August 2021

APPENDIX G
CARIBOU SUPLEMENTAL INFORMATION REPORT

Valentine Gold Project: Caribou Supplemental Information

Additional Information to Support Response to Regulatory and Public Review of the Valentine Gold Project EIS

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Table of Contents

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1.0 INTRODUCTION

Marathon Gold Corporation (Marathon) is proposing to develop an open pit gold mine near Valentine Lake, located in the central region of the Island of Newfoundland, southwest of the Town of Millertown, Newfoundland and Labrador (NL) (Figure 1-1). On September 29, 2020, Marathon filed an Environmental Impact Statement (EIS) with the Impact Assessment Agency of Canada and Newfoundland and Labrador Department of Environment and Climate Change, assessing potential Project and cumulative effects of the Valentine Gold Project (the Project).

An assessment of Project effects on caribou was presented in Chapter 11 of the EIS, supported by baseline studies which were appended to the EIS (Baseline Study Appendix 2: Caribou). Through the regulatory and public review process, Marathon received requests for clarifications and additional information related to the assessment of Project effects on caribou, in the form of information requirements (IRs) through the federal environmental assessment (EA) process, and regulatory and public comments through the provincial EA process. This document presents supplemental information on baseline conditions, the environmental effects assessment, and mitigation and monitoring plans in response to these regulatory and public IRs / comments, and also addresses feedback received from the Newfoundland and Labrador Department of Fisheries, Forestry and Agriculture (NLDFFA)-Wildlife Division following a courtesy review of draft responses and supplemental information to the IRs / comments. Whereas this document presents supplemental information to the EIS, this information does not change the conclusions of the assessment as presented in the EIS.

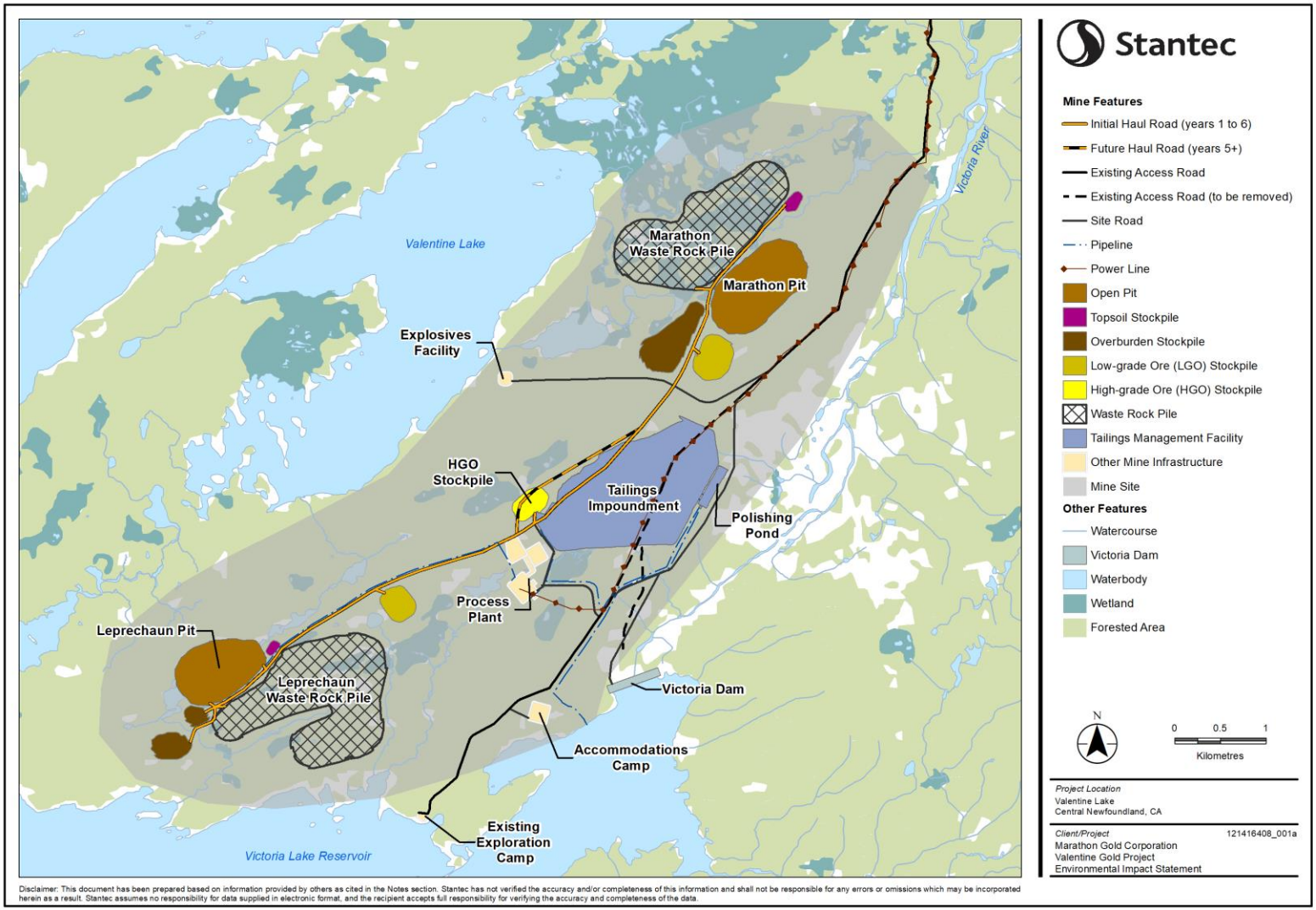


Figure 1-1 Project Site Plan as Presented in the EIS

2.0 SUMMARY OF ENVIRONMENTAL EFFECTS ASSESSMENT FROM THE EIS

The methods used to prepare the EIS were developed by Stantec Consulting Ltd. in consideration of the federal requirements under the *Canadian Environmental Assessment Act*, 2012 (CEAA 2012) and the provincial *Environmental Protection Act* (NL EPA), with specific consideration of the federal and provincial EIS Guidelines developed for the Project. The EIS was prepared by a Study Team which included specialists with expertise in developing EAs for mining projects in Newfoundland and Labrador and other parts of Canada, and more specifically, specialists with expertise in assessing effects of mines and other developments on caribou. The following sections provide an overview of the EA methods used, as well as a summary of key findings related to caribou. While this information is not "new" in relation to that included in the EIS, additional context is provided to demonstrate linkages and overlap between potential environmental effects and the effects pathways considered.

2.1 OVERVIEW OF ENVIRONMENTAL ASSESSMENT METHODS

In environmental assessment, it is considered best practice to identify and assess the specific effects and effects pathways by which project components and activities could affect an identified Valued Component (VC). As described in Section 11.1.3 of the EIS and shown on Figures 2-1 and 2-2 below, effects are assessed within a Local Assessment Area (LAA) and Regional Assessment Area (RAA) which were delineated in consideration of the geographic extent over which Project activities and their effects are likely to affect the VC (i.e., caribou). The assessment also refers to an Ecological Land Classification Area (ELCA) (Figure 2-1), which is the area within which detailed habitat data has been collected. While the extent of the ELC data does not fully cover the Project Area, LAA or RAA, the ELCA is used to inform a quantitative assessment of effects on caribou habitat in reasonable proximity to the Project. In particular, the magnitude of residual effects has been characterized in relationship to the ELCA (i.e., the percentage of the ELCA in which a change will occur; change may include temporary or permanent habitat alteration or loss). In this context, the ELCA has been used as a surrogate for the RAA, as it is an area of sufficient size to provide regional context and is the area for which comparable ELC data is available. This approach results in a rigorous and transparent assessment, whereby the effects pathways, mitigation for those effects, and the resulting residual effects are evaluated and characterized for each phase of the Project.

Predicted effects are considered both individually and in combination in determining if the Project will result in a residual adverse effect that exceeds the established significance threshold for the VC. This approach is consistent with Section 4.3 of the Federal EIS Guidelines for the Project, which indicates that the EIS should include "an analysis of the pathway of the effects of environmental changes on each VC". Provincial EIS Guidelines for the Project do not provide this level of guidance in terms of effects pathway analysis, however, do require the EIS to "identify and justify the selected indicators and measures of ecosystem health (i.e., measurable parameters)". Measurable parameters are used in the EIS to help characterize changes related to effects pathways and have been assessed quantitatively, where possible. The selection of potential effects pathways and measurable parameters used in the EIS was informed by Project-specific federal and provincial EIS guidelines, recent EAs for mining projects in NL and other parts of Canada, comments received during engagement, and professional judgement.

