliance, the GNWT indicated that "*the feasibility of this option will be considered as the next version of the WMMP is updated*". We have now reviewed the September 2017 version of the updated WMMP (V.2) and this issue is partially addressed in Section 4.3.1. The mitigation for the project now includes a more detailed breakdown of how flight paths will be altered. For example, flights associated with highway construction will consider the minimum altitude guidelines (but see Section 6.1, Recommendation 5), flight paths will generally follow the cleared highway right of way, generalized calving locations of collared boreal caribou will be provided to pilots if available, pilots will be expected to scan for large mammals before landing, caribou/ bison/moose will not be harassed by helicopters, pilots will increase altitude and veer away from caribou/ bison/moose if the animals exhibiting a startle response. The only remaining issue is if these mitigations will be monitored in any way.

13.1 Recommendations

We recommend the following:

1. We recommend that an annual audit on flight path and altitude compliance on a small subset of flights be completed and is included as part of the annual review.
2. If there are outstanding issues then GNWT will be able to improve this process and inform future road construction projects.

3. See also recommendation 5, in section 6.1 for modifying flight altitude during sensitive seasons for boreal caribou and wood bison.

14.0 RARE PLANTS, COMMUNITY SURVEYING AND MOOSE HABITAT SETBACKS

Within written questions submitted by the NSMA prior to the technical meeting (Topic 12, q. 1, 2), we noted that setback distances and survey measures to protect rare plants are communities were not fully described in V.1 of the WMMP. This version of the WMMP indicated that setbacks would be used around wetlands, rare plant populations, and rare ecological communities. However, it was unclear what the anticipated setback distances will be. Wetland areas are particularly important feeding site and habitat for moose. A scientifically supported setback distance from wetland areas would help protect moose that may be in the area and mitigate against impacts to moose and moose habitat during construction and operation of the road.

While it is beneficial that the project footprint will be surveyed by a qualified biologist/botanist for the presence of rare plant species and communities, it is also crucial for the effectiveness of the survey that the surveys occur at the correct time of year to fully capture and allow for identification of rare plants and communities. For example, where construction activities are indicated within the fall and winter months, pre- construction surveys will not be effective for identifying vegetation unless it was done in the preceding summer.

In response to concerns raised by the NSMA, the GNWT has indicated that "*setbacks will be revisited in the next version of the WMMP*" and that "*the feasibility and parameters of this option will be considered as the next version of the WMMP*", for surveying times. We have now reviewed the WMMP (V.2), where this has been partially addressed in Section 4.1.1. The revised "herbaceous plant survey" monitoring plan will include both invasive and rare plants. However, we could no longer find any mention of setback distances for wetlands, rare plant populations, and rare ecological communities within the second revision of the WMMP.

14.1 Recommendations

As the GNWT has not yet provided clarification on pre-clearing surveys and setbacks for rare plant populations, wetlands, and rare ecological we would like the GNWT to ensure that these details are included within the next iteration of the WMMP, and that additional key habitat features (beyond dens and nests), are included for potentially occurring SAR.

15.0 BISON SETBACKS

In written questions submitted prior to the technical hearing, the NSMA asked why bison setbacks were missing from Table B – Timing Restrictions and Setback Distances found in Appendix B within V.1 of the WMMP (Topic 28, q. 1). In response to this question, the GNWT indicated that "*setbacks will be re-evaluated in the next version of the WMMP*". We have now reviewed the September 2017 version of the WMMP (V.2) and this original omission has not been adequately addressed. Instead of adding bison set-backs to the table, the entire appendix and table were removed from the WMMP as part of the revision process.

Within the updated (V.2) WMMP, several changes were made that we do not agree with. In V.2 of the WMMP, there is now no “Table of Timing Restrictions and Setback Distances” for wildlife. We would have preferred this table remain in the WMMP and for it to be improved on (e.g., by adding key mitigation for other wildlife species, especially other SAR and species of importance to hunters), as this would serve as a good summary of species-specific mitigation.

