BMC MINERALS (NO.1) LTD

Laura Cabott, Chair
Yukon Environmental and Socio-Economic Assessment Board
Suite 200-309 Strickland Street
Whitehorse, Yukon Y1A 2J9

July 24, 2020

Dear Ms. Cabott,

Re: Kudz Ze Kayah Response Report #6 – YESAB Project 2017-0083

Please find attached BMC's response to YESAB's Information Request #6.

Should you have any questions please contact me directly.

Sincerely,

Kelli Bergh, Environmental Manager
778-233-7058
kellib@bmcminerals.com

Cc: **Andrew Reid – Senior Assessment Officer**

BMC MINERALS (NO.1) LTD

KUDZ ZE KAYAH PROJECT

RESPONSE #6 TO YESAB EXECUTIVE COMMITTEE INFORMATION REQUEST KZK

PROJECT PROPOSAL

July 2020

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym	Definition
AEG	Alexco Environmental Group Inc.
BMC	BMC Minerals (No 1.) Ltd.
cm	centimetres
DEM	Digital Elevation Model
FCH	Finlayson Caribou Herd
ha	hectare
HR	home range
HSI	Habitat Suitability Index
IPCC	Intergovernmental Panel on Climate Change
IR	Information Request
km	kilometres
km^2	square kilometres
KZK	Kudz Ze Kayah
LSA	Local Study Area
MAP	mean annual precipitation
NMP	North Mountain Population
masl	metres above sea level
PC	Post-calving
PEM	Predictive Ecosystem Mapping
RCP	Representative Concentration Pathways
RRDC	Ross River Dena Council
SNAP	Scenarios Network for Alaska and Arctic Planning
W/m^2	Watts per square metre
YESAB	Yukon Environmental and Socio-economic Assessment Board
ZOI	Zone of Influence

1. INTRODUCTION

BMC Minerals (No.1) LTD (BMC) submitted the Kudz Ze Kayah (KZK) Project Proposal to the Yukon Environmental and Socio-economic Assessment Board (YESAB) for a Screening level assessment in March 2017 (BMC, 2017a).

In November 2019 YESAB prepared the Draft Screening Report (YESAB, 2019) and made it available for public comment. In considering comments submitted and Project Proposal materials, YESAB determined that it requires additional information from BMC in order to conclude the screening. Specifically, YESAB has issued Information Request #6 in relation to the effects assessment for caribou (YESAB, 2020).

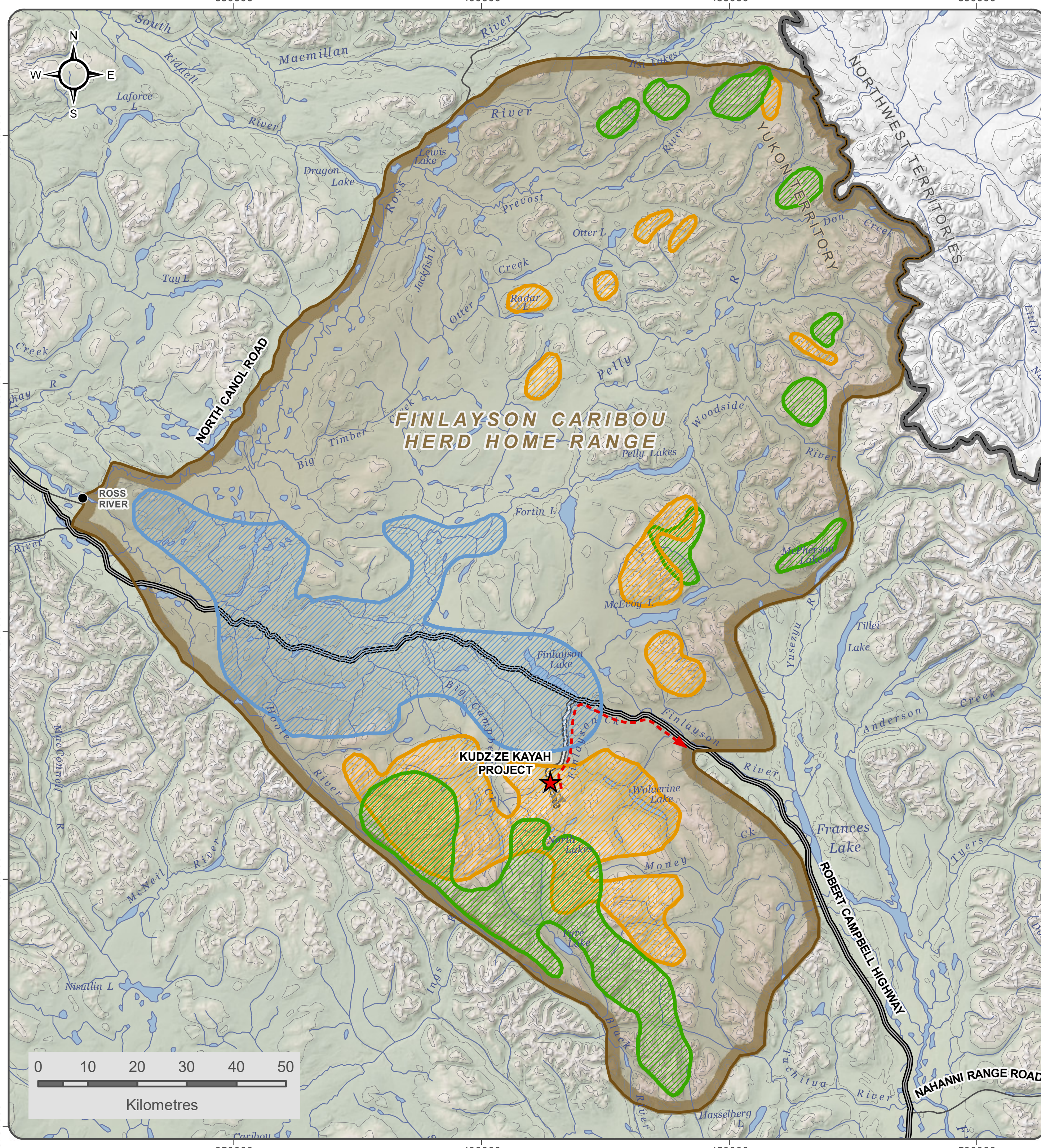
This Response Report #6 provides the additional information requested by YESAB. For clarity and ease of understanding, BMC has listed the Information Requests (IRs) from YESAB's Information Request #6 (in black text) followed BMC's response (in blue text). The requests and responses follow the same order as YESAB's IR #6.

2. WINTER HABITAT

2.1 R6-1

Model winter habitat suitability and corresponding habitat loss as has been done for post-calving and rutting habitat for the FCH. The model design should show consideration for shifting overwintering patterns for the FCH.

The Finlayson Caribou Herd (FCH) seasonal distribution and habitat ranges are presented in Figure 2-1 (reproduced from Figure 13-3 of the Project Proposal (BMC, 2017a) and were developed based on the Yukon Government's studies of the FCH. This figure shows that the majority of the late winter habitat is northwest of the Project. The figure shows that the only portion of this habitat that overlaps with the Project is the existing Tote Road, which is proposed to be upgraded to an Access Road. This figure also shows that the Robert Campbell Highway passes through the middle of the late winter habitat. During the Project's alternatives assessment, BMC decided the main transportation route would go east on the Robert Campbell Highway to the east of the Project to avoid this high suitability late winter habitat (Section 4.15.4.6 of Chapter 4 of the Project Proposal (BMC, 2017a).



★ Kudz Ze Kayah Project	● Community
Core Post Calving Range	Tote Road/Proposed Access Road
Core Rut Range	Highway
Core Winter Range	Secondary Road
Watercourse	Waterbody
Location of Proposed Infrastructure	Proposed Transportation Route

Caribou disperse north and south from the wintering lowlands to higher calving and post-calving grounds in the spring and summer then congregate back on alpine and subalpine ridges and plateaus during the fall rut. Following the rut, caribou move back to wintering lowlands at varied times depending partially on snow depths.

Datum: NAD 83; Projection: UTM Zone 9N

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KUDZ ZE KAYAH PROJECT

FIGURE 2-1

FINLAYSON CARIBOU HERD SEASONAL DISTRIBUTION AND HABITAT RANGES

JULY 2020

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A late winter habitat suitability index (HSI) model for the FCH was completed in January 2018 and is presented in Appendix A of this Response Report. The purpose of the HSI was to predict the location of caribou late winter habitat within the Local Study Area (LSA), as well as within the traditional home range of the FCH.

The data used to create the habitat suitability map were collected over the last thirty-five years by Yukon Government biologists and recent late winter survey data collected by Alexco Environmental Group Inc. (AEG) in 2015, 2016 and 2017 (as presented in the Project Proposal and responses to information requests) (BMC, 2017a, BMC, 2017b, and BMC, 2017c). Further data collected in 2018, 2019, and 2020 are consistent with the model. In addition, expert knowledge was gathered through interviews with Rick Farnell, several individuals from Yukon Government's Department of Environment (Environment Yukon), AEG, Environmental Dynamics Inc., and other consultants regarding caribou habitat usage. The late winter HSI model variables chosen to determine habitat preference were: elevation; slope; vegetation; and precipitation. The HSI model parameters for late winter are consistent with the post-calving and rut life requisite models, with precipitation added as a variable since snow depth is important for caribou habitat selection in late winter. Precipitation may serve to help assess any future shifts in late winter habitat suitability related to snow depth. The classes within each variable were ranked based on their significance for caribou use during late winter. Both satellite and telemetry data were used to calibrate the model variables, while thirty-five years of aerial survey data were used to evaluate the effectiveness of the model.

Figure 2-2 shows the resulting habitat suitability map for late winter FCH habitat. Based on the habitat suitability model, the percentage of moderately high and high valued late winter habitat across the FCH range is 34% (702,413 hectares (ha)). All habitat rated to have high suitability is located to the northwest of the Project in the Pelly River lowlands. The LSA has no high value late winter habitat; however, approximately (1,583 ha) of the LSA has moderately high value habitat (Figure 2-2 (below) and Figure 5-2 in Appendix A). Approximately 90 ha of moderate and 11 ha of moderately high value late winter habitat is predicted to be directly affected by the existing Tote Road and widening for the Access Road. Approximately 3,582 ha of moderate and 1,583 ha of moderately high value late winter habitat is predicted to be indirectly affected by the Access Road. The habitat that is predicted to be directly and indirectly affected equates to less than 1% of all moderate to high suitability late winter habitat in the FCH range. Winter habitat that overlaps with the mine site footprint was rated to have low to nil suitability Figure 2-2 (below) and Figure 5-2 of Appendix A).

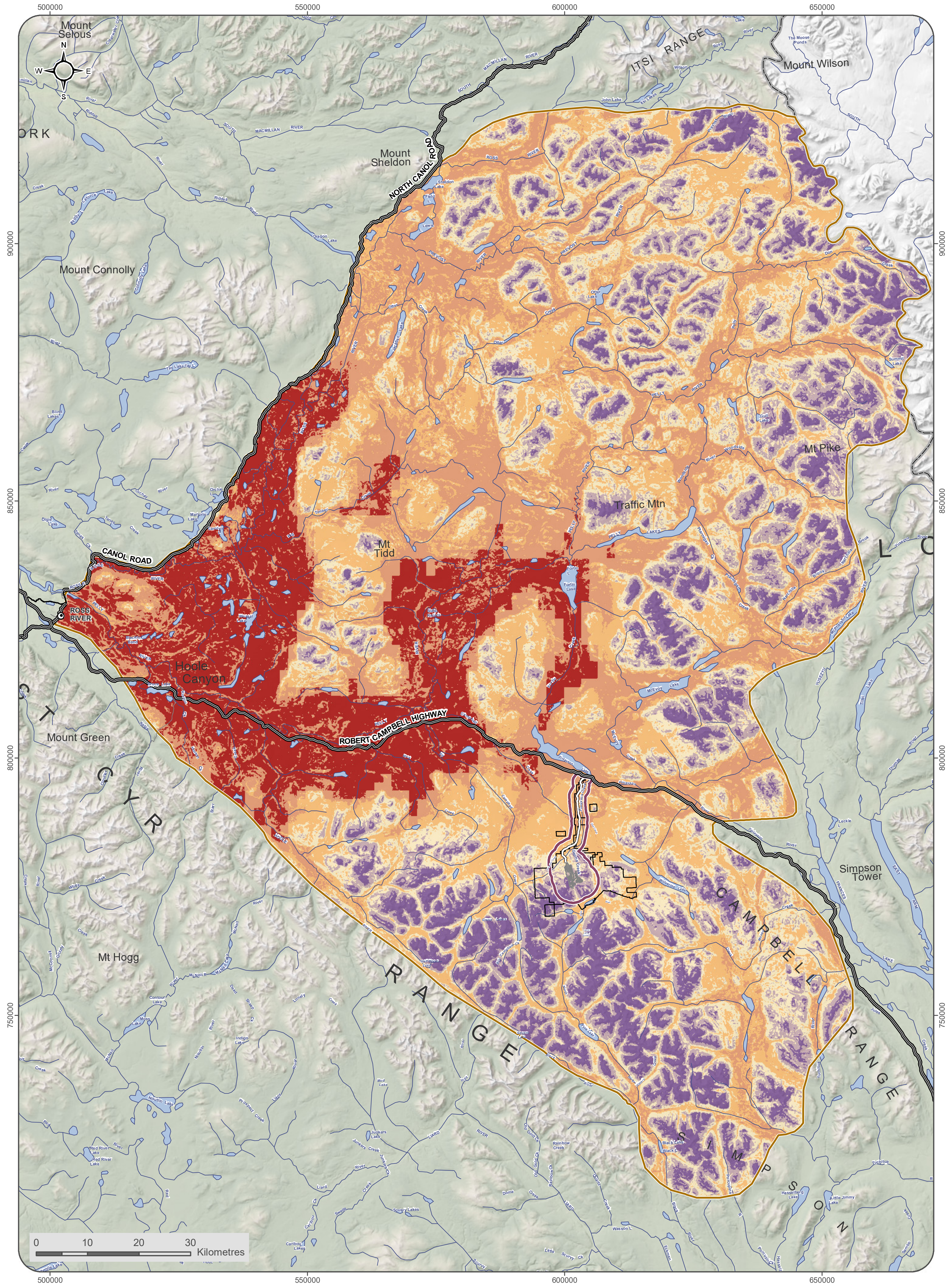
During late winter, the FCH are distributed throughout the lower forest and shrublands around the Pelly River and Finlayson Lake which lies in an orographic rain/snow-shadow north of the Pelly Mountains. As weather systems move from the coast, moisture falls on the south side of the mountains and results in a dry area (rain/snow shadow) on the northeast side of the mountain range (Wahl et al., 1987; Kuzyk et al., 1999). Caribou distribution in any one year varies based on local variations in snow depth throughout the winter. Shallow snow allows the caribou to access the terrestrial lichens while deeper snow makes it more difficult for caribou to feed and move between areas. Based on collar data, caribou move throughout their winter range depending on the snow depth and food availability; therefore, the distribution of caribou at the time of the late winter surveys does not necessarily represent the full use of their late winter range in a given year.

There is marked variation in precipitation across the range of the FCH. The St Cyr Range typically receives 40 to 50 cm of precipitation annually, while the foothills of the Logan Range receive approximately 75 cm annually. Between these ranges, the ‘rain/snow shadow’ region receives <30 cm each year. Late winter snow accumulation data was measured from 1982 to 2015 at snow stations established along the Robert Campbell Highway (which runs through high suitability habitat). The data showed that snowpack in this area of the FCH winter range averages 40 cm. This is markedly less than values reported to impede the mobility of solitary (50 to 60 cm) or groups (80 to 90 cm) of caribou (Russell and Martell, 1984). Abundant lichens and low snow cover provide a highly suitable winter range for the FCH with little or no alternate adjacent range available. The FCH’s traditional winter range is the result of an obligatory response to environmental conditions, and is, therefore, considered to be essential habitat for the FCH (Farnell and McDonald, 1989).

Table 2-1, Table 2-2, and Table 2-3 present the areas of suitable late winter habitat within 1, 2, 3, 5, 10, and 15 km distances from the Robert Campbell Highway, Finlayson airstrip, and Tote Road, respectively. These tables also present the percentages of these habitats relative to the FCH home range (HR) and relative to the FCH winter range. As can be seen, 82% of the high suitability habitat in the FCH winter range is within 15 km of the Robert Campbell Highway (most of which is west of the proposed Project’s transportation route). Effects to this high suitable late winter habitat will be minimized as the proposed transportation route goes east on the Robert Campbell Highway and therefore most of the winter range along the Robert Campbell Highway will be avoided (Figure 2-1).

The Finlayson airstrip is on the eastern side of the late winter range. There is a small percentage of moderate to high suitability habitat with 3 km of the Finlayson airstrip; however, there is 8% of high suitability and 32% of moderately high suitability late winter habitat within 15 km of the airstrip. Note that mitigations for use of the Finlayson airstrip include following the guidelines for Flying in Caribou Country and following flight paths that minimize disturbance. These measures are presented in the Wildlife Protection Plan in Appendix J of Response #2 (BMC, 2017b) and have been summarized in Table 6-1 of Response Report #5 (BMC, 2020).

Similar proportions of late winter suitable habitat are within 3 km of the Tote Road as with the Finlayson airstrip. As was presented in Section 13.4.1.1 of the Project Proposal, there is little overlap of Project activities with the late winter range of the FCH. The Project-related traffic volumes will be relatively low and the disturbance to caribou from traffic is expected to extend less than 1.5 km from the road. Further discussion regarding the zones of influence and disturbance are presented in Chapter 6 below in response to R6-7.



HABITAT SUITABILITY INDEX

- Nil
- Very Low
- Low
- Moderate
- Moderately High
- High

- Local Study Area (Indirect Zone of Influence)
- Finlayson Caribou Herd Home Range
- BMC Minerals (No.1) Ltd. Mineral Claim Areas
- Location of Proposed Infrastructure

Contours, waterbodies and watercourses compiled by Natural Resources Canada at a scale of 1:50,000. Reproduced under license from Her Majesty the Queen, as represented by the Minister of Natural Resources Canada. All rights reserved.

Datum: NAD 83; Projection: UTM Zone 9N

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ENSERO solutions

KUDZ ZE KAYAH PROJECT

FIGURE 2-2

FINLAYSON CARIBOU HERD, LATE WINTER HABITAT SUITABILITY HOME RANGE

JULY 2020

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Table 2-1: FCH Late Winter Habitat Suitability Within Range of the Robert Campbell Highway

Distance	Habitat Suitability Class	Area between Robert Campbell Highway and Buffer in FCH Home Range (ha)	% of FCH Range	Area between Robert Campbell Highway and Buffer in Winter Range (ha)	% of FCH Winter Range
1km					
	High	14,348.3	5%	11,558.0	9%
	Moderately High	9,330.3	2%	5,741.9	8%
	Moderate	2,172.8	0%	695.9	2%
	Low	550.5	0%	51.6	1%
	Very Low	0.8	0%	-	0%
	Nil	-	0%	-	0%
2 km					
	High	27,419.0	10%	21,898.1	17%
	Moderately High	17,765.1	4%	11,380.4	17%
	Moderate	5,379.4	1%	2,305.1	7%
	Low	1,702.1	0%	99.6	1%
	Very Low	182.2	0%	-	0%
	Nil	18.6	0%	-	0%
3 km					
	High	40,563.6	15%	31,646.0	25%
	Moderately High	24,853.5	6%	16,062.1	24%
	Moderate	8,950.2	2%	4,257.5	13%
	Low	3,349.7	1%	444.9	6%
	Very Low	546.6	0%	14.0	1%
	Nil	132.3	0%	-	0%
5 km					
	High	65,919.9	24%	50,421.1	39%
	Moderately High	38,813.9	9%	25,181.9	37%
	Moderate	16,968.6	3%	7,837.8	25%
	Low	7,084.9	2%	993.6	14%
	Very Low	1,519.2	1%	61.8	4%
	Nil	197.6	0%	3.9	2%
10 km					
	High	114,250.4	42%	89,639.1	70%
	Moderately High	75,648.3	18%	47,756.4	70%
	Moderate	46,012.1	9%	19,139.2	60%
	Low	20,313.2	5%	3,226.1	45%
	Very Low	5,506.8	2%	142.7	10%
	Nil	1,276.2	1%	7.0	3%
15 km					
	High	140,868.3	52%	105,652.8	82%
	Moderately High	107,382.0	25%	60,162.0	89%
	Moderate	85,415.8	17%	30,506.9	96%
	Low	40,617.6	11%	6,866.9	95%
	Very Low	16,673.7	6%	1,370.6	93%
	Nil	7,600.3	4%	201.6	97%

Note: The proposed transportation route extends east of the Project to avoid core late winter range of the FCH.

Table 2-2: FCH Late Winter Habitat Suitability Within Range of the Finlayson Lake Airstrip

Distance	Habitat Suitability Class	Area between Airstrip and Buffer in FCH Home Range (ha)	% of FCH Range	Area between Airstrip and Buffer in Winter Range (ha)	% of FCH Winter Range
1km					
	High	104.4	0%	104.4	0%
	Moderately High	355.6	0%	355.6	1%
	Moderate	20.4	0%	20.4	0%
	Low	-	0%	-	0%
	Very Low	-	0%	-	0%
	Nil	-	0%	-	0%
2 km					
	High	352.4	0%	352.4	0%
	Moderately High	1,113.8	0%	1,113.8	2%
	Moderate	118.7	0%	118.7	0%
	Low	2.2	0%	2.2	0%
	Very Low	-	0%	-	0%
	Nil	-	0%	-	0%
3 km					
	High	923.0	0%	923.0	1%
	Moderately High	2,209.3	1%	2,209.3	3%
	Moderate	185.3	0%	185.3	1%
	Low	3.1	0%	3.1	0%
	Very Low	-	0%	-	0%
	Nil	-	0%	-	0%
5 km					
	High	1,696.0	1%	1,696.0	1%
	Moderately High	6,054.4	1%	6,054.4	9%
	Moderate	867.1	0%	867.1	3%
	Low	56.2	0%	56.2	1%
	Very Low	-	0%	-	0%
	Nil	-	0%	-	0%
10 km					
	High	4,397.3	2%	4,394.5	3%
	Moderately High	18,300.3	4%	17,362.5	26%
	Moderate	8,807.1	2%	8,578.3	27%
	Low	1,503.9	0%	1,494.3	21%
	Very Low	44.1	0%	44.1	3%
	Nil	-	0%	-	0%
15 km					
	High	11,640.8	4%	9,874.4	8%
	Moderately High	29,355.7	7%	25,272.6	37%
	Moderate	25,714.2	5%	17,773.4	56%
	Low	5,799.8	2%	2,365.7	33%
	Very Low	606.6	0%	66.3	4%
	Nil	21.3	0%	-	0%

Table 2-3: FCH Late Winter Habitat Suitability Within Range of the Project's Tote Road

Distance	Habitat Suitability Class	Area between Tote Road and Buffer in FCH Home Range (ha)	% of FCH Range	Area between Tote Road and Buffer in Winter Range (ha)	% of FCH Winter Range
1km					
	High	-	0%	-	0%
	Moderately High	1,230.3	0%	1,235.1	2%
	Moderate	2,328.1	0%	1,097.4	3%
	Low	724.8	0%	91.1	1%
	Very Low	35.6	0%	-	0%
	Nil	-	0%	-	0%
2 km					
	High	-	0%	-	0%
	Moderately High	2,274.3	1%	2,247.0	3%
	Moderate	4,846.6	1%	2,495.5	8%
	Low	1,572.1	0%	265.7	4%
	Very Low	361.7	0%	5.7	0%
	Nil	32.0	0%	-	0%
3 km					
	High	-	0%	-	0%
	Moderately High	3,532.7	1%	3,445.8	5%
	Moderate	7,399.7	2%	3,985.3	12%
	Low	2,503.6	1%	427.3	6%
	Very Low	857.8	0%	18.0	1%
	Nil	128.6	0%	-	0%
5 km					
	High	-	0%	-	0%
	Moderately High	6,704.2	2%	6,568.6	10%
	Moderate	13,109.0	3%	7,170.1	22%
	Low	4,211.9	1%	695.4	10%
	Very Low	2,144.4	1%	41.9	3%
	Nil	672.9	0%	3.9	2%
10 km					
	High	475.3	0%	475.3	0%
	Moderately High	19,097.1	4%	15,463.3	23%
	Moderate	27,442.5	6%	11,808.5	37%
	Low	10,495.3	3%	1,122.1	15%
	Very Low	7,206.8	3%	58.8	4%
	Nil	3,872.1	2%	3.9	2%
15 km					
	High	2,321.9	1%	2,212.4	2%
	Moderately High	32,851.0	8%	22,172.7	33%
	Moderate	47,524.3	10%	15,506.4	49%
	Low	20,155.3	5%	1,575.0	22%
	Very Low	13,672.3	5%	78.5	5%
	Nil	9,259.8	5%	3.9	2%

2.2 R6-2

Discuss the potential implications of shifting winter range use on the assessment of project effects, including the efficacy of proposed mitigation measures.

As discussed in R6-1, late winter range use can vary from year to year. This is observed in the survey data collected over four decades and is shown in the heat maps in Figure 2-3 (Figure 13-7 from Response #2 (BMC, 2017c) and updated in Response Report #5 (BMC, 2020). The 1980s, 1990s and 2000s results presented in Figure 2-3 are based on Yukon Government (YG) data of the Finlayson Caribou Herd range while the 2010s results are based on BMC/YG surveys that only covered a portion of the FCH range (i.e. GMS 10-07).

As presented in response R2-93 of Response #2, the variation in use shown in Figure 2-3 is likely a result of sampling bias, as annual late winter surveys conducted by BMC/YG since 2015 are within GMS 10-07, located on the eastern end of the winter range and did not survey the entire winter range. GMS 10-07 was the regional study area agreed to with Environment Yukon during discussions on the design of the baseline program in 2015. A large portion of the FCH was likely present to the west of GMS 10-07 (but was not part of the study area), this conclusion is based on the relatively low total numbers of caribou observed during the surveys from 2015 to 2019 (which ranged from 19 in 2015 to 198 in 2017) compared to the total population of approximately 2,700 Finlayson Caribou). Despite this sampling bias, the four decades of survey data show that caribou move throughout suitable late winter habitat (Figure 2-2). The main interaction between the Project and the late winter range are the Access Road and use of the Finlayson airstrip. The proposed mitigations to minimize impacts remain the same even if there is some variability in distribution of the late winter range each season and between years.

Factors influencing this movement are variations in snowfall, snow depth and food availability. Caribou might not move as far west during low snowfall years if there is sufficient access to food resources closer to their rut, calving, and post-calving habitat.

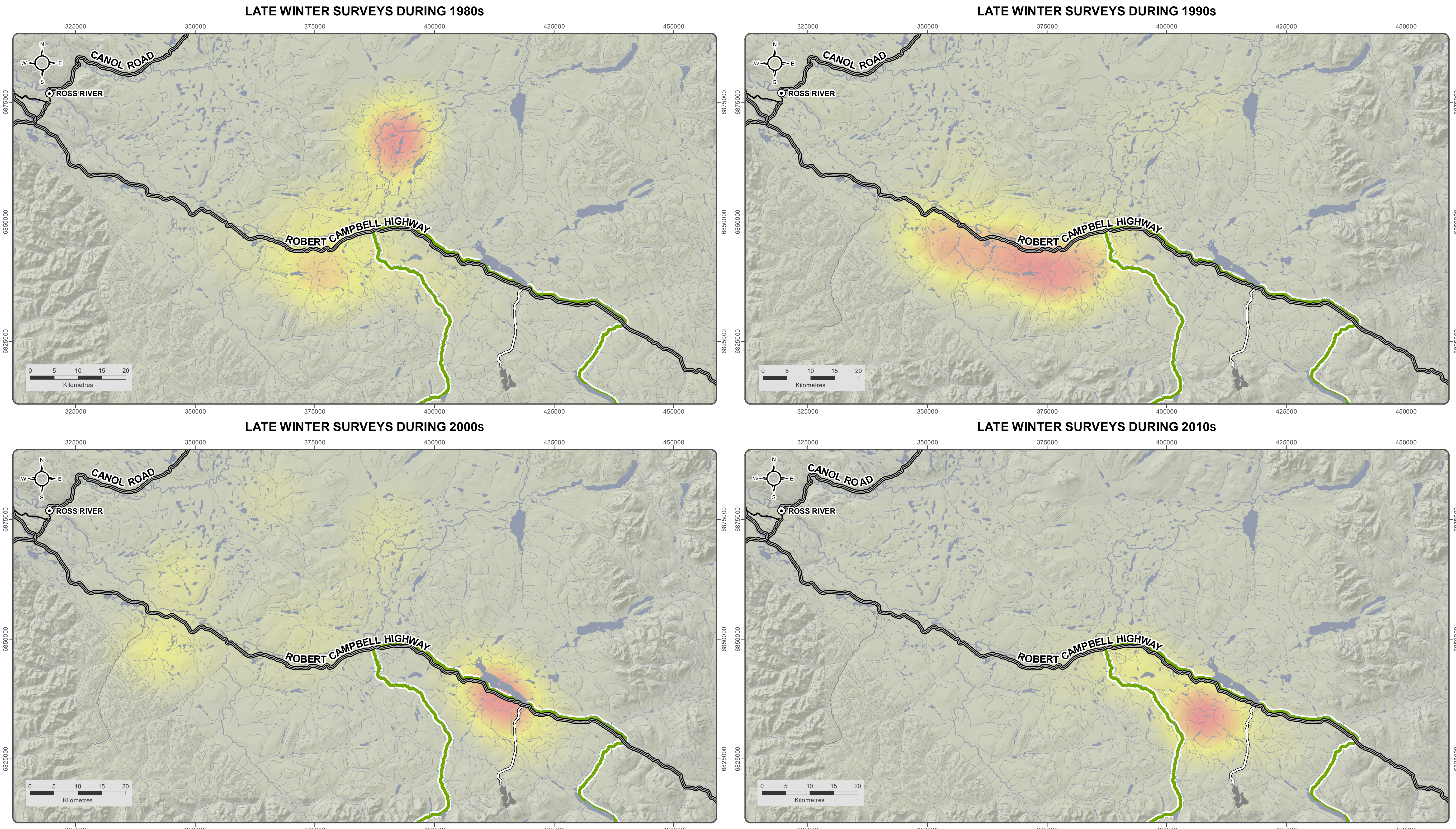
The proposed mitigation measures as presented in the Wildlife Protection Plan (Appendix J of Response #2, BMC, 2017c and summarized in Table 6-1 of Response Report #5, BMC, 2020) are expected to be effective with any shifts of winter range use or suitability. As presented in response R194 of Response #1 (BMC, 2017b), the mitigation and management plans includes a no hunting policy, traffic controls, access control, emergency egress, snow management, and minimizing the height of barriers such as snowbanks. These mitigations will minimize potential adverse effects on caribou movement to and from their winter range as well as habitat use within the late winter range. Potential effects on caribou in winter and mitigations are linked as follows:

- Potential Effect: Mine Access Road hauling - mortality from vehicle collisions;
    - Proposed Mitigation: Controlled access, enforced speed limits, protocol for caribou on the road.
- Potential Effect: Mine Access Road - restricted movement of caribou across road;

- Proposed Mitigation: Create regular breaks in plowed snowbanks along the side of the road to provide egress.

- Potential Effect: Mine Access Road maintenance - attraction to road;
    - Proposed Mitigation: No use of salt on road.
- Potential Effect: Finlayson airstrip - disturbing caribou on wintering grounds;
    - Proposed Mitigation: Regularly scheduled flights with predictable approach.
- Potential Effect: Transportation on Robert Campbell Highway - disturbance and mortality from collisions;
    - Proposed Mitigation: Truck routes for the Project will travel east on the Robert Campbell Highway to avoid the areas with high suitability for winter habitat, enforced speed limits by contractors, follow protocol for caribou on the Highway.

These mitigation measures are based on industry and government-recommended practices adapted for the Project-specific potential effects determined from the effects assessments (Chapter 13 of the Project Proposal (BMC, 2017a)). The Wildlife Protection Plan (Appendix J of Response #2, BMC, 2017c) includes an adaptive management plan and the efficacy of these mitigation measures will be monitored and modifications made to the mitigations if incidents or survey results indicate that these measures are not effective. Note that monitoring, triggers, and corresponding actions related to the adaptive management plan were updated in response to Information Request R3-8 (BMC, 2018a). These updates will be included in the Wildlife Protection Plan that will become a component of the Project's Quartz Mining Licence.



1980s, 1990s and 2000s results are based on Yukon Government data of the Finlayson Caribou Herd range.
2010s results are based on BMC surveys that were conducted in 2015-2020 years and only covered GMS 10-07. Note, no caribous were observed during 2020 late winter ungulate survey.

Finlayson Caribou Herd Late Winter Regions map was produced using Quantum GIS 1.8.0-Lisboa

Datum: NAD 83; Map Projection: UTM Zone 9N

CARIBOU PRESENCE IN LATE WINTER REGIONS

- High Presence
- Moderate Presence
- No Presence

OTHER MAP FEATURES

- Location of Proposed Infrastructure
- RSA (GMS 10-07)
- Waterbody
- Watercourse
- Highway
- Secondary road
- Tote Road/Proposed Access Road
- Contour (1000ft)

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FIGURE 2-3

CARIBOU WINTER PRESENCE FROM YUKON GOVERNMENT AND BMC SURVEYS

JULY 2020

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3. CALVING HABITAT

3.1 R6-3

Provide a summary of location data available from telemetry studies (VHF and GPS collars) during the calving period (May 7 to June 8), in:

a. The project area,

b. Various Zone of Influence around the project area (see 7c, below), and

c. The Finlayson caribou herd range.

As presented in the Wildlife Baseline, Appendix E-8 of the Project Proposal (BMC, 2017a), FCH caribou were collared with VHF collars in the early 1980s by Yukon Government. The relocation telemetry data were collected for the years 1982 to 1986 for the calving season with relocations recorded in late May/early June of each year as presented in Table 3-1. The method for collecting these data utilized a fixed wing aircraft flying transects to locate a collar signal, and then marking the animal location once the collar was located. This method presented a lower accuracy than the satellite collar data as the location of the animal was recorded from the air rather than an exact location on the ground. The relocations recorded from the radio collar program from 1982 to 1986 show few, disperse data points spread over most of the mountains in the north and south of the FCH range (Figure 3-1).