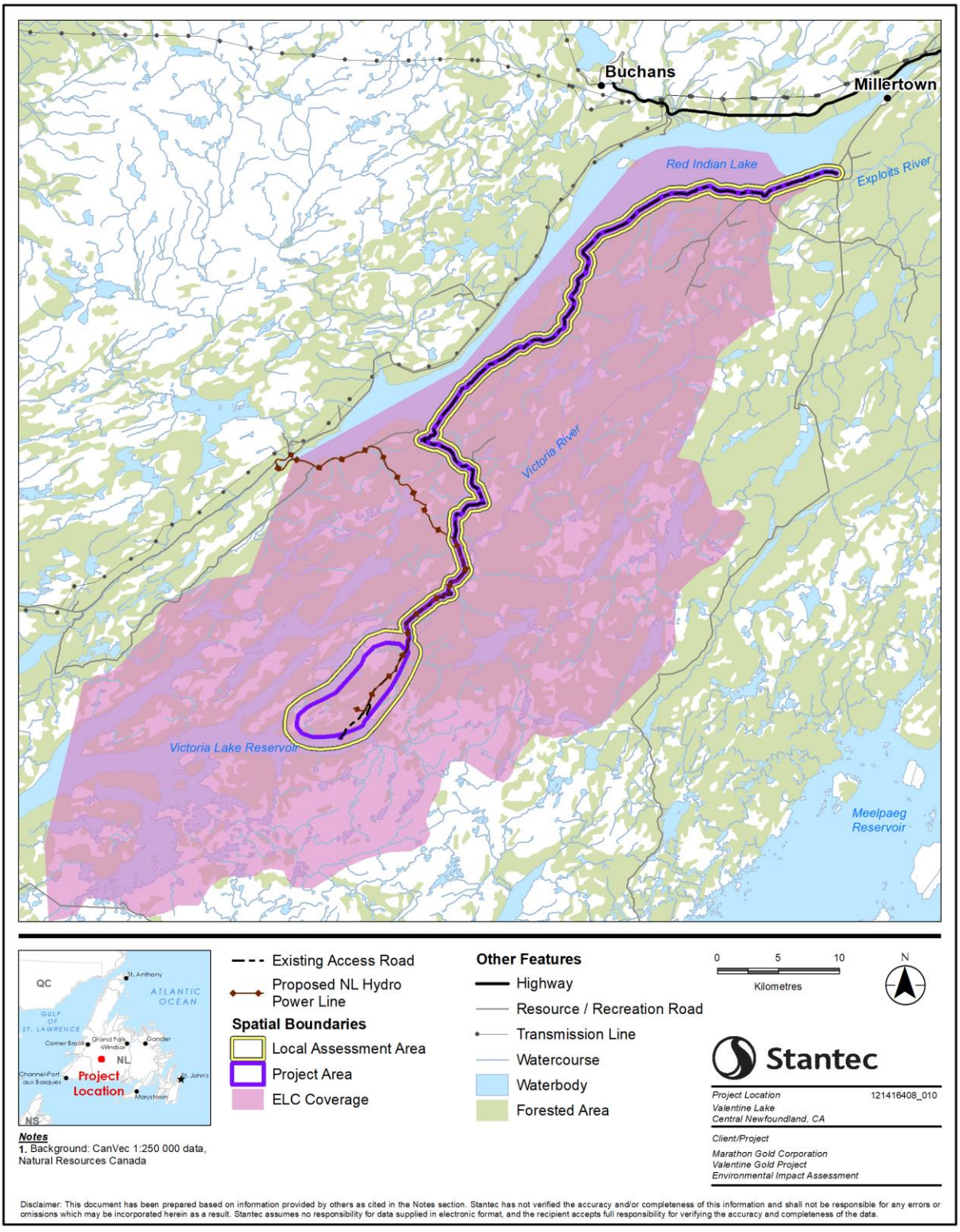


Figure 2-1 ELC Coverage Relative to Project Area and LAA Boundaries

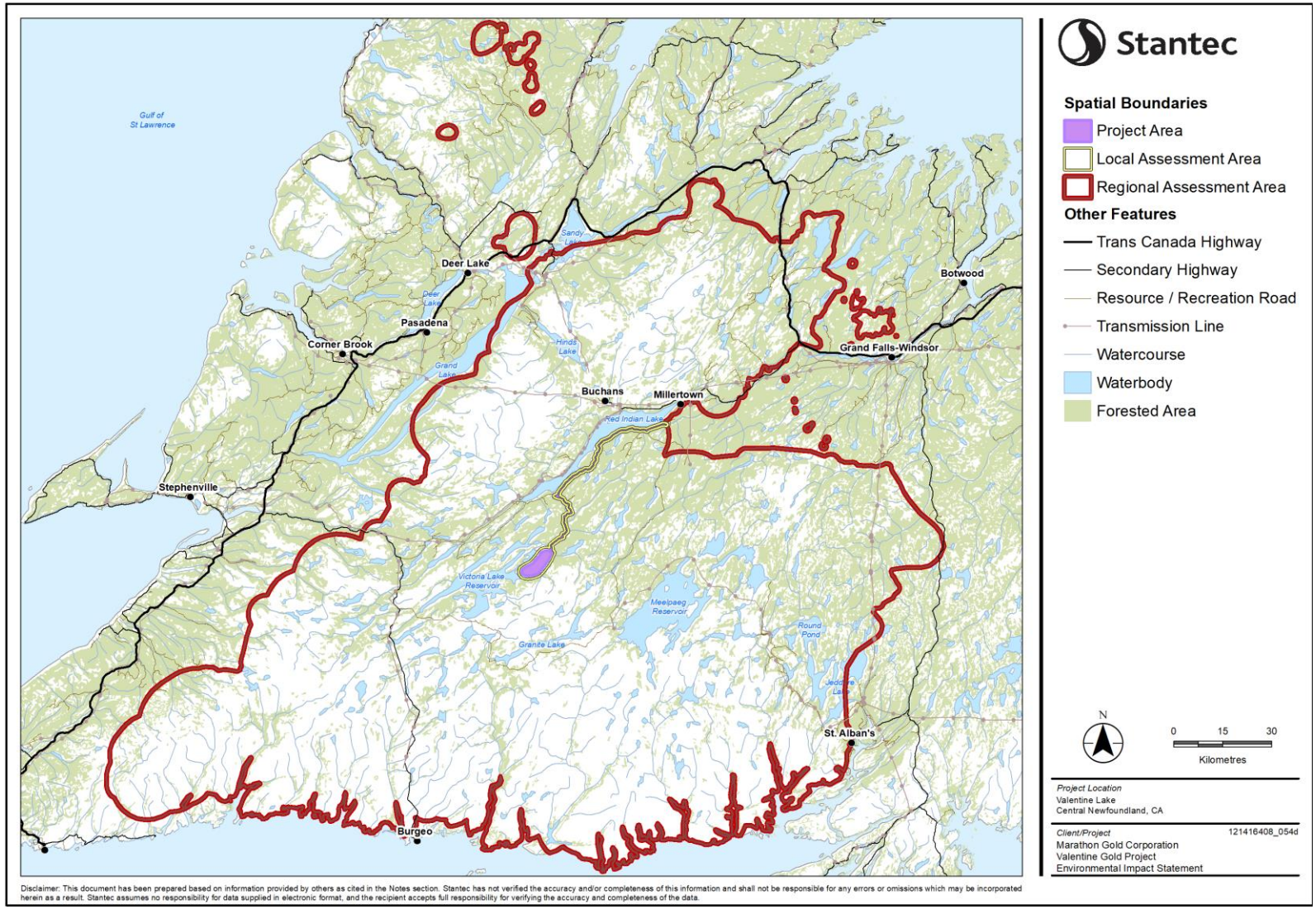


Figure 2-2 Regional Assessment Area

As indicated in Section 11.3.3 of the EIS, three potential effect pathways were identified by which the Project could affect caribou: change in habitat, change in movement, and change in mortality risk. Within the EIS, these effect pathways are first considered separately to demonstrate that the full range of potential effects of the Project are assessed and characterized. Within the assessment of individual effect pathways, linkages between pathways are also identified and discussed (e.g., change in habitat or movement may affect change in mortality risk, as discussed in Section 11.5.3.2 of the EIS - Indirect Mortality Risk). Additional context related to each potential environmental effect and effect pathway is provided in Table 2.1 and described as follows.

- **Change in Habitat:** Direct (e.g., vegetation clearing) and indirect (e.g., sensory disturbance) change in caribou habitat was quantified in the EIS in the context of habitat availability within the 1,830.6 km^2 ELCA. A change in habitat, either directly or indirectly, may also affect movement and mortality risk of caribou. For example, caribou may avoid habitat altered by sensory disturbance in the vicinity of the mine site, which can result in altered migration paths with potential implications on energetic demand, body condition, pregnancy rates, and predation risk. Avoidance behavior can have adverse effects on caribou herds if caribou move into areas with reduced availability of preferred forage, which can lead to smaller calves and subsequent increased vulnerability to predation. Potential Zones of Influence (ZOIs), or areas of avoidance by caribou, associated with the Project are discussed in Section 4.1.3 of this document. Habitats within potential ZOIs may have reduced use or avoidance by Grey River herd caribou during calving and by Buchans herd caribou during migration, particularly for those caribou potentially using the ZOIs closest to the Project and are expected to receive the most sensory disturbance.
- **Change in Movement:** A change in movement paths or patterns arising from habitat change and sensory disturbance, including avoidance of the mine site, is captured as an effect pathway. For the assessment, 'migration corridor' refers to an area used for migration at the population-level. The migration corridor comprises several 'migration paths', that may be used by one or more caribou. Associated measurable parameters identified in the EIS included the amount of existing caribou paths (km^2) lost or altered relative to their availability in the migration corridor and the proportion or relative amount of use of the preferred migration path in the Project Area. In assessing change in movement for caribou, the amount of caribou paths lost or altered by the Project and the high relative use of these paths informed the discussion of the residual effects of the Project (along with scientific literature and professional judgement) and identified the potential for the Project to act as an obstacle to caribou movement.

  The potential effect of the Project as an obstacle to caribou migration, and possible subsequent effects on the Buchans herd population, was the primary factor in the determination of a significant residual effect for caribou. Specifically, a change in movement has potential implications on the timing, movement rate, or use of stopover sites during caribou migration and can result in increased energetic demands. Potential long-term effects of increased energetic demands include a decrease in body condition, pregnancy rate, calving success, and/or caribou recruitment (Section 11.5.2.2 of the EIS). Thus, the risk of a change in movement and potential changes in calving success and recruitment includes potential adverse effects on the Buchans herd population (size and trend).

- **Change in Mortality Risk:** The effect pathway for change in mortality risk included direct change in mortality risk due to vegetation clearing, site preparation activities, and vehicular collisions, and indirect change in mortality risk (e.g., increased predation). While changes in calf mortality was not specifically identified in the effect pathway as an example of indirect change in mortality risk, it was fully assessed as an indirect change in mortality risk in Section 11.5.3 of the EIS and contributed to the determination of a significant residual effect for caribou. Table 2.1 presents the effect pathways and associated measurable parameters for each potential environmental effect as presented in Section 11.3.3 of the EIS, but also provides additional context not previously presented in the EIS.

Table 2.1 Potential Effects, Effect Pathways and Measurable Parameters Considered for Caribou in the EIS

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement	Additional Context and Linkages Between Effects
Change in habitat	Direct and/or indirect loss or alteration of habitat arising from vegetation clearing and mine construction, and/or sensory disturbance (e.g., avoidance)	• Amount of high and moderate-ranked caribou habitat (km^2) directly or indirectly lost or altered relative to its availability in the ELCA	Change in habitat, either directly (e.g., vegetation clearing) or indirectly (e.g., sensory disturbance), may also affect movement and mortality risk of caribou. Sensory disturbance in the vicinity of the mine site can result in altered migration paths for Buchans herd caribou with potential implications on energetic demand, body condition, pregnancy rates, and predation risk. Sensory disturbance can also result in reduced use or avoidance by Grey River herd caribou during calving.

Table 2.1 Potential Effects, Effect Pathways and Measurable Parameters Considered for Caribou in the EIS

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement	Additional Context and Linkages Between Effects
Change in movement	Change in movement paths or patterns arising from habitat loss and/or sensory disturbance (e.g., avoidance)	• Amount of high and moderate -high existing caribou paths (km^2) directly lost or altered relative to availability in the migration corridor • Proportion of relative amount of use of the preferred migration path within the Project Area	'Migration corridor' refers to a broader area used for migration at the population-level. The migration corridor is comprised of several 'migration paths', which are used by individual caribou. A migration path may be used by one or more caribou. The assessment includes potential changes in the functionality of the migratory pathway, with potential implications on the timing, movement rate, or use of stopover sites during caribou migration, and potential increased energetic demands, decreased body condition, decreased pregnancy rates, and increased predation risk. The risk from a change in movement and potential changes in calving success and recruitment includes potential adverse effects on the population (size and trend) of Buchans herd caribou.
Change in mortality risk	Direct change in mortality risk due to vegetation clearing and site preparation activities, vehicular collisions, and indirect change in mortality risk (e.g., increased predation)	• Changes in traffic volumes during the life of the Project • Likelihood of interactions with Project infrastructure, vehicles and equipment	Direct sources of mortality include those attributable to vegetation clearing and site preparation activities, and vehicular collisions. Indirect sources of mortality are assessed qualitatively and include mortality risk factors such as displacement (due to habitat changes) to areas where predation risk is higher, and/or change in energetic demands and resulting effects on body condition.

Concerns have been raised by NLDFFA-Wildlife Division, particularly related to a change in movement, that the measurable parameters selected underestimate the losses that may occur if the main migration path becomes impermeable to travel as a direct result of developing the Marathon open pit and waste rock pile, or indirectly as a result of habitat loss and sensory disturbance associated with the mine site. Measurable parameters identified and used in the assessment for VCs in the EIS inform the overall assessment and are not used in isolation to characterize residual effects. Residual effects are those that remain after consideration of planned mitigation to avoid or reduce effects. Just as there is more than one effect pathway for each VC, there is more than one measurable parameter for each effect pathway. Measurable parameters are used in conjunction with scientific literature and professional judgement to

help characterize residual effects of the Project. However, ultimately, the determination of the significance of residual effects of the Project on a VC considers the combined effects of all identified effects pathways in consideration of pre-determined significance criteria, and provides an overall prediction of the potential risk posed by the Project. Generally, if one effect pathway meets the criteria for a significant adverse effect, then a significant effect determination is made for the VC overall. For the Project, a predicted significant effect for the caribou VC is based on predicted adverse effects on the Buchans herd.

2.2 SUMMARY OF KEY FINDINGS

For the assessment, change in habitat was defined as loss or alteration of habitat, both direct and indirect, that would affect its availability to caribou. As indicated in Section 11.5.1.3 of the EIS, residual effects on change in caribou habitat are predicted to be neutral to adverse, long term in duration (i.e., residual effect extends beyond the operation phase; >12 years) and low in magnitude (i.e., Project changes less than 10% of caribou habitat in the ELCA) for all assessed herds for all Project phases. Adverse effects on habitat are expected to extend beyond the LAA, with caribou showing various degrees of avoidance beyond the 500 m buffer (e.g., depending on season, location, and nature of Project activities).

Change in habitat, either directly or indirectly, may also affect movement and mortality risk of caribou. As indicated in Table 11.14 in the EIS, caribou respond adversely to sensory disturbance (i.e., indirect habitat changes) typically within 2 km to 14 km (Weir et al. 2007; Polfus et al. 2011; Boulanger et al. 2012; Leblond et al. 2013; Johnson et al. 2015; Eftestøl et al. 2019), and in one known example up to 19-23 km (Plante et al. 2018). The avoidance of the mine site can result in altered migration paths with potential implications on energetics, body condition, pregnancy rates, and predation risk. Predator-prey dynamics can also be affected by change in habitat such that the characteristics of altered habitat could facilitate predator movements or improve hunting success (Section 11.5.3.2 of the EIS).

As indicated in Section 11.5.2.3 of the EIS, residual effects on change in caribou movement are predicted to be negligible for the Gaff Topsails and La Poile herds because of the limited overlap between those herds and the extent of Project effects. Change in movement for the Grey River herd is predicted to be adverse but low in magnitude, given the limited overlap of their summer range with the Project. Project-related effects on movement of the Buchans herd are expected to be high in magnitude (i.e., Project changes more than 50% of the proportion of caribou use in the migration corridor) because of the overlap of the Project with a well-defined and well-used migration path. The effect on the Buchans herd is expected to be long term and irreversible and will extend beyond the LAA.

As indicated in Section 11.5.3.3 of the EIS, residual effects on change in caribou mortality risk will be adverse, low in magnitude (i.e., measurable change in caribou mortality risk in the LAA is not anticipated, although individuals may be affected), and medium term in duration (i.e., residual effect extends through the operations phase; 12 years). The risk of increased predation is expected to extend beyond the LAA and will affect all assessed caribou herds, however a change in mortality risk is likely to be greatest for caribou from the Buchans and Grey River herds as their ranges (or part thereof) overlap the Project in at least one season.

The overall significance of Project effects on change in habitat, change in movement, and change in mortality risk is summarized in Section 11.6 of the EIS (Determination of Significance). The adverse residual effects of the Project on caribou from the Gaff Topsails, Grey River, and La Poile herds are expected to be low in magnitude and not significant. Adverse residual effects on caribou from the Buchans herd are expected to be high in magnitude and significant.

While the determination of a significant residual adverse effect on caribou is largely attributed to the overlap between the Project and a primary migration path of the Buchans herd, the conclusion is also linked to other effect pathways, including, for example, direct effects on a change in habitat (i.e., habitat will be lost along the preferred migration path) and indirect effects on mortality risk (e.g., altered migration paths may increase mortality through changes in predation or body condition). The implication of a significant change in movement could also result in changes to the timing of, or movement rate during, migration, ultimately resulting in a change in caribou recruitment and/or survival.

Table 2.2 summarizes Project residual effects on caribou.