To better protect bison, minimum distance setbacks are required for: stopping construction work during sensitive periods, blasting during sensitive periods (beyond the fly rock area), and for stopping snowmobiles, which are not described in V.2 of the WMMP. In the case of work stoppage for general development when animals are in the area, V.1 of the WMMP may have been more protective than V.2, as the original stated that “*the presence of bison in areas of construction and access roads will be communicated to other drivers and all construction vehicles will stop or reduce speeds when bison are within 500 m of the road*”. The V.2 WMMP states that: “*wildlife will have the right of way on all roads during construction”* (p.23). Work stoppage triggers previously included for caribou (500 m) based on the AANDC (2012) Northern Land use guidelines, also appear to be missing in V.2) . As wood bison are also a listed species, setbacks for work stoppage should be included for this species (*e.g*., of 250 m year-round, 500 m during sensitive seasons) to trigger the stoppage of development activities when bison are in the area.

Finally, in question 2 of Topic 18, the NSMA had asked for clarification of a setback for speed *and* a setback for stopping. We agree with the clarified 1km trigger distance for reduced speed limits in response to Bison, and feel that this is an appropriate trigger distance.

15.1 Recommendations

Our recommendations, pertaining to bison setbacks and sensitive periods, are as follows:

1. That the table (Timing Restrictions and Setback Distances) in V.1 of the WMMP, or a similar table be put back into the WMMP, and that setback distances for bison be clarified/added to it.
2. Add an additional setback of 10 m, where drivers will stop construction vehicles when bison are near a roadway (after slowing vehicles down).
3. Include a year-round minimal setback of 250 m for stopping development activities when bison are in the area, and a setback of 500 m during sensitive periods.
4. Set a blasting buffer area based on ensuring that bison are exposed to less than 90 decibels during blasting. This distance can be devised via noise modelling or by monitoring noise levels during blasts at the planned 500 m setback early in construction, to ensure that noise from blasts does not exceed 90 decibels within that area (adaptively and rapidly alter setback if needed).
5. The snowmobile setback distance for caribou (250 m), which were present in V.1, but were lost in V.2 of the WMMP, should be added back into the next iteration of the WMMP. And a snowmobile setback for Bison should be added.

16.0 MISSING SETBACK DISTANCE REFERENCES

The NSMA submitted a written question preceding the technical hearing (Topic 29, question 1) to gain insight into the rationale for the values provided in Table B of V.1 of the WMMP, "Timing Restrictions and Setback Distances". Throughout the table, numerous setback distances were given without any references or rationale. In response to this question, the GNWT provided three references: Northern Land Use Guidelines documents (specifically the guidelines for Seismic Operations), and from the Inuvik to Tuktoyaktuk Highway's 2013 Wildlife and Habitat Protection Plan. Flight altitudes were obtained from the EISC guidelines and GNWT guidelines ("Flying Low? Think Again" brochure). We have now reviewed the September 2017 version of the WMMP (V.2) and these materials are included in citations and appendices to the document, which adequately addresses the NSMA's concerns surrounding rationale and referencing.

17.0 SETBACK DISTANCES FOR CARIBOU WATER CROSSINGS

The NSMA provided a written question prior to the technical hearing (Topic 31, question 1), which sought clarification about whether there are any caribou water crossings in the project area. The AANDC (2012) recommends setbacks for water crossings for caribou (barren-ground, woodland and peary caribou) as they are an important, key, habitat feature for these species. According the AANDC (2012) guidelines, water crossings near blasting or seismic activity must have a minimum setback distance of 10 km between May 15 – Oct 15. From May 15 – Oct 15 barren-ground caribou are also protected from general activities with a setback distance of 1 km around water crossings.

In response to this question, the GNWT indicated that "*setbacks will be re-evaluated in the next version of the WMMP*". We have now reviewed the September 2017 version of the WMMP (V.2) and this issue has not been adequately addressed. The only mention of water crossings is found in Section 2.1, Project Description, which does not specifically reference water crossings for caribou (but for the project). This information does not address our comment referring to mitigation for caribou water crossings. This suggests that this issue has not been considered further by GNWT. Furthermore, the WMMP (V.2) does not even include water crossings as key wildlife habitat (Section 19.0).