Table 3-1: VHF Radio Collar Relocations in Late May / Early June 1982 to 1986

Year	Number of Collars Relocated
1982	51
1983	15
1984	12
1985	23
1986	27
Total	**128**

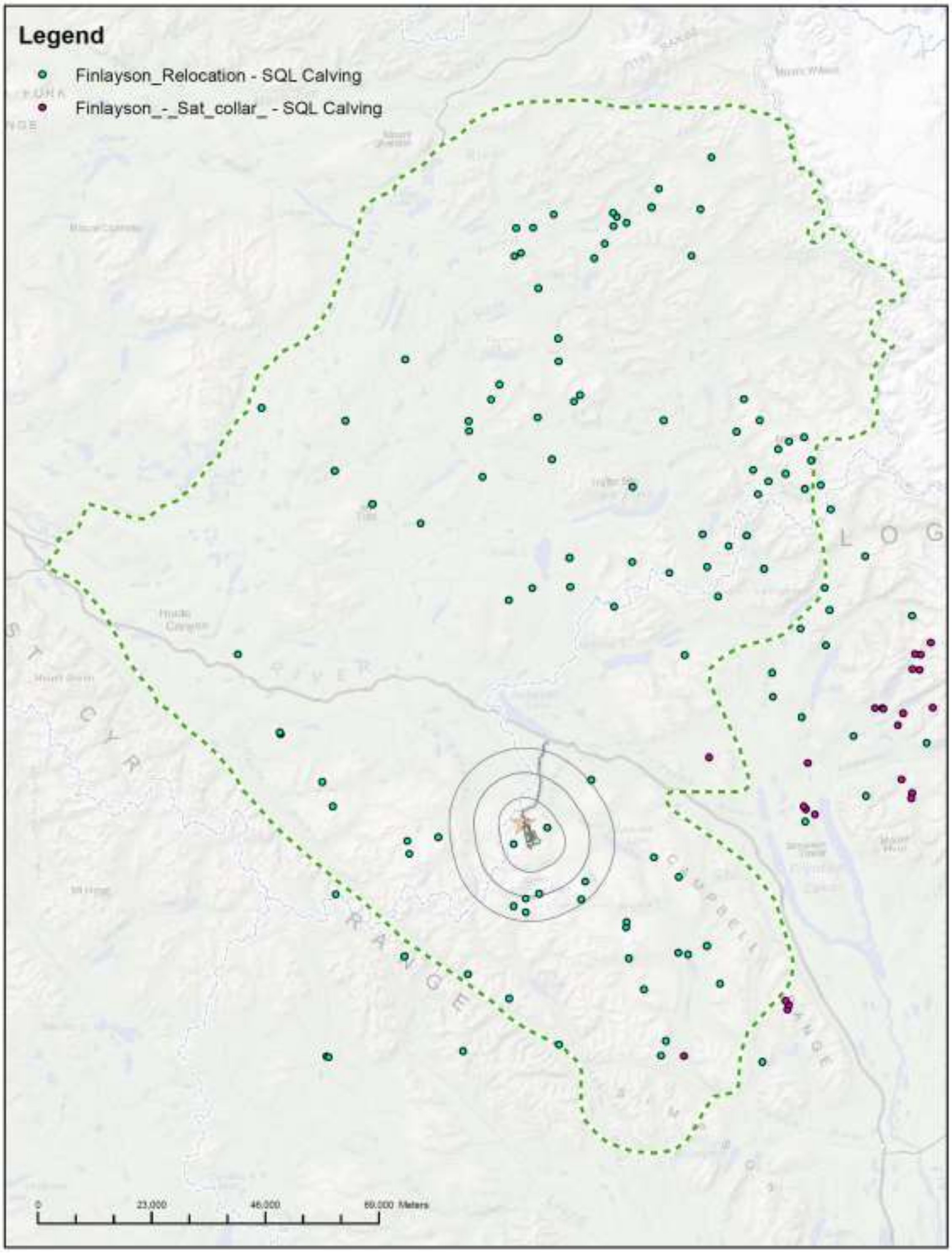


Figure 3-1: General Distribution of Collared Caribou During Late May / Early June

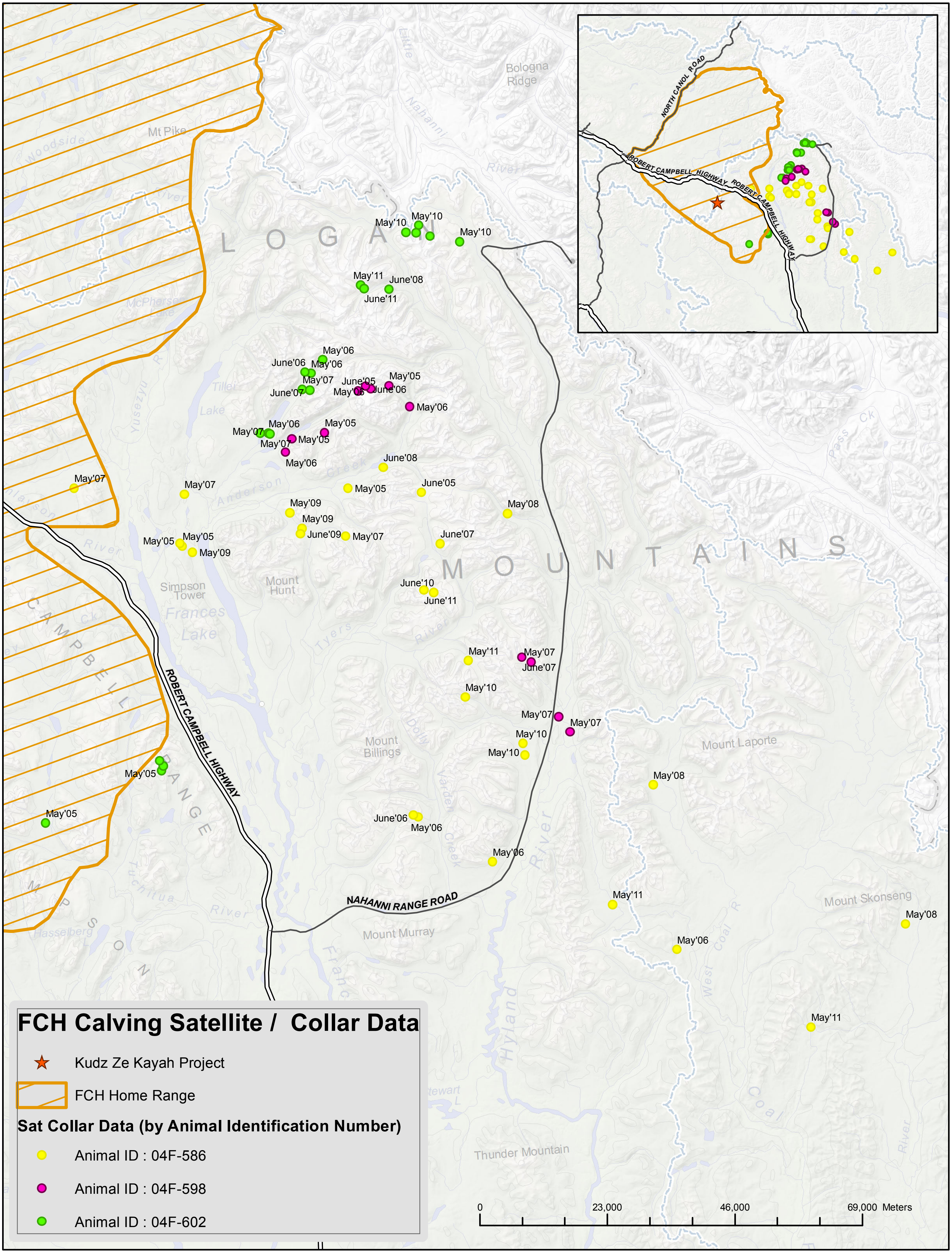
Three FCH caribou were also collared during the Nahanni caribou herd satellite collar program with location data collected for the years 2004 to 2011. These data are of the highest accuracy within the three datasets but contained the lowest frequency of observations. Furthermore, the objective of the satellite collar study was to monitor the adjacent Nahanni caribou herd. This created a bias as the three individuals that were collared were often integrated with the Nahanni herd whose range is most often to the east of the FCH home range. Weekly location data were recorded for these three individuals. Figure 3-2 shows the relative distribution of the three caribou during the calving period of each year from 2005 to 2011. As can be seen from the distribution, the caribou disperse during the calving period and the locations change from year to year.

Although limited, the available historic calving telemetry data for the FCH support the interpretations of seasonal Northern Mountain Population (NMP) woodland caribou life history behaviour presented in the literature. The FCH is migratory and moves to different seasonal habitats within their home range to meet specific life cycle needs (Adamczewski et al., 2010). In the spring, two-thirds of the FCH begin moving from their wintering grounds in the forested lowlands east of the Pelly River to the Pelly Mountains in the southeast. The remaining one-third of the FCH travels to the mountains north of Finlayson Lake. As summer approaches, female caribou disperse in the mountains to calve on ridges and upper plateaus to avoid predators (Bergerud et al., 1984; Bergerud and Page, 1987; Bergerud, 1992). They remain dispersed in small bands in the uplands through summer and seek out snow patches to escape insect harassment and warm temperatures (Morshel and Klein, 1997). The limited data also support the lack of site fidelity.

The NMP of woodland caribou differ from barren-ground caribou, in that there are no specific calving areas or calving grounds (COSEWIC, 2014). Mountain caribou are typically their most dispersed at calving as parturient females space away from one another as an anti-predation strategy. Furthermore, calving caribou will use a variety of habitats, from scree slopes above the treeline, to forested stands. Calving sites are scattered widely at higher elevations as indicated from traditional knowledge presented in the Kaska Dena land use framework (Dena Kayah Institute, 2010 cited in Species at Risk Committee, 2019).

Research by Hegel (2010) has suggested that the ability of parturient caribou to access higher elevations at calving provides greater success in terms of recruitment. This is likely due to the ability to altitudinally space away from wolves and to have good visibility of approaching predators, namely wolves and bears. Thus, it can be argued that one of the largest impacts on calving caribou is not necessarily on their calving habitat per se, but rather on their ability to move to areas that provide suitable characteristics for calving (Hegel, 2010).

Studies by Gustine et al. (2006) showed that at a large scale, calving sites were selected that avoided predation risk and avoided high vegetation biomass. Being able to use alternate calving areas in response to predation risk, and availability of sufficient forage availability for increased energy demands required for lactation, was found to be an important survival technique for woodland caribou.



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This life history of dispersing during the calving season is confirmed by the collaring research being conducted in the Southern Lakes region of the Ibex and the Carcross/Laberge Northern Mountain Population woodland caribou herds (Environment Yukon, 2020). Figure 3-3 and Figure 3-4 show the distribution of 85 collared caribou from these herds from March to June 2019 and January to June 2020. A scale bar on the images is not available for the website captures; however, for reference, Whitehorse to the Yukon border is an aerial distance of 80 km. In both years and both herds, the distribution is restricted from January to April in their winter ranges and then the caribou disperse into the mountains during the May calving period and then are more aggregated on the upper mountains where there are snow patches in June. Note that the May distribution varied between 2019 and 2020 and some caribou even moved north to different wintering, calving and post-calving areas from 2019 to 2020 (i.e. high plasticity / low site fidelity, which supports the descriptions that caribou calving sites vary to optimize food availability and predator avoidance; Gustine et al., 2006; COSEWIC, 2014).

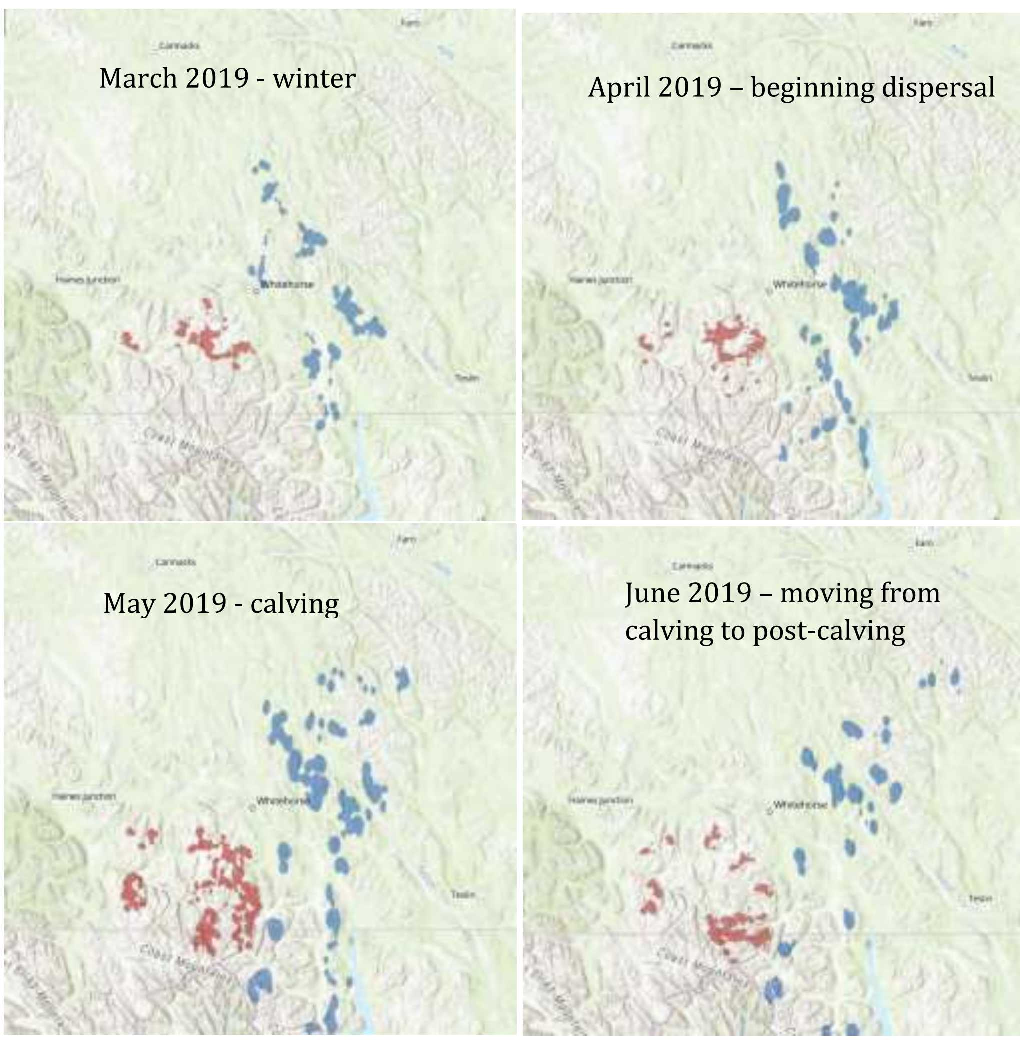


Figure 3-3: Ibex (red) and Carcross/Laberge (blue) Herd Collar Distributions March 2019 – June 2019 (Source: Environment Yukon, 2020)

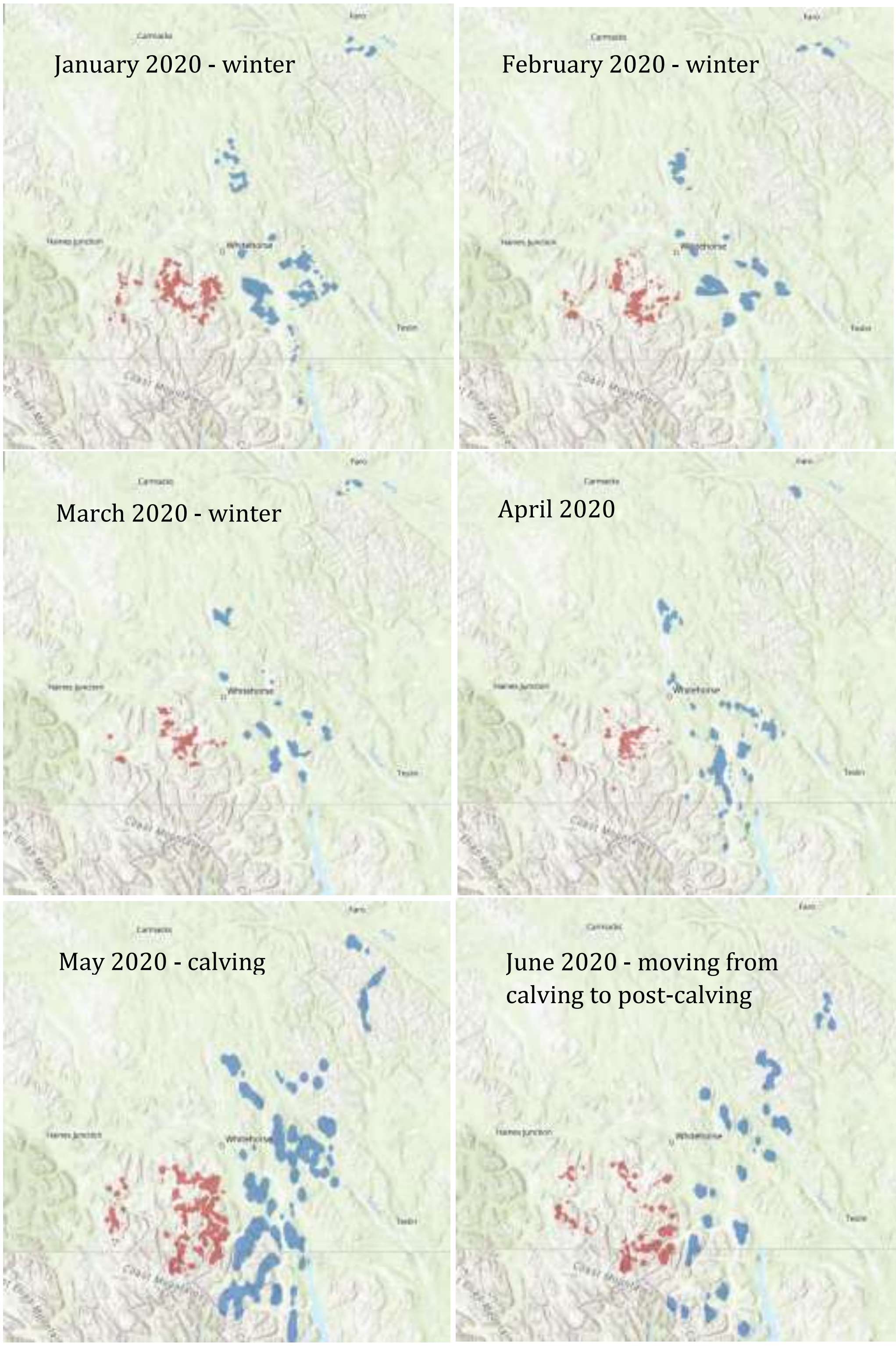


Figure 3-4: Ibex (red) and Carcross/Laberge (blue) Herd Collar Distributions January 2020 – June 2020 (Source: Environment Yukon, 2020)

4. CARIBOU MOVEMENT CORRIDORS

4.1 R6-4

Provide a discussion of habitat connectivity from late winter to calving and post-calving habitat that:

a. Discusses barrier effects for caribou due to roads and project location.

b. Discusses known migration corridors in the project area.

c. Contemplates any proposed mitigation measures and their effectiveness.

a) Barrier effects for caribou can result from physical barriers, sensory barriers and changes to landscape/habitat. Physical barriers include snowbanks that are too high with no regular breaks, and project infrastructure such as buildings, tailings and waste rock storage areas. Sensory barriers can result from areas with increased human presence and activity. Changes in landscape, such as cut lines and roads, can also act as a barrier to caribou particularly when traffic volumes are high. These barriers and zones of influence were discussed in Section 13.4.1.1 of the Project Proposal (BMC, 2017a) as follows:

"*some potential indirect impacts to caribou are noise, human presence, linear disturbance, and dust deposition. In addition, movement corridor avoidances have been documented reducing habitat use in response to disturbances at distances of 250 m to 14 km (Dyer et al., 2001; Polfus et al., 2011; Boulanger et al., 2012). The distance of the response varies by species and/or ecotype (e.g., mountain versus woodland versus barren ground), terrain, vegetation types, and intensity and frequency of disturbance. Much of this research is based on the boreal population of woodland caribou or barren ground caribou whose ecology differs from NMP woodland caribou (Fuller and Keith, 1981; Bradshaw et al., 1995; Mallory and Hillis, 1998; Gray, 1999; Dzus, 2001; McLoughlin et al., 2003). Boreal caribou are sensitive to stresses caused by human encroachment and are declining throughout most of their range (Ferguson and Gauthier, 1992; Bradshaw et al., 1995; Rettie and Messier, 1998; Dyer et al., 2001; Oberg, 2001; Vors and Boyce, 2009). Conversely, NMP caribou occur in diverse multiple predator-prey systems, exhibit gregarious behaviour, and make extensive use of open, upland habitats. There is less known about potential adverse effects to NMP caribou from anthropogenic disturbance and results from research on boreal or barren-ground caribou in other parts of Canada may not be entirely applicable to NMP caribou.*

A study performed on the Atlin herd of NMP caribou found the zone of influence (ZOI) around the town of Atlin, B.C. (population 350) was 9 km in winter and 3 km in summer (Polfus et al., 2011). The study also found a high use road had a ZOI of 2 km in both summer and winter, a low use road 1 km in both summer and winter, and a mine had ZOI of 0.25 km in winter and 2 km in summer. Avoidance was linked to the seasons and the magnitude of the activity (e.g., busy roads were avoided by 2 km, less travelled roads were avoided by 1 km) (Polfus et al., 2011). While caribou avoided roads similarly across seasons, the ZOI around the mine and town differed across seasons. Weir et al. (2007) examined a mine project in Newfoundland that is comparable to the proposed Project, providing relatively comparable information regarding caribou distribution before and after mine construction, and before and during mine operation. They detected up to 36% reduction in caribou distribution within 4 km of the mine site during late winter (Weir et al., 2007)."

Based on the known information on effects from roads and mines, the Project's Access Road may result in some avoidance, but will not be a barrier given that it is only 24 km in length and will have relatively low traffic levels. It is also expected that there will be some avoidance, but caribou will move around the Project to their seasonal grounds. Therefore, it is expected that caribou will be able to transit across the Access Road and around the Project and habitat will maintain connectivity between wintering, calving, post-calving, and rutting areas. The mitigation measures presented in Section 18.7.3 of the Project Proposal (BMC, 2017a) will be employed to minimize effects along the Access Road and will minimize effects on caribou movement for all movement periods.

b) Information Request R183a requested: "*Provide additional information on Project interactions and effects with caribou in the context of each of the following parameters: a. Migration*"

As per BMC's response to this request (BMC, 2017b):"*use of specific migration paths in the study area are not presented because they are unknown at this time. Providing observations at this level would require intense study (collaring animals, camera traps, high intensity aerial survey, frequent track counts, etc.) beyond the scope of environmental assessment studies and would be unprecedented. More specific regular movement pathways in relation to the Project area will become apparent during the operational phase of the Project from incidental observations on the road and around the operation. Large scale migratory use of the area is clearly evident from range use maps that are provided in Chapter 3 of the Wildlife Baseline Report, Appendix E-8 of the Project Proposal. Detailed use by individuals and groups of caribou remains indefinable*."

To further address questions regarding indirect effects on migration, response R2-85 (BMC, 2017c) stated, *"…specific migration paths in the study area are not presented because they are unknown at this time (Farnell, pers. comm., 2017). Providing observations at this level would require intense study (camera traps, high intensity aerial survey, frequent track counts, etc.) beyond the scope of environmental assessment studies and would be unprecedented. Nonetheless, it can be inferred that the caribou move across the landscape between the Pelly River and Finlayson lowlands wintering grounds and their montane calving and rutting grounds based on extensive knowledge and surveys of the FCH (Farnell, pers. comm., 2017)."*

YESAB accepted the responses in January 2018 when the Project Proposal was deemed adequate.

From other studies, woodland caribou have been found to move quickly from wintering lowlands through valleys with shallower snow depths to higher elevation calving sites. The migration patterns of caribou herds vary and most herds do not follow regular migration patterns (Gullickson and Manseau, 2000).

As seen in Figure 3-3 and Figure 3-4 for the neighbouring Ibex and Carcross/Laberge herds, the Northern Mountain Populations of woodland caribou do not follow regular migration routes. BMC is interested in the results from the Southern Lakes caribou collaring studies and how results may inform the understanding of the FCH movements in their range. Historic collar data from the FCH was limited but did not identify any regular movement corridors. RRDC does not currently support collaring of caribou of the FCH. If future collaring programs are acceptable, there may be an opportunity to complete additional monitoring and modeling using methodologies similar to those by Saher and Schmiegelow (2005) to determine movement patterns. Nonetheless, BMC's mitigation measures presented in the Wildlife Protection Plan in Appendix J of Response #2 (BMC, 2017c) include mitigation measures to minimize impacts on movement patterns for the Access Road and Project infrastructure.

c) Mitigation measures developed for the Project to address potential impacts on the FCH are tied to the caribou's annual cycle of habitat use and movement. The mitigation measures were presented Chapter 13 of the Project Proposal (BMC, 2017a), in response to R184 (BMC, 2017b), the Wildlife Protection Plan (Appendix J of Response #2 (BMC, 2017c), and were more recently summarized in Table 6-1 of Response Report #5 (BMC, 2020). The Wildlife Protection Plan will form part of the Quartz Mining Licence. Figure 4-1 illustrates these mitigations through the annual cycle. During the main movement periods in spring and late fall, potential impacts from the Project include mortality from vehicle collisions and disturbance of movement patterns. Proposed mitigations to minimize these impacts include controlled access, enforced speed limit, protocols for caribou on road (stop until caribou clear from road), snow management and reduced traffic by using convoys or leaving longer periods without traffic, and avoid travel at dawn /dusk. In addition, high use crossing locations will be identified and additional measures taken with signage and training to slow traffic and alert drivers to the risk in these areas.

The mitigation measures were developed to minimize the interaction of the Project with the caribou and are also based on measures implemented on other projects that have been found to be effective. For example, management of snowbank height to less than 0.5 m resulted in the road not being a barrier for caribou crossing at the Ekati mine in the Northwest Territories (Rescan, 2012).

An adaptive management approach as presented in the Wildlife Protection Plan in Appendix J of Response #2 (BMC, 2017c) is also proposed to monitor effectiveness of mitigation measures and determine if changes are required to improve effectiveness. Response to R3-8 (BMC, 2018a) provided adaptive management measures to address the effectiveness of mitigation measures. For caribou movement, monitoring will include aerial surveys, wildlife records program and incident reporting. If there are changes in the FCH distribution from aerial surveys (statistically significant change in distribution based on year on year analysis of distribution of groups and individuals relative to the Project; and review of the number and types of caribou encounters and incidents over time). An analysis will be done to assess if the reduction of sightings is due to reduced reporting, and if so the wildlife recording program will be strengthened. If the root cause is traffic, traffic patterns will be modified to allow for longer periods without traffic during movement periods.

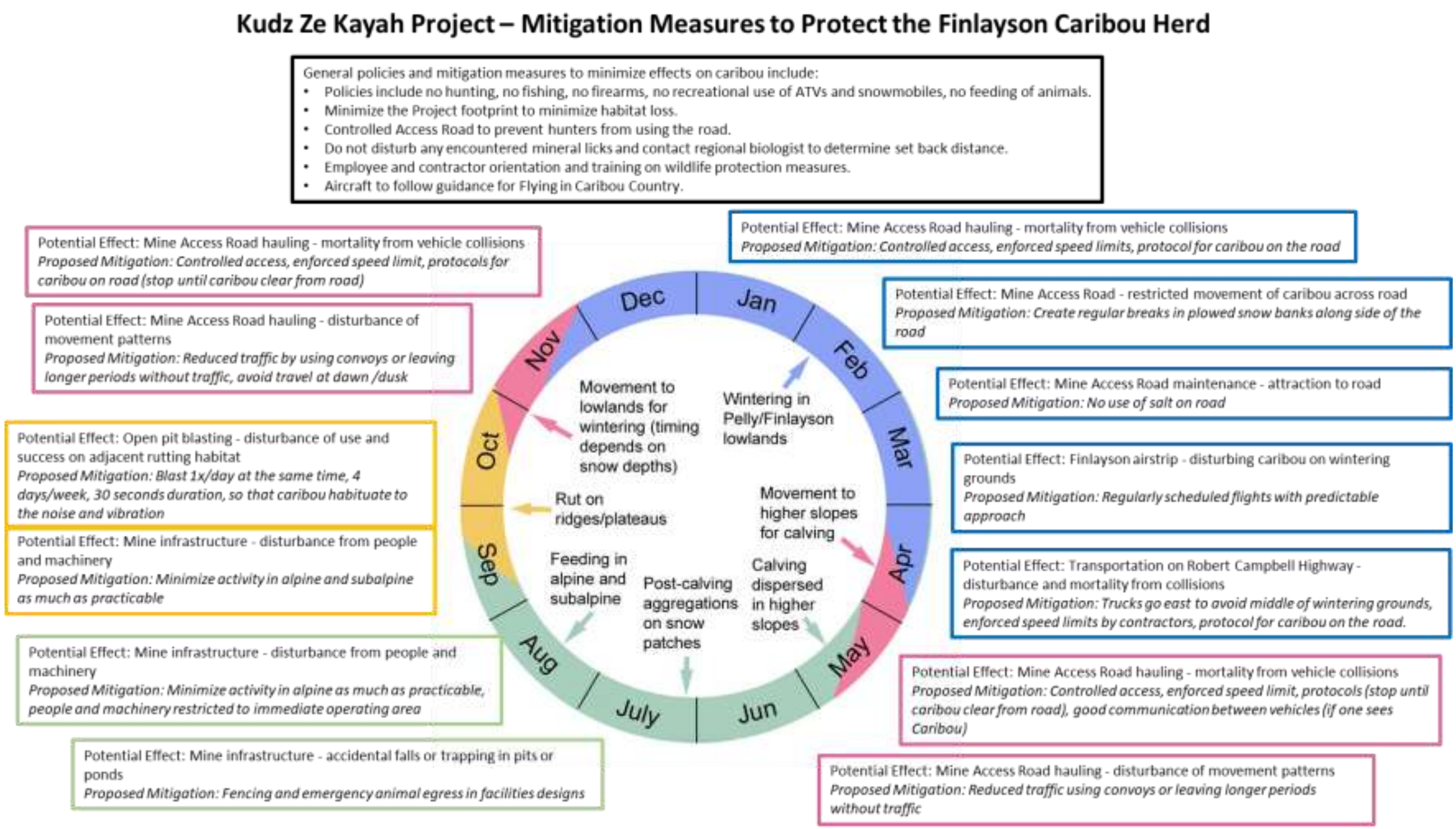


Figure 4-1: Kudz Ze Kayah Project – Mitigation Measures to Protect the Finlayson Caribou Herd

5. OBSERVATIONS IN PROXIMITY TO THE PROJECT

5.1 R6-5

Provide estimated density of caribou during rut surveys within the 1, 2 and 3 km distance ranges from the project, in addition to the number of groups, count of individuals, and their average group sizes.

As presented in the response to Information Request R198 (BMC, 2017b): "*It is acknowledged that caribou density can be a useful metric to describe caribou distribution. However, the radii to outer distance of concentric circles are not uniform and varied in topography; therefore, simple density does not accurately compare densities at distance from the Project. A visual estimation of observations (which cannot be published, at the request of Yukon Government and as per BMC's data sharing agreement with Yukon Government) indicates that densities in the FCH's preferred habitats are very similar in each of the zones which would not be fully reflected by density metrics*." In other words, each concentric ring is not of uniform density, but includes areas with high densities of individuals where the habitat has high suitability and low densities of individuals where the habitat has low suitability. Table 5-1 presents a summary of percent distribution of individuals and groups of caribou within 1, 2, 3, 5, 10 and 15 km distance ranges from the Project, based on data collected from 1982 to 2019. Figure 5-1 shows the respective distances extending out from the Project.

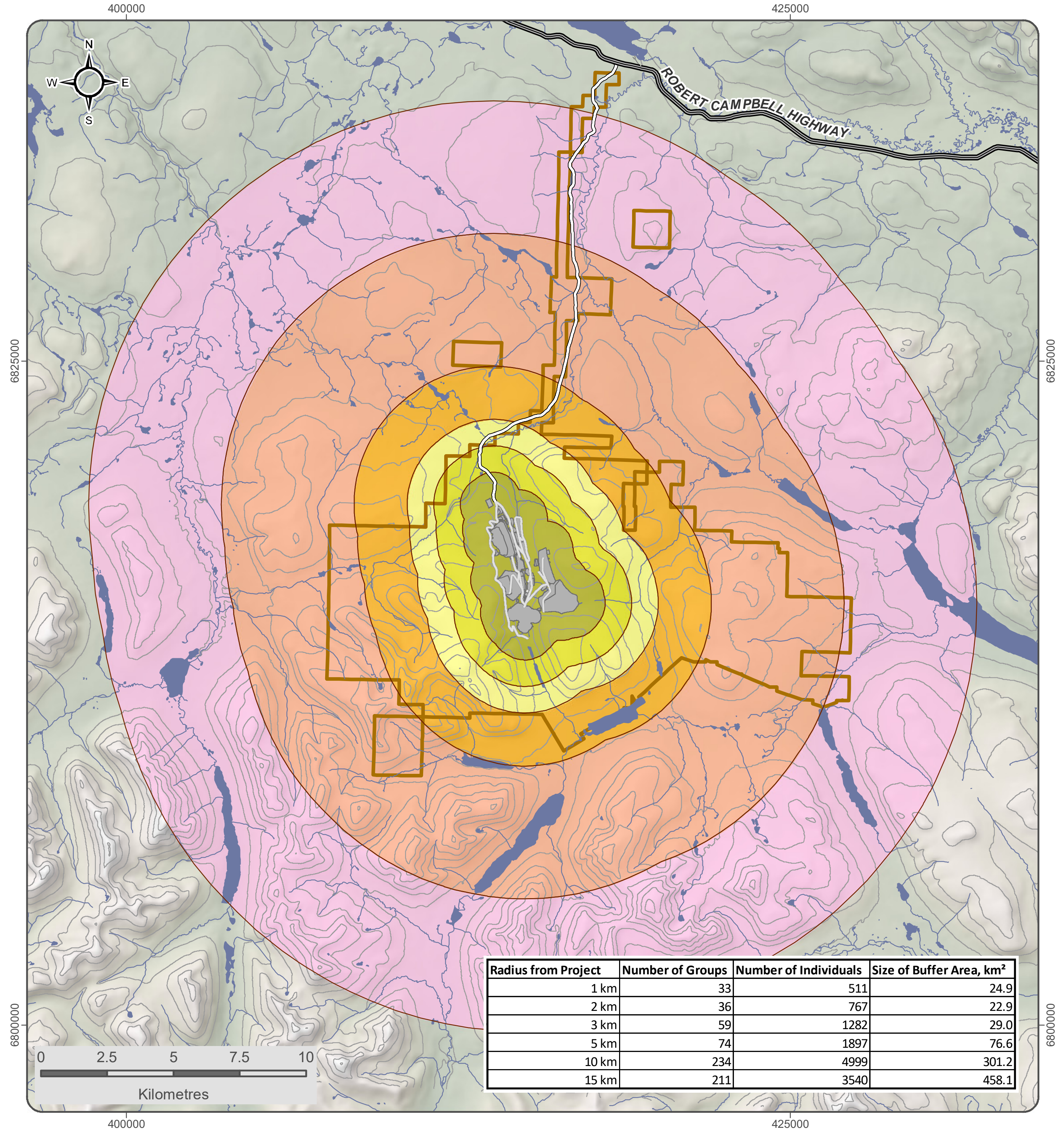
To understand the distribution of densities of caribou during the rut surrounding the Project, the best representation is the caribou rut habitat suitability map from Figure 13-9 of Chapter 13 of the Project Proposal (BMC, 2017a), updated in Response Report #5 (BMC, 2020) and reproduced here as Figure 5-2. The Project is located in the Geona Creek Valley with moderately suitable rut habitat. Higher caribou densities are found in high suitability rut habitat on the mountains to the east and west of the Project. Note that higher densities correlate well with the high suitability rut habitat shown throughout the FCH range which was presented in Figure 13-8 of Chapter 13 of the Project Proposal (BMC, 2017a) and reproduced here in Figure 5-3. The distribution of individuals and groups continues to be the same relative to distance from the Project as shown in Figure 5-4 and Figure 5-5, which are updates to Figures 3-9 and 3-10 from Appendix E-8 of the Project Proposal (BMC, 2017a) and are also updates to Figures 2-4 and 2-5 of Response Report #5 (BMC, 2020).

Note that the Project infrastructure ranges in elevation from 1300 masl and 1550 masl, which is lower than the highest suitability rut habitat which ranges from 1500 masl to 1800 masl (Appendix B of Appendix E-8 of the Project Proposal, BMC, 2017a).

Table 5-1: Caribou Distribution at Varying Distances from the Project During Rut Surveys

Distance from the Project	Area of ring (km^2)	Number of data points from 1982 to 2019 per km^2; note this is not a density of individuals in any given year and not evenly distributed)	Percent of Groups of the FCH	Percent of Individuals of the FCH	Mean Group Size
Project to 1 km	24.9	20.5	1%	1%	15.5
1 km to 2 km	22.9	33.5	2%	2%	21.3
2 km to 3 km	29	44.2	2%	3%	21.7
3 km to 5 km	76.6	24.8	3%	4%	25.6
5 km to 10 km	301.2	16.6	10%	12%	21.4
10 km to 15 km	458.1	7.7	9%	8%	16.8

Note: Density of actual animals in any given year cannot be inferred from these data. Data points are a culmination of observations in the database over the period from 1982 to 2019.