Table 2.2 Project Residual Effects on Caribou

Residual Effect	Residual Effects Characterization							
	Project Phase	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change in Habitat	C	A	L	RAA	LT	C	I	D
	O	A	L	RAA	LT	C	I	D
	D	A/N	L	RAA	LT	C	I	D
Change in Movement	C	A	H	RAA	LT	C	I	D
	O	A	H	RAA	LT	C	I	D
	D	A	H	RAA	LT	C	I	D
Change in Mortality Risk	C	A	L	RAA	MT	IR	R	D
	O	A	L	RAA	MT	IR	R	D
	D	A	L	RAA	ST	IR	R	D

Table 2.2 Project Residual Effects on Caribou

Residual Effect	Residual Effects Characterization							
	Project Phase	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context

KEY
See Table 11.10 of the EIS for detailed definitions

Project Phase
C: Construction
O: Operation
D: Decommissioning

Direction:
P: Positive
A: Adverse
N: Neutral

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PA: Project Area
LAA: Local Assessment Area
RAA: Regional Assessment Area

Duration:
ST: Short term
MT: Medium term
LT: Long term
P: Permanent

N/A: Not applicable

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socio-Economic Context:
D: Disturbed
U: Undisturbed

Project effects on change in habitat, movement, and mortality risk for caribou will act cumulatively with similar residual effects resulting from past (e.g., hydro developments), present, and reasonably foreseeable projects and activities (EIS Chapter 20 – Cumulative Effects Assessment). As stated in Table 20.14 (Section 20.8 of the EIS), cumulative effects resulting from the Project and reasonably foreseeable future activities are predicted to be high in magnitude, based on the following:

- While a small amount of caribou habitat will be lost, suitable habitat remains abundant and widespread throughout the cumulative effects RAA.
- The Project may contribute to a small change in caribou mortality risk; however, it is not anticipated to affect the viability of caribou in the RAA.
- Project-related contributions to cumulative effects on change in movement have the potential to disrupt the preferred migration path of the Buchans herd. Future activities combined with potential Project effects, specifically changes in movement, may measurably affect the abundance or sustainability of caribou (i.e., the Buchans herd) in the cumulative effects RAA.
- As stated in Table 20.14 (Section 20.8 of the EIS), with mitigation, the cumulative effects from the Project and reasonably foreseeable future activities are expected to be significant.

3.0 UPDATED BASELINE INFORMATION

The following sections provide additional context and clarification of baseline information on caribou in the Project Area (Figure 2-1). Specifically, this section integrates the findings of field studies (i.e., spring and fall camera programs and post-calving aerial surveys) with other baseline information (e.g., herd range estimates and migration paths) to characterize caribou use of the area and inform the effects assessment. Where available, additional baseline data collected since the submission of the EIS has been included. Details on current and proposed future baseline work is provided in Section 3.5.

3.1 INFORMATION SOURCES

Information sources used to understand caribou use of the Project Area are listed below. Data that was available for the EIS was included as a baseline study appendix (BSA) or otherwise incorporated into the body of the EIS as noted. Information sources not previously referenced as part of the EIS were obtained following EIS submission and have been presented as part of this supplemental analysis. Information sources include:

- Results from remote camera programs in fall 2019 (BSA.2, Attachment 2-A) and spring 2020 (BSA2, Attachment 2-B)
- Results from a remote camera program in fall 2020 (new data)
- 2020 aerial post-calving survey (BSA.2, Attachment 2-C)
- Incidental observations made during other avifauna and wildlife surveys (BSA.7)
- Estimates of herd ranges (kernel densities) based on caribou telemetry data obtained from NLDFFA-Wildlife Division (EIS Section 11.2.2.1)
- Delineation of heavily used wildlife trails (migration paths) in the mine site using Light Detection and Ranging (LiDAR) data (BSA.2, Attachments 2-A and 2-B)
- Dynamic Brownian bridge movement model (dBBMM) outputs to delineate the migration corridor and paths for the Buchans and Gaff Topsails herds (EIS Section 11.2.2.1)

3.2 CARIBOU MOVEMENTS THROUGH THE PROJECT AREA

Information provided by the NLDFFA-Wildlife Division (Government of NL 2019) and subsequent LiDAR analyses identified several caribou migration paths through the mine site, including one between the north end of Valentine Lake and the Victoria River. Use of this migration path by Buchans Herd caribou was confirmed during both spring and fall migration via the remote camera program, and through dBBMM using caribou collar telemetry data that identified a primary spring and fall migration corridor through the Project Area (Section 11.2.2.1 of the EIS). While caribou migration movements were found to be more dispersed in spring than in fall, consistent use of the area by caribou was observed where the Marathon open pit and waste rock pile are proposed.

The following sections summarize the information available to date on caribou herd migration patterns in the Project Area based primarily on the remote camera program. Standardized results of the camera program (by season and camera location) are also provided. As the migration corridor for the Buchans

herd overlaps with the Project Area, this discussion assumes that the caribou detected by the remote cameras were most likely migrating Buchans caribou, with potential for a small number of resident Grey River caribou to be included in the data.

The information presented below will be used in combination with ongoing baseline work (Section 3.5) and future monitoring programs (Section 6.2) during Project development to assess potential change in caribou movement, which will help to inform the timing and nature of mitigation (e.g., temporary reductions in Project activities, as required).

3.2.1 Remote Camera Monitoring Data

The remote camera monitoring program was initiated in fall 2019 as part of baseline data collection to help inform future monitoring efforts. Camera placement (n=12) (Figure 3-1) was aligned with well-defined migration paths through the mine site (identified using LiDAR data, and informed by input from NLDFFA-Wildlife Division) which had indicated a prominent caribou migration path through the Marathon pit (Government of NL 2019). Five general areas were selected for camera deployment: Valentine Lake outlet (VAL1, VAL2, VAL3), Marathon pit (MAR1, MAR2, MAR3, MAR4), Main Road (MAINRD, MARBOG), South Side of Victoria River (SS1 and SS2) and Victory pit (VIC1).

The sites used for the fall 2019 caribou program were also used for the spring 2020 and fall 2020 caribou programs to support a direct comparison (except SS2 because of challenges associated with retrieving the camera) and to inform subsequent camera monitoring initiatives.

Additional cameras were purchased and deployed in spring 2021 in targeted locations (in consultation with NLDFFA-Wildlife Division; refer to Section 3.5 for camera locations) to gather additional information on:

- localized movements (e.g., exit and entry points to the mine site and use of less prominent wildlife trails within and adjacent to the mine site);
- the timing of migration; and
- information on group size and composition.

The spring 2021 data were not available for presentation at the time this report was prepared.

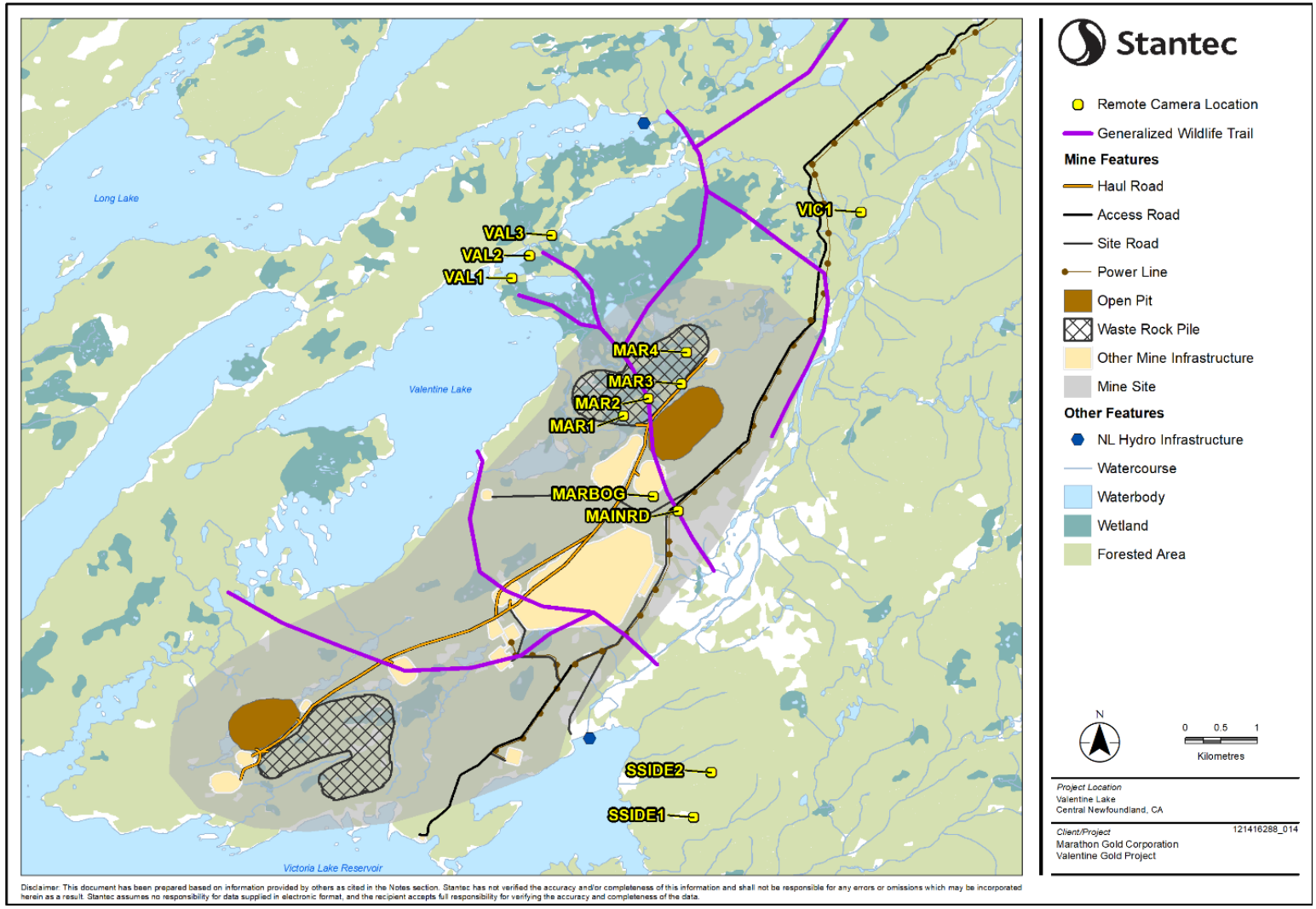


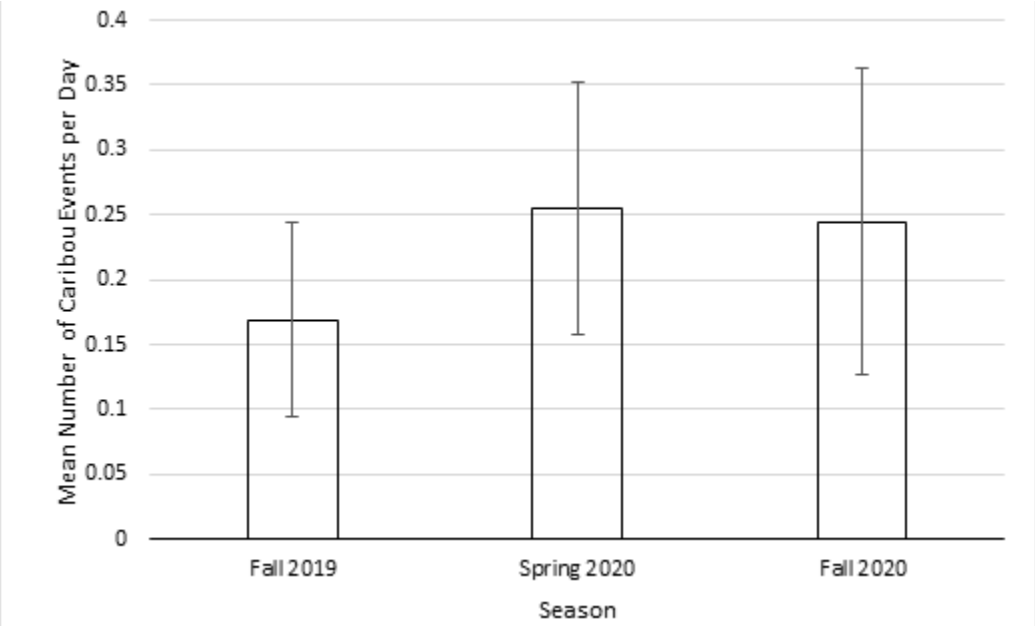
Figure 3-1 Camera Locations used during the 2019 and 2020 Remote Camera Caribou Program

For the analysis, an event was defined as beginning when one or a group of animals entered the frame and ending when they had exited the frame for more than two minutes (Rowcliffe et al. 2008, Stantec 2015). The likelihood of overestimating the number of individual caribou was reduced through a combination of camera placement and image classification techniques. The cameras for the fall 2019 to fall 2020 programs were positioned perpendicular to the migration paths. As such, most of the caribou captured by the cameras were moving across the frame. Additionally, most of the caribou moved across the frame either singly or in small groups, or in longer 'strings' comprised of many animals. When viewed in chronological order, it was possible to mark the progression of individual caribou across the frame based on their relative proximity to landmarks and other caribou. Only new animals entering the frame were counted and added to the total for that discrete event (as opposed to summing the total number of caribou in each image). This technique reduced the likelihood of overestimating the number of individual caribou.

Summary metrics for caribou events and number of caribou detected were provided for each season, and caribou events and number of caribou detected were also summarized daily within each season and among the pool of cameras. The mean number of events per monitoring day, and the mean number of caribou detections per monitoring day (and associated standard error (SE) and deviation) are new calculations that were not included in BSA.2. The data collected from each camera is summarized for fall 2019 and 2020, and spring 2020 in Tables 3.2 to 3.4 and Figures 3-2 to 3-5 which are new and were not included in BSA.2. The mean number of camera events per monitoring day in the fall 2019 camera program was 0.17 (SE = 0.08), and the mean in fall 2020 was 0.24 (SE = 0.12) (Table 3.1, Figure 3-2). The spring 2020 camera program had a mean of 0.25 caribou events per monitoring day (SE = 0.09) (Table 3.1).