17.1 Recommendations

We request the following:

1. As the GNWT has not yet provided a firm commitment to determining whether there are caribou water crossings that interact with the project, and adding the recommended setback distances around them (following AANDC et al., 2012), we would like the GNWT to ensure that this will be included in the next iteration of the WMMP.
2. Ensure that water crossings are included under "key habitat features" (Section 19.0) along with appropriate buffers.

18.0 MITIGATION TO REDUCE DISTURBING CARIBOU IN SENSITIVE PERIODS

The NSMA submitted a written question prior to the technical hearing (Topic 42, q.1) about the logistical constraints that may be faced with completing construction in winter during periods of extended darkness, in that it may limit an environmental monitors' ability to observe animals within proposed mitigation distances. This question was asked because the DASR and V.1 of the WMMP indicated that the proponent sought to minimize project effects on boreal caribou during sensitive periods, *e.g.* calving, by performing land-clearing primarily in the winter. All blasting work in the tentative construction schedules in Appendix B of the DASR is also planned to begin in mid-January, when the length of day at northern latitudes is very short. The NSMA was concerned that darkness (and forest) may inhibit Golder's planned mitigation measures to restrict blasting when caribou and wood bison are within a given setback distance. The NSMA also had concerns that darkness may also limit the successful operationalization of other mitigation such as for driving at a reduced speed and pausing other construction activities when certain species are within buffer areas. Primarily, the NSMA sought to determine if there was more information on the proposed monitoring methods that could render the mitigation sound when operationalized, as working mitigation is assumed when rating residual effects within the effects assessment.

In response to these concerns, the GNWT indicated that "*this mitigation can be refined in the next version of the WMMP*". We have reviewed the September 2017 version of the WMMP (V.2) and this is not adequately addressed. Appendix E describes details of mitigation specific to boreal caribou, however it does not address the issue of how visibility in extended darkness will be dealt with (e.g., use of infrared equipment, scopes, etc.). Reliance on collar data to trigger mitigation in the absence of an effective ground-based monitoring program will not be protective, as boreal caribou are not typically found in large groups, and this method will only protect a small proportion of boreal caribou associated with collared animals (and sometimes, during the calving period, only the collared individual alone) (Section 5.1.1).

There is no mention of solutions to the issue of monitoring in the dark within WMMP (V.2) for wildlife. Other mitigations for bison and other wildlife are described with the assumption that monitors will have up to 1 km of visibility. This issue is also likely to be compounded by snowfall during the winter period. As discussed in the DASR "*bison may also be attracted to the roads for use as a travel corridor during winter months when snow may impede movement*". With higher levels of road use potentially overlapping dark periods, it will be important to be aware of, and plan to address this issue.

18.1 Recommendations

We would still like the GNWT to acknowledgement of the issues associated with limited visibility in extended dark periods and to propose solutions to deal with this limitation within the next iteration of the WMMP. There are now numerous infrared scopes that can greatly increase detections of wildlife in the dark, at far distances. We recommend that the GNWT look into infrared scopes proposed for monitoring at the Back River mine project in Nunavut.

19.0 PRE-CONSTRUCTION SURVEYS FOR WILDLIFE FEATURES OF SPECIES AT RISK

During the written questions, the NSMA submitted two questions (Topic 8, questions 1 and 2) to gain more information on what methodologies would be used to survey and evaluate the presence of "key wildlife features" for SAR. Habitat loss mitigation included within version 1 of the WMMP included contacting ENR and/or EC if a key wildlife feature of a SAR is discovered, suspension of activity pending consultation with these agencies. However, it is unclear what survey methods would be used to identify such features, the search intensity, who would be responsible for those surveys, and how far in advance of construction they would take place. If a method of stumbling upon a feature during construction is used, there is a much higher likelihood of missing such features. Also, some features may not be apparent at one time of year, so surveys would need to be done in advance, and at the appropriate time of year, such that the habitat features could be identified.