Radius from Project	Number of Groups	Number of Individuals	Size of Buffer Area, km²
1 km	33	511	24.9
2 km	36	767	22.9
3 km	59	1282	29.0
5 km	74	1897	76.6
10 km	234	4999	301.2
15 km	211	3540	458.1

1 Kilometre Buffer
2 Kilometre Buffer
3 Kilometre Buffer
5 Kilometre Buffer
10 Kilometre Buffer
15 Kilometre Buffer
Location of Proposed Infrastructure
BMC Minerals (No.1) Ltd. Mineral Claim Areas
Waterbody
Watercourse
Tote Road/Proposed Access Road
Proposed Mine Road
Contour (120 m interval)

KUDZ ZE KAYAH PROJECT

FIGURE 5-1

NUMBER OF CARIBOU OBSERVED DURING RUT SURVEYS IN VARYING ZONES OF INFLUENCE

Datum: NAD 83; Projection: UTM Zone 9N

BMC MINERALS

JULY 2020

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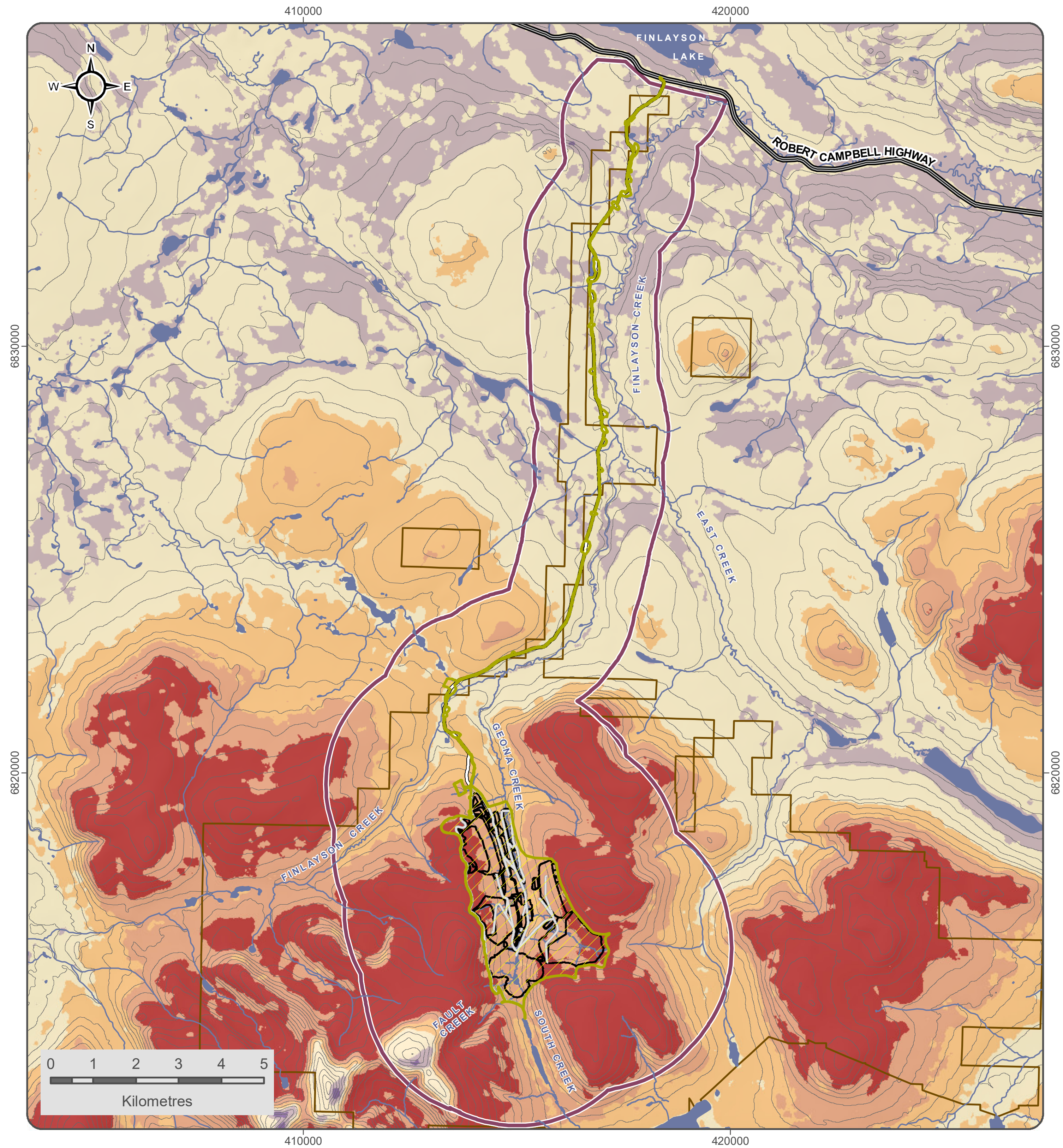

HABITAT SUITABILITY INDEX

- Nil
- Very Low
- Low
- Moderate
- Moderately High
- High

- Tote Road/Proposed Access Road
- Proposed Mine Road
- Direct Disturbance Area
- Local Study Area (Indirect Zone of Influence)
- Location of Proposed Infrastructure
- BMC Minerals (No.1) Ltd. Mineral Claim Areas

KUDZ ZE KAYAH PROJECT

FIGURE 5-2

RUT HABITAT SUITABILITY LOCAL STUDY AREA AND PROPOSED MINE FOOTPRINT

JULY 2020

Datum: NAD 83; Projection: UTM Zone 9N

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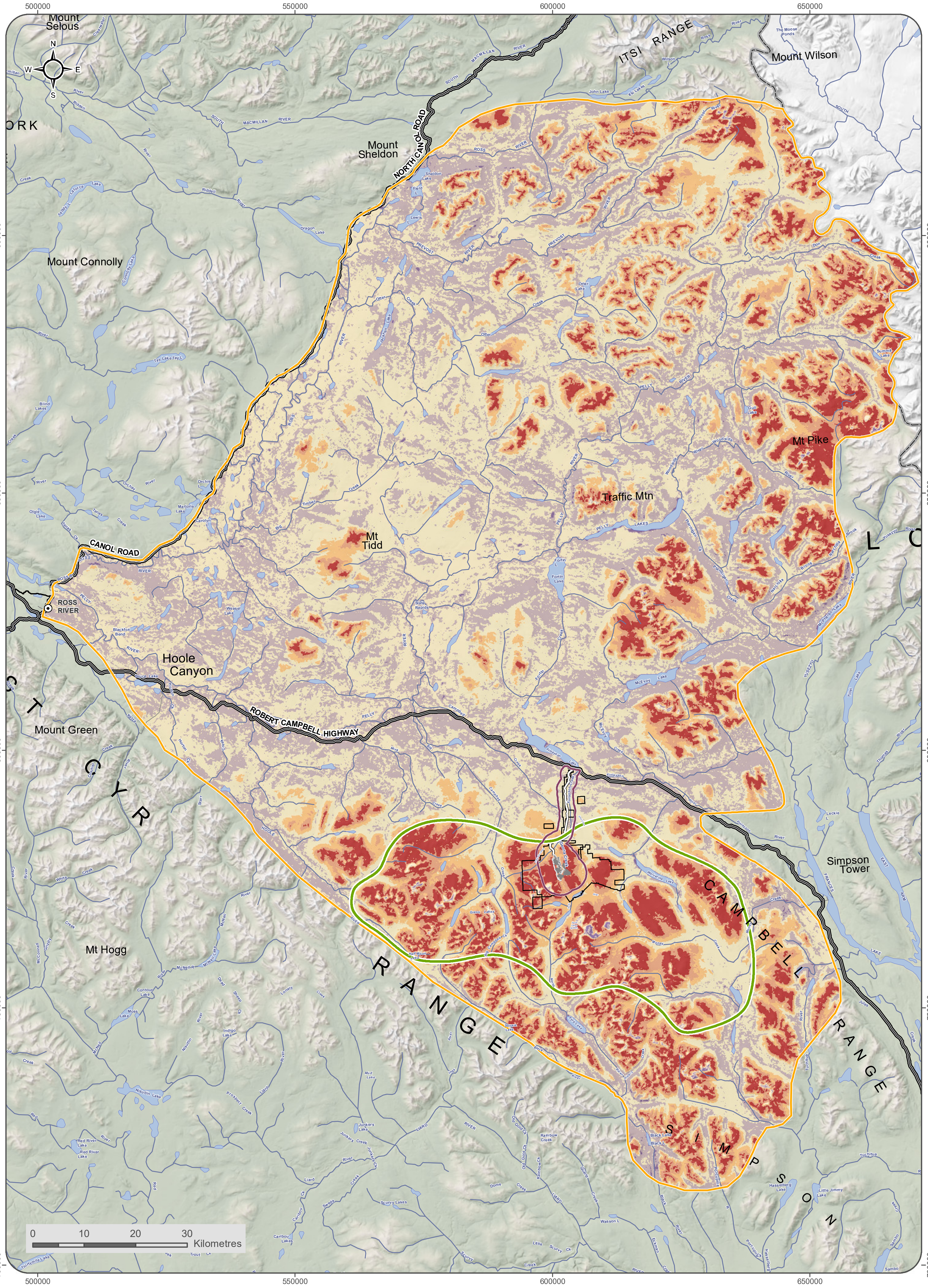

HABITAT SUITABILITY INDEX

- Nil
- Very Low
- Low
- Moderate
- Moderately High
- High

- Local Study Area (Indirect Zone of Influence)
- Caribou Rut Study Area
- Finlayson Caribou Herd Home Range
- BMC Minerals (No.1) Ltd. Mineral Claim Areas
- Location of Proposed Infrastructure

Contours, waterbodies and watercourses compiled by Natural Resources Canada at a scale of 1:50,000. Reproduced under license from Her Majesty the Queen, as represented by the Minister of Natural Resources Canada. All rights reserved.

Datum: NAD 83; Projection: UTM Zone 9N

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KUDZ ZE KAYAH PROJECT

FIGURE 5-3

FINLAYSON CARIBOU HERD RUT HABITAT SUITABILITY HOME RANGE AND REGIONAL STUDY AREA

JULY 2020

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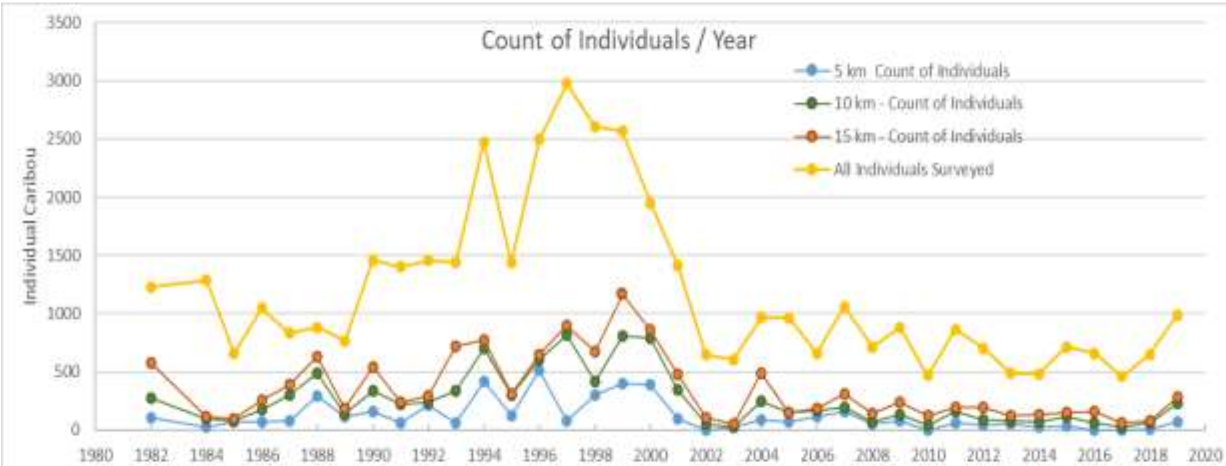


Figure 5-4: Number of Caribou Observed per Year During Rut Surveys at Varying Distances from the Project

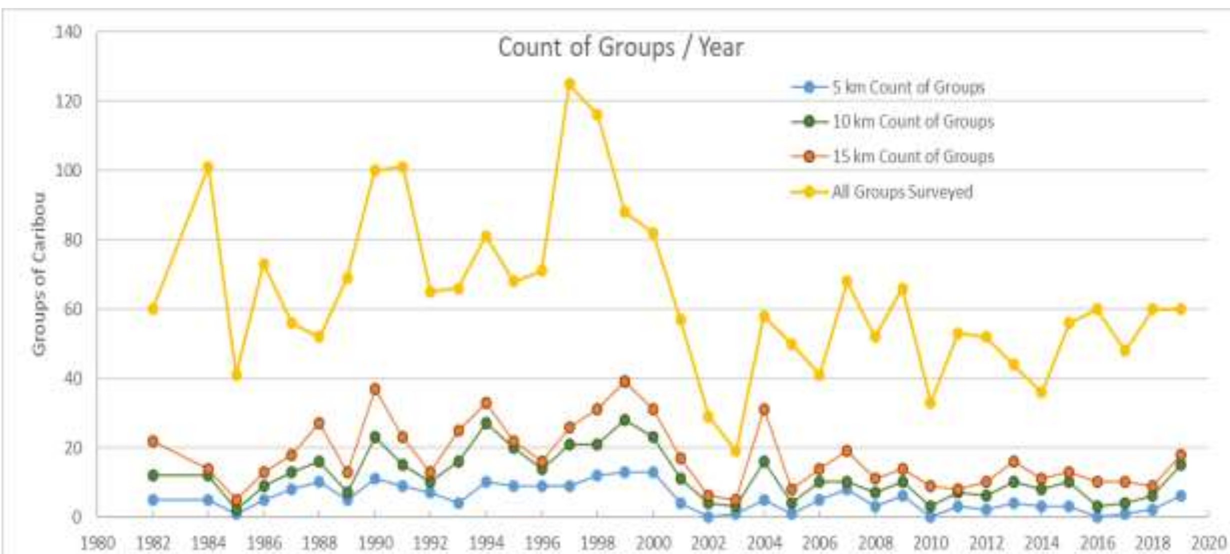


Figure 5-5: Number of Caribou Groups Observed per Year During Rut Surveys at Varying Distances from the Project

5.2 R6-6

Discuss the implications of any differences in density across each buffer (1, 2, 3, 5, 10, and 15km) on potential project effects.

Density rings were presented for the rut period in the Project Proposal (BMC, 2017a), updated in Figure 2-6 of Response Report #5 (BMC, 2020), and summarized in Table 5-1 to display data without showing individual locations. As per BMCs data sharing agreement with Yukon Government, BMC is not permitted to share specific caribou rut location data. Table 5-1 (above) presents the relative densities of caribou in each of the distances out from the Project. Although, as discussed above, these are not actual densities since these are total caribou observed over the surveys from 1982 to 2019.

The distribution of densities is better represented by the habitat suitability maps where the higher densities are seasonally located in high suitability habitat and low densities in low suitability habitat. Rut habitat suitability maps were developed from actual caribou occurrence on specific habitat attributes of elevation, slope, aspect, and vegetation cover. The majority of the Project footprint in located in the Geona Creek valley bottom and lower slopes in elevation from 1300 metre above seas level (masl) and 1550 masl, which is lower than the highest suitability rut habitat which ranges from 1500 masl to 1800 masl (Appendix B of Appendix E-8 of the Project Proposal, BMC, 2017a). And in the LSA, high suitability rut habitat is located on the higher mountain plateaus to the northeast and southwest of the Project in the areas shown in Figure 5-2 and Figure 5-3. These plateaus are only part of the rut habitat range that covers the surrounding Pelly Mountains in the southern part of the FCH range and rut habitat on mountains in the north part of the FCH range.

6. SENSITIVITY OF EFFECTS PREDICTIONS

6.1 R6-7

Provide a sensitivity analysis for the predictions of direct and indirect habitat loss from models of caribou habitat suitability that considers sensitivity to:

a. Removal of the 50% down-weighting for indirect habitat loss.

b. Inclusion of a wider range of habitat classes beyond moderately high and high quality.

c. Consideration of a wider range of buffer (Zone of Influence) distances, including 4, 5, 10 and 15 km on the project area and roads.

a) Table 6-1 and Table 6-2 present the resulting rut and post-calving habitat within a range of zones of influence from Project infrastructure, specifically 3 km, 4 km, 5 km, 10 km, and 15 km. Following the methodology of the Project Proposal, the zones of influence around the Access Road were half that for the Project infrastructure. The 50% down weighting for indirect habitat loss was only for species with a 300 m zone of influence. Caribou indirect habitat loss was not down weighted in Chapter 13 of the Project Proposal (BMC, 2017a).

b and c) Table 6-1 and Table 6-2 present the areas and relative percentages of habitat of each suitability class of rut and post-calving habitat within the zones of 3, 4, 5, 10, and 15 km. These zones relative to suitable habitat classes for rut and post-calving are illustrated in Figure 6-1 and Figure 6-2. Moderately high and high suitability habitat classes were included in the calculation of potentially disturbed habitat in Section 13.4.1.1 the Project Proposal (BMC, 2017a) since the majority of caribou observations occur within the moderately high and high suitability habitat classes. As presented in response to Information Request R254 (BMC, 2017b), inclusion of additional classes of habitat suitability increased the area potentially affected but resulted in only small changes in the relative percentages of habitat potentially affected.

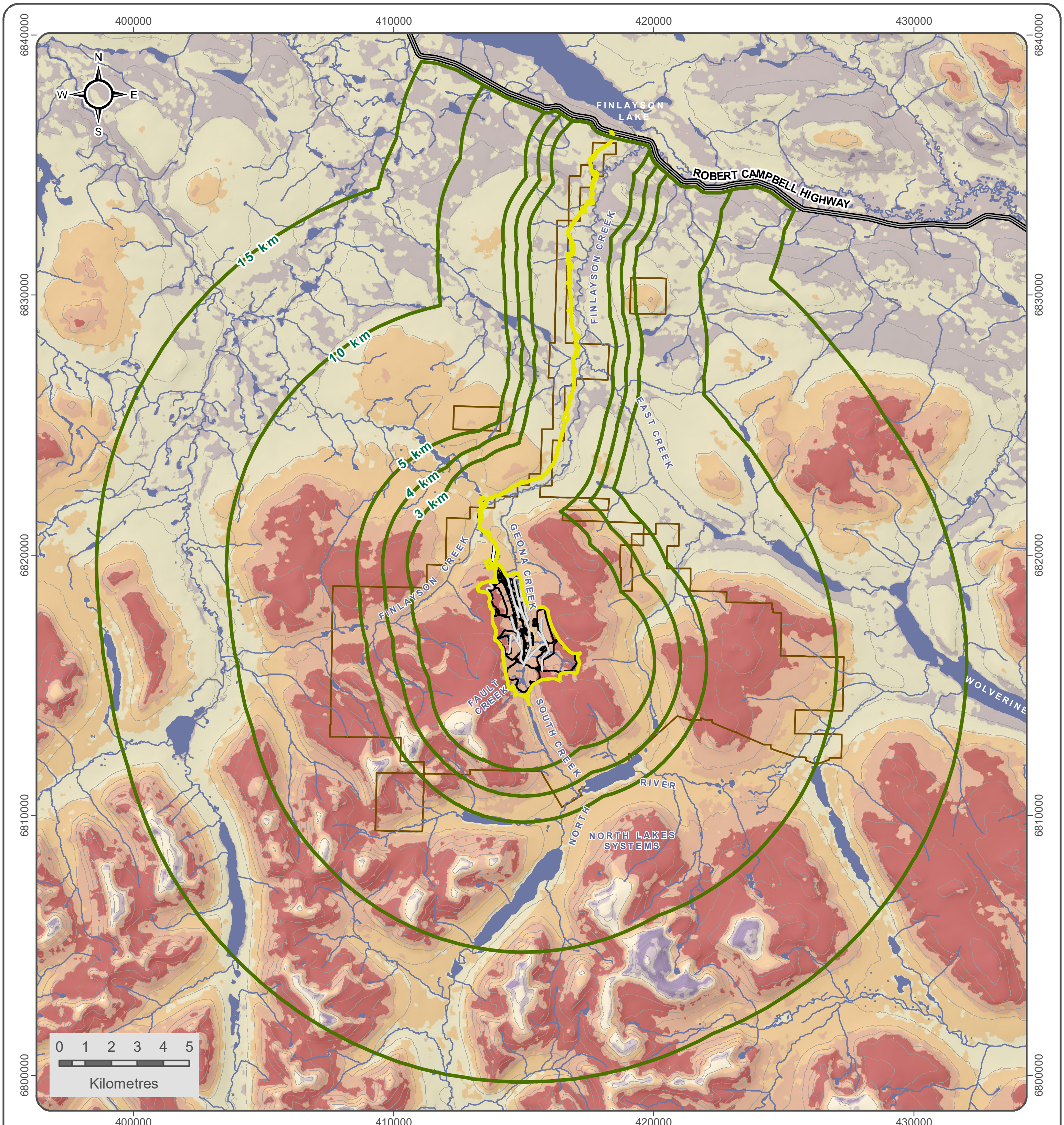
As presented in response to Information Requests R253 and R254 (BCM, 2017b), with respect to the addition of moderate suitability rut and post-calving habitat: "*The exclusion of moderate and low suitability habitat for the assessment of magnitude carries very little risk for underestimating potential effects. For caribou, the loss in rut habitat decreases from 3.0% to 2.8% and the loss in post-calving habitat increases from 1.8% to 2.2% in the zone of influence (regional study area for caribou) with the inclusion of moderate suitability habitat*."

From the range of zones requested to be evaluated, the percentage of moderate to high suitability rut habitat relative to similarly suitable rut habitat in the FCH home range increases from 4% within 3 km from the Project to 7% at 5 km to 28% at 15 km. Similarly, for moderate to high suitability post-calving habitat, the percentages in the zones evaluated increase from 4% within 3 km from the Project to 6% at 5 km to 29% at 15 km. However, it is noted that the zone of influence of 3 km around the Project infrastructure and 1.5 km on either side of the Tote Road was chosen based on literature presented in Section 13.4.1.1 of the Project Proposal (BMC, 2017a) which said:

> "*A study performed on the Atlin herd of northern woodland caribou found the zone of influence (ZOI) around the town of Atlin, B.C. (population 350) was 9 km in winter and 3 km in summer (Polfus et al., 2011). The study also found a high use road had a ZOI of 2 km in both summer and winter, a low use road 1 km in both summer and winter, and a mine had ZOI of 0.25 km in winter and 2 km in summer. Avoidance was linked to the seasons and the magnitude of the activity (e.g., busy roads were avoided by 2 km, less travelled roads were avoided by 1 km) (Polfus et al., 2011). While caribou avoided roads similarly across seasons, the ZOI around the mine and town differed across seasons. Weir et al. (2007) examined a mine project in Newfoundland that is comparable to the proposed Project, providing relatively comparable information regarding caribou distribution before and after mine construction, and before and during mine operation. They detected up to 36% reduction in caribou distribution within 4 km of the mine site during late winter (Weir et al., 2007).*"

Further, the Project noise modeling has been overlaid with the range of YESAB's requested zones and is presented in Figure 6-3. As can be seen, the noise levels (during the approximate 10 year Operations phase of the Project) are only expected to extend out to 1 km from the Project infrastructure footprint, after which they return to baseline levels, this is well within the 3 km zone of influence used in the Project Proposal (BMC, 2017a). BMC maintains that the expected magnitude of impacts is low and geographic extent is low as presented in Table 13-31 of the Project Proposal (BMC, 2017a). The seasonally-sensitive mitigation measures illustrated in Figure 4-1 and detailed in the Wildlife Protection Plan in Appendix J of Response #2 (BMC, 2017c) and summarized in Table 6-

1 of Response Report #5 (BMC, 2020) will be implemented to minimize disturbance of caribou using habitat in the Project area and the monitoring and adaptive management plan will be implemented to ensure the mitigations are effective at minimize impacts.



HABITAT SUITABILITY INDEX

- Nil
- Very Low
- Low
- Moderate
- Moderately High
- High

- Zone of Influence
- Direct Disturbance Area
- Location of Proposed Infrastructure
- BMC Minerals (No.1) Ltd. Mineral Claim Areas
- Tote Road/Proposed Access Road
- Proposed Mine Road
- Contour (100m interval)

Zone of Influence was calculated using 3km, 4km, 5km, 10km Buffer around Proposed Infrastructure Footprints and half the distance around Tote Road/Proposed Access Road

Datum: NAD 83; Projection: UTM Zone 9N

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KUDZ ZE KAYAH PROJECT

FIGURE 6-1

RANGE OF ZONES OF INFLUENCE FROM PROJECT FOR FCH RUT HABITAT SUITABILITY

JULY 2020

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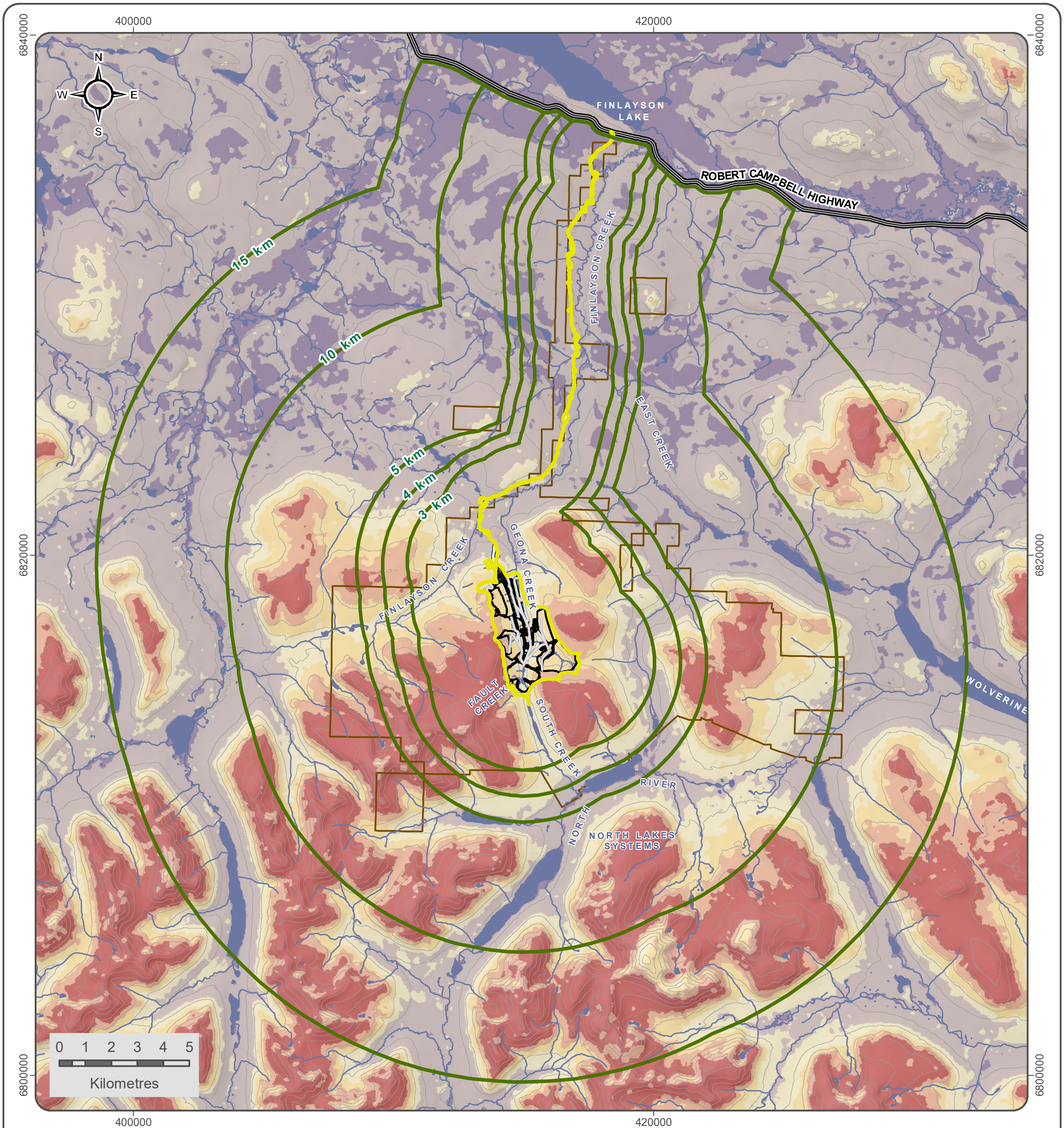

HABITAT SUITABILITY INDEX

- Nil
- Very Low
- Low
- Moderate
- Moderately High
- High

- Zone of Influence
- Direct Disturbance Area
- Location of Proposed Infrastructure
- BMC Minerals (No.1) Ltd. Mineral Claim Areas
- Tote Road/Proposed Access Road
- Proposed Mine Road
- Contour (100m interval)

Zone of Influence was calculated using 3km, 4km, 5km, 10km Buffer around Proposed Infrastructure Footprints and half the distance around Tote Road/Proposed Access Road

KUDZ ZE KAYAH PROJECT

FIGURE 6-2

RANGE OF ZONES OF INFLUENCE FROM PROJECT FOR FCH POST-CALVING HABITAT SUITABILITY

JULY 2020

Datum: NAD 83; Projection: UTM Zone 9N

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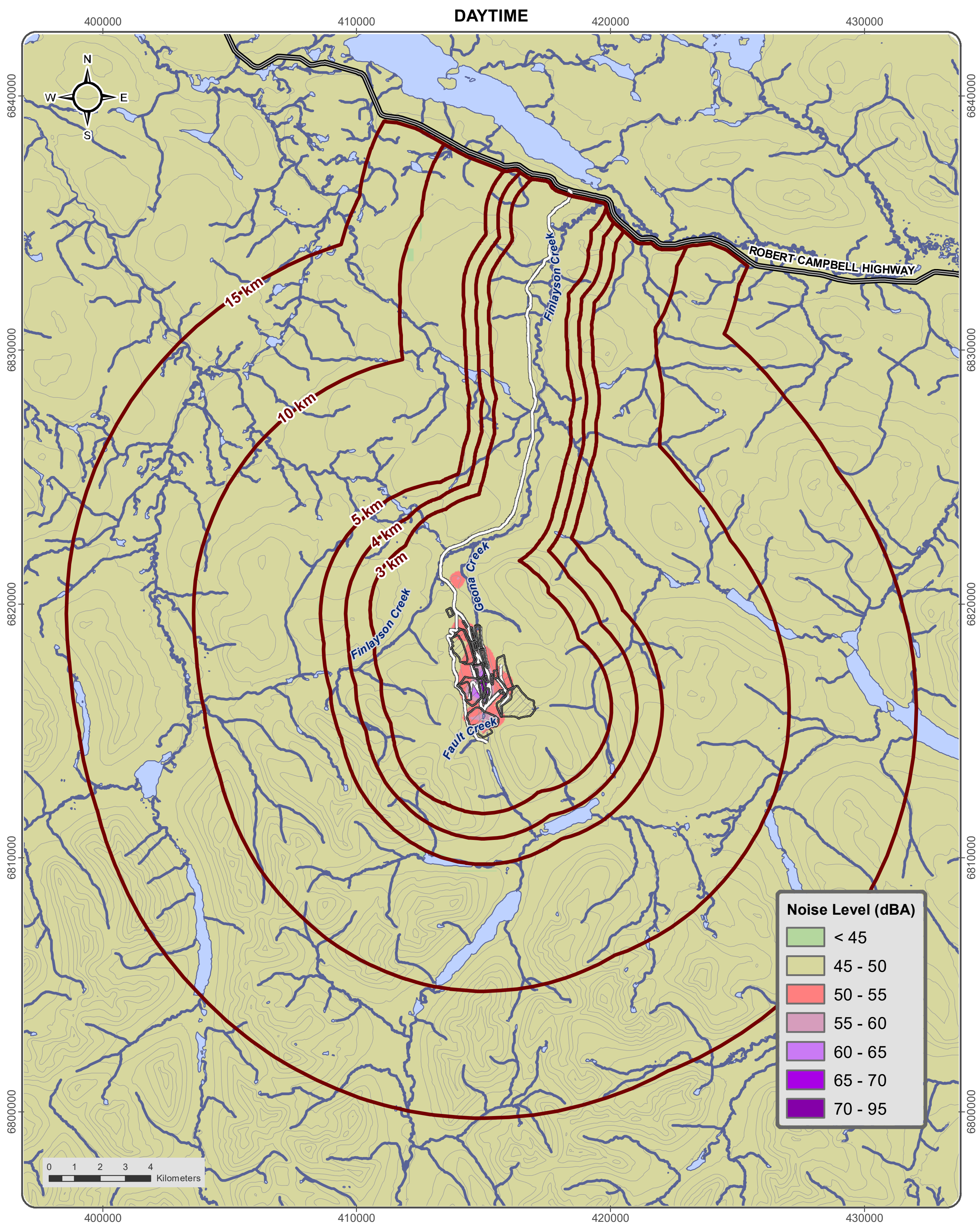

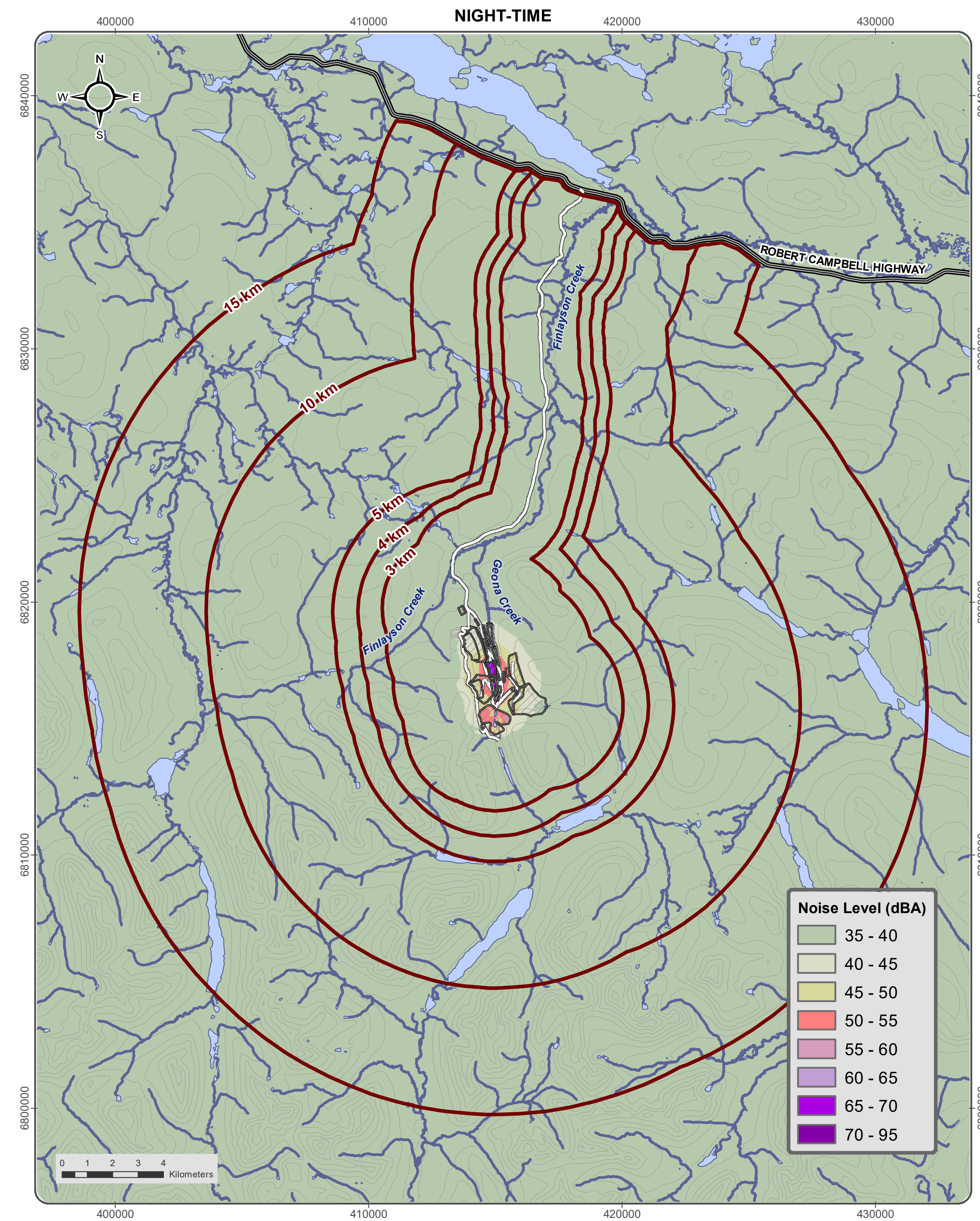

Distance Zone from the Project
Location of Proposed Infrastructure (Year Ten)
Tote Road/Proposed Access Road and Project Site Roads
Contour (100m interval)
Watercourse
Waterbody

Noise Levels Predictions shown on this map were produced with SoundPLAN Essential 3.0

Datum: NAD 83; Projection: UTM Zone 9N

Standard Noise Levels: Daytime - 50 dBA; Night-Time - 40 dBA

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KUDZ ZE KAYAH PROJECT

FIGURE 6-3

NOISE IMPACTS RELATIVE TO THE DISTANCE FROM THE PROJECT

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Table 6-1: Areas of FCH Rut Habitat within Varying Zones from Project

Habitat Suitability Index	FCH Home Range (HR)		FCH Rut Range		Directly Affected by Project Footprint				3 km Zone (1.5 km from Tote Road)			
	Area (ha)	%	Area (ha)	%	Area in HR	% of FCH HR	Area in Rut Range	% of Rut Range	Area in HR	% of FCH HR	Area in Rut Range	% of Rut Range
Nil	17,429	1%	1,066	1%	0	0%	0	0%	3	0%	2	0%
Very Low	569,618	28%	6,263	3%	4	0%	1	0%	1,059	0%	26	0%
Low	873,822	43%	31,326	16%	65	0%	120	0%	3,689	0%	604	2%
Moderate	214,961	11%	41,401	21%	135	0%	383	1%	2,152	1%	1,810	4%
Moderately High	190,802	9%	53,352	27%	572	1%	716	1%	2,458	1%	2,431	5%
High	170,564	8%	61,789	32%	220	0%	511	1%	3,109	2%	3,107	5%

Habitat Suitability Index	4 km Zone (2 km from Tote Road)				5 km Zone (2.5 km from Tote Road)			
	Area in HR	% of FCH HR	Area in Rut Range	% of Rut Range	Area in HR	% of FCH HR	Area in Rut Range	% of Rut Range
Nil	3	0%	2	0%	7	0%	6	1%
Very Low	1,343	0%	29	0%	1,674	0%	129	2%
Low	4,819	1%	755	2%	6,460	1%	1,423	5%
Moderate	3,380	2%	2,844	7%	4,826	2%	3,932	9%
Moderately High	3,400	2%	3,373	6%	4,141	2%	4,115	8%
High	3,952	2%	3,950	6%	4,703	3%	4,709	8%

Habitat Suitability Index	10 km Zone (5 km from Tote Road)				15 km Zone (7.5 km from Tote Road)			
	Area in HR	% of FCH HR	Area in Rut Range	% of Rut Range	Area in HR	% of FCH HR	Area in Rut Range	% of Rut Range
Nil	27	0%	26	2%	540	3%	520	49%
Very Low	4,142	1%	910	15%	9,280	2%	2,463	39%
Low	15,591	2%	4,604	15%	32,385	4%	11,160	36%
Moderate	11,899	6%	8,108	20%	18,408	9%	12,652	31%
Moderately High	10,128	5%	9,416	18%	15,901	8%	14,003	26%
High	11,366	7%	10,811	17%	18,806	11%	16,851	27%

Table 6-2: Areas of FCH Post-Calving Habitat within Varying Zones from Project

Habitat Suitability Index	FCH Home Range (HR)		FCH PC[1] Range		Directly Affected by Project Footprint				3 km Zone (1.5 km from Tote Road)			
	Area	%	Area	%	Area in HR	% of FCH HR	Area in PC Range	% of PC Range	Area in HR	% of FCH HR	Area in PC Range	% of PC Range
Nil	387,308	19%	1,221	1%	2	0%	0	0%	818	0%	0	0%
Very Low	1,079,333	53%	35,818	23%	61	0%	0	0%	4,836	0%	0	0%
Low	227,851	11%	24,459	15%	404	0%	0	0%	1,995	1%	0	0%
Moderate	103,859	5%	22,105	14%	392	0%	0	0%	1,627	2%	0	0%
Moderately High	102,407	5%	28,605	18%	129	0%	0	0%	1,183	1%	0	0%
High	136,213	7%	46,360	29%	7	0%	0	0%	2,011	1%	0	0%

Habitat Suitability Index	4 km Zone (2 km from Tote Road)				5 km Zone (2.5 km from Tote Road)			
	Area in HR	% of FCH HR	Area in PC Range	% of PC Range	Area in HR	% of FCH HR	Area in PC Range	% of PC Range
Nil	1,182	0%	0	0%	1,732	0%	299	25%
Very Low	6,570	1%	0	0%	8,974	1%	570	2%
Low	2,877	1%	1	0%	3,454	2%	624	3%
Moderate	2,173	2%	2	0%	2,595	2%	669	3%
Moderately High	1,652	2%	2	0%	2,017	2%	1,051	4%
High	2,443	2%	1	0%	3,038	2%	2,449	5%

Habitat Suitability Index	10 km Zone (5 km from Tote Road)				15 km Zone (7.5 km from Tote Road)			
	Area in HR	% of FCH HR	Area in PC Range	% of PC Range	Area in HR	% of FCH HR	Area in PC Range	% of PC Range
Nil	4,640	1%	299	25%	10,253	3%	330	27%
Very Low	21,630	2%	570	2%	40,144	4%	2,036	6%
Low	7,799	3%	624	3%	11,768	5%	1,752	7%
Moderate	6,025	6%	669	3%	9,120	9%	1,941	9%
Moderately High	5,180	5%	1,051	4%	8,920	9%	2,708	9%
High	7,878	6%	2,449	5%	15,115	11%	6,259	14%

[1]PC = Post-calving

7. CUMULATIVE EFFECTS

7.1 R6-8

Provide an analysis of cumulative disturbance in the Finlayson caribou herds' range that includes consideration of historic fire activity and human disturbance within the range. Describe model sensitivity to the date range used for fires incorporated into the model.