Table 3.1 Caribou Events and Detections During Fall 2019, Spring 2020, and Fall 2020 Remote Camera Programs

	Fall 2019	Spring 2020	Fall 2020
Total Number of Caribou Events	157	205	180
Mean Number of Caribou Events per Monitoring Day	0.17	0.25	0.24
Median	0.00	0.00	0.00
Range	0-40	0-9	0-22
Standard Deviation	0.26	0.31	0.39
Standard Error	0.08	0.10	0.12
Total Number of Caribou Detected	2,071	701	1,847
Mean Number of Caribou Detected per Monitoring Day	1.71	0.86	1.75
Median	0	0	0
Range	0-1,033	0-84	0-547
Standard Deviation	4.48	1.55	3.61
Standard Error	1.29	0.49	1.09
Note: Values calculated based on the following monitoring periods: fall 2019 – October 5 to December 31, 2019; spring 2020 – March 28 to June 18, 2020; fall 2020 – September 27 to December 31, 2020			



Note: Means calculated using the following dates: fall 2019 – October 5 to December 31, 2019; spring 2020 – March 28 to June 18, 2020; fall 2020 – September 27 to December 31, 2020

Figure 3-2 Mean Caribou Events During Fall 2019, Spring 2020 and Fall 2020

The results are summarized as follows:

- **Fall (2019 and 2020):** Most recorded caribou events occurred at camera location MAR1 (in the Marathon Pit area) (2019: maximum of 40 events/day, mean = 0.85 events per monitoring day; 2020 maximum 22 events/day, mean = 0.96 events per monitoring day). MAINRD (on the existing access road) also recorded a high number of events (2019: maximum of 16 events/day, mean = 0.52 events per monitoring day; 2020 maximum 22 events/day, mean = 1.15 events per monitoring day (Tables 3.2 and 3.3, Figures 3-3 and 3-4). Remaining camera locations had means ranging from 0.01 to 0.52 events/day with 1-6 events per monitoring day in 2019, and 0.01 to 0.14 events per monitoring day with 0-7 events per monitoring day.
- **Spring 2020**: The number of caribou observed was lower during spring migration than fall migration. Most caribou events occurred at camera location VAL1, with a maximum of 9 events in one day and a mean of 1.12 events per monitoring day (Table 3.4, Figure 3-5). Remaining camera locations had means ranging from 0.01 to 0.35 events per day and maximums ranging from 1 to 4 events per day.

The small mean values and other metrics provided in Tables 3.2 to 3.4 and Figures 3-3 to 3-5 are a result of the data being zero-inflated, meaning that a relatively high proportion of the camera monitoring days had zero events. For example, in all three datasets, most cameras had medians and first and third quartiles that were zero and means that were less than one; the exceptions were camera location MAINRD in fall 2020 (Figure 3-4, Table 3.3) and VAL1 in the spring 2020 program (Figure 3-5, Table 3.4).

This zero-inflated data is indicative of a relatively quick migration past the camera locations relative to the overall migration period.

Table 3.2 Number of Caribou Events and Caribou Detected at Remote Camera Sites in Fall 2019

Camera ID[A]	Number of Days Deployed	Number of Caribou Events	Number of Caribou Observed	Mean Number[B] of Events per Monitoring Day[C] (± SE)	Mean Number[B] of Caribou Observed per Monitoring Day[C] (± SE)
VAL1	83	3	3	0.04 ± 0.02	0.05 ± 0.27
VAL2	114	30	212	0.34 ± 0.14	2.40 ± 17.26
VAL3	114	1	1	0.01 ± 0.01	0.01 ± 0.11
MAR1	75	64	1,228	0.85 ± 0.55	16.37 ± 119.91
MAR2	75	14	122	0.19 ± 0.10	1.63 ± 12.71
MAR3	75	1	1	0.01 ± 0.01	0.01 ± 0.12
MAR4	75	3	3	0.04 ± 0.02	0.04 ± 0.20
MARBOG	75	0	0	0 ± 0	0 ± 0
MAINRD	75	39	499	0.52 ± 0.29	0 ± 0
VIC1	75	1	1	0.01 ± 0.01	0.01 ± 0.12
SSIDE1	99	1	1	0.01 ± 0.01	0.01 ± 0.11
SSIDE2	130	0	0	0 ± 0	0 ± 0

Notes:
[A] Camera locations are provided in Figure 3-1.
[B] Means and standard errors rounded to two decimal places.
[C] Number of monitoring days was calculated up to December 31, or until camera ceased recording: Mar1, Mar2, Mar3, Mar4, Main Rd, MarBog, and Vic1 - October 5 to December 18 (75 days); Val1 - October 5 to December 26 (83 days); Val2, Val3, SS1, and SS2 – October 5 to December 31 (88 days); see Figure 3-2 for camera locations.

Table 3.3 Number of Caribou Events and Caribou Detected at Remote Camera Sites in Fall 2020

Camera ID[A]	Number of Days Deployed	Number of Caribou Events	Number of Caribou Observed	Mean Number[B] of Events per Monitoring Day[C] (± SE)	Mean Number[B] of Caribou Observed per Monitoring Day[C] (± SE)
VAL1	149	3	3	0.03 ± 0.03	0.03 ± 0.93
VAL2	149	13	120	0.14 ± 0.06	1.26 ± 0.93
VAL3	149	0	0	0 ± 0	0 ± 0
MAR1	150	92	1,158	0.96 ± 0.34	12.06 ± 6.32
MAR2	115	1	1	0.01 ± 0.01	0.01 ± 0.01
MAR3	115	1	2	0.01 ± 0.01	0.02 ± 0.02
MAR4	115	1	2	0.01 ± 0.01	0.02 ± 0.02
MARBOG	115	7	40	0.07 ± 0.07	0.42 ± 0.41
MAINRD[D]	54	62	521	1.15 ± 0.50	5.43 ± 3.26
VIC1	83	0	0	0 ± 0	0 ± 0
SSIDE1	150	0	0	0 ± 0	0 ± 0

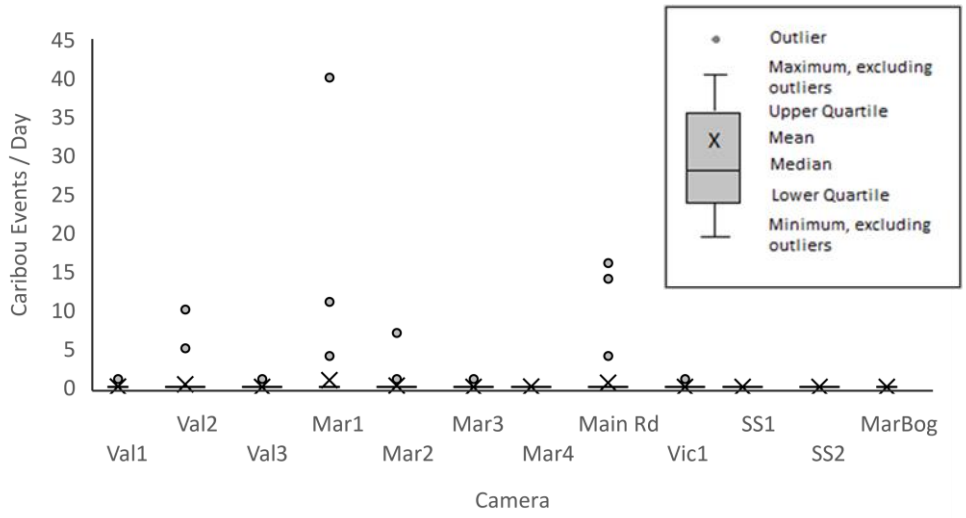
Notes:

[A] Camera locations are provided in Figure 3-1.

[B] Means and standard errors rounded to two decimal places.

[C] Number of monitoring days was calculated up to December 31, or until camera ceased recording: Mar1, Mar2, Mar3, Mar4 and MarBog – September 27 to December 31 (96 days); Val1, Val2, Val3 and SS1 – September 28 to December 26 (95 days); Vic1 – September 28 to December 19 (83 days); MainRd – September 27 to November 11 (54 days); see Figure 3-1 for camera locations.

[D] MAINRD recorded events until November 19, 2020 due to battery failure.

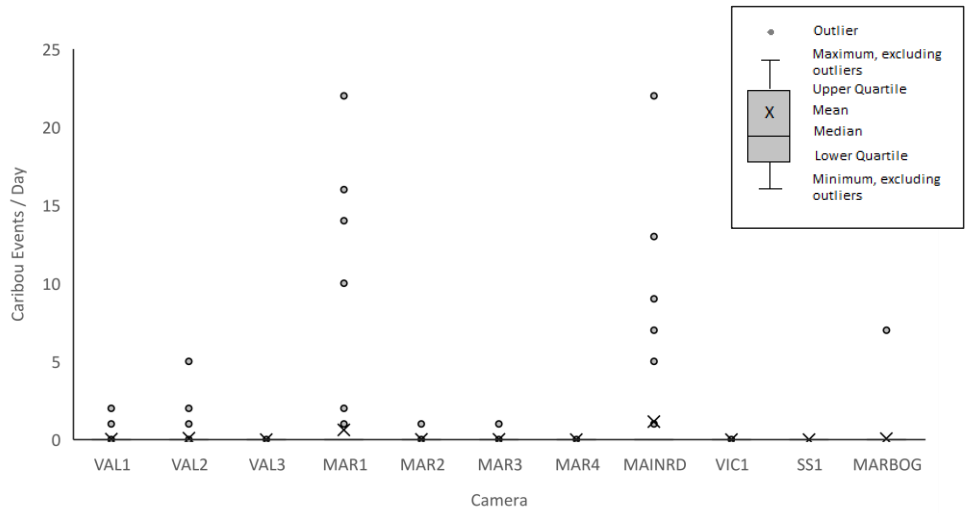


Notes:

1. Dates of recording for Mar1, Mar2, Mar3, Mar4, Main Rd, MarBog, and Vic1 were October 5 to December 18 (75 days); Val1 was October 5 to December 26 (83 days); Val2, Val3, SS1, and SS2 was October 5 to December 31 (88 days).

2. Camera locations are provided in Figure 3-1.

Figure 3-3 Caribou Events per Day - Fall 2019 Remote Camera Program



Notes:

1. Dates of recording for SS1 was September 28, 2020 to February 24, 2021 (150 days); MAR1, VAL1, VAL2, and VALl3 were September 28 to February 23, 2021 (149 days); MAR2, MAR3, MAR4, and MARBOG were September 27, 2020 to January 19, 2021 (115 days); VIC1 was September 28, 2020 to January 19, 2021 (83 days); MAINRD was September 27 to November 19, 2020 (54 days).
2. Camera locations are provided in Figure 3-1.

Figure 3-4 Caribou Events per Day - Fall 2020 Remote Camera Program

Table 3.4 Number of Caribou Events and Caribou Detected at Remote Camera Sites in Spring 2020

Camera ID[A]	Number of Days Deployed	Number of Caribou Events	Number of Caribou Observed	Mean Number[B] of Events per Monitoring Day[C] (± SE)	Mean Number[B] of Caribou Observed per Monitoring Day[C] (± SE)
VAL1	82	92	442	1.12 ± 0.21	5.39 ± 12.87
VAL2	83	29	81	0.35 ± 0.08	0.98 ± 2.63
VAL3	83	1	1	0.01 ± 0.01	0 ± 0
MAR1	81	20	86	0.25 ± 0.07	1.06 ± 4.15
MAR2	85	13	20	0.15 ± 0.06	0.24 ± 1.16
MAR3	86	20	25	0.24 ± 0.07	0.29 ± 0.86
MAR4[D]	60	12	20	0.2 ± 0.09	0.33 ± 1.32
MARBOG	85	1	1	0.01 ± 0.01	0 ± 0
MAINRD[E]	0	-	-	0 ± 0	0 ± 0
VIC1	82	4	4	0.05 ± 0.02	0.05 ± 0.22
SSIDE1	79	13	21	0.16 ± 0.06	0.27 ± 0.96

Notes:

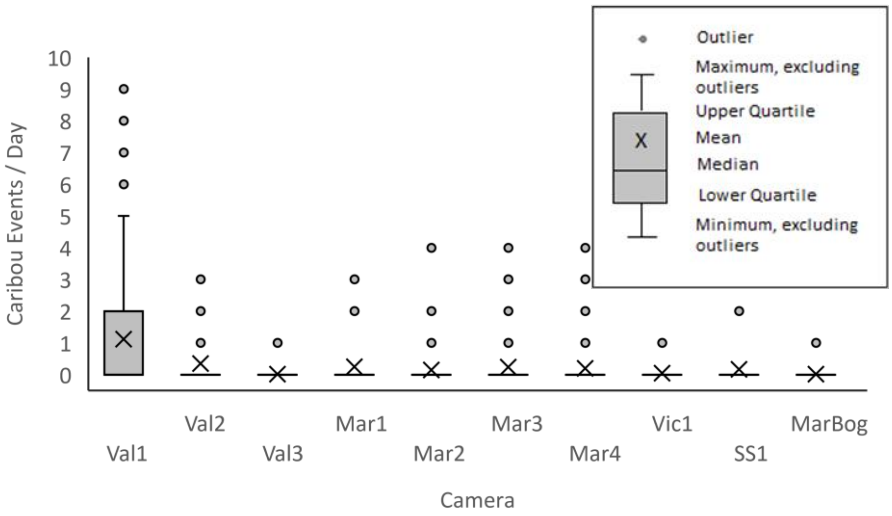
[A] Camera locations are provided in Figure 3-1.

[B] Means and standard errors rounded to two decimal places.

[C] Number of monitoring days was calculated up to June 18, or until camera ceased recording: SS1 - March 26 to June 12 (78 days); Mar1 - March 26 to June 14 (80 days); Val1 and Vic1 - March 26 to June 15 (82 days); Val2 and Val3 - March 26 to June 16 (83 days); Mar2, Mar3, and MarBog - March 26 to June 18 (85 days); Mar4 - March 26 to May 24 (60 days; malfunctioned); MainRd - malfunctioned for the entire duration it was deployed (0 days) ; see Figure 3-1 for camera locations.