In response to these questions, the GNWT indicated that "*additional information on this topic will be available in the next version of the WMMP*". We have now reviewed the September 2017 (V.2) of the WMMP and this issue has not been adequately addressed in Sections 4.3.1. Information within this section now states that "*in the event that an active mammal den or bird nest is identified during construction, GNWT-ENR will be consulted to determine an appropriate strategy to avoid or minimize disturbance. A protocol for pre-clearing den surveys will be developed once the final TASR alignment and borrow source locations are determined*." Section 4.4.1 also mentions pre-clearing den surveys, and states that "*operations near the den will be temporarily suspected by the Project Supervisor, and ENR will be consulted.*"

This revision of the WMMP no longer refers to "key wildlife features" at all in relation to SAR, and is therefore less protective, as it appears to only limit consideration of dens and nests as key wildlife features. We would argue that rutting areas, mineral licks, bat roots, water crossings, hibernacula, and other wildlife features should not be excluded as key wildlife features, and would indeed be protected under current legislation. The revisions did not address the NSMA's questions regarding survey methodology, effort, and seasonal timing. Although the GNWT indicates that they will work towards developing detailed pre-clearing den survey methodology, survey methods for other features are not mentioned.

19.1 Recommendation

We request the following revisions or additions to the WMMP:

1. As the GNWT has not yet provided a firm commitment to appropriate survey methodologies for key, potentially occurring habitat features for species at risk, we would like the GNWT to ensure that these details are clearly articulated within the next WMMP (V.3)

Concerns Related to Proposed Monitoring Plans

20.0 NON-NATIVE/INVASIVE SPECIES MONITORING

In written questions submitted by the NSMA (Topic 10, q. 1, 2), monitoring of invasive species were not fully described in the DASR or V.1 of the WMMP. V.1 of the WMMP noted that invasive species will be monitored annually during each year of construction and if non-native/invasive species are identified due to construction, a response plan will be prepared. This plan did not include the operations phase which may also experience invasive species issues.

It is important that invasive species not be allowed to colonize and spread, as this can impact ungulate forage and habitat over time. Mitigation options for habitat loss state that if non-native/invasive species are identified within the corridor due to construction, a response plan will be prepared. It is unclear how this monitoring will be completed, and how long monitoring will occur for following road completion. As reclamation and natural regeneration can be a very slow process, particularly in the north, it may be necessary to monitor for invasive species for a minimum of five years, or at more widely spaced intervals over a longer period.

Roads affect both abiotic and biotic landscape components including sedimentation, light, dust, soil water content, soil temperature, drainage, run-off pattern, air and water chemistry (Coffin, 2007; Trombulak and Frissell, 2000). These physical changes can directly influence biotic components, particularly vegetation. Road dust can affect vegetation and plant communities growing at considerable distance from unpaved road edges. Dust can cover vegetation and affect photosynthesis, respiration, and transpiration and can lead to introduction of phytoxic pollution into plant tissues through increased adsorption (Coffin, 2007). Although dust effects are often limited to within 20 m of road edges, measurable effects have been observed as far as 200 m on the downwind side (Forman and Alexander, 1998).

Road edges also provide conditions that encourage establishment of plants that are adapted to disturbance, including some introduced and invasive plants (Forman and Alexander, 1998). For example, Nitrogen from vehicle exhaust, and resultant nutrient enrichment of surrounding area, was observed to change vegetation within 100 to 200 metres of roads (Forman and Alexander, 1998; Angold, 1997). Road effects resulting in increased nutrient availability and higher pH have been shown to promote colonization of non-native, highly competitive plants in tundra ecosystems. This spread is often exacerbated by slope (Mullerova *et al*., 2011).

Introduced plant species can spread and cause harm to natural habitats, out-competing native plant species, and degrading habitat quality for ungulates and other species. Climate model projections show an Arctic- wide end of century increase of 13 Celsius in late fall and 5 Celsius in late spring for a business-as-usual emission scenario (Overland *et al*., 2013). These temperature increases can change ecological conditions significantly, making conditions less severe, and permitting establishment invasive species. Between 2005 and 2010 the number of alien plant species in the NWT increased from 94 to 116. These were mostly found in or near communities, near roads and along disturbed areas such as cut-lines, pipelines and mine sites (NWT, 2015).

This trend may correlate with observed trends in climate and human activity. Certain introduced plant species have succeeded in spreading in some Arctic habitats, mostly those already disturbed by human activities (NWT, 2015).