Cumulative effects on the Finlayson caribou herd were assessed in Section 13.5 of the Project Proposal (BMC, 2017a), R2-91 of Response #2 (BMC, 2017c) and Chapter 8 of BMC's Response to Information Request #4 (BMC, 2018b). The fire history in the Project area is presented in Section 3.1 and Figure 3-3 of the vegetation baseline, Appendix E-6 of the Project Proposal (BMC, 2017a).

The cumulative effects assessment presented in Section 13.5.1 the Project Proposal (BMC, 2017a) does not change significantly with the addition of burns because:

- The burns do not greatly affect key seasonal ranges since spring, summer, and fall habitat is mostly in higher elevations than the burns;
- The footprints of disturbance from exploration and mining projects were overestimated as the entire concessions within which activities occur periodically in a small proportion; and
- Burns are needed to renew lichens which is a key dietary requirement of the FCH.

Studies indicate variable response of caribou to burns. From Environment Canada, 2012, the Northern Mountain Population of woodland caribou may avoid burns for up to 60 years (Joly et al., 2003). Caribou are known to expand their range around burns and are also known to find forage within young stands of recent burns (Schaefer and Pruitt 1991; Thomas and Armbruster 1996). Fires are known to be necessary to reduce moss and renew lichen populations upon which the caribou browse (Klein 1982; Schaefer and Pruitt 1991).

The discussion on the cumulative effects on the FCH from Section 13.5.1.1 of the Project Proposal (BMC, 2017a) says:

> "*cumulative effects on the FCH were assessed based on a quantification of the zones of influence from the various projects and activities in the FCH's range* [Figure 7-1]*. This figure illustrates how the FCH range is bounded on the west by the North Canol road and the Town of Ross River, and partitioned north and south by the Robert Campbell Highway. Mineral properties of Fyre Lake, Wolverine, Pelly Exploration, and KZK influence caribou rut habitat (Figure 13 8* [from the Project Proposal, BMC, 2017a]) *in the FCH range south of the Robert Campbell Highway; the Selwyn mineral property influences rut habitat at the north end of the FCH range. Together, these activities influence approximately 12% (2,365 km²) of the FCH range (20,369 km²) after adding the direct footprints of the claims and roads and a 2 km avoidance zone supported by the study by Polfus et al. (2011). The Project and associated claims equates to 2% (375 km²) of the 12% cumulative disturbance in the FCH range. It should be noted that disturbance is conservatively based on claim boundaries since information is limited for specific footprints of*

disturbance. Actual footprints will be less, but this provides a coarse estimate to gauge relative and worst-case cumulative disturbance.

Other pressures on the FCH include First Nation, guided, and recreational hunting, which cannot be easily mapped; however, hunting has been found to generally occur in 1 km of roads (Daust and Morgan, 2013). The resulting magnitude of cumulative effect from habitat loss and fragmentation is considered low, less than 10% (referring back to Table 13-30) when actual footprints are considered rather than overly conservative mineral claim blocks.

It should also be noted that the human development is just part of the complex set of factors affecting the FCH population. Other major influencing factors include predation, annual weather variability (especially snow depth and distribution), and climate change. Predation is known to be one of the most significant factors affecting the FCH population given the results from the wolf control program discussed earlier in Section 13.3.1 [when the FCH population doubled as a result of the wolf cull from 1983 to 1989]. As discussed earlier in Section 13.4.1.1, the available habitat could support a larger herd; therefore, the incremental increase of development of the Project is not expected to be a large contributor to cumulative effects on the FCH. Causes of population change appear to be less likely attributed to habitat losses than to predator and climate changes. A consistent monitoring program (led by Yukon Government) over time would help track variations in the population and give clues to the causes of population changes."

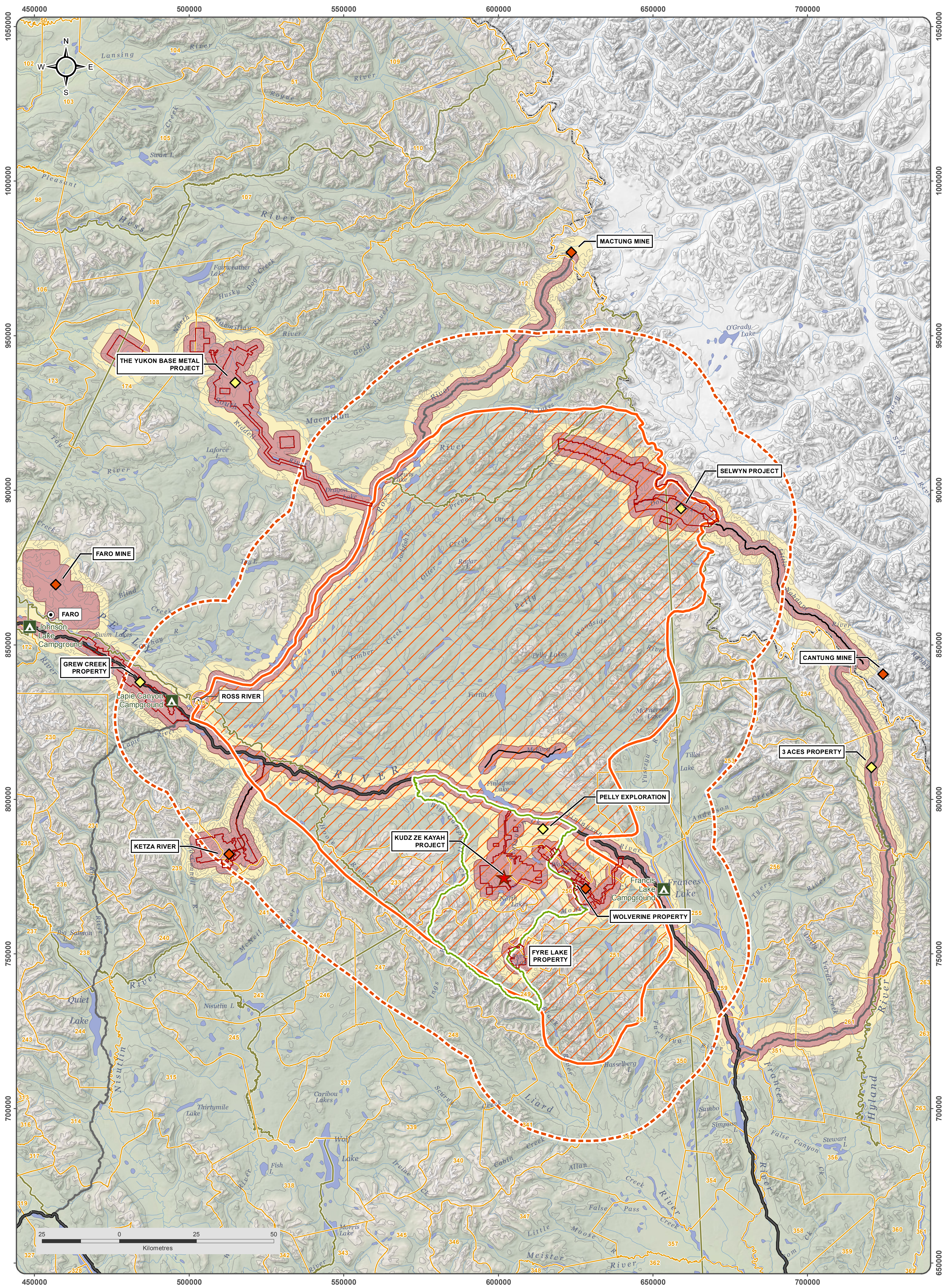
The oldest available records on fires is the 1950s. Indicators of older forest fires are evident from burn scars, charcoal in soil pits and distinctive age classes between sub-alpine fir (90 years old) and surviving veteran white spruce (>150 years old).

Looking at the burn areas with respect to the cumulative effects, Figure 7-2 shows the overlap of the FCH range with anthropogenic disturbance (from Figure-13-20 of the Project Proposal, BMC, 2017a), the historic fires in the range (from Figure 3-3 of Appendix E-6 of the Project Proposal, BMC, 2017a), and the FCH seasonal ranges (from Figure 1 of Appendix L of Response #2, BMC, 2017c. Figure 7-2 presents a summary of the areas of historic fires relative to the FCH range size.

The majority of historic burns have been near the North Canol Road, in some of the valleys and to the east of the FCH range along the Robert Campbell Highway. There are some 30, and 60-year old burns that overlap a small portion (3.5% and 8.3%, respectively) of the FCH winter range. There are some 20 and 30-year old burns that overlap the southeast post-calving range (1.2% and 1.5% overlap, respectively); however, these burns are mainly in the valleys and do not affect the higher elevation, preferred calving and post-calving habitat. There is little overlap of burns with the rut range (30-year old burn overlapping 1.0% and 80-year old overlapping 0.2% of the rut range). When averaged over each decade, approximately 2.8% of the FCH home range is affected by fires every decade, of which 2% is in the late winter range and less than 0.5% in the post-calving and rut ranges. If added onto the other anthropogenic effects in the FCH home range, and assuming habitat will regenerate over time following burns, the cumulative activities and natural disturbance of fires is expected, overall, to be low, below the 10% magnitude threshold of effects for the FCH range. Note that there is little direct anthropogenic disturbance, measured in the hundreds of hectares compared to the 20,369 km^2 area of the FCH home range.

A cumulative effects model of natural and anthropogenic changes over time was not determined to be necessary given the small amount of anthropogenic disturbances in this landscape. There is also expected to be little cumulative disturbance in each of the key seasonal habitats for the FCH. As presented in the discussion above, the anthropogenic disturbance estimates are very conservative; therefore, even with fire disturbance, the cumulative effects are still expected to be low magnitude, below 10% (as per the cumulative impact assessment methods presented in Chapter 5 of the Project Proposal) (BMC, 2017a).

Regarding the influence of forest fire on development of the habitat suitability models, there is little influence. The models included the variables of slope, aspect, and vegetation cover, plus precipitation for the late winter model. The habitat suitability modeling was based on caribou location data collected from 1982 to 2017. During this period, burns affected 3.6% of high suitability late winter range, 2.7% of post-calving range, and 1% of rut range (Figure 7-2). The suitability index for vegetation used the regional Predictive Ecosystem Mapping which was completed in 2013. Therefore, the influence of burns on the model development is expected to be low and would be difficult to measure for the level of accuracy of the model.



Kudz Ze Kayah Project	FCH Habitat Range	Quartz Mining Activity
Exploration/Licencing	FCH Habitat Range 25 km Buffer	Regional Study Area (Game Management Subzone 10-07)
Temporary Closure/Reclamation/Closed/ Abandoned	Potential Disturbance/Activity (5 km Buffer)	Trapline Concession
Community	Potential Disturbance/Activity (10 km Buffer)	Outfitting Concession
Campground		

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FIGURE 7-1
WILDLIFE CUMULATIVE EFFECTS ASSESSMENT AREAS AND PROJECT BOUNDARIES

OCTOBER 2018

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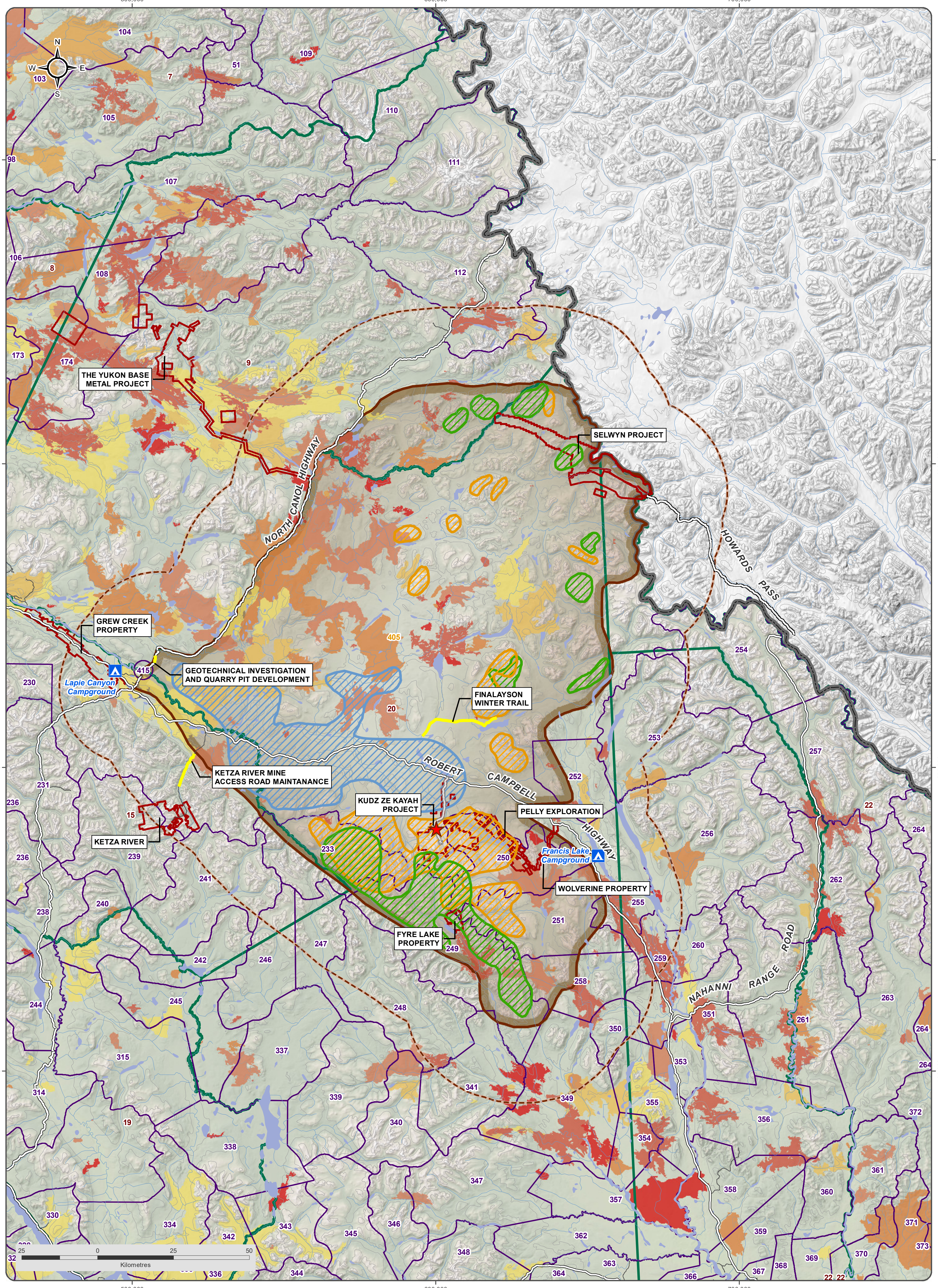

FOREST FIRE HISTORY (by Decade)

- 1950
- 1960
- 1970
- 1980
- 1990
- 2000
- 2010

- Kudz Ze Kayah Project
- Campground
- Quartz Mining Activity
- Outfitting Concession
- Trapline Concession
- Core Post Calving Range
- Core Rut Range
- Core Winter Range
- FCH Habitat Range 25km Buffer
- FCH Habitat Range
- Transportation Projects
- Tote Road/Proposed Access Road
- Primary road
- Secondary Road
- Yukon Territory Border

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FIGURE 7-2

FCH CUMMULATIVE EFFECTS - ANTHROPOGENIC DISTURBANCE AND HISTORIC FIRES

JULY 2020

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Table 7-1: Historic Fires in the FCH Range

Fire History Decade	Total Area of Home Range Affected by Burn by Decade (km^2)	Percentage of Area of Home Range Affected by Burn by Decade	% of FCH Late Winter Range	% of FCH Post-Calving Range	% of FCH Rut Range	Percentage of Area of Home Range + 25 km buffer Affected by Burn by Decade
1950	587.10	2.9%	1.1%	0.0%	0.0%	3.3%
1960	693.60	3.4%	8.3%	0.0%	0.2%	3.1%
1970	15.62	0.1%	0.0%	0.0%	0.0%	0.2%
1980	918.25	4.5%	1.1%	0.0%	0.0%	3.6%
1990	1250.31	6.1%	3.5%	1.5%	1.0%	4.4%
2000	376.44	1.8%	0.1%	1.2%	0.0%	2.5%
2010	81.84	0.4%	0.0%	0.0%	0.0%	0.6%
Average per decade	560.45	2.8%	2.0%	0.4%	0.2%	2.5%

8. CLIMATE CHANGE

8.1 R6-9

Provide a discussion of potential project effects on the Finlayson caribou herd in relation to climate change, considering:

a. Changes to habitat suitability

i. Including how the HSI model's formula, weightings, and output might vary given changes in climate.

b. Changes to movement patterns and migration corridors.

Predicted changes to climate over the Project's life (i.e. Construction of approximately two years, Operations of approximately 10 years, Reclamation and Closure of 3 years, and Post-closure of approximately 13 years) was presented in Section 16.6 of the Project Proposal (BMC, 2017a). This information forms the basis of the potential changes to caribou habitat suitability, movement patterns and migration corridors and is therefore repeated in this response report.

8.2 PREDICTED CHANGES TO CLIMATE

Climate change is defined by the Intergovernmental Panel on Climate Change (IPCC) as "*change in the state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer*" (IPCC, 2013). Global climate is unequivocally warming, and will continue to warm in the future (AMS 2012; IPCC, 2013). Heavy precipitation events have become more intense and frequent, and will continue to do so, although confidence in the size and amount of change is lower than confidence for change in air temperature (AMS, 2012). Uncertainty increases when considering local effects and the effects of climate change on the environment, such as vegetation, glaciers, streamflow, and wildfires. Table 8-1 presents a summary of climate change related phenomena at the global scale and associated likelihood assessment (IPCC, 2013). The IPCC assesses the likelihood of an outcome as virtually certain, very likely, likely, as likely as not, unlikely, very unlikely, or exceptionally unlikely. The level of confidence is based on the available evidence and ranges from very low to very high.

Table 8-1: Global-scale Assessment of Recent Observed Changes, Human Contribution to the Changes, and Projected Further changes for the Early (2016–2035) and Late (2081–2100) 21st Century

Phenomenon and Direction of Trend	Assessment that changes occurred (typically since 1950 unless otherwise indicated)	Assessment of a human contribution to observed changes	Likelihood of further changes	
			Early 21st century	Late 21st century
Warmer and/or fewer cold days and nights over most land areas	Very likely	Very likely	Likely	Virtually certain
Warmer and/or more frequent hot days and nights over most land areas	Very likely	Very likely	Likely	Virtually certain
Warm spells/heat waves Frequency and/or duration increases over most land areas	Medium confidence on a global scale Likely in large parts of Europe, Asia and Australia	Likely	Not formally assessed	Very likely
Heavy precipitation events Increase in the frequency, intensity, and/or amount of heavy precipitation	Likely more land areas with increases than decreases	Medium confidence More likely than not	Likely over many land areas	Very likely over most of the mid-latitude land masses and over wet tropical regions
Increases in intensity and/or duration of drought	Low confidence on a global scale Likely changes in some regions	Low confidence More likely than not	Low confidence	Likely (medium confidence) on a regional to global scale

Source: IPCC, 2013

Northern latitudes have experienced twice the rate of the global mean increase in surface air temperatures (McBean et al., 2005) and the North "is projected to warm most" (Collins et al., 2013). From 1950 to 1998, the Canadian western Arctic experienced warming of 1.5°C to 2.0°C (Zhang et al.. 2000).

Example effects of climate change that have the potential to affect the Project include:

- Melting of permafrost potentially resulting in instability of infrastructure;

- Increased forest fire risk due to increased temperatures, changes in precipitation, and increased thunderstorms;
- Increased extreme weather events (snow, rain, wind) potentially affecting Project infrastructure; and
- Changes to hydrological flow regimes in watercourses around the Project area affecting water conveyance and storage systems or surrounding infrastructure.

Table 8-2 below presents the global warming projections associated with the different Representative Concentration Pathways (RCP) scenarios used in the IPCC Fifth Assessment Report (AR5) Coupled Model Intercomparison Project Phase 5 (CMIP5). The scenarios describe four possible climate futures, all of which are considered possible depending on how much greenhouse gases are emitted in the years to come. The four RCPs (i.e., RCP2.6, RCP4.5, RCP6, and RCP8.5) are named after a possible range of radiative forcing values in the year 2100 relative to pre-industrial values (+2.6, +4.5, +6.0, and +8.5 Watts per square metre [W/m^2], respectively). The temperature ranges presented in Table 8-2 are considered likely (66 to 100% probability) by the IPCC. The level of confidence is rated as medium for the 2046-2065 global temperature projections. Temperature projections on a shorter-term scale, corresponding to the Project Operations phase (approximately 10 years), are available for downscaled climate data discussed further below.

Table 8-2: Projected Change in Global Mean Surface Air Temperature for 2046-2065 Relative to the Reference Period of 1986-2005 (°C)

Scenario	Mean	*Likely* Range*
RCP2.6	1.0	0.4 to 1.6
RCP4.5	1.4	0.9 to 2.0
RCP6.0	1.3	0.8 to 1.8
RCP8.5	2.0	1.4 to 2.6

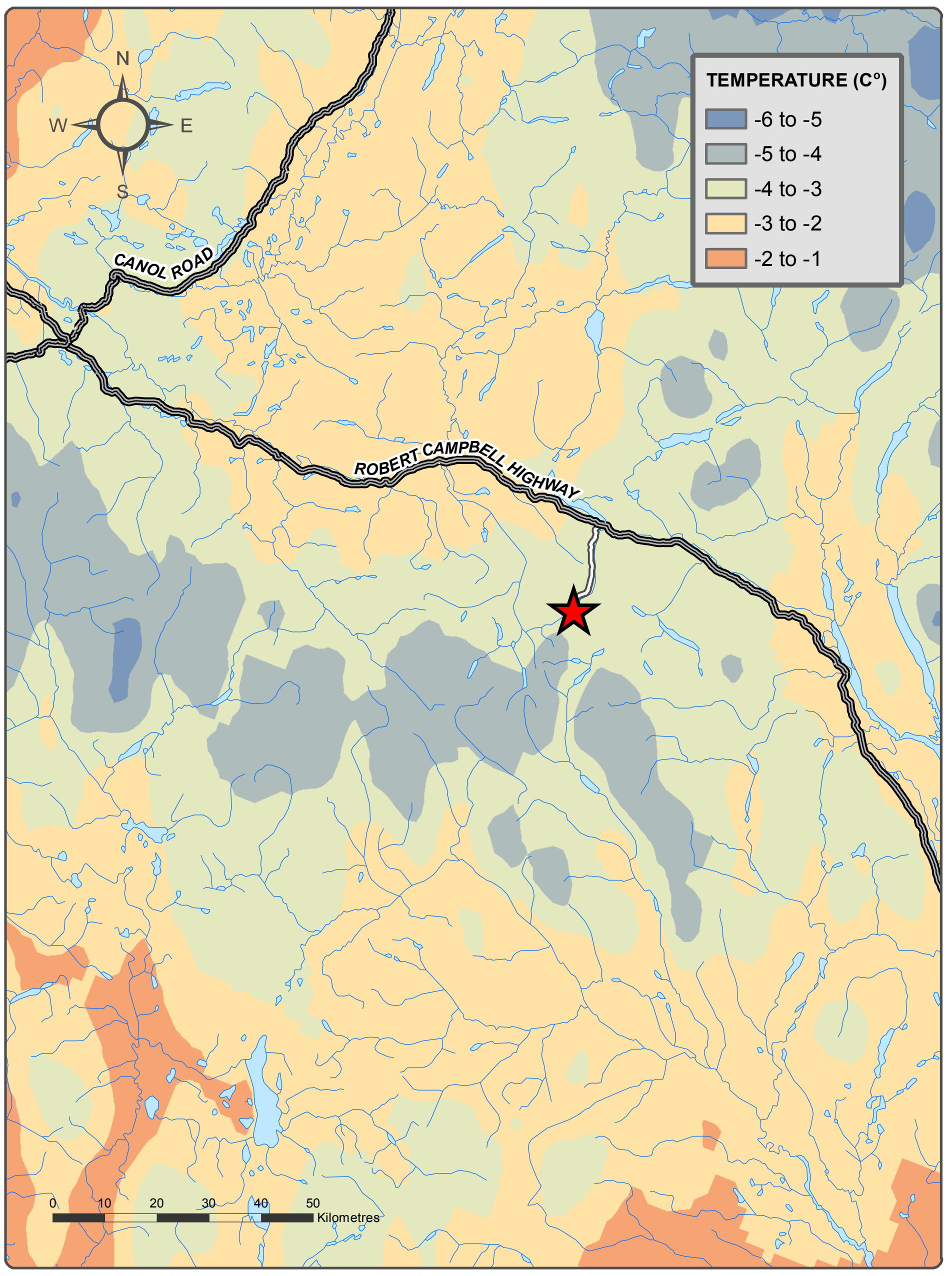
* Calculated from projections as 5–95% model ranges. These ranges are then assessed to be likely ranges after accounting for additional uncertainties or different levels of confidence in models. For projections of global mean surface temperature change in 2046–2065 confidence is medium, because the relative importance of natural internal variability, and uncertainty in non-greenhouse gas forcing and response.

Source: IPCC, 2013.

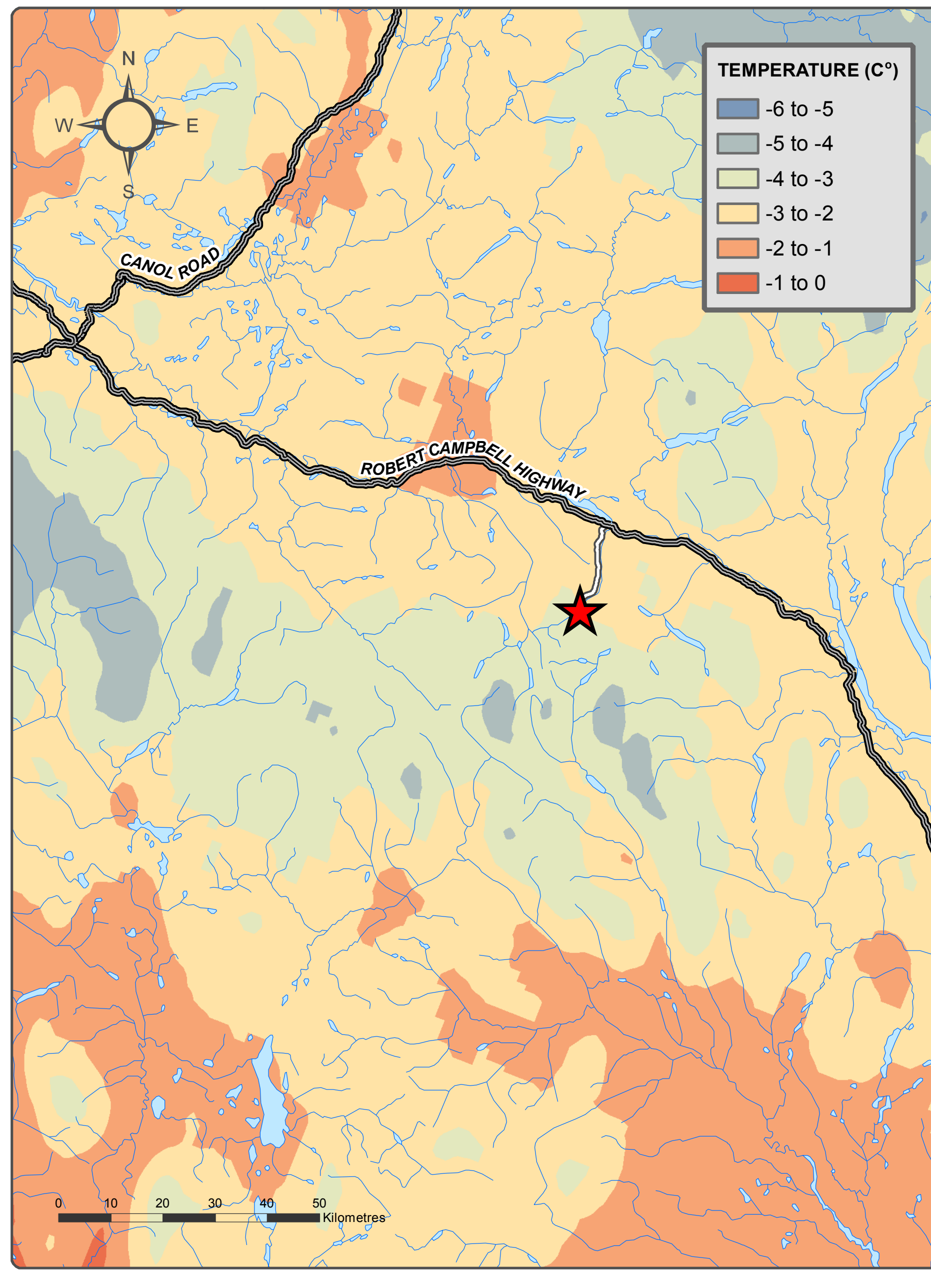
Figure 8-1 to Figure 8-4 show observed historical and projected mean annual temperature and precipitation data for the Project area. Data presented in Figure 8-1 to Figure 8-4 are from the first ensemble model run of the CMIP5 and were downscaled for sub-Arctic and Arctic regions of Alaska and Canada by the University of Alaska Scenarios Network for Alaska and Arctic Planning (SNAP). Results are shown for the RCP4.5 and RCP8.5, corresponding to low and high radiative forcing scenarios, respectively. Typically, precipitation varies more across time and space and is thus more uncertain than temperature (SNAP, 2016).

Depending on the scenario, mean annual temperature could increase by 1 to 2°C in the Project area over the Project's life (Construction to Post-Closure). Figure 8-3 and Figure 8-4 show that the change in mean annual precipitation (MAP) over the Project's life may not be substantial, but surrounding mountainous areas could see an increase in MAP.