[D] Possible malfunction – only detected caribou until May 24, 2020

[E] Camera malfunction



Notes:

1. Dates of recording for SS1 were March 26 to June 12 (78 days), Mar1 were March 26 to June 14 (80 days), Val1 and Vic1 were March 26 to June 15 (82 days), Val2 and Val3 were March 26 to June 16 (83 days), Mar2, Mar3, and MarBog were March 26 to June 18 (85 days), Mar4 were March 26 to May 24 (60 days; malfunctioned), and Main Rd (not included in figure) malfunctioned for the entire duration it was deployed (0 days).
2. Camera locations are provided in Figure 3-1.

Figure 3-5 Caribou Events per Day - Spring 2020 Remote Camera Program

3.2.2 Understanding of Spring and Fall Movements

Spring Migration

The Dynamic Brownian bridge movement model (dBBMM) analysis found that the mine site intersects the spring migration corridor of the Buchans herd for approximately 5.5 km where caribou move through a relatively narrow band (< 3 km wide) as they head north from their winter range (Figure 3-6). The spring migration corridor crosses the northern section of Victoria Lake Reservoir and Long Lake and includes one stopover (high use) area located on the south side of Star Lake, west of the hydroelectric development (Figure 3-6). The dBBMM analysis defined stopovers as the upper 25% quartile of the utilization distribution for each seasonal migration period and is assumed to represent 'migratory stopovers' (e.g., resting, foraging). Two other potential stopover areas are located east of Victoria Lake Reservoir, one of which overlaps with the mite site (Figure 3-6). The remaining quartiles (25-50%: moderate-high use and 50-75%: moderate-low use) were considered connecting movement pathways between stopover sites, and the last quartile (75-99%) represented relatively low use areas.

Remote cameras detected caribou moving north in the spring toward the mine site from a location south of the existing access road and large bog. More than 500 caribou were observed exiting the north side of the mine site near the outlet of Valentine Lake, along a narrow land bridge (also used during fall migration), as they headed north toward their calving range. Although the remote camera data and the

dBBMM suggested a more dispersed corridor in spring than in fall, there was a high-use migration path where caribou moved northward from the bog complex south of the site through the proposed location of the Marathon open pit and waste rock pile and exited at the north end of Valentine Lake along a narrow land bridge (VAL1 and VAL2).

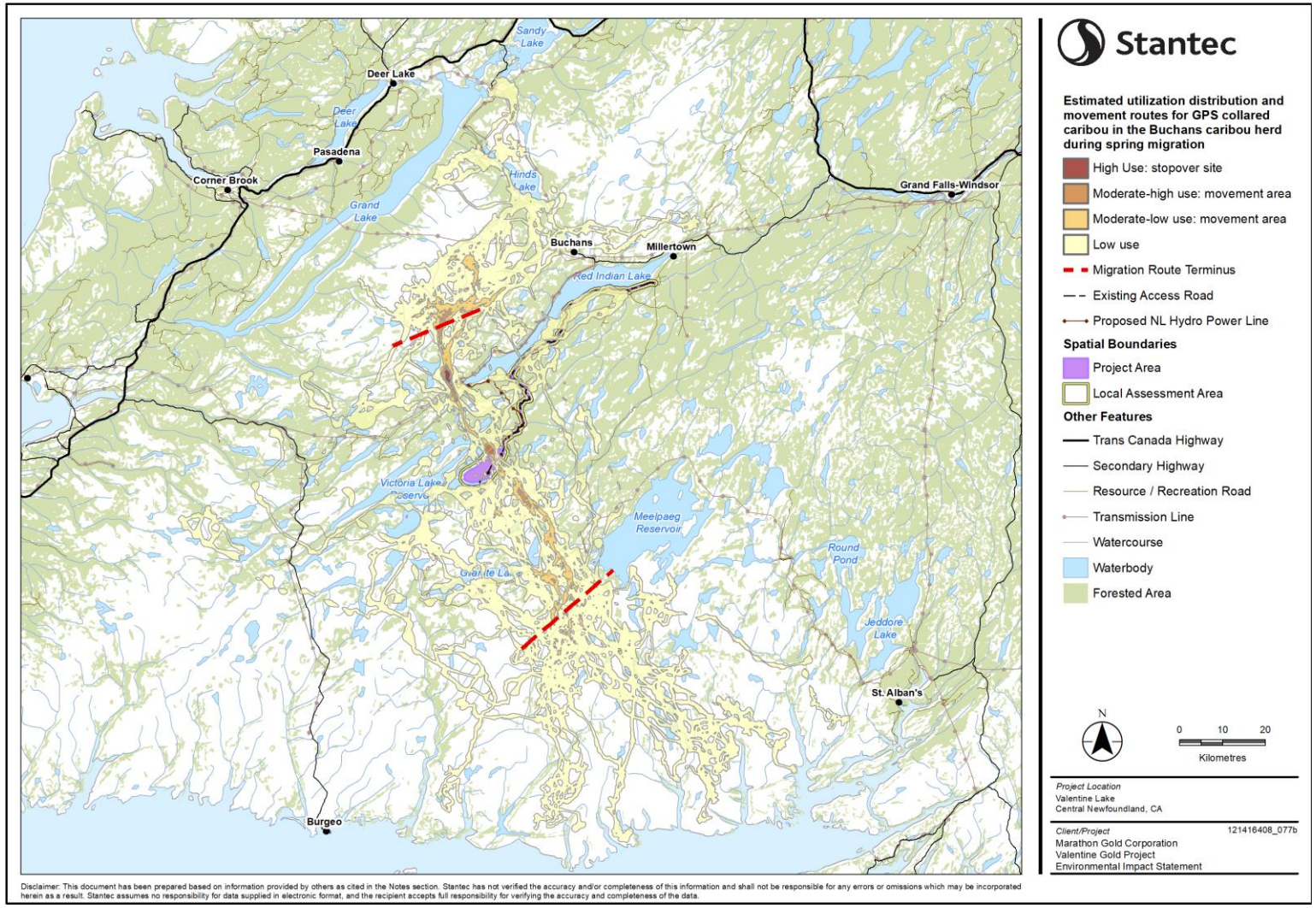


Figure 3-6 Estimated Utilization Distribution and Migration Corridor and Paths for GPS Collared Caribou in Buchans Herd (2007-2012 and 2016-2017) During Spring Migration

Fall Migration

The dBBMM analysis identified four stopover sites along the fall migration corridor, among which is a high use area south of Star Lake (also used during spring migration) and another stopover area near the south arm of Granite Lake (Figure 3-7). The other two stopover areas are smaller and are near Victoria Lake Reservoir: one south of the mite site, and one that overlaps the mine site.

Remote cameras detected caribou entering the mine site at the north end of Valentine Lake along a narrow land bridge (VAL2). Caribou then moved through the proposed waste rock pile location near Marathon open pit as they travelled south to their winter range. Camera MAR1 at the west end of the waste rock pile detected a relatively high rate of caribou movement. Additionally, approximately 500 caribou were counted at the main access road in fall 2019 and fall 2020. After crossing the road, caribou moved through a large bog located south of the main access road (confirmed via dBBMM; see Figures 3-6 and 3-7). These findings (dBBMM and cameras) indicate a high degree of use along this migration path during fall (Valentine Lake south to large bog).

3.3 TIMING OF MIGRATION

General (non-herd specific) migration periods for caribou on the Island of Newfoundland indicate that spring migration occurs from April 1 to May 19 and fall migration occurs from November 1 to December 15 (Emera 2013). Documented spring migration dates for the Buchans herd closely match these dates but differ during fall migration. Between 1995 and 2000, Mahoney and Schaefer (2002) observed median migration dates for the Buchans herd in spring from April 17 to May 23, and in fall from October 8 to November 7.

To better understand the timing of Buchans caribou migration through the Project Area, caribou telemetry data from 2015 to 2017 was analyzed to investigate movements between winter (December 16 to March 31) and summer (May 20 to August 31) ranges (Section 11.2.1.3 of the EIS). Migration paths through the Project Area were then modelled using dBBMM, and the dates specific to movements through the Project Area were determined from the telemetry data (Table 3.5). Results of this analysis indicated interannual variation in the timing of migration, with combined spring migration dates through the mine site occurring from April 18 to May 10, and in fall migration from November 17 to December 12. These dates coincide with general spring and fall migration periods for caribou on the Island of Newfoundland (Emera 2013) but occur over a shorter period for all years investigated.

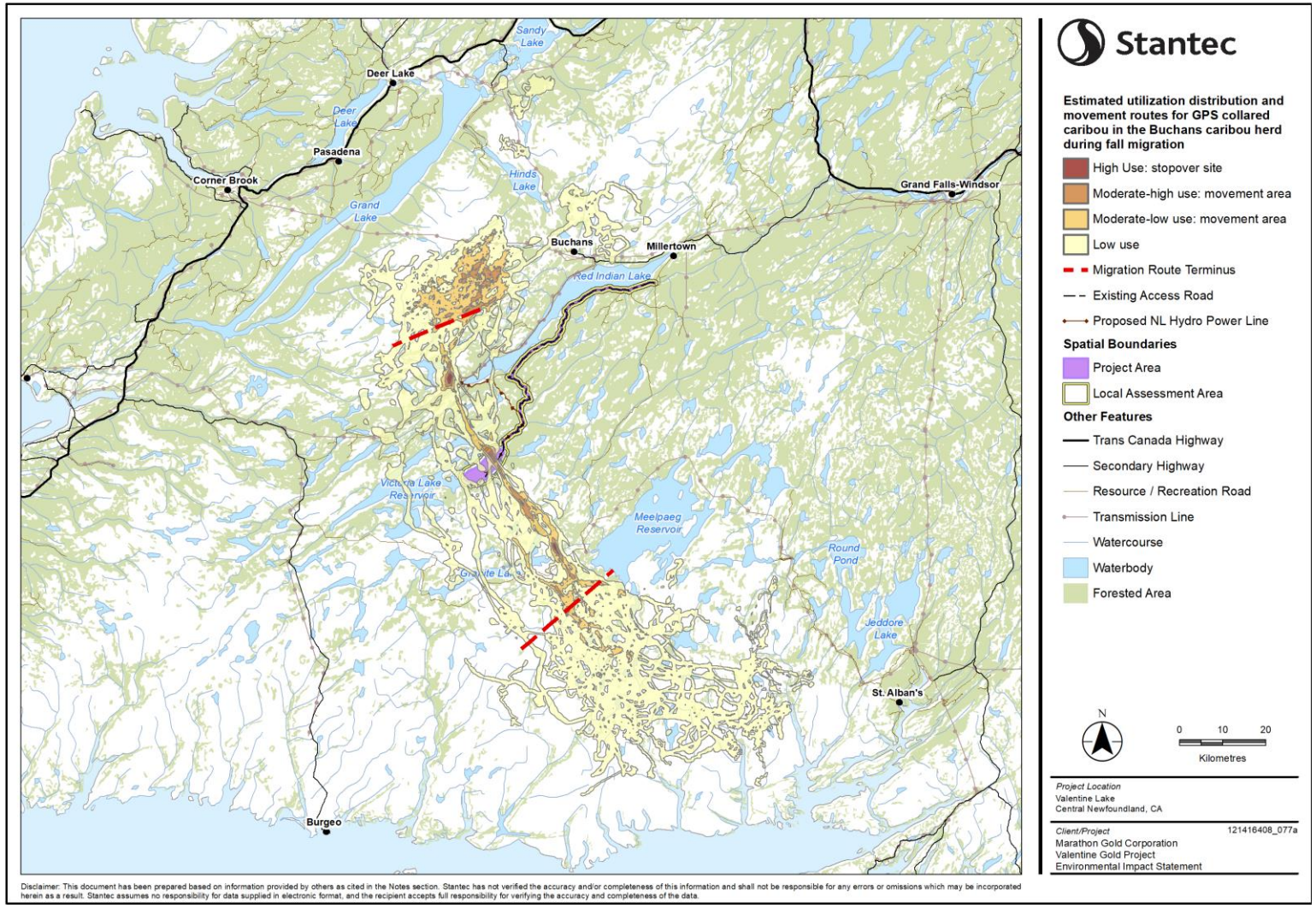


Figure 3-7 Estimated Utilization Distribution and Migration Corridors for GPS Collared Caribou in the Buchans Herd (2006-2012 and 2015-2017) During Fall Migration

Table 3.5 Timing of Migration of the Buchans Caribou Herd through the Project Area based on Telemetry Collar Data

Year	Spring Migration	Fall Migration
2015	-	November 17 – 20
2016	April 18 – 22	November 28 – 30
2017	April 29 – May 10	December 6 – 12
Note:"-" indicates that no studies were completed during that season / year		

The remote camera program initiated in 2019 was designed to acquire additional information on the timing of caribou migration through the mine site and to provide supplementary information on general use of the area by caribou. As such, camera deployment locations were selected strategically, with bias, to better understand caribou-Project interactions and to inform mitigation measures.

The timing of caribou movement through the Project Area based on remote camera data is discussed in Section 11.2.2.1 of the EIS and presented in detail in BSA.2, Attachment 2-A (fall 2019) and BSA.2, Attachment 2-B (spring 2020). The migration dates are summarized in Table 3.6 (and includes new information from remote camera data in fall 2020; spring 2021 data are not yet available). As expected, the timing of caribou migration through the Project Area occurred over a shorter period compared to the general migration periods.

Table 3.6 Timing of Migration of the Buchans Caribou Herd through the Project Area based on Remote Camera Imagery

Year	Spring Migration	Fall Migration
2019	-	November 9 – 12
2020	April 25 – May 7	October 31 – November 3
Note: "-" indicates that no studies were completed during that season / year		

3.4 POPULATION ESTIMATES – POST-CALVING AERIAL SURVEY

The goal of the 2020 Post-Calving Survey (BSA.2, Attachment 2-C) was to provide an estimate of the size of the Buchans herd population on the calving grounds, and to determine caribou demographics (e.g., group size and composition) for resident Grey River caribou and for the Buchans herd on the calving grounds. In its review of the EIS and supporting documentation, the NLDFFA-Wildlife Division raised concerns about the methods used for the population component of the survey (i.e., distance sampling) and the resulting population estimate. Marathon acknowledges that there were errors in the survey methods applied by the responsible consultant and that a reliable 2020 population estimate was not available. Subsequently, the 2020 population estimate for the Buchans herd was not used in the EIS. However, Marathon considers the information that was available for caribou to be sufficient for assessing and characterizing potential Project effects. Further, Marathon recently completed a 2021 population estimate with NLDFFA-Wildlife Division having both reviewed the methods and provided assistance in undertaking the survey. The 2021 survey data and report were not available for presentation at the time this report was prepared.