In response to questions submitted by the NSMA and during the technical hearing, the GNWT indicated that the "*the feasibility of this option will be considered as the next version of the WMMP is updated*". We have now reviewed the September 2017 version of the WMMP and this is mostly adequately addressed in Section 4.1.1, which states that *"herbaceous plant surveys of the Project footprint will be completed during the growing season by a qualified botanist in advance of construction, one year following construction and again after five years of operations. If rare plants and/or invasive species are found, ENR will be consulted to determine next steps*."

20.1 Recommendation

We are very pleased with this addition to the WMMP. We would recommend one more survey, to be done by a qualified botanist, 10 years after the start of road operations, as northern invasive species can be slow to establish.

21.0 ADAPTIVE MANAGEMENT FOR WILDLIFE

The NSMA submitted written questions prior to the technical review about why there was no adaptive management discussed in V.1 of the WMMP (Topic 26, q. 1). In response to, the GNWT indicated that "*Additional information on this topic will be available in the next version of the WMMP*". We have now reviewed the September 2017 version of the WMMP (V.2) which addressed adaptive management in Section 6.2, and which is mostly adequate.

21.1 Recommendations

We suggest that the GNWT include a conceptual option for immediate adaptive management (options that do not need to follow weekly or annual reports). For instance, if a certain activity is causing distress in a SAR, the environmental lead on site should have the authority to halt activity and to increase or alter the mitigation to prevent further impacts.

22.0 MONITORING FOR TRAFFIC EFFECTS ON WILDLIFE

The NSMA raised concerns during the technical hearings that the proposed use of annualize average daily traffic may not capture traffic related effects of importance to wildlife. For instance, traffic rates are likely to fluctuate by season and time of day, and will impact wildlife that are proximate to the road during seasons with traffic exceeding species-specific thresholds. Furthermore, some animals are active during the day, some in the morning and evening (crepuscular), and others at night (nocturnal). Therefore, they may be differently impacted based on the patterns of traffic occurring throughout the day. For example, we would expect crepuscular species to be differently affected by traffic that is more concentrated in the morning and evening than species that are active midday and at night.

As a second issue, the NSMA also raised concerns about the fact that the proponent, in their original WEMP, planned to monitor traffic, and declare that traffic rates had exceeded projected levels, only if a 3-year average of (annual average traffic) exceeded the projected rates by 50%. The NSMA expressed concern that the large amount of averaging (over each year, and then over a 3- year period), and allowance for a 50% exceedance over even these averages could enable much larger impacts than predicted, as the averaging allows for very high seasonal traffic levels (that can impact wildlife) to be "averaged out" by low traffic periods overmultiple years.

We have reviewed the September 2017 draft of the WMMP (V.2) (which now combines the previous version of the WMMP with the WEMP). Section 5.2.1 of the September 2017 WMMP now proposes to report traffic in a way that answers two monitoring questions:

1. Are daily traffic levels averaged over a 3-year period, staying within 50% of the levels maximum annual average daily traffic levels predicted for the TASR?
2. What average and maximum daily traffic levels during sensitive seasonal period for boreal caribou, moose, and bison, or during periods of higher known collision risk?

The second of these questions helps to address the NSMA's concern, as it asks and questions pertaining to maximum daily traffic during periods of importance to the species noted. We only note that the NSMA would like those traffic levels also reported for the rut and post-calving periods, as these two seasonal periods are not yet recognized by the GNWT as sensitive.

The GNWT states that the literature suggests a threshold of 300-500 vehicles will affect these species, and they propose to use a maximum daily traffic threshold of 200 vehicles to answer question 2, following the precautionary principle. A brief literature review was provided in Appendix G of the WMMP (V.2) to support this threshold. We consider this proposed threshold in sections 27.1 and 27.2 that follow by providing an independent literature review. The main goal of this review is to determine if we can independently concur with Golder's cut-off points and thresholds, and to determine the degree of certainty that exists in the literature.