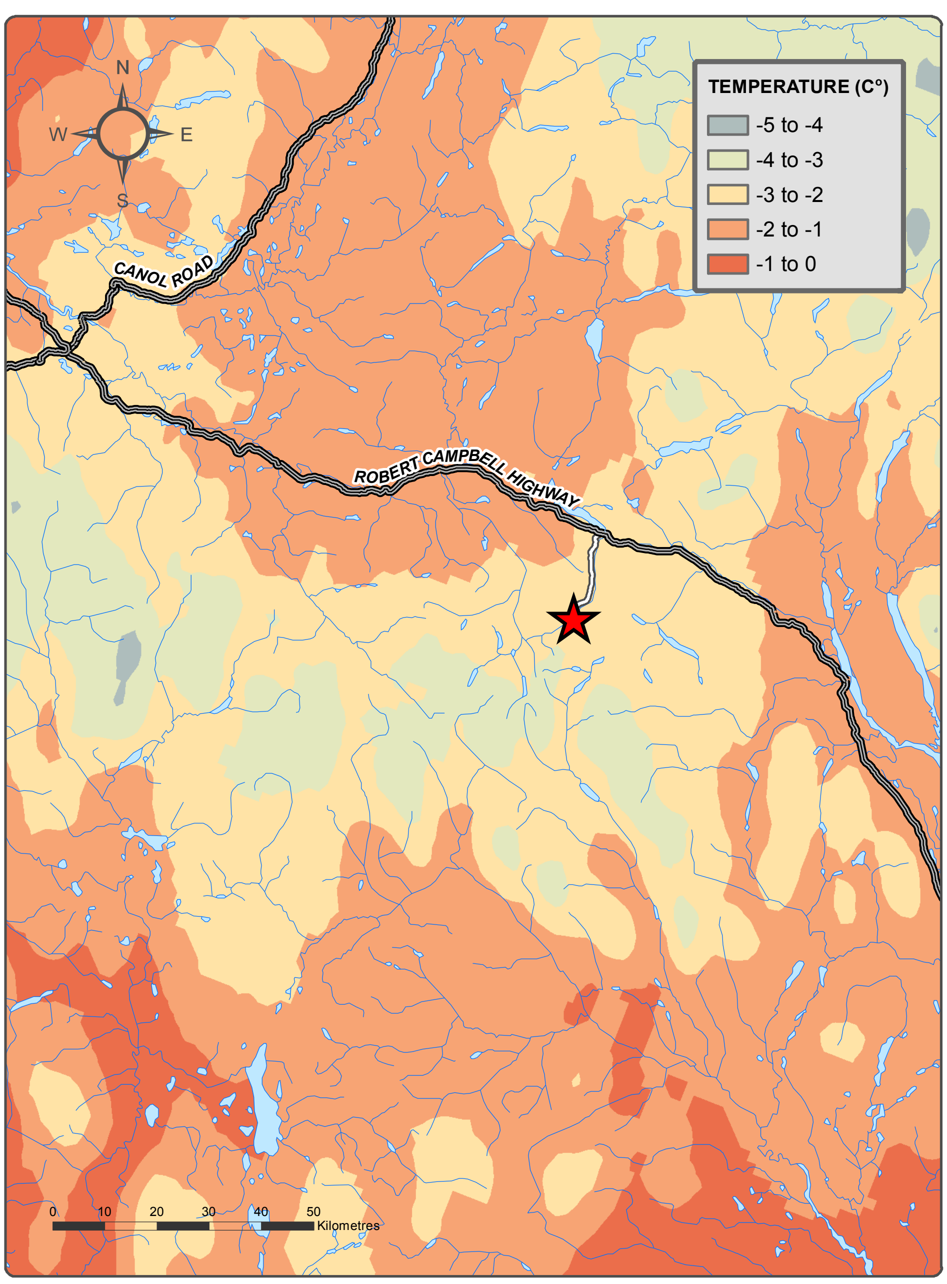
OBSERVED HISTORICAL MEAN ANNUAL TEMPERATURE, 2000-2009



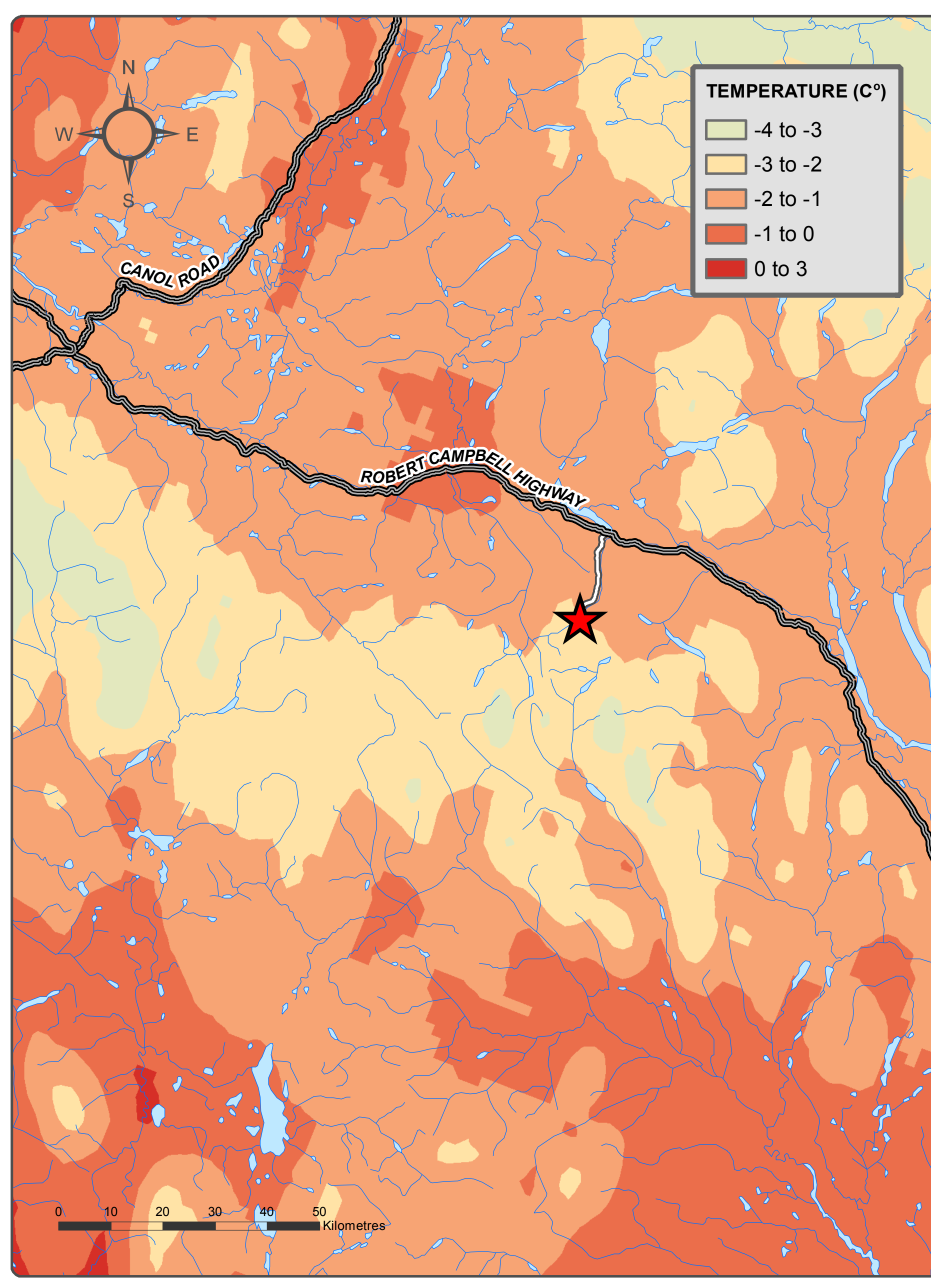
2020-2029 MEAN ANNUAL TEMPERATURE PROJECTION, RCP4.5 SCENARIO



2030-2039 MEAN ANNUAL TEMPERATURE PROJECTION, RCP4.5 SCENARIO



2040-2049 MEAN ANNUAL TEMPERATURE PROJECTION, RCP4.5 SCENARIO



Kudz Ze Kayah Project

Tote Road/Proposed Access Road

Robert Campbell Highway

Watercourse

Waterbody

Annual Temperature Data was derived from Scenarios Network for Alaska and Arctic Planning, University of Alaska. 2016. http://ckan.snap.uaf.edu/dataset

National topographic Data Base (NTDB) compiled by Natural Resources Canada at a scale of 1:50,000. Reproduced under license from Her Majesty the Queen, as represented by the Minister of Natural Resources Canada.

Datum: NAD 83; Projection: UTM Zone 9N

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FIGURE 8-1

OBSERVED HISTORICAL AND MODEL PROJECTED MEAN ANNUAL TEMPERATURE, RCP4.5 SCENARIO

JUNE 2020

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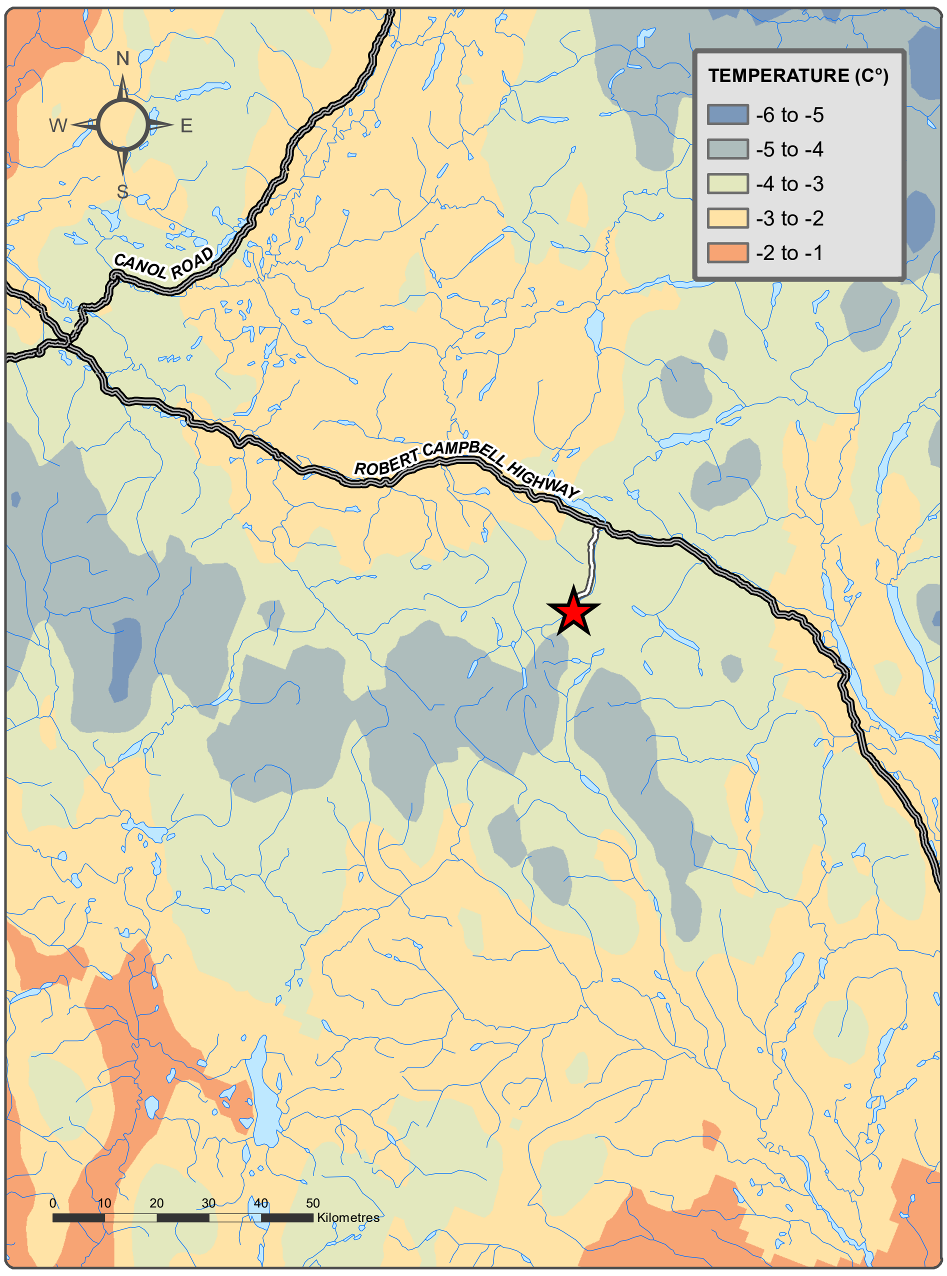
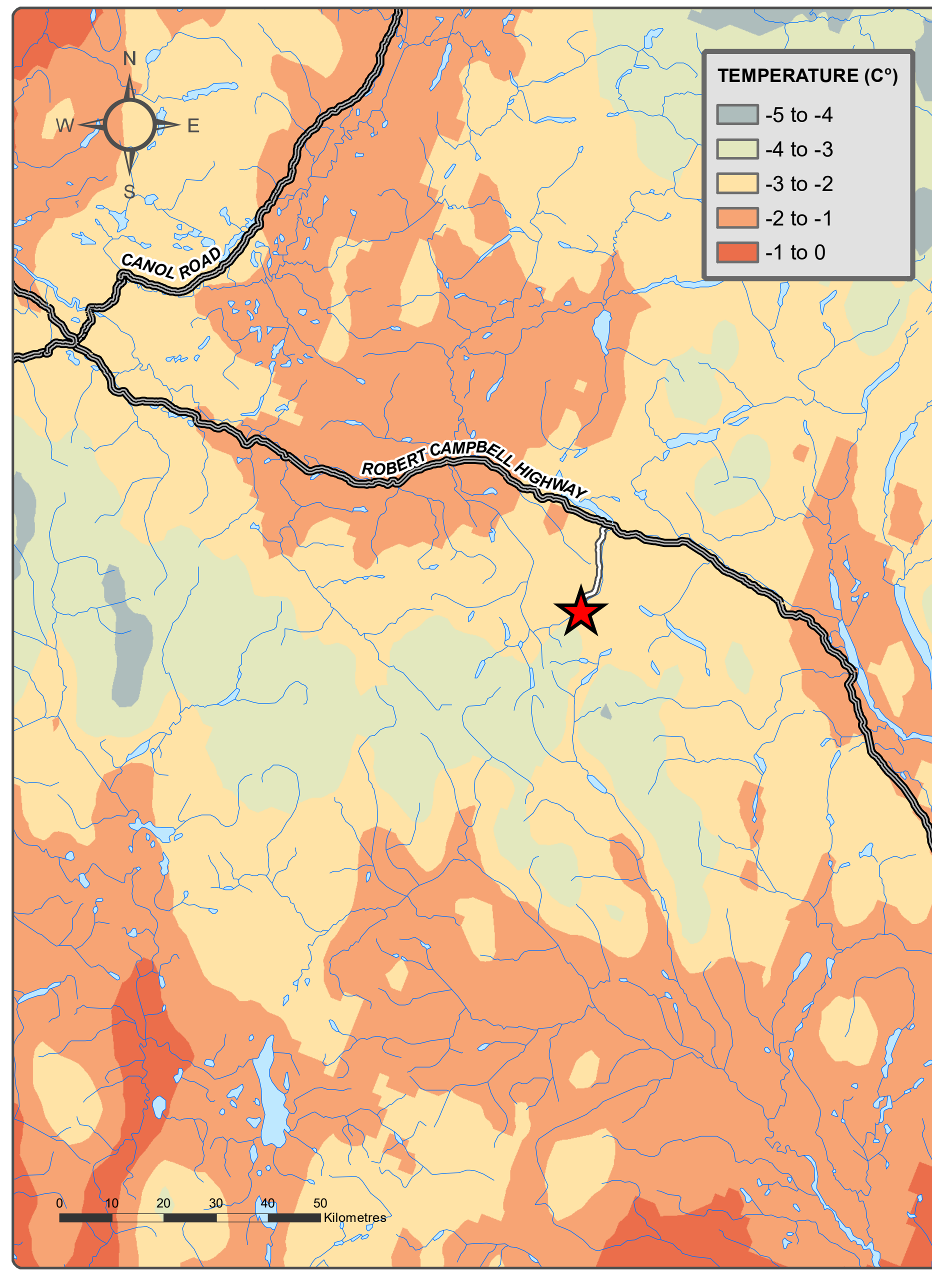
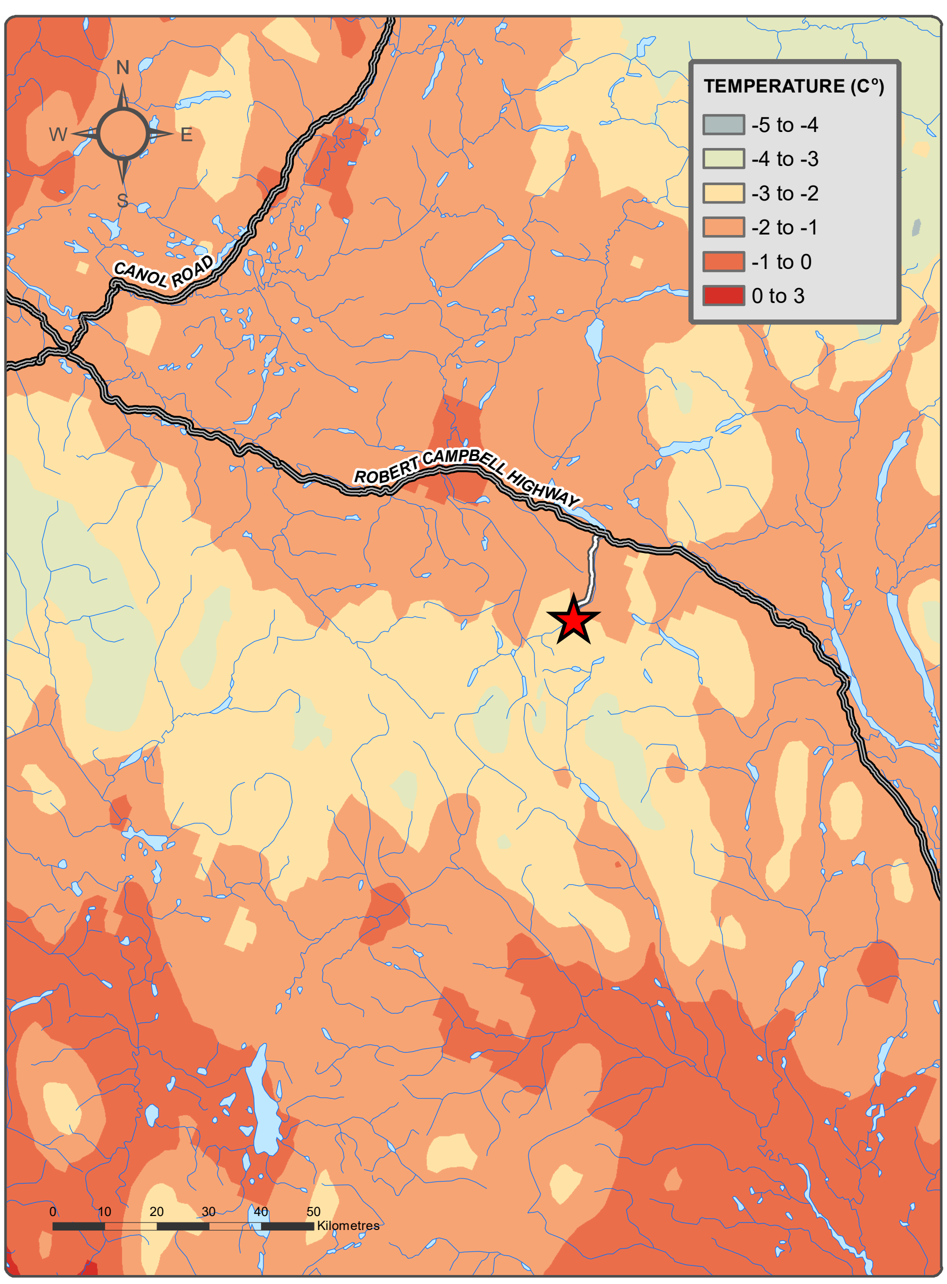
OBSERVED HISTORICAL MEAN ANNUAL TEMPERATURE, 2000-2009



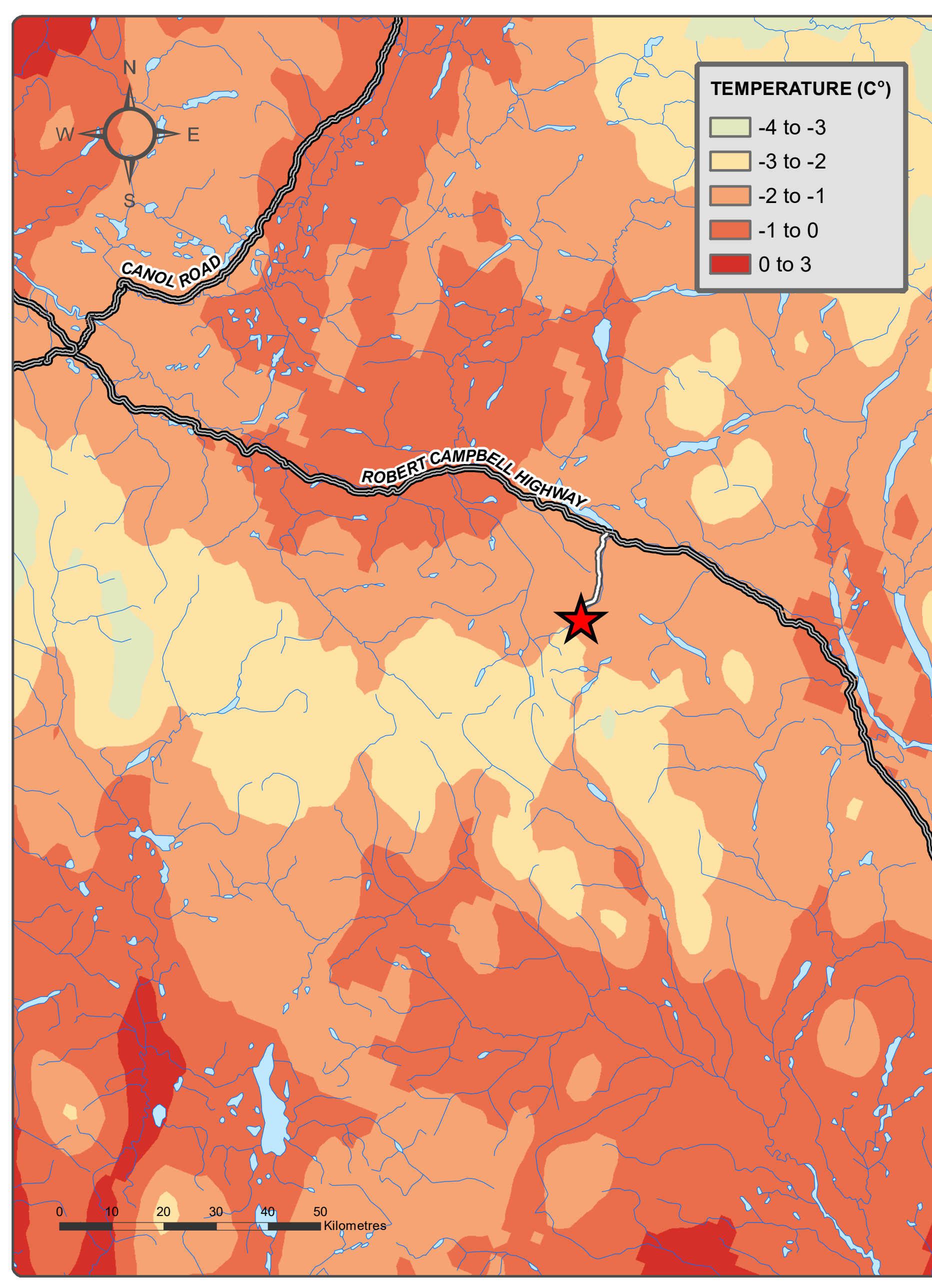
2020-2029 MEAN ANNUAL TEMPERATURE PROJECTION, RCP8.5 SCENARIO



2030-2039 MEAN ANNUAL TEMPERATURE PROJECTION, RCP8.5 SCENARIO



2040-2049 MEAN ANNUAL TEMPERATURE PROJECTION, RCP8.5 SCENARIO



Kudz Ze Kayah Project

Tote Road/Proposed Access Road

Robert Campbell Highway

Watercourse

Waterbody

Annual Temperature Data was derived from Scenarios Network for Alaska and Arctic Planning, University of Alaska. 2016. http://ckan.snap.uaf.edu/dataset

Datum: NAD 83; Projection: UTM Zone 9N

BMC MINERALS

ENSERO solutions

KUDZ ZE KAYAH PROJECT

FIGURE 8-2

OBSERVED HISTORICAL AND MODEL PROJECTED MEAN ANNUAL TEMPERATURE, RCP 8.5 SCENARIO

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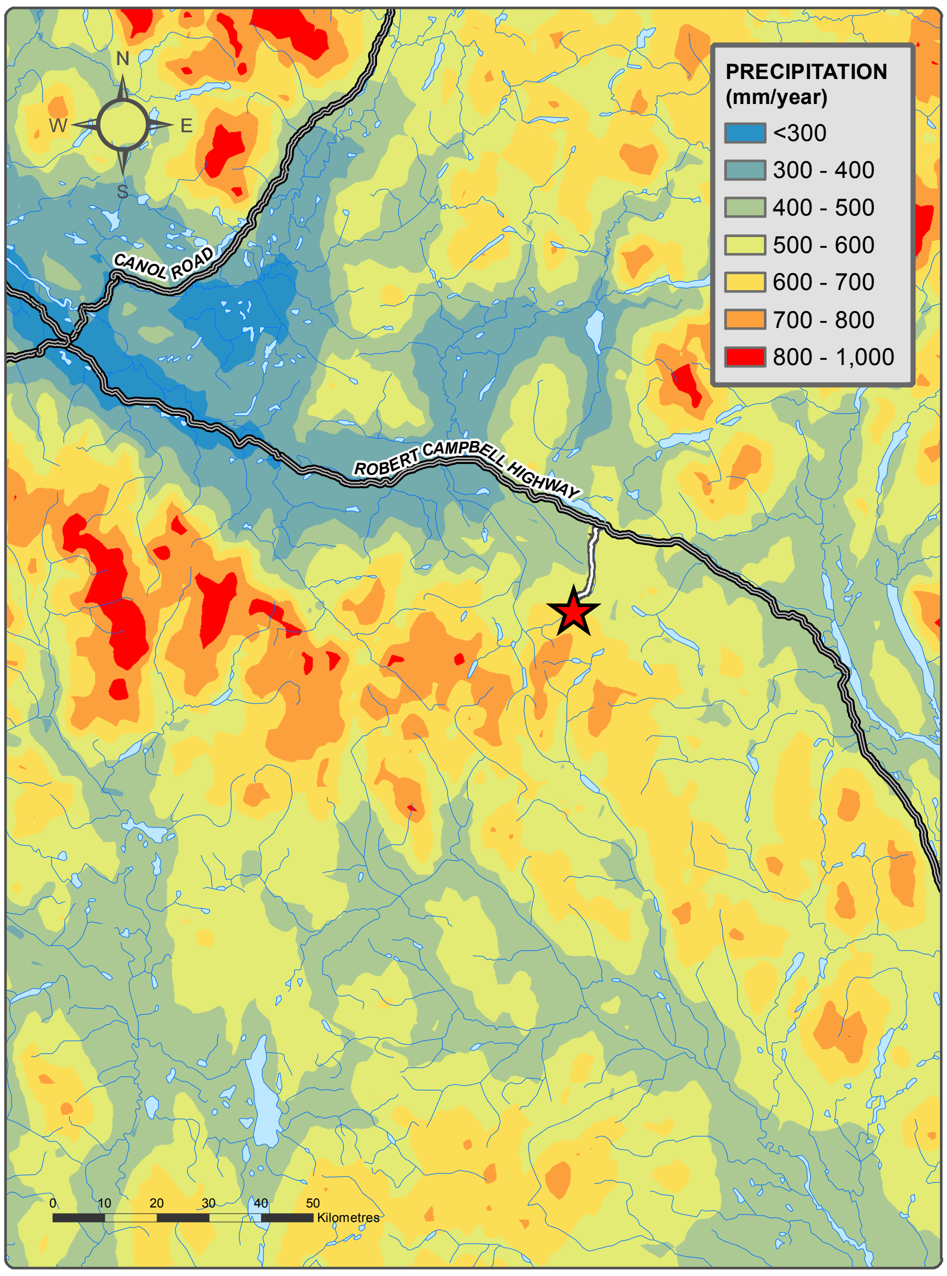
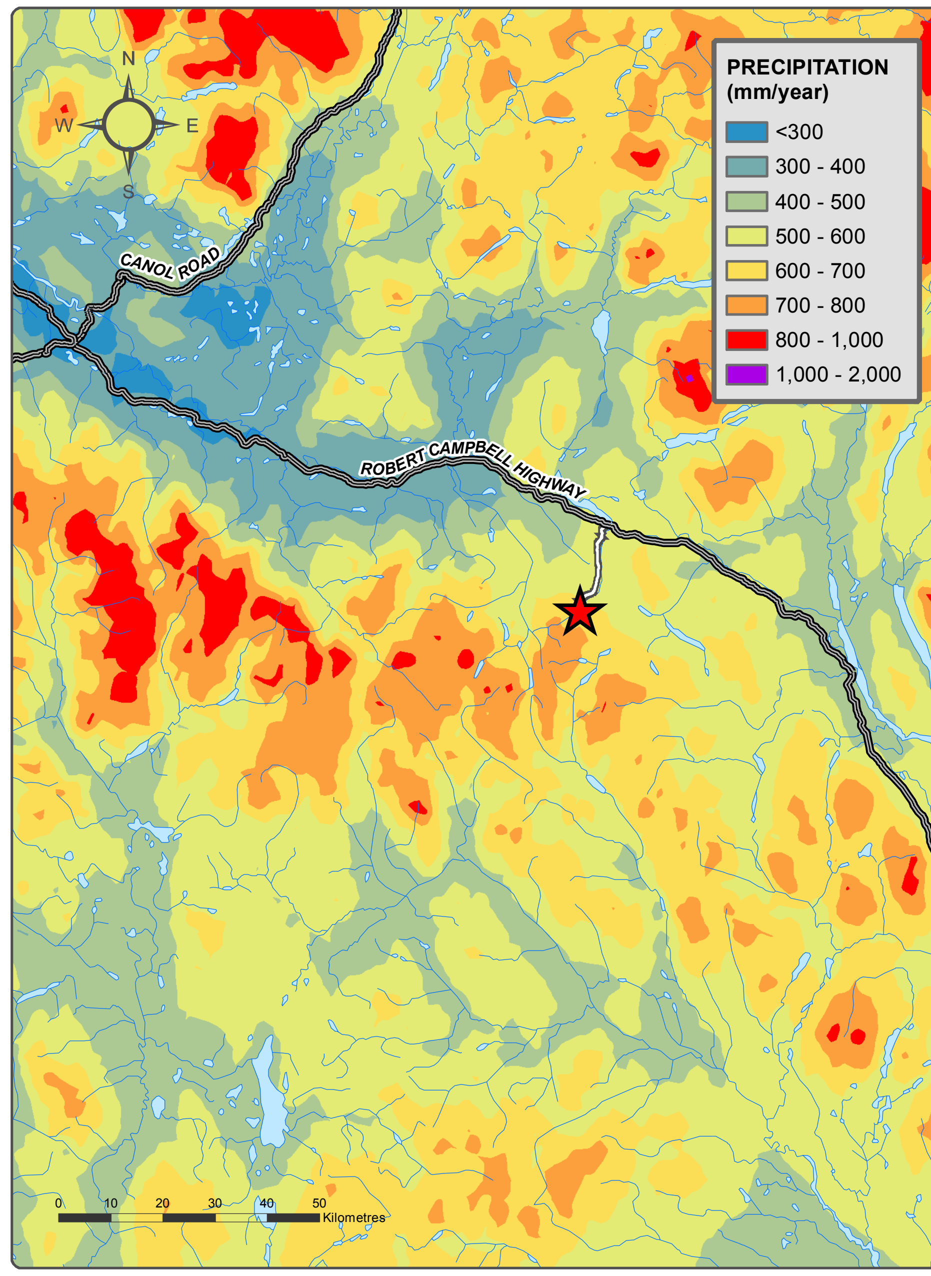
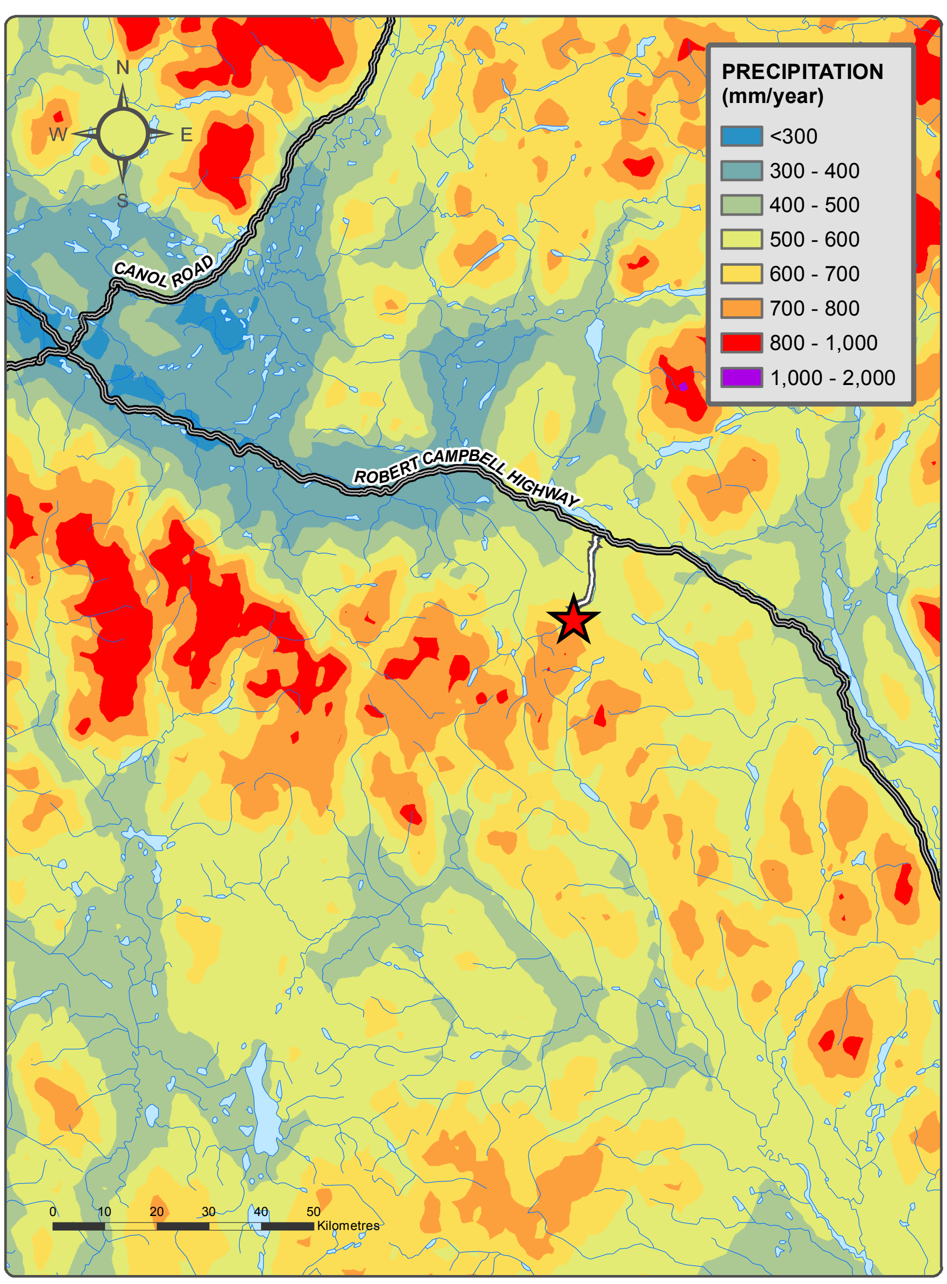
OBSERVED HISTORICAL MEAN ANNUAL PRECIPITATION, 2000-2009



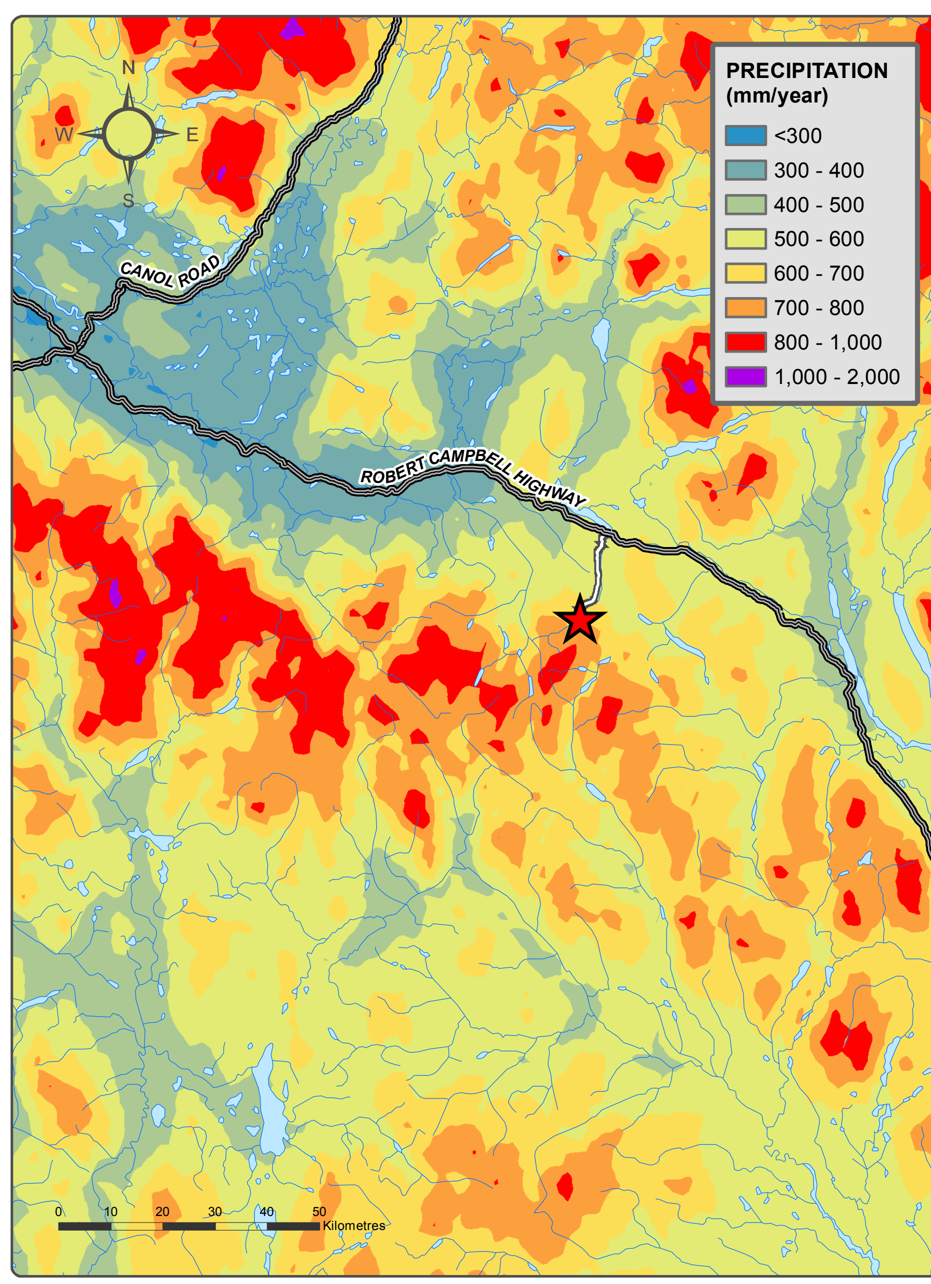
2020-2029 MEAN ANNUAL PRECIPITATION PROJECTION, RCP4.5 SCENARIO



2030-2039 MEAN ANNUAL PRECIPITATION PROJECTION, RCP4.5 SCENARIO



2040-2049 MEAN ANNUAL PRECIPITATION PROJECTION, RCP4.5 SCENARIO



★ Kudz Ze Kayah Project
Tote Road/Proposed Access Road
Robert Campbell Highway
Watercourse
Waterbody