3.4.1 Buchans Herd Caribou

The most recent population estimate for the Buchans herd was 4,112 individuals in 2019, down slightly from a previous estimate of 4,500 individuals in 2007 (Table 11.5 of the EIS). Results from the 2019-2020 camera programs showed that more than 500 caribou use a common migration path through the mine site during both spring and fall, and the aerial surveys in 2020 identified at least 1,700 caribou congregated north of the mine site during the post-calving period. The 2020 post-calving aerial survey documented 307 caribou groups, with most groups occurring more than 30 km north of the mine site. Results from the 2021 survey are not yet available but are expected to provide a population estimate for the Buchans caribou herd that can be used as a reference for comparison to population estimates during construction and operations and at post-closure.

3.4.2 Grey River Caribou

Kernel density estimates used to describe seasonal range use of collared caribou (e.g., location, area) (see Section 11.2.2.1 of the EIS) indicate that caribou from the Grey River herd are expected to occupy the area around the mine site during the post-calving period. However, no caribou were observed in the mine site during the June 2020 aerial survey. Although not a comprehensive population estimate, the aerial caribou survey completed in 2020 documented 212 caribou in 82 groups from the Grey River herd, with the largest cluster of groups being approximately 10 km west of the mine site. Nine individuals were observed within the Project's LAA (i.e., within 1 km of the mine site or 500 m of the access road) (Figure 2-1). Results from the 2021 aerial survey will provide additional insight on important calving areas for the Grey River herd.

3.5 CURRENT AND FUTURE BASELINE WORK

Marathon has worked with, and will continue to work with, the NLDFFA-Wildlife Division to provide additional baseline information on caribou habitat use and movement through the Project Area prior to Project development. This includes the following initiatives:

- Deployment of 60 Global Positioning System (GPS) collars on caribou from the Buchans and Grey River herds; these collars are in the process of being deployed by staff from NLDFFA-Wildlife Division (39 of 60 collars deployed and operating at the time of this report) and the data will provide additional baseline data and support future environmental effects monitoring.
- The remote camera program has been expanded to gather supplementary information on caribou exit and entry points to the mine site, as well as caribou use of less prominent wildlife trails within and adjacent to the mine site. The camera program is intended to provide information on group size and composition, as well as the timing of spring and fall migration through the mine site. In consultation with NLDFFA-Wildlife Division, 15 additional cameras were deployed in spring 2021 in targeted locations (26 cameras total) (Figure 3-8), based on LiDAR imagery, dBBMM outputs, and the results of the Caribou Alternate Migration Pathway Analysis (described in Section 4.1.1). Future program refinements, including additional cameras and locations, are anticipated based on survey outcomes and continued consultation with NLDFFA-Wildlife Division.

- A post-calving and population survey of the Buchans caribou herd was completed in spring 2021 with consultation and support from NLDFFA-Wildlife Division. As specified in the 2021 research permit, Marathon will provide the results of the survey to NLDFFA-Wildlife Division.

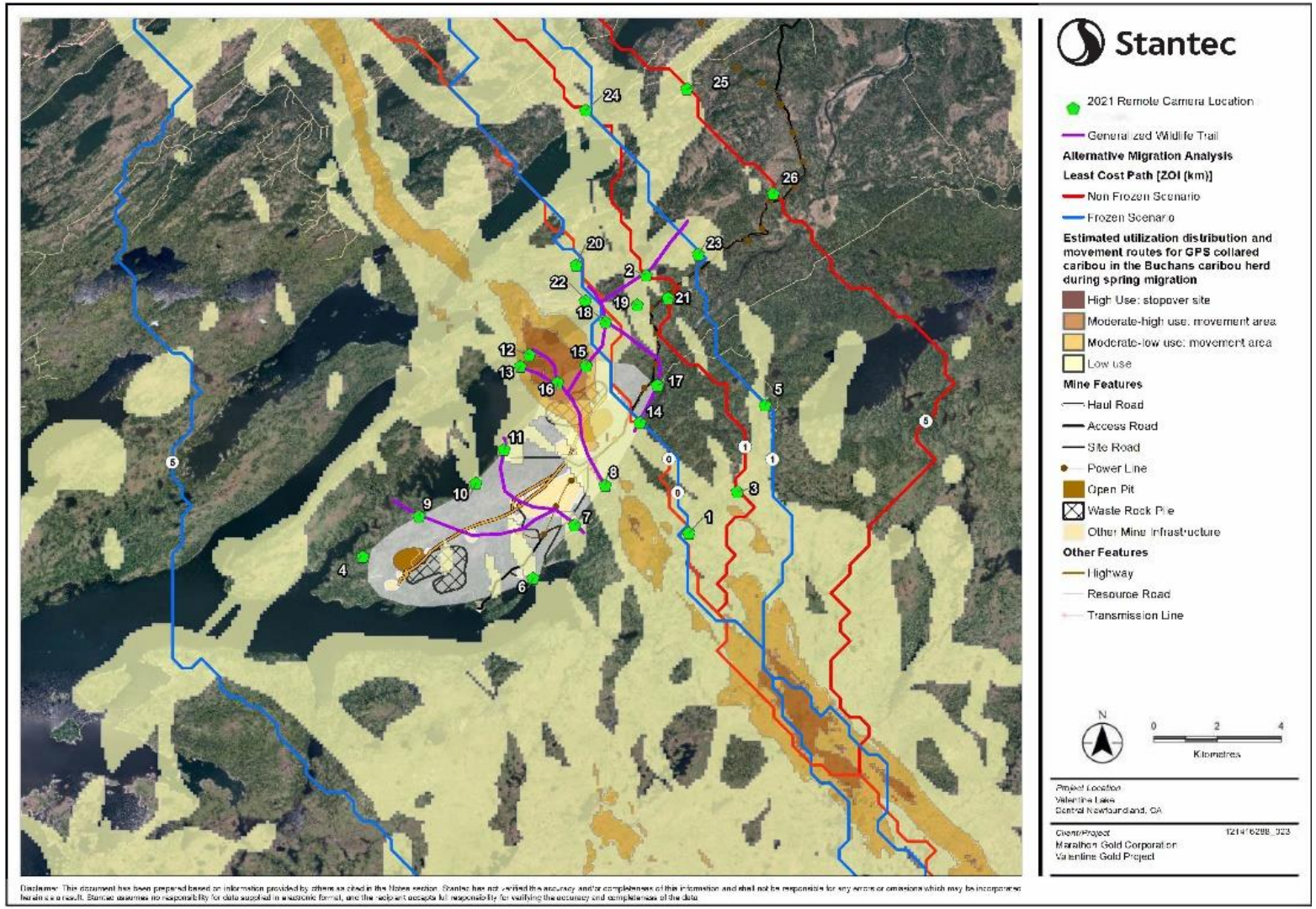


Figure 3-8 Camera Locations used during the Spring 2021 Remote Camera Caribou Program

4.0 KEY ISSUES RAISED IN INFORMATION REQUESTS

A comprehensive assessment of the effects of all Project components (i.e., "the Project") on caribou is provided in Section 11.5 of the EIS. The following section provides additional information and clarification to the assessment provided in the EIS, focusing on the following key issues raised during regulatory and public review of the EIS:

- Caribou movement
- Sensory disturbance
- Zones of influence
- Calf mortality
- Combined (within Project) and cumulative effects

4.1 CARIBOU MOVEMENT

Through review of the EIS by regulators and the public, questions and concerns have been raised regarding the Project's effects on movement of the Buchans herd, including the potential for the Project to act as a barrier to caribou movement and how a Project-induced change in movement could lead to increased mortality risk or other herd-level effects, particularly if the Buchans herd were to stop migrating. For the assessment, the definitions proposed by Beyer et al. (2016) for impediments to wildlife movement were used. Different types of impediments are defined based on whether the feature can be crossed or circumnavigated. Disturbances that must be circumnavigated and cannot be crossed can be classified as 'obstacles' (Beyer et al. 2016). Within the EIS, the mine site is assessed as an obstacle to caribou movement as it is anticipated that caribou will demonstrate avoidance of the Project and will not migrate through the site. This includes the presence of the Marathon open pit and waste rock pile, which overlap preferred migration paths of the Buchans herd (Section 11.5.2.2 of the EIS). Linear features, such as the power line and the existing access road, can be considered barriers (i.e., Beyer et al. [2016] defines these features as those that can be crossed but not navigated around or avoided).

As described in Section 11.5.2.2 of the EIS, caribou select migration paths that provide adequate forage and resting habitat (Saher 2005), are less energetically demanding (e.g., less rugged, open terrain) (Saher and Schmigelow 2005), and have relatively low predation risk compared to other potential migration paths (Bergerud et al. 1990; Ferguson and Elkie 2004). The migration path analysis completed for the EIS (Section 11.2.2.1) identified a high-use population-level migration path that overlaps the mine site. While up to 55% of the collared caribou migrated along a dominant path, the analysis identified a network of lesser used migration paths within the larger migration corridor indicating that there may be a degree of variability in the paths used between years or individuals. The remote camera data also suggested a high-use path between the Marathon open pit and waste rock pile and the north end of Valentine Lake along a narrow land bridge. While the Project overlaps only a small portion of the migration corridor, the overall functionality of the migratory corridor could be affected if the Project affects existing and important migration patterns. Such a change could lead to increased energetic demands for

migration and result in decreased body condition and ultimately decreased survival rate of migrating caribou.

To assist in understanding the potential effects of the Project on migration patterns of the Buchans herd, an analysis of alternate migration pathways was undertaken by Marathon after the EIS was submitted for review. The results of this analysis are summarized in Section 4.1.1, and Section 4.1.2 provides a follow-up discussion on the potential risk of change in movement to caribou populations, particularly for the Buchans herd.

4.1.1 Caribou Alternate Migration Pathway Analysis

The preferred migration path that is used by more than half of the collared Buchans caribou overlaps with the Project. Therefore, an analysis of potential alternate caribou migration paths (Caribou Alternate Migration Pathway Analysis) (Appendix A) was completed to address the likely response that caribou adjust their migration path to avoid the mine site. This GIS-based analysis was supported by literature relating to caribou avoidance of disturbances, the presence of physical obstacles, energetic costs, predation risk, and the use of existing migration paths outside of the identified primary migration path, which are historically used by some caribou from the Buchans herd.

The least-cost path (LCP) analysis was undertaken to: predict potential alternate migratory pathways that may be used by the Buchans herd during spring and fall migrations during Project activities; identify the habitat types within and along alternate migration paths; and estimate changes in energetic costs based on distance travelled. The analysis included modelling the relative energetic cost for an animal to move between locations, assuming complete avoidance of potential ZOIs (i.e., 1 km, 5 km, 10 km, and 15 km) around the mine site and under frozen and unfrozen scenarios. A ‘baseline’ movement pathway was predicted by running the LCP analysis with no ZOI to serve as a comparison to potential alternate pathways. Generally, the baseline LCP migration path and the dBBMM results presented in the EIS (Section 11.2) had a high degree of congruence, suggesting the caribou are currently migrating along the shortest, LCP, and that additional LCP analyses could be reasonable predictors of potential alternate migration pathways. This type of model “determines” potential migratory paths around pre-defined ZOIs and presented habitat characteristics based on preferences identified through the baseline conditions as preferential.

The analyses indicated that if caribou alter their migration path because of the Project, caribou would travel 0 km to 13 km farther than the baseline LCP during frozen conditions, and 6 km to 30 km farther than the estimated baseline LCP during unfrozen conditions (spring and fall migration combined). The associated relative energetic costs of these alternative pathways range from 1.01 to 1.41 times greater than the baseline LCP. Baseline and alternate pathways traverse primarily open habitats (e.g., coniferous forest, low shrub, and wetland-shrub types), with proportions of open coniferous habitats decreasing with increasing ZOI distance (up to 13% less at the 15 km ZOI). While the decreased proportion of open habitats on the predicted alternate pathways suggest that those paths may have higher resistance values and be more energetically demanding during migration, the habitats on the alternate pathways are largely similar to the baseline pathway.

4.1.2 Potential Risk of Change in Movement to Caribou Populations

Maintaining the functionality of migration paths by preserving connectivity between seasonal ranges is vital to sustaining viable populations of migratory ungulates (Monteith et al. 2018). The Caribou Alternate Migration Pathway Analysis illustrates the relative cost of predicted alternate spring and fall migration pathways that are outside of the preferred migration path for each of the ZOIs examined. While it is unlikely that there will be a failure to migrate to the calving grounds, the reduction in preferred migration habitat and potential changes to the timing, movement rate, or use of stopover sites during migration may have effects on caribou recruitment and survival (e.g., increased adult and calf mortality). Effect pathways of changes to movement include increased energetic costs, decreased forage availability, or increased mortality risk (e.g., if predators prefer habitat types that caribou would typically avoid), described as follows:

- Reduced forage availability can lead to smaller calves and subsequent increased vulnerability to predation. However, within the ELCA, high and moderate-value caribou habitat comprises approximately 80 to 90% of habitats available within potential ZOIs up to 15 km from the mine site, suggesting that the availability of preferred forage is similar within these zones.
- Changes to movement could result in increased energy consumption. The LCP analysis predicts that the energetic requirements of the alternate pathways could be between 1% and 41% greater than the baseline LCP, depending on the degree of avoidance of the Project. The effects of increased energetic demands during migration are discussed in Section 11.5.2.2 of the EIS. Potential long-term effects of increased energetic requirements include decreased body condition, pregnancy rates, calving rate, caribou recruitment, and increased adult and calf mortality.
- Change in movement patterns or location of paths could result in a decrease in body condition, which can increase mortality risk for adult caribou and calves (Section 11.5.3 of the EIS).