22.1 Independent Review of Traffic Thresholds

The main support for 300-500 vehicles per day threshold comes from Alexander *et al.* (2005), which mainly corresponded with effects on carnivores. These overall results, showing relatively high permeability levels, may be partly due to the fact that the authors aggregated species into guilds, and then provided permeability measures for the guild. The authors acknowledged this point, by stating that "*permeability could appear higher because of more crossings by tolerant species within the guild*" (Alexander *et al.,* 2005). This averaging effect should be viewed cautiously. Looking at the most sensitive species instead would provide a more appropriate, precautionary approach. For ungulates, however, the relationship with roads shown in this study is particularly perplexing, as high traffic roads had the greatest permeability, and the very high traffic volume roads were the same as moderate and low (and were less permeable than high traffic roads). This perplexing pattern suggests that some other confounding factor may be behind these relationships, which may be related to it being conducted in a National Park within the Canadian Rockies.

Alexander *et al.*'s (2005) study would not be the first conducted in the Rocky Mountains or within a National Park that has shown counterintuitive results that contradict other studies. For example, Roever *et al.* (2010) found that grizzlies in a steep valley system of the northern Rocky Mountains (Jasper National Park), were more likely to approach roads irrespective of traffic volumes. Northrup *et al*. (2012), however, showed quite conclusively that collared grizzly bears in southwestern Alberta were sensitive to traffic, selecting roads with fewer than 20 vehicles per day. The results of Roever *et al.* (2010) are likely due to the topographic constraints of the Rocky Mountains, as spring grizzly bear habitat and travel corridors are mainly concentrated in the valley bottoms, where roads have also been built. These valleys are surrounded by steep, rocky cliff faces and mountains. A similar phenomenon may affect ungulates in the Rockies, whereby the road network has been placed in existing major (and limited) valleys. Hence, wildlife are sometimes forced to interact with major roads for seasonal migrations, and to access required seasonal habitat. Furthermore, hunting is prohibited in National Parks, which can change the associated fear that would occur in wildlife in response to roads and traffic over time.

Charry and Jones (2009) completed a review of existing literature on the various thresholds for all wildlife with regards to traffic. They recommend that planners limit new traffic on remote roads to less than 300-400 vehicles per day. However, this recommendation was not specific to ungulates, or endangered species, but rather a broad suggestion for road construction stakeholders for all wildlife, including birds, reptiles, and amphibians. The only study that this paper references for ungulates and traffic thresholds is, again, the Alexander *et al.* (2005) study; hence this review does not add any additional information. Other studies on ungulates presented by Charry and Jones (2009) focus on much higher traffic levels and significant impact thresholds such as greater than 10 moose-vehicle collisions per 100 km at 2,000 AADT (Seiler 2005) and average probability of elk occurrence at 40% within 200 m of the road at 2,400 AADT (Gagnon *et al.* 2007). These values suggest that larger values, at around 2,000 AADT, cause critical impacts for ungulates; however, there is much less information to define appropriate traffic effect thresholds. There appear to be few low volume traffic studies in the literature on which to base this guideline for ungulates.

The study conducted by Burson *et al.* (2000), also referenced in Appendix G, did not clearly relate wildlife sightings to traffic volumes, instead comparing wildlife observation trends over time. The only traffic value given, a limit of 10,000 vehicles per season (roughly equal to 95 vehicles per day) in 1986, does not tell us the range of traffic in other years from 1973 to 1997. Other systematic changes at the wildlife park such as fewer people getting off the buses at viewing stops, no hunting occurring in the Park, and the potential for habituated individuals, may confound the results.

As mentioned in Golder's review, Leblond *et al.* (2013) demonstrates several significant impacts of a road modification project including a reduction in crossing (77% of caribou did not cross the completed highway), home ranges were reduced to exclude the highway, and fewer caribou were found within a 5,000 m effect zone during and after highway modifications. High traffic volumes were defined as >186 vehicles per hour for a highway (which equates to 4,464 vehicles per day). Their results also indicated that "*most individuals were using areas away from the highway before its modifications, suggesting that road disturbance had already shaped caribou distribution*" at traffic rates less than 186 vehicles per hour (Leblond *et al.*, 2013). This significant effect level of about 4,500 vehicles is useful; however, this study still fails to inform a clear lower limit for safe traffic for ungulates.

As we were not satisfied that the literature provided within Appendix G, could enable us to arrive at a traffic threshold with certainty, we conducted our own, independent review seeking additional context and studies. This independent review is included in Section 22.2.