Annual Precipitation Data was derived from Scenarios Network for Alaska and Arctic Planning, University of Alaska. 2016. http://ckan.snap.uaf.edu/dataset

Datum: NAD 83; Projection: UTM Zone 9N

KUDZ ZE KAYAH PROJECT

FIGURE 8-3

OBSERVED HISTORICAL AND MODEL PROJECTED MEAN ANNUAL PRECIPITATION, RCP4.5 SCENARIO

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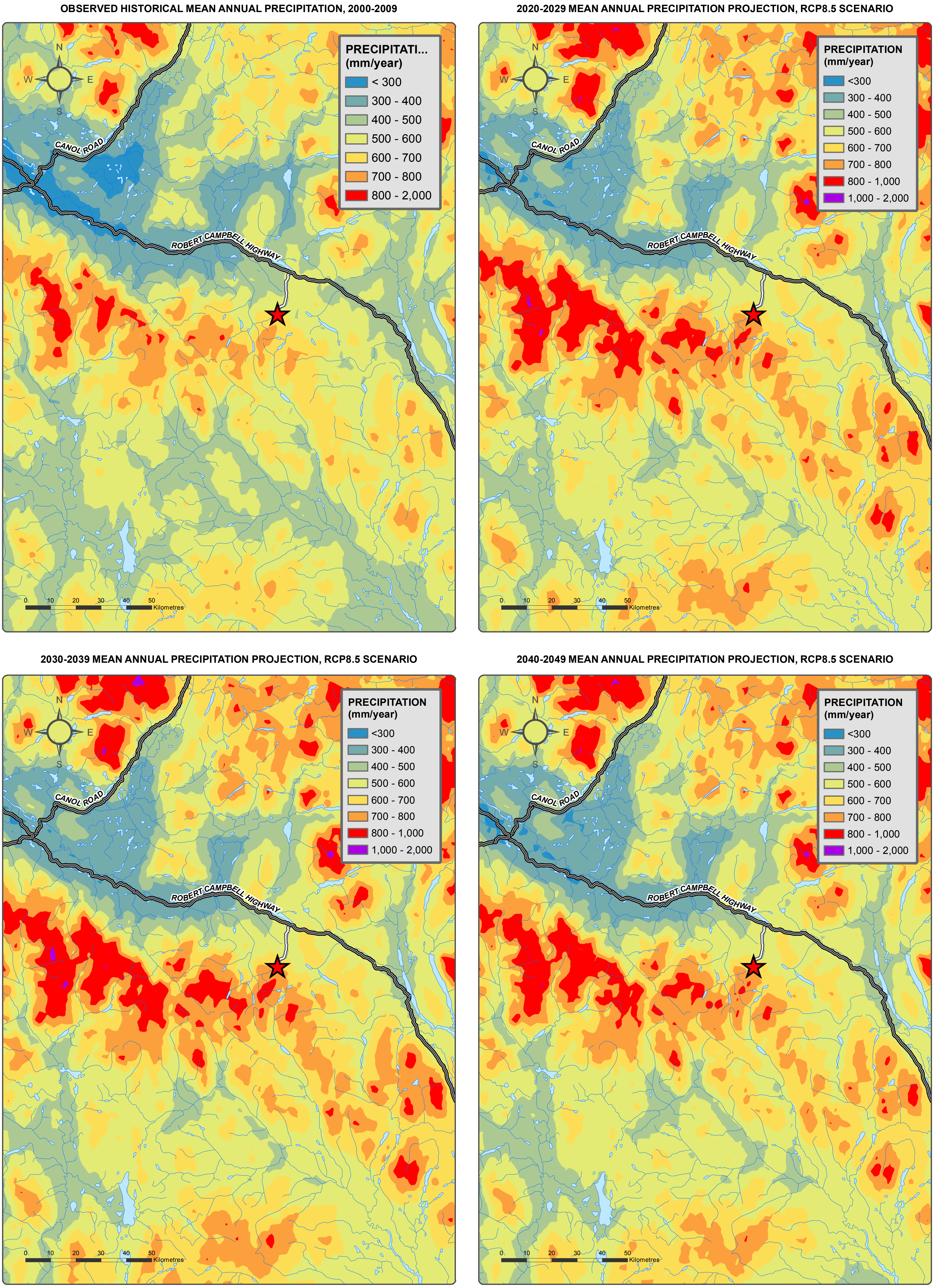

Kudz Ze Kayah Project

Tote Road/Proposed Access Road

Robert Campbell Highway

Watercourse

Waterbody

Annual Precipitation Data was derived from Scenarios Network for Alaska and Arctic Planning, University of Alaska. 2016. http://ckan.snap.uaf.edu/dataset

National topographic Data Base (NTDB) compiled by Natural Resources Canada at a scale of 1:50,000. Reproduced under license from Her Majesty the Queen, as represented by the Minister of Natural Resources Canada. All rights reserved.

Datum: NAD 83; Projection: UTM Zone 9N

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KUDZ ZE KAYAH PROJECT

FIGURE 8-4

OBSERVED HISTORICAL AND MODEL PROJECTED MEAN ANNUAL PRECIPITATION, RCP8.5 SCENARIO

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In 2015, a report was developed through the Northern Climate ExChange at the Yukon Research Centre; titled *Yukon Climate Change Indicators and Key Findings* which is a cross-sector, structured, evidence based assessment of Yukon climate change knowledge (Streicker, 2016). Table 8-3 provides a list of examples of some of the high and very high confidence findings, characterizing climate change in Yukon.

Table 8-3: Examples of Key Findings of Yukon Climate Change

Element	Finding
Climate	In Yukon, annual average temperature has increased by 2°C over the past 50 years.
	This increase is twice the rate of Southern Canada and the entire globe.
	Winters are warming more than other seasons: 4°C over the past 50 years.
Melt and Thaw	Warmer temperatures have resulted in widespread melting of glaciers and the rate of melt is increasing. The Alaska-Yukon icefields have shown retreat in glacier fronts and volumes, contributing to increased river flow and global sea level rise. Yukon has lost 22% of its glacial cover over the last 50 years.*
	Permafrost is degrading and more thawing is projected. Permafrost thaw typically occurs through an increase in the depth of the active layer.*
	Thawing ground will disrupt transportation, buildings, and other infrastructure. Permafrost degradation has potentially serious implications for those mine dams and tailing ponds which are dependent on permafrost berms.*
	Warming and thaw of permafrost are very likely to alter the release and uptake of greenhouse gases from soils, vegetation, and coastal oceans.
Water	Changes in the hydrologic response are driven by changes in temperature and precipitation. Increasing melt of glaciers, degradation of permafrost, variability in both rain and snow, earlier snowmelt, and late season fluctuations through the freeze-thaw cycle all affect the hydrologic regime. *
	Streamflow and groundwater flow patterns are changing. As permafrost degrades, pathways increase for groundwater, resulting in an increase in winter low flows.
	Flood risk is increasing. Rain and storm events are projected to increase; late season freeze-thaw cycles on rivers are creating ice which is more prone to ice-jam damming; heavy snowpack with warmer springs is leading to freshet flooding.
	Warming, degradation of permafrost, and increased flooding negatively impact water quality through increased turbidity and in some cases through contaminants.

* indicates very high confidence findings (Streicker, 2016)

8.3 HABITAT SUITABILITY

This specific information request is related to how the Project's Habitat Suitability Index (HSI) models might change, given the predicted changes to climate (described above) over the Project's life and how that might subsequently alter the potential Project effects on the FCH and or the proposed mitigations to minimize those effects.

In order to determine how a mean annual temperature increase by 1 to 2°C may impact the results of the habitat suitability model "*Including how the HSI model's formula, weightings, and output might vary given changes in climate*" and then relate that change to the assessment of the Projects potential effects and mitigations one must understand the current habitat use, modelled parameters and assumptions and proposed mitigations. Therefore, this information is provided in the following sections.

It should be noted that the majority of effects on the FCH will be during the Construction and Operations Phases of the Project (an approximate 13 year period). Project effects will be minimal upon the successful Reclamation and Closure of the Project (as per the Reclamation and Closure Plan, Appendix H-1 of the Project Proposal) (BMC, 2017).

8.3.1 OVERVIEW

The FCH has a traditional home range of 23,000 km^2 in east-central Yukon, lying mainly in the Yukon Plateau-North and Pelly Mountains Ecoregions (Adamczewski et al., 2010) (seen in Figure 2-1). The FCH habitat suitability maps produced are meant to aid BMC's development of avoidance measures, mitigation measures, and management plans to minimize the disruption of important caribou habitat during the development and operation of the proposed Project.

The habitat suitability maps for the FCH represent the preferred habitat types for post-calving, rut, and late winter periods.

The FCH habitat requirements for the spring, summer and fall seasons are detailed below.

Spring Habitat: Spring (April to June) is the migratory and calving period for the FCH, as they travel from their traditional winter habitat in the Pelly River lowlands to calve in the highlands of the Pelly Mountains in the southeast. As the snow disappears, the caribou move to the upper mountain slopes and ridges to browse on the new growth of herbaceous plants such as sedges, grasses, forbs, and dwarf shrubs. Caribou will forage on mostly green vegetation in the spring and growing season. Caribou require access to large quantities of nutritious vegetation for growth, to be in good reproductive condition for the rut, and to amass enough fat stores to survive the winter (Gerhart et al., 1996; Skoog, 1968).

The calving period is from early May to early June with a median peak of calving in mid May (Chisana Caribou Recovery Team, 2010). Northern mountain caribou prefer solitary calving sites that are distant from alternate prey species such as moose, and decreased food abundance for predator species (Bergerud and Page, 1987). Female caribou will use high elevation alpine areas with good visibility, or subalpine habitats with sufficient cover to reduce detection by predators (Fenger et al., 1986). Later in June, the cows and newborn calves may aggregate in groups, although some cows with or without calves may remain on their own over the summer (Cichowski, 1993; Bergerud and Page, 1987).

Summer Habitat: June to September is the post-calving and growth period for northern mountain caribou. Summer range consists primarily of upper elevation subalpine and alpine habitats where caribou disperse into small groups (Stevenson et al., 1994). Summer diet for woodland caribou is known to consist of forbs, deciduous leaves, lichens, fungi, grasses, and sedges. In the Kluane Range in Yukon Territory, Oosenbrug and Theberge (1980) reported that caribou selected birch-sedge meadows, sedge meadow communities, and habitats with high sedge component (i.e., making up more than 50% of vegetation in sampled fecal matter). The authors also reported dominant landforms used by caribou during the summer as ridges, plateaus, and upper elevation streams.

Numerous studies on caribou during the post-calving season have shown that during warm summers insects have a pronounced effect on caribou behaviour and group dynamics. Vexation from biting insects decreases the amount of time spent feeding and increases energy expenditure, thus limiting summer nutrition and body condition (Mörschel and Klein, 1997). Caribou have a limited timespan during the summer for growth and building new fat reserves for the coming winter. Females need to compensate for energy costs of gestation and lactation (Gerhart et al., 1996), and males have to build body reserves for the rut (Skoog, 1968). Constraints on the ability of caribou to feed optimally during this period of high forage quality and availability could have a negative effect on their body condition (Parker et al., 2009). Body condition of females affects their potential of becoming pregnant in fall, and also affects calf survival the following year (Gerhart et al., 1996). To find relief from insects and high temperature stress, caribou seek the exposed windy ridges and snow patches (Ion and Kershaw, 1989). Variations in summer temperature between and among years should directly influence caribou behaviour during the post-calving season. Further, the variety and amount of insects, insect-relief habitat, and different weather patterns should cause additional variations in caribou behaviour.

Fall Habitat: During the rut, northern mountain caribou aggregate in open alpine and subalpine habitats (Morgan, 2015). The rut generally occurs in the fall and is at its peak by mid-October. Woodland caribou then begin to migrate to their winter range after the peak of the rut with most caribou on the winter range by mid-November (MacLean, 2003). However, the 2015 to 2019 early winter ungulate surveys for KZK have found that in the Project area caribou may stay on their rutting grounds until mid-December depending on weather pattern variations from year to year.

Migration Habitat: In the late fall, the FCH migrate back from their rutting range in a northwest direction towards the Pelly lowlands. During this seasonal movement, the caribou traverse through a variety of ecosystems. The caribou's diet changes as the FCH migrate to lower elevations and herbaceous plants begin to die. The availability of forbs, sedges, and other deciduous plants decrease and caribou become more reliant on the winter staple of terrestrial lichens found in the mature forests (Johnson et al., 2004). Lichen make up 70% of the FCH diet in winter (Environment Yukon, unpublished data). In the spring, the direction of travel reverses as does their source of food as they move through boreal forest, subalpine, shrub land, and eventually to the alpine tundra zones.

8.3.2 RUT AND POST-CALVING HABITAT SUITABILITY MODELS

The rut and post-calving HSI models were presented in Appendix E of the Project Proposal (BMC, 2017a) and were subsequently modified in response to Information Request R188 and R2-88 (BMC, 2017b and c, respectively).

The habitat suitability models for the rut and post-calving were developed using four environmental variables and were evaluated with the existing monitoring record of caribou. The four variables were elevation, slope, aspect, and vegetation cover. These parameters describe the geographical context for habitat requirements and were the most readily available for assessing habitat suitability for the large range being assessed. Other parameters such as minimum area, isolation, adjacency, and edge can also be used for suitability mapping (Clarke, 2012); however, the geographical context parameters captured key caribou habitat preferences described in the literature. The data used for model calibration and validation determined whether these four parameters provided an accurate model.

For each season the respective variables were divided into classes ranging from 0 to 1, with 0 representing not suitable habitat (nil) and 1 representing highly suitable habitat (high). The classes within the variable were ranked based on their significance for caribou during the specific season. Significance of each class was determined using the distribution and frequency of observations from the calibration dataset.

Elevation

Elevation data were interpreted from the 25 m DEM (Digital Elevation Model) and were computed as a continuous variable for the purpose of the HSI. A linear fuzzy membership function was applied to determine the suitability ranking between suitable and not suitable habitat, based on elevation breaks derived from the frequency of occurrences of satellite and relocation data points at a given elevation. Suitable habitat for caribou during the post-calving season is at a higher elevation than the rut season as caribou avoid predation, heat, and insects on high elevation ridges and plateaus (Ion and Kershaw, 1989). The equation and function used for post-calving and rut seasons are shown in Table 4-3 of Appendix E-8 of the Project Proposal (BMC, 2017a).

The model shows that suitable rut habitat ranges in elevation from approximately 1200 to 1900 masl with the highest suitability between 1500 and 1800 masl; while suitable post-calving habitat ranges in elevation from approximately 1300 to 2700 masl with the highest suitability between 1600 to 1900 masl. Within the 3 km zone of influence of the Project, the mountains are approximately 1700 masl to 2000 masl (Figure **8-5**). In a climate change scenario of an increase of 1 to 2°C over the

Project's lifetime, the rut range of highly suitable elevations may shift; however, given the wide range of suitable elevation for rut habitat there is not expected to be a measurable change in available suitable habitat around the Project. With respect to post-calving, the caribou may move to higher elevations depending on where the snow patches are; however, this high elevation habitat is limited immediately surrounding the Project (see Figure **8-5**); therefore, the suitable post-calving habitat may decrease in the immediate mountains surrounding the Project under this scenario.

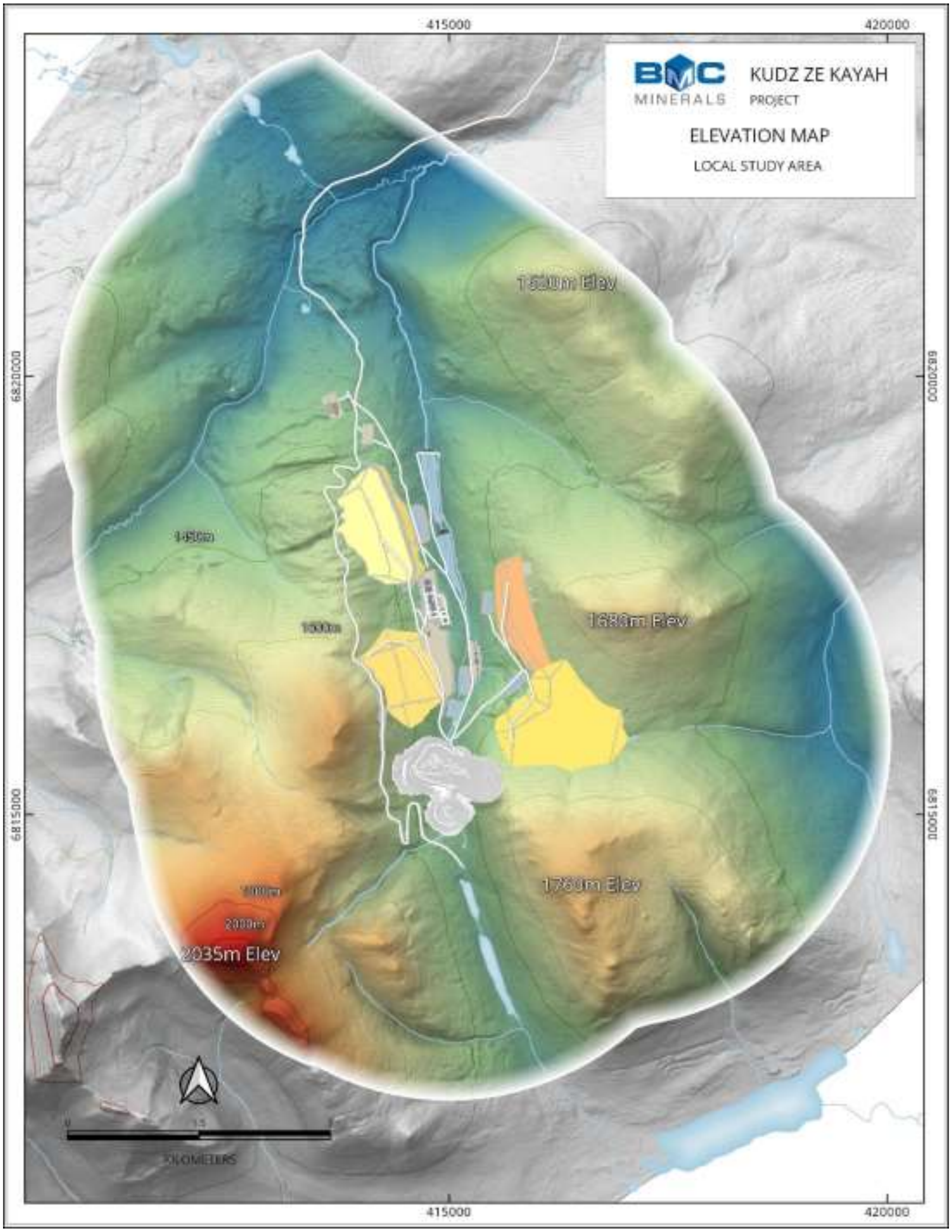

Figure 8-5: Mountain Elevations Adjacent to the Project Infrastructure

Slope

Slope, or terrain steepness, was derived from the 25 m DEM using ArcGIS 10.4 and was modelled in degrees of slope between neighbouring raster cells. Slope was treated as a continuous variable for the purpose of the HSI model using a linear fuzzy membership function to derive the values between suitable and unsuitable habitat. Functions of slope suitability were interpreted using frequency of occurrence of animals based on the satellite and relocation data for the respective seasons. The equation and function used for post-calving and rut seasons are shown in Table 4-4 of Appendix E-8 of the Project Proposal (BMC, 2017a) and updated in response R188 (BMC, 2017b).

The model shows that the most suitable rut slope habitat ranges from 0 to approximately 25 degrees (generally flatter slopes) while the most suitable post-calving slope habitat ranges from 10 to 50 degrees. Under a climate change scenario of an increase of 1 to 2°C, the preference for the range of highly suitable slope habitat is unlikely to change. The caribou will likely always prefer flatter surfaces where the plateaus are during the rut and will continue to have a high range of slope preference during post-calving.

Aspect

Aspect was derived from the 25 m DEM using the aspect tool in ArcGIS. Aspect was classified into four quadrants of cardinal direction and treated as a discrete variable for the HSI. The satellite and relocation collar data were used to calibrate the aspect variable and provided the distribution shown in Table 4-5 of Appendix E-8 of the Project Proposal (BMC, 2017a) and updated in response R188 and R2-88 (BMC, 2017b; BMC, 2017c). Aspect did not show as strong of a variance between class values and as a result received a lower variable weighting in comparison to the other variables. The caribou will likely continue to slightly prefer the southwest aspects during rut and eastern aspects during post-calving and there is not expected to be a measurable change in suitability under the climate change scenario of an increase of 1 to 2°C.

Vegetation Cover

Vegetation cover type was classified based on the Regional Ecosystems of East-Central Yukon Predictive Ecosystem Mapping (PEM) that was completed in 2013 by Makonis Consulting Ltd (Grods et al., 2013). The PEM spatial data and methodology was received from Environment Yukon. The PEM product was developed using land cover, surficial material, and base features (watercourses, waterbodies, and elevation) as a means to predict the broad ecosystem units in the defined study area. The final product was evaluated by ground-truthing, polygon interpretation through ecosystem plots measurements, and boundary traverses. The PEM is recommended to be used at a scale of 1:100,000 or smaller (Grods et al., 2013). For the purpose of the modeling, the PEM was classified into the dominant vegetation cover, not utilizing the landscape classification as these aspects were already addressed in the model. Satellite and relocation data were intersected with the PEM and the suitability index rating was developed based on the data distribution and expert knowledge as shown in Table 4-6. of Appendix E-8 of the Project Proposal (BMC, 2017a) and updated in response R188 (BMC, 2017b).

Vegetation communities are changing with climate change and a study of images over the last century in the Rocky Mountains has shown that treelines are advancing in elevation and more quickly at higher latitudes (Trant et al., 2020). The rising treeline may reduce caribou high elevation terrain at some time in the future; however, the rate of change in vegetation in Yukon is not yet known, but is unlikely to significantly change the quantity of suitable habitat over the life of the Project.

8.3.3 WINTER HABITAT SUITABILITY MODEL

Winter habitat suitability maps were not initially produced for caribou, as the traditional core winter range is approximately 100 km northwest of the Project site, and therefore, not considered within the zone of influence of the Project. A late winter habitat suitability model was completed in January 2018 and is included with this report as Appendix A. The model incorporated elevation, slope, aspect, vegetation, and precipitation to account for snow depth. Snow depth is a driving factor for habitat suitability since it affects access to food through the critical winter months.

Moderate numbers of the FCH have been observed ranging in the mature forested areas south of Finlayson Lake, adjacent to the Project's lower access road, during years when the snow pack is shallow as was seen during the 2015 late winter survey (Adamczewski et al., 2010; EDI, 2015). Snow depths vary significantly from year to year and even within the year which makes it difficult to predict changes in suitable habitat with climate change. It is possible that the range of suitable habitat may shift or expand with warming temperatures and shorter winters. However, from the predicted persistence of the precipitation shadow north of the Pelly Mountains (seen in Figure 8-3 and Figure 8-4 which corresponds closely to the high suitability late winter habitat in Figure 2-2) it is expected that the high suitability late winter habitat in the Pelly River lowlands will remain over the life of the Project.

8.4 POTENTIAL HABITAT USE CHANGES AND MOVEMENT PATTERNS DUE TO CLIMATE CHANGE

With climate change there are likely to be fewer available snow patches for post-calving on the lower elevation mountains that occur adjacent to the Project area and caribou will be more likely to find snow patches on higher mountains south of the Project. Potential changes in available snow patches during the post-calving period were discussed in response to Information Request R183F in (BMC, 2017b) as follows.

> *"It is acknowledged that snow patches were identified as important for avoiding insect harassment but there is no information about key snow patches in the study area or effects and measures to mitigate project disturbance in these areas. Snow patches are an important habitat for caribou in summer. Climatic evidence has shown they are diminishing. A comparison can be made between the post-calving locations and locations of snow patches that can be seen on*

Google Earth and the post-calving locations are essentially equivalent to the locations of snow patches. In the LSA, snow patches are mainly on the ridges west of the proposed mine infrastructure and occasionally on the mountain to the east. Therefore, the degree that the Project interferes with snow patches would be equivalent to the habitat loss calculation for the post-calving assessment (i.e. 1.8% loss of highly suitable post-calving habitat in the regional post-calving study area)."

"*The elevation of the snow patches may provide an indication of their longevity with climate change. The snow patches just west of the mine are around 1800 m elevation and located about 1.8 km from the centre of the mine infrastructure so there is a high likelihood that these patches will be abandoned during the Construction and Operations phases. Throughout the regional range, the snow patches appear to range from 1600 to 2150 m elevation. With climate change, the snow patches around the Project are unlikely to be the first to go, but unlikely to be the last either. Mitigations to minimize caribou disturbance are already included in Section 18.7.3 of the Project Proposal (BMC, 2017a) for employees and equipment to remain within Project boundaries and in Section 18.10.3 for noise reduction measures. The post-calving monitoring program will be modified to take GPS locations and pictures of the boundaries of a number of reference snow patches to help track snow patch changes over time.*"

In addition, response to Information Request R2-85f and Appendix R2-L (BMC, 2017c) provided information about snow patches to help determine how significant this geographic area is with respect to caribou population dynamics, rather than just to habitat suitability: "*During post-calving surveys, up to 90% of caribou observations are made on snow patches where the animals congregate to avoid the heat and insects making them important habitats (Ion and Kershaw 1989). This habitat use is a known behaviour spanning at least 8000 years (Farnell et al. 2004)*."

As presented in Chapter 4 Response to R6-4 and in the Chapter 8 Overview above, the FCH movement patterns are seasonal, dispersing from wintering grounds in the Pelly lowlands into the mountains to the south and the north of their range for the spring, summer and fall, and returning to the wintering grounds in the late fall and early winter (Figure 2-1). The Ibex and Carcross/Laberge herds show similar patterns (Figure 3-3 and Figure 3-4). These movement patterns are expected to shift with any shifting suitable or available habitat as discussed in Section 8.3 above.

The timing of habitat use may also change with a changing climate. However, it is unlikely that there will be significant changes in the caribou habitat suitability and use or movement patterns during the life of the Project (as presented in the discussion about the changes in habitat suitability and predicted climate changes above).

BMC's season-specific mitigation measures as presented in Figure 4-1 and detailed in the Wildlife Protection Plan in Appendix J of Response #2 (BMC, 2017c) and summarised in Table 6-1 of Response Report #5 (BMC, 2020) are designed to minimize impacts on the FCH for the current expected impacts during the life of the mine – with consideration of climate change. The current monitoring program incorporates elements such as snow patch monitoring to assist in monitoring changes in suitable habitat with climate change. In addition, the adaptive management program is designed to review monitoring data on a regular basis to identify any unexpected changes, potentially due to climate change so that the mitigations can be adapted to continue to minimize impacts on the FCH. Through the adaptive management program, BMC will continue to review additional mitigation and management strategies that are being carried out throughout the world to conserve biodiversity as the climate changes. Some strategies to assist with biodiversity adaptation to climate change might include reducing threats, additional monitoring and studies, modelling, relocation, and improved integration and coordination between all parties interested in and responsible for conservation (Heller and Zavaleta, 2009).

BMC is also committed to carrying out the ongoing caribou monitoring program for the Project, and to working with Kaska and the Yukon Government on programs to help manage and maintain the FCH population given the challenges of a changing climate.

9. REFERENCES

Adamczewski, J., R. Florkiewicz, R. Farnell, C. Foster, and K. Egli. 2010. *Finlayson caribou herd late-winter population survey, 2007.* Yukon Fish and Wildlife Branch Report SR-10-01. Whitehorse, Yukon, Canada.

Alexco Environmental Group. 2018. *Caribou Late Winter Habitat Suitability Report*, Kudz Ze Kayah Project. Prepared for BMC Minerals (No.1) Ltd.

AMS (American Meteorological Society). 2012. *Climate change: An information statement of the American Meteorological Society*. Boston, MA. Retrieved on January 20, 2017 from https://www.ametsoc.org/ams/index.cfm/about-ams/ams-statements/statements-of-the-ams-in-force/climate-change/.

Bergerud, A. T., Butler, H. E., and D. R. Miller. 1984. *Antipredator tactics of calving caribou: dispersion in mountains*. Canadian Journal of Zoology 62: 1566-1575.

Bergerud, A.T. 1992. *Rareness as an antipredator strategy to reduce predation risk. Transaction of the International Game Biologist Congress.* 19:15-25.

Bergerud, A.T., and R.E. Page. 1987. *Displacement and dispersion of parturient caribou at calving as antipredator tactics. Canadian Journal of Zoology.* 65: 1597-1606.

BMC, 2017a. K*udz Ze Kayah Project Proposal to YESAB Executive Committee*. March 2017.

BMC, 2017b. *Kudz Ze Kayah Project, Response Report #1 to YESAB Executive Committee Adequacy Review of KZK Project Proposal.* July 2017.

BMC, 2017c. *Kudz Ze Kayah Project, Response Report #2 to YESAB Executive Committee Adequacy Review of KZK Project Proposal.* November 2017.

BMC, 2018a. *Kudz Ze Kayah Project, Response Report #3A to YESAB Executive Committee Information Request*. June 2018.

BMC, 2018b. *Kudz Ze Kayah Project, Response Report #4A to YESAB Executive Committee Information Request.* December 2018.

BMC, 2020. *Kudz Ze Kayah Project, Response Report #5 to YESAB Executive Committee Information Request.* April 2020.

Boulanger, J., Poole, K.G., Gunn, A., Wierzchowski, J. 2012. *Estimating the zone of influence of industrial developments on wildlife: A migratory caribou Rangifer tarandus groenlandicus and diamond mine case study. Wildlife Biology*, 18, 164-179.

Bradshaw, C.J., Boutin, S., Hebert, D.M., Rippin, A.B. 1995. *Winter peatland habitat selection by woodland caribou in northeastern Alberta. Canadian Journal of Zoology*, 73, 1567–1574.

Chisana Caribou Recovery Team. 2010. *Recovery of the Chisana Caribou Herd in the Alaska/Yukon Borderlands: Captive-Rearing Trials.* Yukon Fish and Wildlife Branch Report TR-10-02.

Cichowski, D.C. 1993. *Seasonal movements, habitat use, and winter feeding ecology of woodland caribou in west-central British Columbia.* B.C. Min. For., Victoria, B.C. Land Manage. Rep. No. 79. 54p.

Clarke, H. 2012. *Knowledge-based habitat suitability modeling guidelines. Whitehorse*: Yukon Environment.

Collins, M., Knutti, R., Arblaster, J., Dufresne, J.L., Fichefet, T., Friedlingstein, P., et al. 2013. *Long-term climate change: Projections, commitments and irreversibility.* In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2014. *COSEWIC assessment and status report on the caribou Rangifer tarandus, Northern Mountain population, Central Mountain population and Southern Mountain population in Canada.* Ottawa, ON, pp. 113.

Daust, D., and Morgan, D. 2013. *Moose: Summary of objectives and knowledge for decision supp*ort. Bulkley Valley Centre for Natural Resources Research and Management, pp. 19. Retrieved on January 18, 2017 from http://bvcentre.ca/files/integrated/Moose_Values_and_Knowledge.pdf.

Dena Kayeh Institute. 2010. *Kaska Dena Management Practices: Kaska Dena Land Use Framework*. Prepared by the Dena Kayeh Institute, June 2010. Lower Post, BC.

Dyer, S.J., O'Neil, J.P., Wasel, S.M., Boutin, S. 2001. *Avoidance of industrial development by woodland caribou. Journal of Wildlife Management*, 65, 531-542.

Dzus, E. 2001. *Status of the woodland caribou (Rangifer tarandus caribou) in Alberta. Alberta Environment, Fisheries and Wildlife Division, and Alberta Conservation Association, Wildlife Status Report No. 30,* Edmonton, AB, pp. 47. Retrieved on January 18, 2017 from http://aep.alberta.ca/fish wildlife/species at risk/species at risk publications web resources/mammals/documents/SAR-StatusWoodlandCaribouAlberta-Jan2001.pdf.

EDI, Environmental Dynamics Inc. 2015. *Kudz Ze Kayah, Late Winter Ungulates Survey*. Prepared for BCM Minerals Ltd.

Environment Canada. 2012. *Management Plan for the Northern Mountain Population of Woodland Caribou (Rangifer tarandus caribou) in Canada.* Species at Risk Act Management Plan Series. Environment Canada, Ottawa. vii + 79 pp.

Environment Yukon, 2020. Southern Lakes Caribou. Website http://yukon.maps.arcgis.com/apps/MapSeries/index.html?appid=94e97fc1c92142e0b1b263d71e3355b0#.

Farnell, R., and J. McDonald. 1989. *The influence of wolf predation on caribou mortality in Yukon's Finlayson caribou herd. Proceedings of the 2nd North American Caribou Workshop. Alaska Department of Fish and Game. Juneau.* Wildlife Technical Bull No. 8:52-70.

Fenger, M.A., Eastman, D.S. and C.J Clement. 1986. *Caribou habitat use on the Level Mountain and Horseranch ranges, British Columbia.* R.E. Page. 1986. 41pp + 4 maps. (Also printed as Surveys and Resource Mapping Branch Working Report WR-8).

Ferguson, A.D., and Gauthier, L. 1992. *Status and trends of Rangifer tarandus and Ovibos moschatus populations in Canada.* Rangifer, 12, 127-141.

Fuller, T.K., and Keith, L.B. 1981. *Woodland caribou population dynamics in northeastern Alberta. Journal* of Wildlife Management, 45, 197–213.

Gerhart, K. L., R. G. White, R. D. Cameron, and D. E. Russell. 1996. *Growth and body composition of arctic caribou.* Rangifer 16:393-394.

Gray, D.R. 1999. *Updated status report on the Woodland Caribou (caribou des bois) Rangifer tarandus dawsoni and Rangifer tarandus caribou in Canada.* Prepared for the Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON, pp. 36.

Grods, J., S.R. Francis, K. McKenna, J.C. Meikle and S. Lapointe. 2013. *East-central broad ecosystems (Version 1.1).* Downloaded from Yukon government private ftp site on July 13th, 2016. Spatial data created for Energy, Mines and Resources, Government of Yukon by Makonis Consulting Ltd. And Associates, West Kelowna, BC.

Gullickson, D. and M. Manseau. 2000. *South Nahanni woodland caribou herd seasonal range use and demography*. Parks Canada Agency. 79p.

Gustine, D.D., Parker, K.L., Lay, R.J., Gillingham, M.P. and Heard, D.C. 2006. *Calf Survival of Woodland Caribou in a Multi-Predator Ecosystem. Wildlife Monographs,* 165: 1-32. doi:10.2193/0084-0173(2006)165[1:CSOWCI]2.0.CO;2.

Hegel, T.M., Mysterud, A., Huettmann, F. and Stenseth, N.C. 2010. *Interacting effect of wolves and climate on recruitment in a northern mountain caribou population.* Oikos, 119: 1453-1461. doi:10.1111/j.1600-0706.2010.18358.