Change in movement patterns or location of paths could expose caribou to higher predation rates. The presence of predators can be particularly detrimental to caribou populations that overlap abundant primary prey species, such as moose (*Alces alces*), that can support high predator densities (Section 11.5.3.1 of the EIS). The primary predators of caribou calves on the Island of Newfoundland, coyote (*Canis latrans*) and black bear (*Ursus americanus*), are both present near the mine site (Chapter 12 of the EIS) and have the potential to occur in suitable habitat elsewhere in the RAA. Moose have also been confirmed in the Project Area, and similarly are expected to occur in suitable habitat throughout the RAA. As habitats along the predicted alternate pathways are largely similar to the baseline pathway, it is expected that the densities of primary prey species (e.g., moose) and predators will also be similar between the alternate pathways and the baseline pathway.

Potential risks from a change in movement (described above) include a possible increase in the risk of adverse effects on the Buchans herd population. As indicated above, the Buchans herd currently migrates between seasonal ranges using a migration corridor that overlaps with the Project. There are three potential migration scenarios for Buchans caribou during mine development:

- Caribou could continue to migrate along the paths that cross the mine site
- Caribou could avoid the mine site or other Project infrastructure (e.g., power line, existing access road) resulting in migration along alternate paths that would be longer and result in greater energetic consumption
- Caribou could avoid the Project Area resulting in a failure to migrate, subsequently remaining either north or south of the Project year-round

Discussions of the scenarios where caribou continue migration through the mine site, and where caribou select alternate migration paths that avoid the mine site were presented in Section 11.5.2 of the EIS. The third scenario, where caribou fail to migrate, is considered unlikely. While the literature suggests that caribou migration patterns are frequently affected by disturbance, a herd-wide failure to migrate has not been reported as a response to disturbance (e.g., Murphy and Curatolo 1987; Dyer et al. 2002; Vistnes et al. 2004; Mahoney and Schaefer 2002a, b; Wilson et al. 2016). As the risk of caribou ceasing to migrate was considered unlikely based on profession judgment and available information, it was not fully discussed in the EIS. It is however discussed in this section and the implications of a failure to migrate for the Buchans herd is provided in Section 5.1. The three scenarios described above could apply to caribou on an individual, group, or population basis. Each scenario and their possible resulting outcomes are described in Table 4.1, with linkages between effects pathways.

Continuation of migration through the Project Area could lead to reduced body condition and/or direct mortality from interaction with mine infrastructure or vehicles, and stress resulting from sensory disturbance. This could result in reduced calving rates and increased mortality. Migration along alternate, longer paths due to avoidance of the Project could lead to reduced body condition due to greater energetic requirements. Additionally, migration along alternate paths with less suitable forage could also reduce body condition. Caribou could also fail to migrate to either the calving or the winter areas, resulting in caribou remaining year-round in one area. This could lead to reduced body condition or an increase in predation or hunting pressure. While the Project will not change the amount of legal hunting, caribou that fail to migrate may have increased hunting pressure if they remain in areas with greater hunter access than their preferred range. Additionally, a change in the seasonal ranges of the Buchans herd could create increased competition for resources with the adjacent herds. The distribution of Buchans caribou that fail to migrate may overlap the seasonal ranges of adjacent herds (e.g., Grey River). If the density of caribou increases in these areas of overlap, the availability of preferred forage could be limited due to increased competition which can affect body condition of not only the Buchans caribou, but also of caribou in adjacent herds. As noted there could be a range of different outcomes based on how individual caribou from the Buchans herd respond to Project effects. The long-term effects of each of these scenarios, however, is that population size and trend could be adversely affected.

Table 4.1 Potential Caribou Migration Scenarios (Buchans Herd)

Migration Scenario	Effects Pathways						Possible Outcomes
Migrate through Mine Site along Preferred Paths	• Changes to migration pattern (e.g., timing, speed of migration, number of stopovers)	⇨	• Increased stress • Increased energetic requirements • Reduced forage availability	⇨	• Reduced body condition	⇨	• Reduced calving rate • Increased adult mortality • Increased calf mortality
	• Direct mortality risk from mine infrastructure or vehicle collision	⇨					• Increased adult mortality • Increased calf mortality
Migrate along Alternate Paths and Avoid Mine Site	• Changes to migration pattern (e.g., timing, speed of migration, number of stopovers)	⇨	• Increased energetic requirements • Reduced forage availability	⇨	• Reduced body condition	⇨	• Reduced calving rate • Increased adult mortality • Increased calf mortality
	• Changes to the location of migration paths	⇨	• Increased energetic requirements • Reduced forage availability	⇨	• Reduced body condition	⇨	• Reduced calving rate • Increased adult mortality • Increased calf mortality
		⇨	• Increased predation or hunting pressure[1]	⇨			• Increased adult mortality • Increased calf mortality
Failure to Migrate	• Increased stress • Reduced forage availability	⇨	• Reduced body condition	⇨			• Reduced calving rate • Increased adult mortality • Increased calf mortality
	• Increased predation or hunting pressure[1]	⇨					• Increased adult mortality • Increased calf mortality

Note:
[1] An increase in hunting pressure is not expected to increase calf mortality as hunters select adult caribou.

4.2 SENSORY DISTURBANCE

Through review of the EIS by regulators and the public, questions and concerns have been raised regarding the potential effects of Project-related light, noise, dust, and vibration on caribou. While the effects of sensory disturbance were assessed in the EIS, additional context is provided in this section in response to these questions and concerns.

Sensory disturbances such as noise, light, dust, vibration, and visible human activity are key disturbance stimuli for caribou and can decrease habitat quality (i.e., habitat degradation) and indirectly affect caribou movement and mortality risk, particularly if these changes affect migration behaviour. As stated in Section 11.5.1.1 of the EIS, “Noise and vibration disturbance generated through equipment and activities, such as rock breakers, blasting and heavy equipment operations have the potential to indirectly affect caribou habitat adjacent to the Project Area and may cause reduced use or avoidance by caribou.” Traffic and maintenance activities on the access road may also indirectly affect caribou habitat through dust deposition in adjacent areas (e.g., caribou may avoid consuming dust covered plants; changes in soil alkalinity may affect the availability of forage plants).

Avoidance of the Project by caribou due to sensory disturbance is discussed in Section 11.5.1.2 of the EIS, with relevant literature summarized in Table 11.14. Additionally, Section 11.5.2.2 includes a discussion of caribou avoidance of anthropogenic disturbances and effects resulting from a change in migratory movements. Mitigation to reduce the effects of noise, light, and dust are provided in Table 5.11 (Chapter 5 – Atmospheric Environment) and Table 11.13 (mitigation measures related to caribou) of the EIS, and are presented in full in Section 6.1 of this report.

Noise emissions are one of the primary mechanisms for sensory disturbance to caribou and are expected to occur primarily during the construction and operation phases of the Project. The exact nature of the sensory disturbance, however, may be less important compared to the loss of habitat due to avoidance of the sensory disturbance itself. Although some work has attempted to isolate the effects of noise from other potentially confounding factors by simulating sound stimuli (see Mccourt et al. 1974 in AMEC Americas Ltd. 2005), previous studies have generally not separated the effects of habitat loss from the effects of sensory disturbance (e.g., Vors et al. 2007; Plante et al. 2018). Assessing caribou avoidance of noise in the absence of other confounding sensory effects (e.g., human presence, light, dust) has not been demonstrated in the literature.

As indicated in Section 11.5.1.3 of the EIS, predicted effects on caribou habitat through indirect effects from sensory disturbance are expected to extend beyond the 500 m buffer assessed in the EIS, with caribou showing varying degrees of avoidance beyond that distance. Section 4.3 of this document provides additional information on Project-related residual effects on a change in caribou habitat at potential ZOIs of up to 15 km from the mine site.

The following information is provided as additional context for sensory disturbance effects on caribou and does not change the EIS prediction of a significant residual adverse effect on caribou.

Dust and Caribou Habitat

Sources of fugitive dust were assessed in Chapter 5 of the EIS. Dust will be generated during construction and operational activities, including blasting, material handling and processing, and wind erosion of stockpiles and tailings beach surfaces.

The EIS predicted that emissions created during construction are anticipated to be low in magnitude and will generally be confined to within 1 km to 2 km surrounding the mine site. An atmospheric dispersion model was used to predict maximum ground level concentrations of particulate matter during normal operation of the Project at receptor locations (i.e., cabins, exploration camp, accommodations camp, and outfitters camp) within a 40 km by 40 km area centered around the mine site. Results of the analysis indicated that the highest predicted concentrations of fugitive dust are expected to occur within 1 km to 2 km of the mine site (refer to Figure 5.2 in the EIS) and that the predicted concentrations should generally reach background levels within 10 km to 15 km of the mine site.

In response to regulatory and public comments received during the EIS review process, a screening-level assessment of road dust due to vehicle traffic along the access road was conducted. Road dust was selected for the screening assessment, as it is expected to be of primary concern with respect to Project related traffic on the 80 km unpaved access road. The maximum predicted 24-hour concentrations are predicted to be below the respective 24-hour NL Ambient Air Quality Standards (TSP = 120 ug/m^3, PM10 = 50 ug/m^3, PM2.5 = 25 ug/m^3). These maximum concentrations occur in the immediate vicinity of the access road and drop rapidly with distance. Within 500 m (downwind of the road) the predicted concentrations reach background levels. The results of the screening assessment of road dust along the access road do not change the conclusion of the EIS that releases associated with vehicle traffic along the access road are not expected to result in a significant change in air quality in the LAA.

Given the large distance between the mine site and most of the access road, air contaminant releases from the road are generally not expected to overlap with those from the mine site. The overall mine site layout reduces the haul road distances to both maximize operational efficacy and minimize Project effects. Section 11.5.1.1 of the EIS states that dust may reduce caribou habitat suitability by altering vegetation communities and functionally reducing caribou forage. Chen et al. (2017) reported significant increases in the amount of dust and soil pH levels, corresponding with reductions in the percent cover of vascular plants and lichen, associated with the Misery Haul Road at the Ekati Diamond Mine. Specifically, the zone of increased dust on leaves was observed within 1 km of the road, elevated pH levels and reduced vascular plants were observed within 10 m of the road, and reduced lichen cover was observed within 1 km of the road.

Mitigation measures to reduce the amount of fugitive dust from Project activities during construction and operation are provided in Table 5.11 (Chapter 5 – Atmospheric Environment) and Table 11.13 (mitigation measures related to caribou) of the EIS and Section 6 of this report. Measures to be put in place to reduce dust emissions, including application of water to site roads and haul roads during dry periods, will serve to reduce potential adverse effects of dust on caribou. Measures to be implemented to reduce traffic on the access road (e.g., transportation of workers to/from the site via buses) will also reduce dust emissions (as well as reducing sensory disturbance and risk of mortality through vehicle collision). Furthermore, it is anticipated that many caribou are likely to avoid the area with the highest potential

concentrations of fugitive dust (i.e., 1 km to 2 km from the mine site) due to noise and visual stimuli associated with construction and operation.

Noise and Stress Response

Noise was assessed in Chapter 5 (Atmospheric Environment) of the EIS. Information on noise levels in the Project Area is in the following EIS sections:

- Baseline sound pressure levels within the Project Area (Section 5.2.2.4)
- Noise sensitive receptors within the Project Area (Section 5.2.2.4)
- Sound levels at each noise sensitive receptor (Section 5.2.2.4)
- Modelling scenarios that predict worst-case construction and operation for noise emission (Section 5.5.3.2)
- Noise emission sources from Project construction and operation activities (Sections 5.5.3.1 and 5.5.3.2)
- Sound power levels for each noise emission source using manufacturer's data, acceptable theoretical calculation methods, or similar equipment noise data from an archived database of measurements (Section 5.5.3.2)
- Acoustic model to assess noise levels during construction and operation of the Project (Section 5.5.3.2)
- Predicted sound levels within the LAA and RAA, and at the noise sensitive receptors resulting from Project activities (Section 5.5.3.2)

Sound pressure levels related to construction are predicted to be 35 dBA (background levels) at approximately 5 km from the mine site, and at 25 dBA at approximately 8 km from the mine site. Sound pressure levels related to the access road are predicted to be 25 dBA at approximately 1 km from the access road during employee rotation changes. During operation, sound pressure levels related to operation are predicted to be below 35 dBA at approximately 5 km from the mine, and 25 dBA at approximately 10 km from the mine. Sound pressure levels related to the access road are predicted to be 25 dBA at approximately 1 km during employee rotation changes. Within the mine site, predicted sound pressure levels could reach approximately 80 dBA (e.g., rock breaker: 80 dBA at 100 m distance; processing plant: 67 dBA at 100 m; edge of Marathon pit: 52 dBA at 100 m; edge of Leprechaun pit: 55-60 dBA at 100 m). Noise and vibrations associated with blasting were addressed in the EIS and are described below in the following section.

Studies have shown that effects of acoustic emissions on wildlife have the potential to occur above 40 dBA (Shannon et al. 2016). Bradshaw et al. (1997) found that caribou exposed to simulated noise levels between 90 and 110 dB had an increased rate of movement following exposure. Maier et al. (1998) found that caribou responded to noise levels of 46 dB to 127 dB associated with low-level jet aircraft overflights in Alberta by either interrupting resting bouts (late winter), increasing activity (during the insect season), or by increasing activity and moving farther from the disturbance (post-calving).