22.2 Independent Literature Review

We conducted a search on the Web of Science databases to find existing studies on road traffic impacts on ungulates. Unfortunately, there is a lack of information available for boreal caribou, except for a few studies by Dyer and colleagues, and the Leblond *et al.* (2013). Dyer *et al.* (2001, 2002) used GPS-collared woodland caribou data in northeastern Alberta to investigate caribou habitat use and road crossings. They collected vehicle traffic data in the late winter (Feb) and summer (Aug) using three traffic classifiers placed throughout their study area road network, as well as two human traffic surveyors. The highest traffic rates occurred in the winter (600-800 vehicles per day) as this was the busiest season in the oilfield. The lowest traffic occurred in the summer (<100 vehicles per day). The authors found that woodland caribou in open coniferous wetland avoided the area within 0-100 m of the road during all time periods, suggesting that even low traffic levels, or some secondary attribute(s) of the road (e.g. predation risk), act as a deterrent. In closed coniferous wetland, caribou avoided habitat up to 250 m from the road in late winter, corresponding to the time of highest recorded traffic levels (Dyer *et al*., 2001). In another study using the same dataset, Dyer *et al*. (2002) found that caribou crossed roads significantly less than controls in late winter, summer, and rut periods[3]. The greatest barrier effect occurred in late winter, possibly due to higher traffic levels; however, there were also significant barrier effects in the summer, which suggest that low traffic levels may also impact boreal caribou behaviour. Mechanisms to explain this pattern could include avoidance of the road and traffic itself, or avoidance of predators or hunters associated with the road at traffic levels within this study.

There are other studies that have investigated the effects of road traffic on barren-ground caribou in Alaska. In Denali National Park, traffic on the park road increased dramatically from the early 1970s to the late 1990s. Traffic levels, including shuttle buses and private vehicles, were reported as 77 vehicles per day in 1973-74 and ranged from 93-144 vehicles per day in 1982-83 (Singer and Beattie, 1986). Yost and Wright (2001) subdivided the park road into strata by traffic volume, ranging from approximately 1,000 to 7,100 shuttle buses per year in 1996-97. In a 3-month tourist period, this corresponds to 11-79 buses per day. While the earlier study found that

[3] The rut period is not included as a sensitive season by the GNWT, however, numerous studies show different sensitivities of ungulates to roads during the rut.

animals exhibited flight behaviour, and flight distances increased near roads/vehicles (Singer and Beattie, 1986), later studies found that traffic appeared to have little effect on wildlife distribution or behaviour (lack of adverse responses >100 m from the road), likely due to habituation (Burson *et al.*, 2000; Yost and Wright, 2001). Studies within Denali National Park may, therefore, not be applicable to the proposed study area within the NWT, where wildlife would not yet be habituated to human activity, and where human activity still represents a hunting risk.

Other studies in Alaska have focused on road and traffic impacts on the Central Arctic Herd of barren-ground caribou near the Prudhoe Bay Oilfield. In the early 1980s, mean traffic levels were estimated to be 15-20 vehicles per hour (Smith and Cameron, 1985; Murphy and Curatolo, 1987), corresponding to 360-480 vehicles per day. From 1982-87, mean traffic levels were estimated to be approximately <200 vehicles per day, and more commonly <100 vehicles per day (Cameron *et al.* 1992). While many of these studies were investigating the effects of pipelines and other oilfield structures, they also found that road traffic elicited negative behavioural responses in caribou (Murphy and Curatolo, 1987), affected the success of crossing pipelines (Smith and Cameron, 1985; Curatolo and Murphy, 1986), and redistributed caribou farther from the road (Cameron *et al.*, 1992). However, they also observed that caribou were attracted to roads for seasonal insect avoidance. During peak insect periods, caribou on the road would run short distances when startled by vehicles, and "*typically returned shortly after vehicles passed*" (Murphy and Curatolo, 1987). Only the Curatolo and Murphy (1986) study investigated sites with different levels of road traffic, ranging from 15 to 30 vehicles per hour (360-720 vehicles/day). They found that caribou crossing frequency was lowest (5%) when traffic adjacent to the elevated pipeline was the highest (30 vehicles per hour). When traffic rates were half this value, caribou had 30% crossing frequency where there was a pipeline, and 78% crossing frequency without a pipeline. While these results suggest that pipelines themselves have a greater barrier effect, further research is needed to investigate the effects of lower traffic levels (≤200 vehicles per day) on caribou movement, behaviour, and productivity.