Heller, N. and E. Zavaleta. 2009. *Biodiversity management in the face of climate change: A review of 22 years of recommendations*. Biodiversity Conservation 142(2009) 14-32. doi: 10.1016/j.biocon.2008.10.006.

Ion, P. G., and G. P. Kershaw. 1989. *The selection of snowpatches as relief habitat by woodland caribou (Rangifer tarandus caribou), MacMillan Pass, Selwyn/Mackenzie Mountains, N.W.T., Canada.* Arctic Vol. 21, No. 2, 203-211.

IPCC (Intergovernmental Panel on Climate Change). 2013. *Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis.* Contribution of Working Group I to the Fifth

Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Johnson, C.J., K.L. Parker, D.C. Heard, and D.R. Seip. 2004. *Movements, foraging habits, and habitat use strategies of northern woodland caribou during winter: Implications for forest practices in British Columbia*. BC Journal of Ecosystems and Management 5(1):22–35.

Joly K. B.W. Dale, W.B. Collins, and L.G. Adams. 2003. *Winter habitat use by female caribou in relation to wildland fires in Interior Alaska.* Canadian Journal of Zoology 81:1192-2001.

Klein, D.R. 1982. *Fire, lichens, and caribou.* Journal of Range Management. 35:390-395.

Kuzyk G.W., M.M. Dehn and R. S. Farnell. 1999. *Body size comparisons of alpine and forest wintering woodland caribou in Yukon*. Canadian Journal of Zoology 77:1017-1024.

MacLean, N. 2003. *Species Account and Wildlife Habitat Suitability Model Assumptions: Woodland Caribou*. Prepared for: Ministry of Water, Land and Air Protection.

Mallory, F.F., and Hillis, T.L. 1998. *Demographic characteristics of circumpolar caribou populations: ecotypes, ecological constraints, releases, and population dynamics*. Rangifer, 10, 49-60.

McBean, G., Alekseev, G., Chen, D., Førland, E., Fyfe, J., Groisman, P.Y., et al. 2005. *Arctic climate: Past and present.* In: Arctic Climate Impact Assessment. Cambridge University Press, Cambridge, United Kingdom, pp. 22–60.

McLoughlin, P.D., Taylor, M.K., Cluff, H.D., Gau, R.J., Mulders, R.R., Case, L., et al. 2003. *Population viability of barren-ground grizzly bears in Nunavut and the Northwest Territories.* Arctic, 56, 185-190.

Morgan, T. 2015. *Finlayson Caribou Fall Composition Survey 2015. Liard regional management, Environment Yukon Watson Lake, Yukon.Mörschel, E. M. and D.R. Klein. 1997.Effects of Weather and Parasitic insects on the behaviour and group dynamics of the Delta herd, Alaska.* Canadian Journal of Zoology 75:1659-1670.

Mörschel, F. M., and Klein, D. R. 1997. *Effects of weather and parasitic insects on behavior and group dynamics of caribou of the Delta herd, Alaska. Can. J. Zool.* 75, 1659–1670. doi: 10.1139/z97-793.

Oberg, P.R. 2001. *Responses of mountain caribou to linear features in a west-central Alberta landscape*. M. Sc. Thesis, University of Alberta, Edmonton, Alberta, pp. 139.

Oosenbrug, S.M. and J.B. Theberge. 1980. *Altitudinal movements and summer habitat preferences of woodland caribou (Rangifer tarandus caribou) in the Kluane ranges, Yukon Territory, Canada.* Arctic 33:59–72.

Parker, K. L., Barboza, P. S. and Gillingham, M. P. 2009. *Nutrition integrates environmental responses of ungulates.* Functional Ecology, 23: 57–69.

Polfus, J.L., Hebblewhite, M., Heinemeyer, K. 2011. *Identifying indirect habitat loss and avoidance of human infrastructure by northern mountain woodland caribou.* Biological Conservation, 144, 2637-2646.

Rescan. 2012. *EKATI Diamond Mine: Literature Review – Exclusion Barriers and Wildlife. Prepared for BHP Billiton Canada Inc. by Rescan Environmental Services Ltd.: Yellowknife, Northwest Territories.* http://www.registrelep.gc.ca/virtual_sara/files/cosewic/sr_Caribou_Northern_Central_Southern_2014_e.pdf.

Rettie, W.J., and Messier, F. 1998. *Dynamics of woodland caribou populations at the southern limit of their range in Saskatchewan.* Canadian Journal of Zoology, 76, 251-259.

Russell, D.E., A.M. Martell and W. A. C. Nixon. 1993. *Range ecology of the Porcupine caribou herd in Canada*. Rangifer Special Issue No. 8.Statistics Solutions. (2016). Kendall's Tau and Spearman's Rank Correlation Coefficient. Accessed on October 17, 2016 at http://www.statisticssolutions.com/kendalls-tau-and-spearmans-rank-correlation-coefficient/.

Saher D.J. & F.K.A. Schmiegelow. 2005. *Movement pathways and habitat selection by woodland caribou during spring migration*. Rangifer Special Issue No. 16: 143-154.

Schaefer, J.A., and W.O. Pruitt. 1991. *Fire and Woodland Caribou in southeastern Manitoba.* Wildlife Monographs 116:1-39.

Skoog, R. C. 1968. *Ecology of caribou (Rangier tarandus granti) in Alaska.* Ph.D. Thesis. University of California, Berkeley.

SNAP (Scenarios Network for Alaska and Arctic Planning). 2016. *SNAP Data.* University of Alaska. Retrieved on January 20, 2017 from http://ckan.snap.uaf.edu/dataset.

Species at Risk Committee. 2019. Draft Species Status Report for Woodland Caribou (Northern Mountain Population) (Rangifer tarandus caribou) in the Northwest Territories. Species at Risk Committee, Yellowknife, NT.

Stevenson, S.K., H.M. Armleder, M.J. Jull, D.G. King, E.L. Terry, B.N. McLellan and K. N. Child. 1994. *Mountain caribou in managed forests: preliminary recommendations for managers. BC Ministry of Forests.*

Streicker, J. 2016. *Yukon climate change indicators and key findings 2015*. Northern Climate ExChange, Yukon Research Centre, Yukon College, pp. 84. Retrieved on January 25, 2017 from https://www.yukoncollege.yk.ca/downloads/Indicator_Report_Final_web.pdf.

Thomas, D.C., and H.J. Armbruster. 1996. *Woodland caribou habitat studies in Saskatchewan: second annual report and some preliminary recommendations.* Unpublished report, Canadian Wildlife Service, Environment Canada, Edmonton, AB T6B 2X3. 46 pp.

Trant, A., E. Higgs, B.M. Starzomski. 2020. *A century of high elevation ecosystem change in the Canadian Rocky Mountains.* Nature Scientific Reports. 10:9698. https://doi.org/10.1038/s41598-020-66277-2.

Vors, L.S., and Boyce, M.S. 2009*. Global declines of caribou and reindeer.* Global Change Biology, 15, 2626–2633.

Wahl, H.E., D.B. Fraser, R.C. Harvey, and J.B. Maxwell, J.B. 1987. *Climate of Yukon*. Environment Canada. Climatological Studies No. 40. Ottawa.

Weir, J.N., Mahoney, S.P., McLaren, B., Ferguson, S.H. 2007. *Effects of mine development on woodland caribou Rangifer tarandus caribou distribution.* Wildlife Biology, 13, 66-74.

YESAB. 2019. *Draft Screening Report and Recommendation Kudz Ze Kayah Project. Project Number 2017-0083.* Nov 20, 2019.

YESAB. 2020. *Request for Supplementary Information – Information Request Number 6*. Assessment 2017- 0083. BMC Minerals Inc. Kudz Ze Kayah Mine. June 23, 2020.

Zhang, X., Vincent, L.A., Hogg, W.D., Niitsoo, A. 2000. *Temperature and precipitation trends in Canada during the 20th century*. Atmosphere-Ocean, 38, 395-429.

APPENDIX A.
CARIBOU LATE WINTER HABITAT SUITABILITY REPORT

CARIBOU LATE WINTER HABITAT SUITABILITY REPORT

KUDZ ZE KAYAH PROJECT

BMC-17_Caribou_Late_Winter_HS_Rev0_171219

January 2018

Prepared for:

BMC MINERALS (NO. 1) LTD.

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ALEXCO ENVIRONMENTAL GROUP INC. SIGNATURES

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EXECUTIVE SUMMARY

The Kudz Ze Kayah (KZK) Project is a proposed mine located in Yukon Territory, approximately 260 km northwest of Watson Lake and 115 km southeast of Ross River, within the Yukon Plateau-North Ecoregion, part of the Canadian Boreal Cordillera Ecozone. The Finlayson caribou herd (FCH), part of the Northern Mountain caribou population (*Rangifer tarandus caribou*), is of particular ecological, economic and cultural importance to the Kaska First Nation, the general public, residents and guided hunters alike. The herd is assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as a Species of Special Concern, and was listed as such under the *Species at Risk Act* (SARA) in 2005. As part of the baseline studies, early winter, late winter, post calving, and rut surveys were performed to assess the spatial and temporal distribution of FCH throughout the year within the Project area.

As additional support to the baseline studies, habitat suitability index (HSI) models were prepared to predict habitat selection of the FCH for the rut and post-calving periods. The baseline studies and HSI models were submitted to theYukon Environmental and Socio-economic Assessment Board (YESAB) as part of BMC Minerals (No.1) Ltd.'s (BMC's) KZK Project Proposal for Executive Committee Screening (BMC, 2017). During YESAB's Adequacy review of the Project Proposal they informally requested that a habitat suitability index model also be prepared for the late winter life requisite for the FCH. The late winter habitat overlaps with the existing Project Tote Road (which is proposed to be upgraded to an Access Road). The late winter habitat does not overlap with the proposed mine site.

The data used to create the habitat suitability maps were collected over the last thirty-five years by Yukon Government biologists and recent late winter survey data collected by Alexco Environmental Group Inc. (AEG) in 2015, 2016 and 2017 (AEG, 2016). In addition, expert knowledge was gathered through interviews with Rick Farnell, several individuals from Environment Yukon, AEG, EDI, and other consultants regarding caribou habitat usage. The late winter HSI model variables chosen to determine habitat preference were: elevation; slope; vegetation; and precipitation. The HSI model parameters for late winter are consistent with the post-calving and rut life requisite models, with added precipitation as a variable since snow depth is important for caribou habitat selection in late winter. The classes within each variable were ranked based on their significance for caribou use during late winter. Both satellite and telemetry data were used to calibrate the model variables, while thirty-five years of aerial survey data were used to evaluate the effectiveness of the model.

Model evaluation was carried out using the non-parametric Kendall tau test to determine whether the final suitability ranking (divided into six rank classes) and observation density were correlated. The model with the highest value tau coefficient (strongest correlation) was selected as the final habitat suitability model. The late winter HSI (p-value = 0.0014) suggests a statistically significant (significant if $p < 0.05$) and strong correlation between rated habitat suitability and number of occurrences within each class (tau correlation coefficient = 1).

The Local Study Area (LSA) has no high value late winter habitat; however, approximately 13% (1,583 ha) of the LSA has moderately high value habitat. Approximately 90 ha of moderate and 11 ha of moderately high late winter habitat is predicted to be directly affected by the existing Tote Road and widening for the Project Access Road. Approximately 3,582 ha of moderate and 1,583 ha of moderately high value late winter habitat is predicted to be indirectly affected by the Access Road. The habitat that is predicted to be directly and indirectly affected equates to less than 1% of all moderate to high suitability late winter habitat in the FCH range.

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Acronyms

AEG .... Alexco Environmental Group Inc.

BMC .... BMC Minerals (No. 1) Ltd.

COSEWIC .... Committee on the Status of Endangered Wildlife in Canada

DEM .... Digital Elevation Model

FCH .... Finlayson Caribou Herd

GIS .... Geographic Information System

ha .... hectares

HSI .... Habitat Suitability Index

KFN .... Kaska First Nation

KZK .... Kudz Ze Kayah

LSA .... Local Study Area

masl .... metres above sea level

NMP .... Northern Mountain Population

PEM .... Predictive Ecosystems Map

SARA .... Species at Risk Act

YESAA .... Yukon Environmental and Socio-economic Assessment Act

YESAB .... Yukon Environmental and Socio-economic Assessment Board

YG .... Yukon Government

GLOSSARY

Aspect: the direction that something faces or points towards.

Digital Elevation Model: a digital model or 3D representation of a terrain's surface.

Expert Opinion: a belief or judgement about a topic given by an expert on the subject.

Geographic Information System: a computer system designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data.

Habitat Suitability Index: a tool for predicting the suitability of habitat for a given species based on known affinities with environmental parameters.

Kaska First Nation: a transboundary Nation involving Kaska people from the Ross River Dena Council and Liard First Nation in southeastern Yukon, and Daylu Dena Council, Dease River First Nation and Kwadacha Nation in northern British Columbia.

Linear Fuzzy Membership: reclassifies the input data to a 0 to 1 scale based on the linear relationship of being a member of a specified set. 0 is assigned to those locations that are definitely not a member of the specified set, 1 is assigned to those values that are definitely a member of the specified set, and the entire range of possibilities between 0 and 1 are assigned to some level of possible membership (the larger the number, the greater the possibility).

Local Study Area: the area encompassing a 3 km buffer surrounding the proposed Project infrastructure and a 1.5 km buffer around the Tote Road.

Non-parametric Kendall Tau Test: a statistic used to measure the correlation between two ranked variables.

Northern Mountain Population: a distinct ecotype of woodland caribou that have unique habitat preferences and behaviour.

Orographic: resulting from the effects of mountains in forcing moist air to rise.

Predictive Ecosystems Map: a modelled approach to ecosystem mapping, whereby existing knowledge of ecosystem attributes and relationships are used to predict ecosystem representation in the landscape.

Zone of Influence: the spatial area of influence affecting an animal's behaviour caused from mining activities.

1 INTRODUCTION

The Finlayson caribou herd (FCH) is of particular ecological, economic and cultural importance in the region to the Kaska First Nation (KFN), resident, and guided hunters alike. Therefore, conservation and effective management of this herd has been identified as a key concern by many stakeholders, including federal and territorial governments, First Nations, and the general public. The herd is part of the Northern Mountain caribou population (*Rangifer tarandus caribou*), assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as a Species of Special Concern, and was listed as such under the *Species at Risk Act* (SARA) in 2005. There has been considerable research on the Northern Mountain population (NMP) of caribou in recent years. It has been found that population dynamics of the NMP are largely driven by natural forces and not necessarily human activities and the KZK Project is one of only a few developments that could influence NMP ecological behavior. It should be noted that even though there is ample research carried out on the Boreal population of woodland caribou, direct reference to the NMP ecotype is not always applicable. The two populations are ecologically quite different. Caribou of the Boreal population are sedentary at low density in lowland habitats with unique life history strategies (Environment Canada, 2012b). Northern Mountain caribou are gregarious and use open upland habitats (Environment Canada, 2012a). Both occur as part of very different multi-predator/prey systems. Less is known about northern mountain ecotype – particularly regarding anthropogenic effects.

The federal government has published a Management Plan for the NMP of woodland caribou in Canada**.** The main goal of the plan is to prevent the NMP from becoming threatened or endangered by engaging responsible agencies to manage the NMP caribou and their habitat carefully (Environment Canada, 2012b). Two of the objectives of the management plan are:

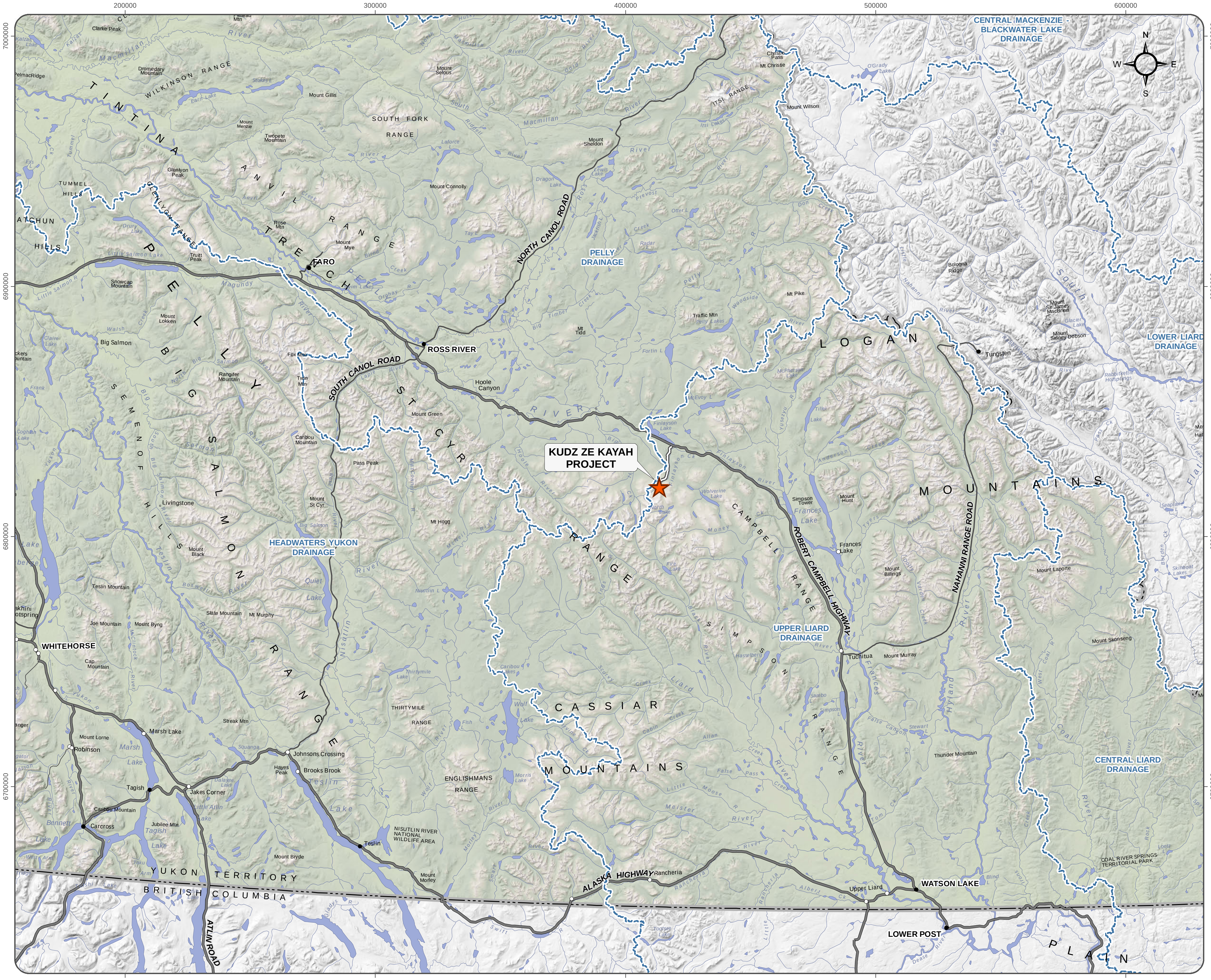
- Identify and assess the quality, quantity and distribution of important habitats for the population; and
- Manage and conserve important habitats to support caribou herds.

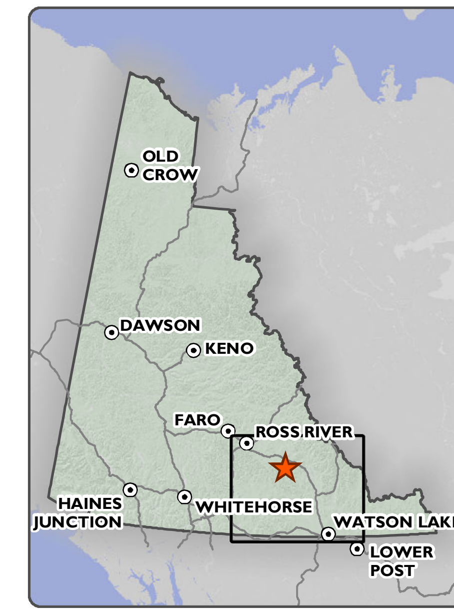
In order to identify and assess the quality, quantity and distribution of important habitats of the FCH population at the Kudz Ze Kayah (KZK) Project site (the Project), habitat suitability index (HSI) models for the rut and post-calving periods were developed and submitted in early 2017 as part of the Project Proposal for Executive Committee review under the *Yukon Environmental and Socio-economic Assessment Act* (YESAA). During the Yukon Environmental and Socio-economic Assessment Board's (YESAB) Adequacy review of the Project Proposal they informally requested that a habitat suitability index model also be prepared for the late winter life requisite of the FCH. The late winter habitat overlaps with the access route for the KZK Project, but not the proposed mine site.

The purpose of the HSI was to predict the location of caribou late winter habitat within the Local Study Area (LSA), as well as within the traditional home range of the FCH. The LSA was defined as the area encompassing a 3 km buffer surrounding the proposed Project mine site, and a 1.5 km buffer on either side of the Access Road. The herd has a traditional home range of 23,000 km^2 in east-central Yukon, lying mainly in the Yukon Plateau-North and Pelly Mountains Ecoregions (Adamczewski et al., 2010). The information and maps produced herein are meant to aid BMC's development of avoidance measures, mitigation measures, and management plans to minimize the disruption of important caribou habitat during the development and operation of the proposed Project. Results will also be utilized to assess the potential residual effects to caribou where avoidance of disruption to important caribou habitat is not practicable.

2 ENVIRONMENTAL SETTING

The Project is located in the northeastern foothills of the Pelly Mountains, approximately 260 km northwest of Watson Lake, 115 km southeast of Ross River and 24 km south of Finlayson Lake, Yukon (Figure 2-1: and Figure 2-2:). Late winter surveys completed from 1982 to 2017 for the FCH range focused on areas with the best winter habitat north and south of the Robert Campbell Highway. The Project is in the Geona Creek valley, situated primarily within the subalpine, extending marginally into the lower alpine. The surrounding montane landscape consists of rounded mountaintops, ridges, and high plateaus, with secondary and tertiary creek systems. Wetlands are concentrated along the Geona Creek drainage. The lower valley slopes host open to sparse white spruce (*Picea glauca*) and subalpine fir (*Abies lasiocarpa*) forest with a well-developed shrub understorey. The treeline occurs at approximately 1,550 metres above sea level (masl), giving way to a tall shrub and meadow matrix of the upper subalpine. Beyond 1,700 masl, dwarf shrub, graminoid, and lichen cover defines the alpine tundra zone. The Tote Road corridor parallels the lower reaches of Finlayson Creek. Approximately 18 km of this road goes through open white and black spruce (*Picea mariana*) forest and intercepts a few small wetlands and streams.





MINERALS

KUDZ ZE KAYAH PROJECT

CARIBOU LATE WINTER HABITAT SUITABILITY

FIGURE 2 -1
LOCATION OF KUDZ ZE KAYAH PROJECT SITE

DECEMBER 2017

★ KUDZ ZE KAYAH PROJECT

Digital elevation model created by the Yukon Department of the Environment interpolated from the digital 1:50,000 Canadian National Topographic Database (NTDB Edition 2) contour and watercourse layers. Obtained from Geomatics Yukon.

Canvec compiled by Natural Resources Canada at a scale of 1:10,000 - 1:50,000. Reproduced under license from Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources Canada. All rights reserved.
Drainage areas obtained from National Hydrology Network 2011

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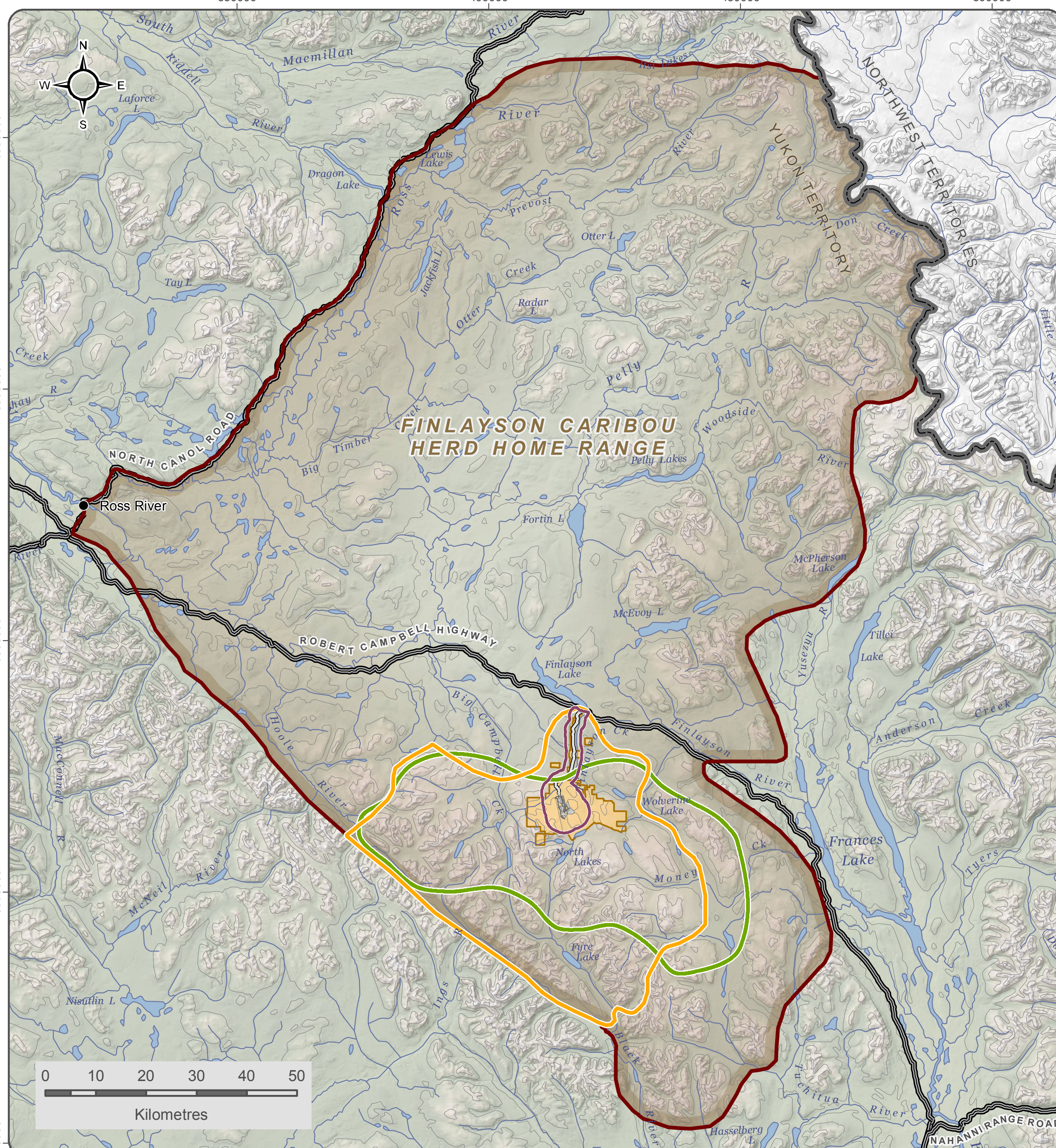

- Local Study Area
- Caribou Post Calving Study Area
- Caribou Rut Study Area
- Finlayson Caribou Herd Home Range (and Late Winter Study Area)
- Robert Cambell Highway
- Tote Road/Proposed Access Road
- Proposed Mine Road
- Location of Proposed Infrastructure
- BMC Minerals (No.1) Ltd. Mineral Claim Areas

KUDZ ZE KAYAH PROJECT
CARIBOU HABITAT SUITABILITY

FIGURE 2-2

FINLAYSON CARIBOU HERD HOME RANGE AND STUDY AREAS

JANUARY 2018

Wildlife Key Area data compiled by the Yukon Department of Environment. Publication Date: May 2009
Obtained from Geomatics Yukon. Datum: NAD 83; Projection: UTM Zone 9N

AEG

BMC MINERALS

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3 Winter Habitat selection

The FCH is an elevational, migratory ecotype that moves to different habitats along traditional seasonal routes to meet specific life cycle needs (Thomas and Gray, 2002). In the spring, two thirds of the herd begin moving from their wintering grounds in the forested lowlands near the Pelly River to the Pelly Mountains in the southeast. The remaining one third of the herd travels to the mountains northeast of Finlayson Lake. As summer approaches, female caribou disperse in the mountains to calve on ridges and upper plateaus to avoid predators (Bergerud et al., 1984; Bergerud and Page, 1987). They remain dispersed in small bands in the uplands through summer seeking out snow patches to escape insect harassment and warm temperatures (Ion and Kershaw 1989, Mörschel and Klein, 1997). The FCH's summer and fall ranges are primarily on alpine plateaus and mountain ridges south of Finlayson Lake which overlap the KZK Project area.

Moderate numbers of the FCH have been observed ranging in the mature forested areas south of Finlayson Lake, adjacent to the northern sections of the Project's the Tote Road. These observations were made during years when the snow pack was shallow as was seen during the 2015 to 2017 late winter surveys (results from 2015 in EDI, 2015).

The FCH habitat requirements for the migration and late winter seasons are detailed below.

Migration Habitat: In the late fall, the FCH migrate back from their rutting range in a northwest direction towards the Pelly lowlands. During this seasonal movement, the caribou traverse through a variety of ecosystems. The caribou's diet changes as the FCH migrate to lower elevations and herbaceous plants begin to die. The availability of forbs, sedges, and other deciduous plants decreases and caribou become more reliant on the winter staple of terrestrial lichens found in the mature forests (Johnson et al., 2004). Lichen make up 70% of the FCH diet in winter (Environment Yukon, unpublished data). In the spring, the direction of travel reverses as does their source of food as caribou move through boreal forest, subalpine, shrub land, and eventually to the alpine tundra zones.

Late Winter Habitat: During late winter, the FCH are distributed throughout the lower forest and shrublands around the Pelly River and Finlayson Lake which lies in an orographic rain/snow-shadow north of the Pelly Mountains. As weather systems move from the coast, moisture falls on the south side of the mountains and results in a dry area (rain/snow shadow) on the northeast side of the mountain range (Wahl et al. 1987, Kuzyk et al, 1999). The caribou distribution in any one year varies based on local variations in snow depth throughout the winter. Shallow snow allows the caribou to crater to access the terrestrial lichens.

There is marked variation in precipitation across the range of the FCH. The St Cyr Range typically receives 40-50 cm of precipitation annually, while the foothills of the Logan Range receive approximately 75 cm annually. Between these ranges, the 'rain/snow shadow' region receives <30 cm each year. Late winter snow accumulation data measured at snow stations established along the Robert Campbell Highway, from 1982 to 2015, showed that snowpack on the FCH winter range averages 40 cm (Figure 3-1). This is markedly less than values reported to impede the mobility of solitary (50-60 cm) or groups (80-90 cm) of caribou (Russell and Martell, 1984). Abundant lichens and low snow cover provide a highly suitable winter range for the FCH with little or no alternate adjacent range available. The FCH's traditional winter range is the result of an obligatory response to environmental conditions, and is, therefore, considered to be essential habitat for the herd (Farnell and McDonald, 1989).

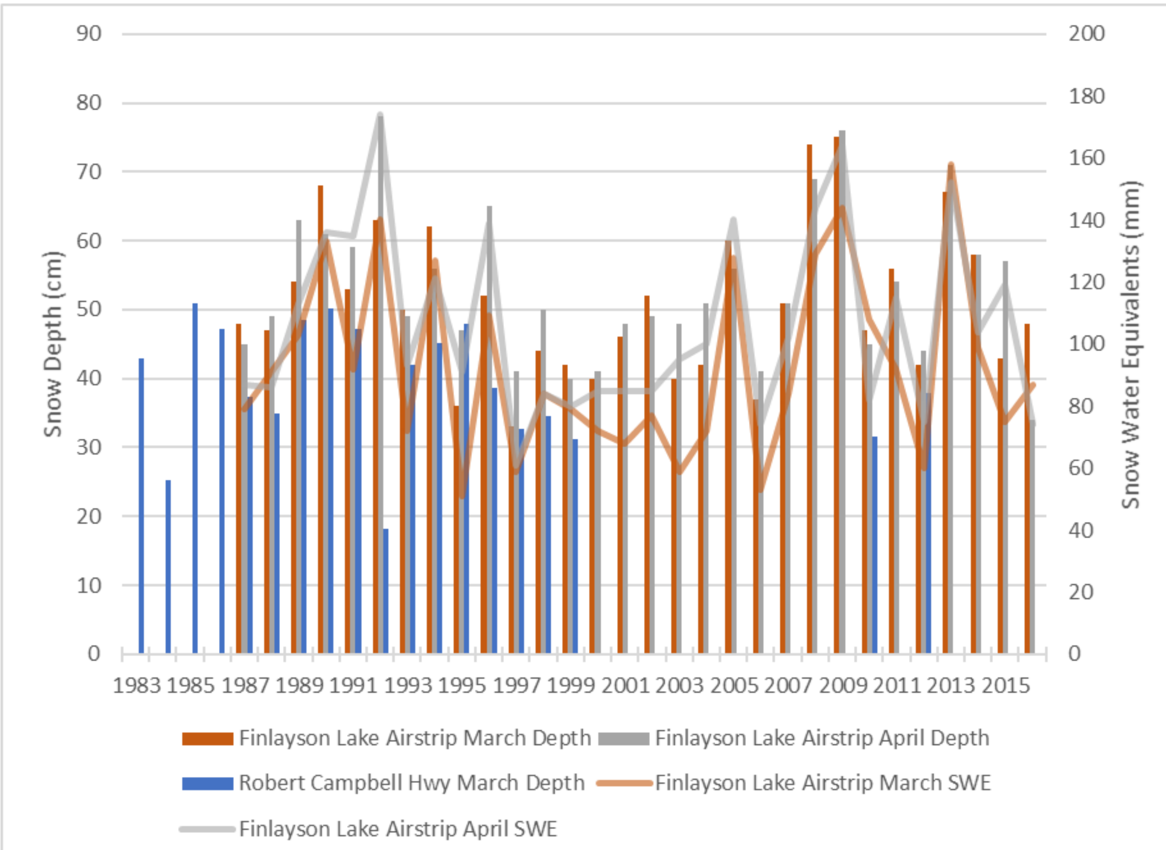


Figure 3-1: Historical Average Snow Depths Near Robert Campbell Highway

4 METHODS

The methods used to generate the caribou habitat suitability index was developed based on the available data covering the FCH home range extent. Subsequently, the variable inputs used to develop the model were limited as they had to cover the entire extent of the FCH home range. The late winter HSI model was developed using four environmental variables (elevation, slope, vegetation, and precipitation) and were evaluated with an extensive existing record of caribou observation locations. The following sections list and describe the data and approach used to produce an HSI for caribou late winter season.

4.1 DATA SOURCE

Data inputs for the model included spatial data and expert knowledge obtained from multiple agencies including Environment Yukon, Geomatics Yukon, AEG, Makonis Consulting and Associates, and PRISM Climate Group. Spatial data used to create and evaluate the model are listed below in Table 4-1.

Table 4-1: Habitat Suitability Index Data Sources

Dataset	Description	Source
Digital Elevation Model (DEM)	Elevation raster dataset; resampled to 25 m	Geomatics Yukon, Yukon Government (YG)
Slope	Slope raster data measuring degrees of slope generated from the DEM (25 m cell size)	Created by AEG based from Geomatics Yukon, Yukon Government data
Aspect	Aspect raster data measuring aspect in degrees generated from the DEM (25 m cell size)	Created by AEG based from Geomatics Yukon, Yukon Government data
Vegetation Cover	Main vegetation cover derived from Ross River Dene Council Predictive Ecosystem Mapping Project (25 m cell size) (Grods et al., 2013)	Makonis Consulting and Associates, provided by Environment Yukon, Yukon Government
Winter Precipitation	Average winter precipitation -1961-1990, (1672 m cell size)	PRISM Climate Group, Northwest Alliance for Computation Science and Engineering, Oregon State University, via SNAP (Scenarios Network for Alaska + Arctic Planning)
Caribou Satellite Collar Points	Satellite collar locations of FCH from 2004-2011	Environment Yukon, Yukon Government
Caribou VHF Relocation Collar Points	Telemetry collar locations of FCH from 1982-1987, 2004	Environment Yukon, Yukon Government
Caribou Aerial Survey Points (YG)	Aerial Survey locations of FCH from 1982-2014	Environment Yukon, Yukon Government
Caribou Aerial Survey Points (AEG)	Aerial Survey locations of FCH from 2015 to 2017	AEG (Project acquired data)

The caribou location data provided by Yukon Government, along with the survey data collected by AEG, were used to generate and evaluate the HSI. Each of the three datasets used different survey methods, which included satellite collar data, telemetry VHF relocation collar data, and aerial survey data. A summary of data inputs by type and season are presented in Table 4-2. Due to the nature and method of the surveys, there are varying levels of accuracy and biases associated with each dataset.