Bruinderink and Hazebroek (1996) reviewed traffic collisions with ungulates in Europe. They found that many countries showed an increase in roadkill over time (for example, moose roadkill in Norway doubled from 1987-1994). This suggested that traffic increases over time may increase the risk to ungulates. However, Bruinderink and Hazebroek (1996) also found that road kills of a roe deer population in the Netherlands had not increased over the past 15 years, despite an increase in traffic over the same period. During this period, the population had also stabilized at about 3,000 animals. These results and other conflicting reports suggest that the impact of traffic volumes on the number of road kills are often unclear or context specific. Further studies such as Seiler (2005), who modelled moose vehicle collisions in Sweden, help to clarify this relationship. Seiler (2005) showed that a maximum of 10.7 and 16.7 moose vehicle collisions per 100 km per year were recorded on roads with traffic volumes at 2,000-4,000 AADT in the model area and 4,000-6,000 annualized average daily traffic (AADT) in the test area, respectively. Overall there was a trend of increasing moose collisions with increasing traffic along generally low traffic roads. This trend occurred to a maximum point, with decreasing collisions above these traffic rates, probably due to avoidance of roads above that traffic level. While little is known about the effect of low traffic rates on wildlife, Seiler's (2005) data regression suggests that at traffic levels of 250

AADT and 500 AADT, approximately 2-3 and 5 moose collisions per 100 km per year, were be expected. Of course, these collision rates would likely vary based on the population size of moose among locations.

22.3 Recommendations

After independently reviewing available literature, we concur with Golder that the cut-off of 200 vehicles per day, during sensitive seasons for wildlife, is reasonable based on limited relevant studies available and the precautionary principle. However, we do request that exceedences of this vehicular rate threshold be examined within two additional sensitive seasons for ungulate and bovid SAR: post-calving and the rut periods. (Sections 30, 15).

While we do not disagree with the GNWT's proposed traffic threshold, there are insufficient data and studies to enable a high degree of confidence in a traffic threshold for use along the TASR, largely due to minimal studies relating low traffic roads and traffic rates to the species of interest. For this reason, the traffic and radio-collar data collected for boreal caribou will be highly valuable for filling in data gaps in our existing understanding of the responses of species to temporal variations in traffic rates along low traffic roads in northern boreal forests. For example, combining boreal caribou collar data with real-time traffic rates by location will enable the proponent to examining step length and redirection of collared caribou, in relation to road proximity and associated traffic rates. These data will enable the proponent to look for patterns in avoidance and deflection, or road use, by caribou in different seasons and at various traffic rates. This sort of study may be used to answer threshold questions more definitively, and to adjust the threshold, if needed. For this reason, we highly recommend that the GNWT collect, and keep, minute-by minute traffic data, and to use those data to conduct a finer-scale statistical analyses of seasonal and daily variability in traffic linked to effects on collared boreal caribou (and other wildlife). When sufficient data are available to draw conclusions, this sort of study will serve to greatly inform effects assessments, and mitigation, in the future.

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22.4 Monitoring for Effects Around Road Salt Application Locations

As the GNWT noted in response to a question submitted by NSMA's prior to the technical hearing (Topic 17, q. 1) "*In rare instances, limited amounts of sodium chloride may be necessary to ensure road safety*", we recommend recording all locations and dates that sodium chloride is applied to the road and reporting those in the annual WEMP. Woodland caribou dramatically increase mineral licking behaviour along roads during the rutting period (Tripp *et al.*, 2006), and we expect that caribou and bison may be attracted to sites where sodium chloride has been applied, particularly in the fall. This may, in turn, lead to increases in vehicular mortality risk. Careful documentation of sodium chloride application locations, along with dates, will aid in correlating collisions with such locations, and may aid the GNWT in adaptive management to deal with this issue (*e.g.*, warning signs around such locations), if needed in the future.