Table 4-2: Input Survey Location Data Summary

Survey Methodology	Caribou Late Winter Season Number of Caribou in Dataset
Satellite collar	14 (but only 3 from the FCH)
VHF Telemetry relocation	136
Aerial survey	1827
Total	**1977**

The satellite collar location data was collected for the years 2004 to 2011; however, only location data pertaining to the late winter seasons for the years 2004 to 2009 were available. These data are of the highest accuracy within the three datasets but contain the lowest frequency of observations due to limited number of caribou tracked. Furthermore, the objective of the satellite collar study was to monitor the adjacent Nahanni caribou herd, and only three individuals from the Finlayson herd were collared. This created a bias as the three individuals that were collared were often integrated with the Nahanni herd whose range is most often to the east of the FCH home range.

The relocation telemetry data were collected for the years 1982 to 1987 and for 2004, but only captured the late winter season from 1982 to 1987. The method for collecting these data utilized a fixed wing aircraft flying transects to locate a collar signal, and then marking the animal location once the collar was located. This method presented a lower accuracy than the satellite collar data as the location of the animal was recorded from the air rather than an exact location on the ground.

The aerial survey data have been collected continuously by Yukon Government from 1982 to 2014, EDI in 2015, and by AEG for 2016 and 2017. The late winter season was surveyed by Yukon Government from 1982 to 1984, 1986, 1990, 1996, 1999, and 2007. Yukon Government also completed a survey in 2017, but the report is not yet available. The survey method utilized a helicopter to target preferred areas expected to be used by caribou during the specific season. The accuracy of the location data was not as precise as the satellite collar data since position is recorded from the helicopter that may be up to 200 m away. Furthermore, the intention of the survey was to target areas of high use and band size for demographic analysis biasing the data and over-representing those specific areas. For the purpose of developing the model, the satellite and relocation data were combined and used to calibrate the model variables while the aerial survey data were used to evaluate the effectiveness of the model.

4.2 Variables

The four variables, elevation, slope, vegetation, and precipitation were selected as model parameters to develop the caribou HSI for the late winter season. These parameters describe the geographical context for habitat requirements and were the most readily available for assessing habitat suitability for the large range area being assessed. Data for the distribution of caribou based on aspect were reviewed, but no trends were seen since the caribou use the lowlands which have little to no slope in the late winter; therefore, aspect was not used in the model.

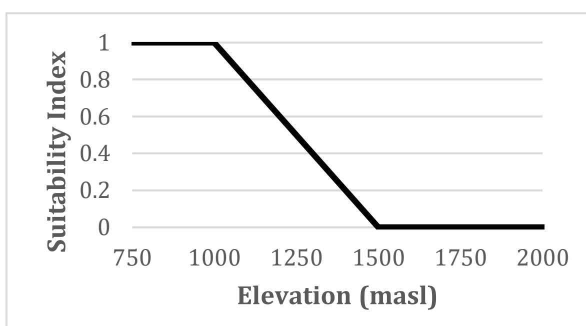
Other parameters such as minimum area, isolation, adjacency, and edge can also be used for suitability mapping (Clarke, 2012); however, the geographical context parameters used in this model captured key caribou habitat preferences described in the literature. The data used for model calibration and validation determined whether these four parameters provided an accurate model.

The variables were divided into classes ranging from 0 to 1, with 0 representing not suitable habitat (nil) and 1 representing highly suitable habitat (high). The classes within the variable were ranked based on their significance for caribou during the late winter season. Significance of each class was determined using the distribution and frequency of observations from the calibration dataset.

4.3 Elevation

Elevation data was interpreted from the 25 m DEM and was computed as a continuous variable for the purpose of the HSI. A linear fuzzy membership function was applied to determine the suitability ranking between suitable and not suitable habitat, based on elevation breaks derived from the frequency of occurrences of satellite and relocation data points at a given elevation. Suitable habitat for the FCH during late winter is known to be in the forested lowlands in the snow-shadow north of the Pelly Mountains (Kuzyk et al, 1999). The equation and function used are shown in Table 4-3.

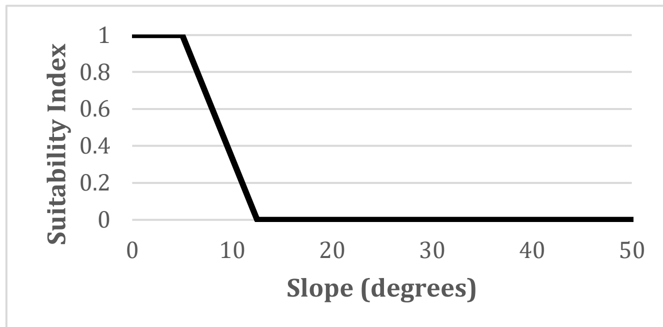
Table 4-3: Fuzzy Membership Function and Class Ranking for Elevation Suitability

Caribou Late Winter Season	
Lower elevation linear function $f(x) = \begin{cases} 0, x \geq 1500 \\ \left(\frac{1500-x}{1500-1000}\right) & 1000 < x < 1500 \;\; x \in X \\ 1, x \leq 1000 \end{cases}$	

4.4 Slope

Slope, or terrain steepness, was derived from the 25 m DEM using ArcGIS 10.4 and was modelled in degrees of slope between neighbouring raster cells. Slope was treated as a continuous variable for the purpose of the HSI model using a linear fuzzy membership function to derive the values between suitable and not suitable habitat. Functions of slope suitability were interpreted using frequency of occurrence of animals based on the satellite and relocation data (Table 4-4).

Table 4-4: Fuzzy Membership Function and Class Ranking for Slope Suitability

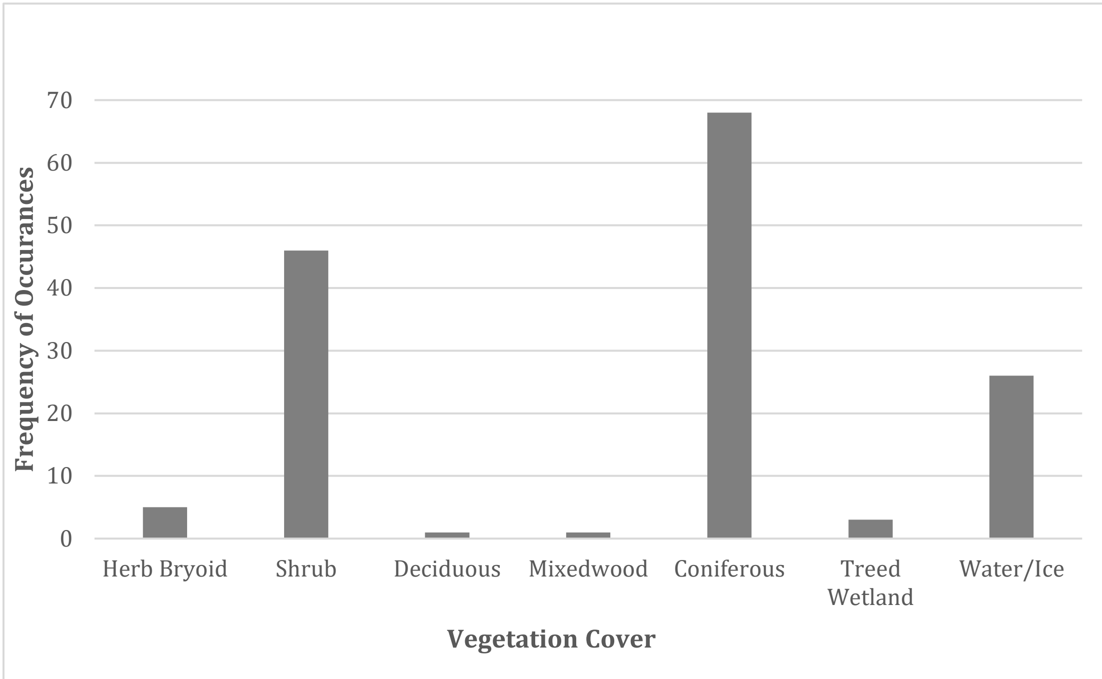
Caribou Late Winter Season	
Slope linear function $f(x) = \begin{cases} 0, & x \geq 12.5 \\ \left(\frac{5-x}{(12.5-5)}\right) & 5 < x < 12.5 \;\; x \in X \\ 1, & x \leq 5 \end{cases}$	

4.5 Vegetation

Vegetation cover type was classified based on the *Regional Ecosystems of East-Central Yukon Predictive Ecosystem Map* (PEM) that was completed in 2013 by Makonis Consulting Ltd (Grods et al., 2013). The PEM spatial data and methodology was received from Environment Yukon. The PEM product was developed using land cover, surficial material, and base features (watercourses, waterbodies, and elevation) as a means to predict the broad ecosystem units in the defined study area. The final product was evaluated by ground-truthing, polygon interpretation through ecosystem plots measurements, and boundary traverses. The PEM is recommended to be used at a scale of 1:100,000 or smaller (Grods et al., 2013). For the purpose of the model, the PEM was classified into the dominant vegetation cover, not utilizing the landscape classification as these aspects were already addressed in the model. Satellite and VHF relocation data were intersected with the PEM and the suitability index rating was developed based on the data distribution and expert knowledge as shown in Table 4-5.

Table 4-5: Distribution and Class Ranking for Vegetation Cover Suitability

Caribou Late Winter Season

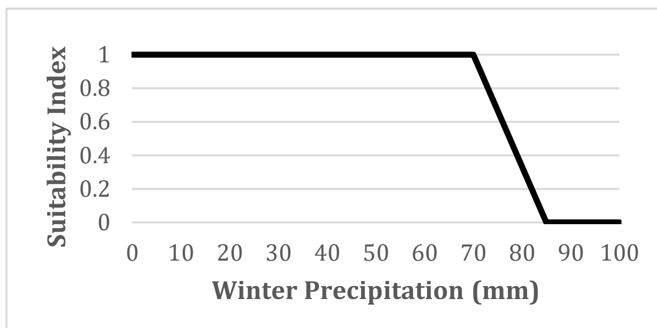


Variable Class	Suitability Index Ranking
Herb Bryoid	0
Shrub	1
Deciduous	0
Mixed Wood	0
Coniferous	1
Treed Wetland	0
Water/Ice	0.5

4.6 Precipitation

The precipitation data used was produced by the Alaska and Arctic Planning of the University of Alaska Fairbanks as part of data package prepared for and obtained from the Northern Climate ExChange (Yukon Research Centre, Yukon College). The precipitation averages by season are based on precipitation data from 30-years (1961-1990) of monthly climatology at 2 km spatial resolution covering Alaska and northern regions of Canada and downscaled to a finer resolution (1,672 m) using the delta method. For the purpose of modelling, the spatial resolution of the data was modified using nearest neighbour resampling to a cell size of 25 m. Winter precipitation was treated as a continuous variable using a linear fuzzy membership function to derive the values between suitable and not suitable habitat. Functions of precipitation suitability were interpreted using frequency of occurrence of animals based on the satellite and VHF relocation data (Table 4-6).

Table 4-6: Fuzzy Membership Function and Class Ranking for Winter Precipitation

Caribou Late Winter Season	
Slope linear function $f(x) = \begin{cases} 0, & x \geq 85 \\ \left(\frac{85 - x}{85 - 70}\right) & 70 < x < 85 \; x \in X \\ 1, & x \leq 70 \end{cases}$	

4.7 Model Development

The caribou HSI model was developed by combining the different environmental variables to predict the habitat suitability for late winter habitat. The result of the model is a raster dataset at a 25 m cell size resolution for the outlined FCH home range study area. The final layer is represented by six habitat index rankings, from nil to high suitability, based on the British Columbia Wildlife Habitat Rating Standards (RIC, 1999). The model development and flowchart are described below and visually represented in Figure 4-1.

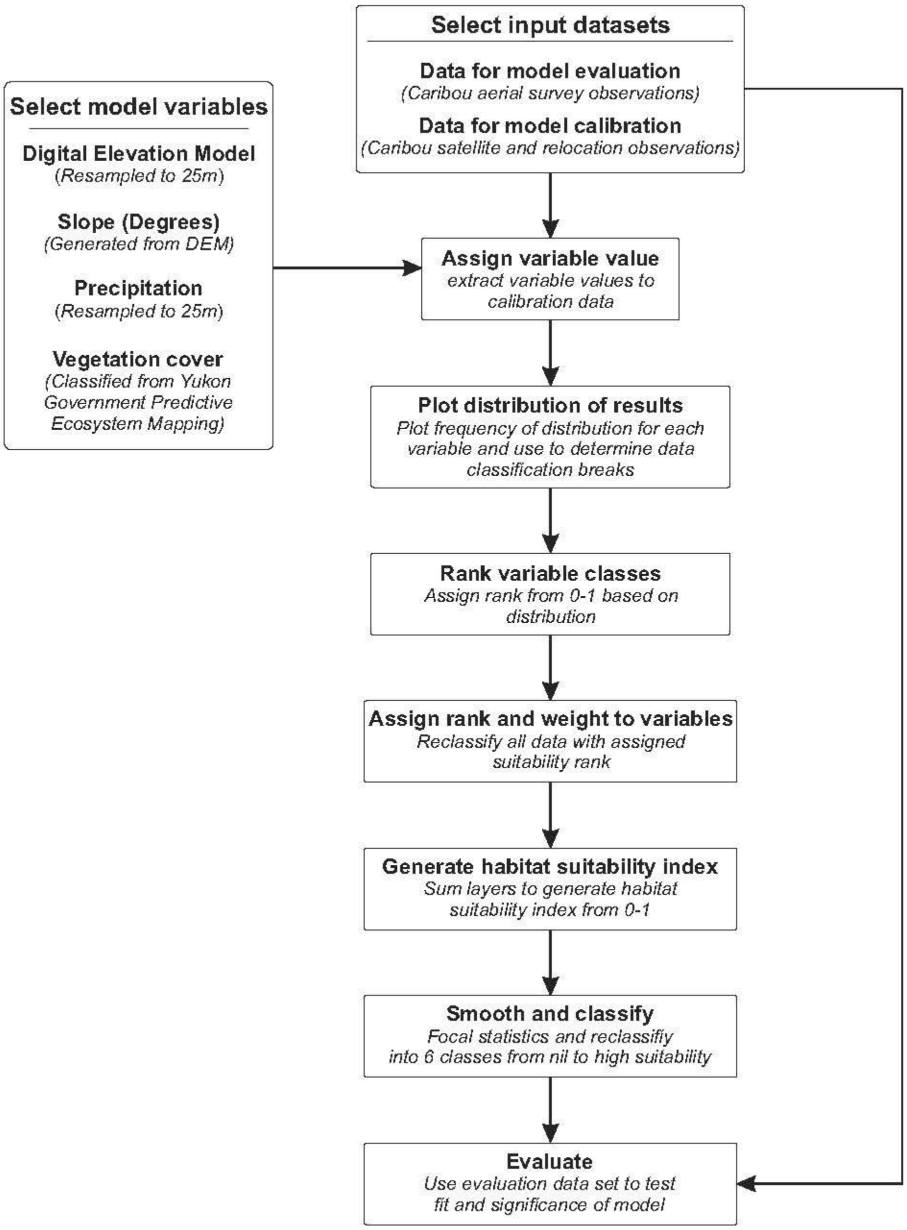


Figure 4-1: Habitat Suitability Index Process Workflow

The HSI model development involved two initial steps. The first to determine the variables that would be used as inputs for the model, and the second to stratify the caribou location data into a dataset for model calibration and a dataset for model evaluation. Splitting the datasets allowed for cross-validation of the model using an independent dataset approach to calibrate and evaluate the model. This approach utilized the satellite collar and VHF relocation collar data as the calibration dataset, and the aerial survey data to evaluate the strength of the model (Guisan & Zimmermann, 2000). The satellite collar data had the highest accuracy, but too few data points so it was combined with the relocation data which had sufficient data points for validation but more survey bias than the lower altitude aerial survey data.

The input model variables were converted into raster datasets with equal cell size of 25 m, so the corresponding variable values would align spatially for analysis. The calibration dataset was intersected with each of the variables and the values were extracted to each point in the calibration dataset. The variable values corresponding to the calibration dataset were independently plotted as histograms representing the frequency of occurrence for each variable (e.g., the number of times a caribou observation concurred with each variable class). Based on the frequency of occurrence the variables were classified from 0 to 1, with 0 being ‘not suitable’ and 1 being the ‘most suitable’ habitat. Elevation, slope, and precipitation variables were treated as continuous variables with the values between 0 and 1 calculated using a linear fuzzy membership equation. The vegetation cover variable is discrete in nature and was treated as such in the model. The vegetation cover was divided into classes and assigned a value between 0 and 1 based on frequency of occurrence and validated by expert opinion on habitat selection by FCH.

After each variable was reclassified based on the exported location values, they were assigned a weight based on their importance as a factor influencing suitability of habitat. Each classified layer was multiplied by its weight and then added together to achieve a final suitability rating from 0 to 1. Caribou habitat selection did not appear to favour any variable; therefore, each variable was weighted evenly using the following formula:

Late Winter Model: 0.25 * [Elevation] + 0.25 * [Slope] + 0.25 * [Vegetation] + 0.25 * [Precipitation]

Focal statistics with a 100 m (4 cell) radius were run on the output HSI to smooth small groupings of isolated cells that were artifacts of the data. The results better represented continuous raster of the landscape. The final HSI raster was divided into equal classes ranging from 0 to 1 and then evaluated against the aerial survey point data to test the correlation and significance of the model.

4.8 Evaluation

Model evaluation was carried out using the non-parametric Kendall tau test to determine whether the final suitability ranking (divided into six rank classes) and observations were correlated. A non-parametric test was used since data did not follow a normal distribution and the Kendall tau test for rank correlation was chosen rather than the Spearman’s test because the Kendall tau is less sensitive to error and is more accurate with smaller data sets (Statistics Solutions, 2016). Observations were from the evaluation dataset (aerial survey data), which was independent from the data used for the model development. The p-value was used to determine whether the correlation was significant or not at a 95% confidence level ($\alpha = 0.05$) and the Kendall tau coefficient was used to determine the strength of the correlation. The tau coefficients obtained for various iterations of the model were compared and the model with the highest value (strongest correlation) was selected as the final habitat suitability model. All statistics were generating using R, a statistical computing software program (R Core Team, 2014).

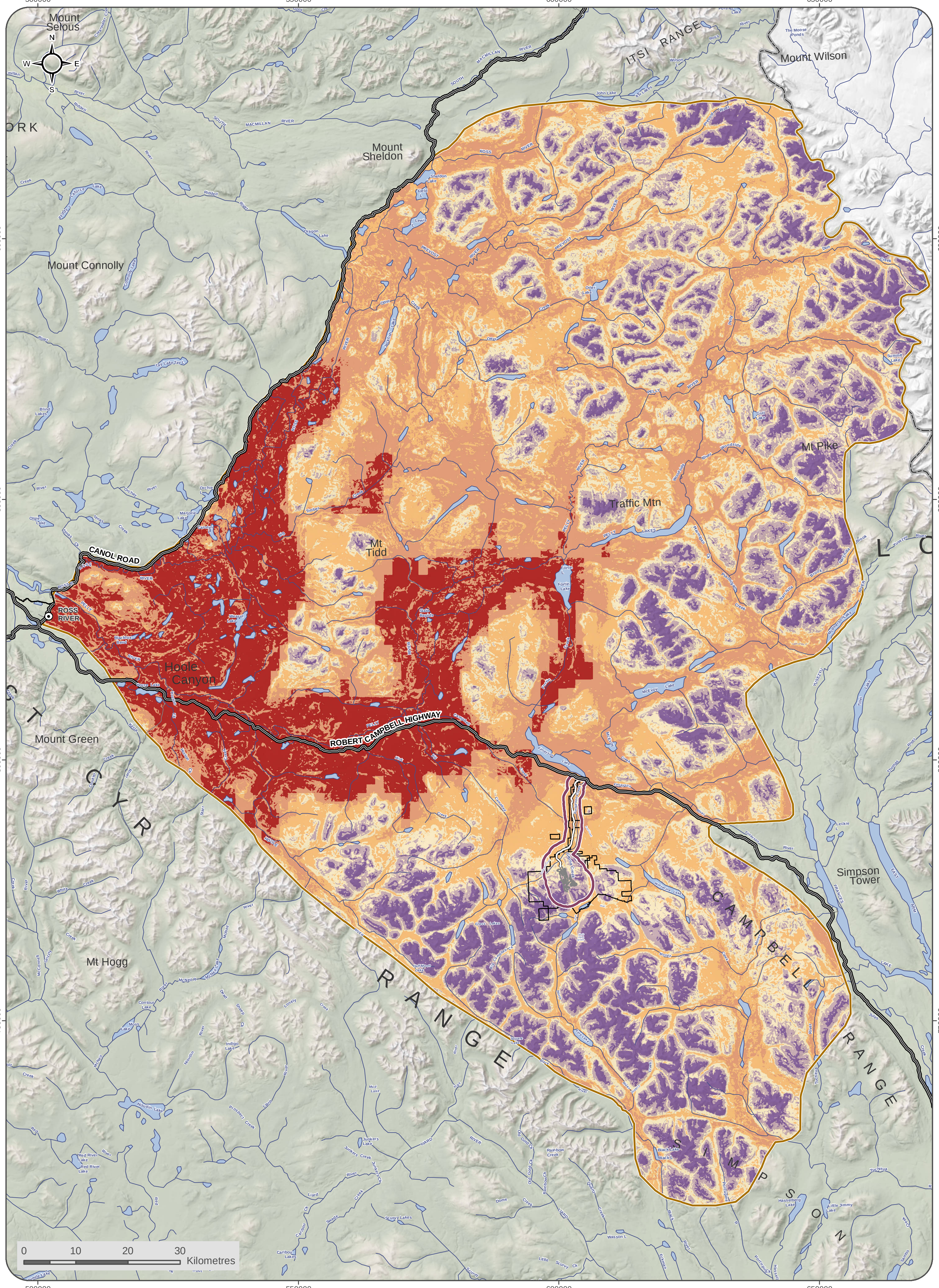
5 RESULTS

Evaluation of the HSI models indicate that there is a strong correlation between the suitability classes of the model and the number of occurrences of caribou within each class. The late winter HSI (p-value = 0.0014) suggests a statistically significant (significant if $p < 0.05$) correlation between rated habitat suitability and number of occurrences within each class and the correlation is strong (tau correlation coefficient = 1). The model calculated the habitat suitability for a total area of 2,036,778 ha, which covers the extent of the FCH home range. The values listed in the first section of Table 5-1 represent the total area as the six habitat suitability classes for the late winter season. The second and third sections of Table 5-1 show the amount and proportion of each HSI class that will be indirectly and directly affected by the Kudz Ze Kayah Project relative to the corresponding habitat class in the FCH range and the LSA.

Table 5-1: Distribution of Suitable Late Winter Habitat Within FCH Home Range

FCH Home Range Late Winter Habitat Suitability Index Study Area				
Habitat Suitability Index	**Number of Cells**	**Area (ha)**	**Percent of FCH home range (HSI)**	
Nil	3,181,865	198,867	10%	
Very Low	4,413,013	275,813	14%	
Low	5,931,425	370,714	18%	
Moderate	7,823,538	488,971	24%	
Moderately High	6,897,562	431,098	21%	
High	4,341,046	271,315	13%	
Total FCH Range Area		**2,036,778**	**100%**	
Indirectly Affected Caribou Late Winter Habitat (i.e., Local Study Area (LSA))				
Habitat Suitability Index	**Number of Cells**	**Area (ha)**	**Percent of FCH home range (HSI)**	
Nil	25,614	1,601	0.8%	
Very Low	43,400	2,713	1.0%	
Low	47,599	2,975	0.8%	
Moderate	57,317	3,582	0.7%	
Moderately High	25,324	1,583	0.4%	
High	0	0	0.0%	
Directly Affected Suitable Caribou Late Winter Habitat				
Habitat Suitability Index	**Number of Cells**	**Area (ha)**	**Percent of FCH home range (HSI)**	**Percent of LSA (HSI)**
Nil	553	35	0.0%	2%
Very Low	6446	403	0.1%	15%
Low	7294	456	0.1%	15%
Moderate	1441	90	0.0%	3%
Moderately High	175	11	0.0%	1%
High	0	0	N/A	0%

Based on the habitat suitability model, the percentage of moderately high and high valued late winter habitat across the FCH range is 34% (702,413 ha) (Figure 5-1). Approximately 13% (1,583 ha) of the LSA has moderately high value and no high value late winter habitat. The LSA is already affected by the existing Tote Road; however, the calculations assumed that the road is new impact. The moderately high value late winter habitat in the LSA is located along the Access Road. Figure 5-2 shows that the proposed mine footprint does not overlap with any moderately high and high late winter habitat. Approximately 90 ha of moderate and 11 ha of moderately high late winter habitat is directly affected by the access road. Approximately 3,582 ha of moderate and 1,583 ha of moderately high value late winter habitat is indirectly affected by the access road. The directly and indirectly affected habitat equates to less than 1% of all moderate to high suitability late winter habitat in the FCH range.



HABITAT SUITABILITY INDEX

- Nil
- Very Low
- Low
- Moderate
- Moderately High
- High

- Local Study Area (Indirect Zone of Influence)
- Finlayson Caribou Herd Home Range
- BMC Minerals (No.1) Ltd. Mineral Claim Areas
- Location of Proposed Infrastructure

Datum: NAD 83; Projection: UTM Zone 9N

BMC MINERALS

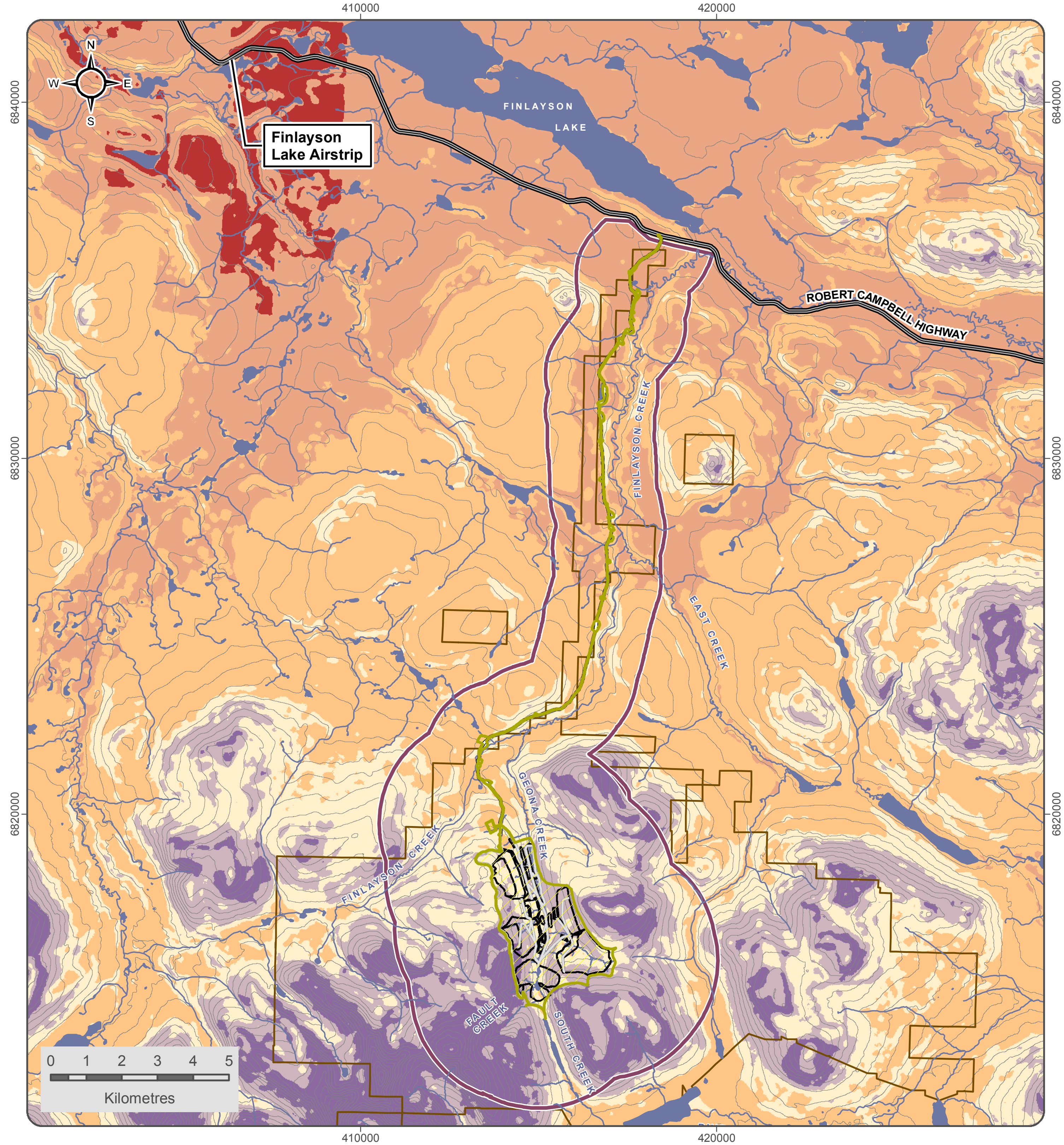
ALEXCO ENVIRONMENTAL GROUP

KUDZ ZE KAYAH PROJECT
CARIBOU HABITAT SUITABILITY

FIGURE 5-1

FINLAYSON CARIBOU HERD LATE WINTER HABITAT SUITABILITY HOME RANGE

JANUARY 2018



HABITAT SUITABILITY INDEX

- Nil
- Very Low
- Low
- Moderate
- Moderately High
- High

- Tote Road/Proposed Access Road
- Proposed Mine Road
- Direct Disturbance Area
- Local Study Area (Indirect Zone of Influence)
- Location of Proposed Infrastructure
- BMC Minerals (No.1) Ltd. Mineral Claim Areas

KUDZ ZE KAYAH PROJECT
CARIBOU HABITAT SUITABILITY

FIGURE 5-2

LATE WINTER HABITAT SUITABILITY LOCAL STUDY AREA AND PROPOSED PROJECT MINE FOOTPRINT

Datum: NAD 83; Projection: UTM Zone 9N

AEG

BMC MINERALS

JANUARY 2018

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6 DISCUSSION

In conclusion, the LSA contains moderate and moderately high late winter habitat along the Access Road, but does not contain high quality late winter habitat for the FCH. The mine site area only has low to no suitable late winter habitat. The HSI model and maps provide an estimate of potentially suitable late winter habitat in the FCH range based on the habitat variables where FCH caribou have been surveyed. The resulting maps have been used to help assess the direct and indirect environmental effects and mitigation measures for the Project. There are other factors that can influence caribou use of suitable habitat that may not be reflected in the HSI model and maps. For example, the model does not reflect year to year local variability in weather or climate change. Burn areas will also factor into habitat suitability and movement throughout the FCH range.

7 LIMITATIONS

HSI models are predictive tools that aim to produce a continuum of preferred habitat for a selected species using available data. The following is a list of limitations associated with the HSI for caribou the late winter season:

- Only a few of the caribou location points were from satellite collars which provide exact locations on the ground. The remaining data have a location accuracy of approximately 200 m which affects the variable values for each location;
- The HSI is a knowledge based model that incorporates quantitative data with expert opinion. The model reflects some biases related to expert opinion;
- Accuracy of the model is limited by the accuracy of the original source data; and
- The model was constructed using data for animal presence while not taking into consideration data on the absence of animals.

8 REFERENCES

Adamczewski, J., R. Florkiewicz, R. Farnell, C. Foster, and K. Egli. (2010). Finlayson caribou herd late-winter population survey, 2007. Yukon Fish and Wildlife Branch Report SR-10-01. Whitehorse, Yukon, Canada.

Alexco Environmental Group (AEG). (2016). Kudz Ze Kayah Project, Wildlife Baseline Report. Submitted as Appendix E-8 of the Project Proposal for YESAB Executive Committee Screening.

Bergerud, A. T., Jakimchuk R. D. and D. R. Carruthers. (1984). The buffalo of the north: caribou (Rangifer tarandus) and human developments. Arctic 37:7-22.

Bergerud, A. T. and R. E. Page. (1987). Displacement and dispersion of parturient caribou at calving as antipredator tactics. Can. J. Zool. Vol. 65:1597-1606.

BMC, 2017. Kudz Ze Kayah Project, Project Proposal for YESAB Executive Committee Screening. March 2017.

Clarke, H. (2012). Knowledge-based habitat suitability modeling guidelines. Whitehorse: Yukon Environment.

EDI Environmental Dynamics Inc. (2015). Kudz Ze Kayah, Late Winter Ungulate Survey 2015. Prepared for BCM Minerals Ltd.

Environment Canada. (2012a). Management plan for the Northern Mountain Population of woodland caribou (Rangifer tarandus caribou) in Canada. Species at Risk Act, Management Plan Series. Environment Canada, Ottawa, pp. 79. Retrieved on January 24, 2017 from http://publications.gc.ca/collections/collection_2012/ec/En3-5-25-2012-eng.pdfGrods, J., S.R. Francis, K. McKenna, J.C. Meikle and S. Lapointe. 2013. East-central broad ecosystems (Version 1.1). Downloaded from Yukon government private ftp site on July 13th, 2016. Spatial data created for Energy, Mines and Resources, Government of Yukon by Makonis Consulting Ltd. and Associates, West Kelowna, BC.

Environment Canada. (2012b). Recovery Strategy for the woodland caribou (*Rangifer tarandus caribou*), Boreal population, in Canada. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa. xi + 138pp.

Farnell, R., and J. McDonald. (1989). The influence of wolf predation on caribou mortality in Yukon's Finlayson caribou herd. Proceedings of the 2nd North American Caribou Workshop. Alaska Department of Fish and Game. Juneau. Wildlife Technical Bull No. 8:52-70.

Grods, J., S.R. Francis, K. McKenna, J.C. Meikle and S. Lapointe. (2013). East-central broad ecosystems (Version 1.1). Downloaded from Yukon government private ftp site on July 13th, 2016. Spatial data created for Energy, Mines and Resources, Government of Yukon by Makonis Consulting Ltd. and Associates, West Kelowna, BC.

Guisan, A., and Zimmermann, N. (2000). Predictive habitat distribution models in ecology. Ecological modelling, 147-186.

Ion, P. G., and G. P. Kershaw. 1989. The selection of snowpatches as relief habitat by woodland caribou (Rangifer tarandus caribou), MacMillan Pass, Selwyn/Mackenzie Mountains, N.W.T., Canada. Arctic Vol. 21, No. 2, 203-211.

Johnson, C.J., K.L. Parker, D.C. Heard, and D.R. Seip. (2004). Movements, foraging habits, and habitat use strategies of northern woodland caribou during winter: Implications for forest practices in British Columbia. BC Journal of Ecosystems and Management 5(1):22–35

Kuzyk G.W., M.M. Dehn and R. S. Farnell. (1999). Body size comparisons of alpine and forest wintering woodland caribou in Yukon. Canadian Journal of Zoology 77:1017-1024.

Morshel, F. M., and Klein, D. R. (1997). Effects of weather and parasitic insects on the behavior and group dynamics of caribou of the Delta herd, Alaska. Canadian Journal of Zoology 75:1659-1997.R Core Team. (2014). R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/

Resources Inventory Committee (RIC). (1999). British Columbia wildlife habitat rating standards, version 2.0. Ministry of Environment, Lands and Parks, Victoria, BC.

Russell, D.E., A.M. Martell and W. A. C. Nixon. (1993). Range ecology of the Porcupine caribou herd in Canada. Rangifer Special Issue No. 8.Statistics Solutions. (2016). Kendall's Tau and Spearman's Rank Correlation Coefficient. Accessed on October 17, 2016 at http://www.statisticssolutions.com/kendalls-tau-and-spearmans-rank-correlation-coefficient/.

Thomas, D.C., and D.R. Gray. 2002. Status report on woodland caribou Rangifer tarandus caribou in Canada. In: COSEWIC Assessment and Update Status Report on woodland caribou *Rangifer tarandus* Caribou in Canada. Ottawa: Committee on the Status of Endangered Wildlife in Canada. Available at: http://www.sararegistry.gc.ca/virtual/sara/files/cosewic/sr%5Fwoodland%5Fcaribou%fe%2Epdf Accessed on September 2016.

Wahl, H.E., D.B. Fraser, R.C. Harvey, and J.B. Maxwell, J.B. (1987). Climate of Yukon. Environment Canada. Climatological Studies No. 40. Ottawa.