Sensory disturbance can result in short-term behavioral and physiological responses by caribou, including a startle response, elevated heart rate, and increased hormone production (e.g., glucocorticoids) (ECCC 2020), the latter of which may indicate a physiological response to stress (MacDougall-Shackleton et al.

2019). While levels of stress hormones in caribou have been shown to increase with exposure to anthropogenic disturbance (e.g., Freeman 2008; Wasser et al. 2011; Renaud 2012; Ewacha et al. 2017; Plante et al. 2020), the evidence is somewhat inconsistent. Potential effects from increased stress in vertebrates include:

- reduced fitness (Bonier et al. 2009)
- poor body condition and potentially lower survival and reproductive rates (Escribano-Avila et al. 2013)
- reduced immune function and increased parasite load or susceptibility to disease (Hughes et al. 2009, Hing et al. 2016)

Project-related physiological stress on caribou has the potential to affect caribou health and, ultimately, population demographics through reduced reproductive and survival rates. Potential long-term effects of the Project on caribou (e.g., reduced calving rates) are discussed in Section 11.5.2.2 of the EIS.

As stated in Section 5.3.1.1 of the EIS, a conservative approach was used to assess Project effects on the acoustic environment, which included the following assumptions related to noise:

- Worst-case conditions were incorporated into the acoustic modelling. For example, the maximum equipment operation at the mine site and the maximum hauling activities are anticipated to occur at different stages of the mine life. For the acoustics assessment, it was assumed that these activity levels occur simultaneously.
- The noise assessment assumed that all equipment was running simultaneously.
- Noise propagation from mining activities was exaggerated by assuming that the ground near the Project will reflect more sound waves than is anticipated.
- The noise assessment assumed that there was no vegetation between the noise source and receptor.

Mitigation measures to reduce the amount of noise produced during construction and operation are provided in Table 5.11 (Chapter 5 – Atmospheric Environment) and Table 11.13 (mitigation measures related to caribou) of the EIS, and Section 6 of this report.

Noise and Vibration from Blasting

Vibrations were modelled in the Blast Impact Assessment completed for the Project (Baseline Study Appendix 1, Attachment 1-C) and blasting was included in the assessment of change in air quality and sound quality presented in Sections 5.5.1 and 5.5.2 (Atmospheric Environment VC) of the EIS.

Blasting during Project construction and operation is impulsive and provides a low frequency air blast and ground vibration. Air blast is low frequency sound generated by energy waves transferred through the air and is measured in dB. Vibration is energy waves transferred through the ground and measured by particle velocity. The type of geology, topography and the blast configuration greatly influence how the energy of the blast is released into the atmosphere. During a blast, the majority of the energy is consumed in fragmenting the desired portion of rock with the remaining energy released as air blast and ground vibration.

During Project operation, blasting will alternate between pits (Marathon and Leprechaun) such that a blast is expected to occur at each pit every second day, averaging one blast per day (approximately one minute in duration) for the Project for approximately 350 blasts per year.

Blasting at mines routinely follows best management practices, namely the Blasters Handbook (ISEE 2011) and the Environmental Code of Practice for Metal Mines (ECCC 2009). These guides include recommended threshold values for blasting and mitigation options to reduce air blast related noise and vibration during blasting events, and these will be consulted during blasting design (Section 5.5.3.1 in the EIS).

Relative to blasting for other types of mining (e.g., iron ore), blasting during gold mining typically uses substantially fewer explosives and is much more localized, thereby resulting in less air blast-related noise and vibration. Marathon is planning to achieve highly accurate blast hole drilling and increasing the rock fragmentation efficiency per unit of explosive used by employing the latest techniques and technologies, such as computer-designed detonation sequencing and 3D blast movement tracking. By increasing blasting efficiency and accuracy, fewer explosives will be needed, reducing sensory disturbance such as noise and vibration emissions.

It is expected that noise and vibration emissions from blasting during Project construction and operation will be easily maintained below the recommended thresholds outlined in these best-practice guides.

A recent study by Eftestøl et al. (2019) found no difference in avoidance behavior of reindeer between workdays with and without blasting, suggesting that sensory disturbance associated with high levels of activity at the mine site have greater effects on caribou than the blasting itself. Mitigation measures to reduce sensory disturbance to caribou include visual surveys for caribou prior to any blasting whereby, if caribou are observed within a 500 m blasting radius, blasting will be delayed until the caribou have left the area (Table 11.13 of the EIS). Activities in the Marathon pit area that may result in sensory disturbance to migrating caribou (e.g., blasting, loading, hauling) will also be reduced or ceased while caribou are migrating within a set distance from the site.

4.3 ZONES OF INFLUENCE

Through review of the EIS by regulators and the public, questions and concerns have been raised regarding the potential extent of the ZOI. Specific concerns were raised regarding whether the ZOI would extend more than 500 m from Project activities, and if it did, how would a larger ZOI indirectly affect change in habitat and ultimately the presence of caribou in that area. Sensory disturbance (e.g., noise, visual, vibration, dust, human activities) is anticipated to be more substantial within a 500 m ZOI than outside a 500 m ZOI, based on proximity, propagation, and attenuation of sensory disturbance associated with Project activities. Therefore, habitat within the 500 m ZOI is expected to have reduced value for, and hence reduced use by, caribou through all Project phases. The use of a 500 m ZOI for caribou is aligned with the federal Scientific Assessment to inform the Identification of Critical Habitat for Woodland Caribou in Canada (Environment Canada 2011), which uses a 500 m buffer on anthropogenic disturbances to define disturbed habitat as a correlate of population decline.

Direct and indirect change in caribou habitat was quantified in the EIS in the context of habitat availability within the 1,830.6 km^2 ELCA. Table 11.15 in the EIS estimates that the amount of high and moderate-value caribou habitat that will be directly affected is 28.5 km^2 and the amount indirectly affected by a 500 m ZOI to represent sensory disturbance is 57.3 km^2. Combined, these areas represent 5.5% of the high and moderate-value habitats available in the ELCA. Because the ELCA is small relative to the population ranges of the four assessed caribou herds (i.e., RAA) (6.4% of 28,809 km^2), the estimated proportion of habitat affected by the Project is larger, and therefore more conservative, than if it was compared to overall caribou range use.

The amount of Project-related change in caribou habitat (direct and indirect effects) on winter, spring, summer, and fall caribou seasonal ranges is provided in Table 4.2 below. As these values are also based on the ELCA, the estimated proportion of habitat affected by the Project is a conservative estimate as well. Table 4.2 includes new information that was not included in the EIS.

Table 4.2 Residual Project-Related Change in Caribou Habitat by Season

Season[1]	Habitat Ranking	Project Area (PA)[2]		Local Assessment Area (LAA)[3]		Ecological Land Classification Area (ELCA)[4]		Area in 500 m buffer only (Indirect Habitat Change km^2)	Magnitude of Residual Effect	
		Area (km^2) in PA	% of PA	Area (km^2) in LAA	% of LAA	Area (km^2) in ELCA	% of ELCA		Area in PA + 500m Buffer (Direct + Indirect Habitat Change km^2)	% of Availability in ELCA
Winter	high	18.7	53.9	52.5	41.3	849.1	46.4	29.3	48.1	5.7%
	moderate	1.3	3.7	21.8	17.2	408.5	22.3	13.8	15.1	3.7%
	low	14.7	42.4	52.7	41.5	573.0	31.3	34.9	49.6	8.7%
Spring	high	18.7	53.9	52.5	41.3	849.1	46.4	29.3	48.1	5.7%
	moderate	9.8	28.1	46.5	36.6	718.5	39.2	28.0	37.8	5.3%
	low	6.2	18.0	28.0	22.1	263.0	14.4	20.7	26.9	10.2%
Summer	high	21.2	61.1	58.2	45.8	979.7	53.5	32.0	53.2	5.4%
	moderate	6.0	17.3	18.9	14.9	179.3	9.8	11.5	17.5	9.8%
	low	7.5	21.6	49.8	39.2	671.5	36.7	34.5	42.0	6.3%
Fall	high	21.2	61.1	58.2	45.8	979.7	53.5	32.0	53.2	5.4%
	moderate	7.3	21.0	40.7	32.1	587.8	32.1	25.3	32.6	5.5%
	low	6.2	18.0	28.0	22.1	263.0	14.4	20.7	26.9	10.2%
Total		**34.7**	**100.0**	**127.0**	**100.0**	**1,830.6**	**100.0**	**78.0**	**112.8**	**6.2%**

Notes:
[1] Information on habitat suitability for the general seasons was compiled from the following sources: Schaefer and Pruitt (1991); Chubbs et al. (1993); Rettie and Messier (2000); Mahoney and Virgl (2003); Courtois et al. (2004); Ferguson and Elkie (2005); Brown et al. (2007); Fortin et al. (2008); LeBlond et al. (2011); Stantec (2012); MacNearney (2013); Bastille-Rousseau et al. (2015); Stewart (2016); Bastille-Rousseau et al. (2018); Stantec (2018); BSA.7, Attachment 7-D.
[2] Project Area includes the mine site plus access road and 20 m buffer.
[3] Local Assessment Area includes a 1 km buffer surrounding the mine site and 500 m buffer surrounding the haul road (Figure 11-1 in the EIS).
[4] Ecological Land Classification Area is the areal extent of detailed habitat information for the Project.

Predicted effects on caribou habitat are expected to extend beyond the 500 m buffer, as indicated in Section 11.5.1.3 of the EIS. These effects are expected to decrease with increasing distance from the Project Area. For example, whereas Rudolph et al. (2012) showed that woodland caribou have reduced use of habitats within and beyond 2 km of roads, the analysis showed that reduced use dissipated exponentially with increasing distance. At distances of 500 m and 1,000 m from roads, the relative probability of caribou occurrence was approximately 60% and 80%, respectively, of the estimated maximum caribou occurrence (see Figure 13 in Rudolph et al. 2012). This suggests that while caribou may exhibit reduced use of habitats beyond the footprint of the Project, reduced use is not uniform across the extent of sensory disturbance and therefore not all habitat would be lost to all caribou.

As indicated in Table 11.14 in the EIS, the literature is highly variable regarding the ZOI for caribou. Recent analyses by Boulanger et al. (2021) found significant ZOIs associated with two operational gold mines in the Northwest Territories, with ZOI distances ranging from 6.1 to 18.7 km over a 15-year period (standardized average of 7.2 km). The authors noted a high degree of annual variation in ZOI size due to several factors including environmental conditions (e.g., forage quality, drought), perceived level of disturbance (e.g., vehicles, blasting, etc.), herd size, and seasonal range size and location (Boulanger et al. 2021). Other researchers have estimated seasonal ZOIs of mine sites that range from 0.25 km and up to 23 km (e.g., Boulanger et al. 2012; Polfus et al. 2011; Plante et al. 2018). On the Island of Newfoundland, caribou showed avoidance of the Hope Brook Gold Mine at distances of up to 6 km during construction, and most caribou avoided the mine site within 4 km during the construction and operation phases (Weir et al. 2007).

There is variability in the literature regarding avoidance distances for linear features such as transmission lines and roads. Avoidance (which includes reduced use or partial avoidance as evidenced by differences in population density) of transmission lines by caribou of 2.5 km to 6 km has been reported (e.g., Nellemann et al. 2001; Vistnes and Nellemann 2001; Nellemann et al. 2003). However, other research has found no avoidance of transmission lines (Reimers et al. 2007; Plante et al. 2018), or avoidance only during construction (Eftestøl et al. 2016). Roads are also avoided by caribou, with the avoidance increasing with greater disturbance levels (i.e., active roads compared to derelict roads) (Leblond et al. 2013) and during the highest traffic period (Dyer et al. 2001). Other ungulates (i.e., red deer) avoid crossing roads during periods of increased traffic (Kušta et al. 2017). While much of the research on caribou ZOIs reflects different disturbances, landscapes, topography, habitats, and caribou behaviours (e.g., migratory vs. sedentary) compared to the Island of Newfoundland, findings suggest that the ZOI for caribou in Newfoundland would also vary among years and herds. No studies that looked at the extent of sensory disturbance on caribou found total abandonment by caribou of the area within the ZOI.

The mechanisms that cause caribou to avoid mines and other anthropogenic disturbances are not fully understood but may include visual and other sensory disturbance, such as noise and dust (Boulanger et al. 2012, 2021) and perceived change in habitat resulting from construction activities. Responses by caribou are variable but can include a shift in individual home ranges to avoid overlap with the disturbed area (e.g., MacNearney et al. 2016), seasonal avoidance (e.g., Boulanger et al. 2012), alteration of behaviors and group sizes in the vicinity of the disturbance (e.g., Weir et al. 2007), and a change in the timing and direction of migration (e.g., Mahoney and Schaefer 2002b).

Table 4.3 provides additional information on low, moderate, and high-value caribou habitat located within a range of potential ZOIs extending up to 15 km from the mine site. This distance was selected based on information in the scientific literature (e.g., Boulanger et al. 2012) and knowledge of the Project and surrounding landscape. As noted, mechanisms that may cause caribou to avoid mines and other anthropogenic disturbances are not well understood and there is a high degree of variation in the effect of ZOIs of different sizes on caribou.

The area within the mine site includes habitats that will be directly affected by the Project, through vegetation clearing during construction and subsequent mine operations. Habitats within potential ZOIs may have reduced use or seasonal avoidance by caribou but are anticipated to be recoverable post-closure.

Table 4.3 Amount of High-, Moderate-, and Low-value Caribou Habitat within the Project Area, Potential Zones of Influence, and the ELCA

Habitat Value Ranking[1]	PA[2]		Project Area + 500 m buffer		Potential Zone of Influence (Distance from Mine Site)[3,4]								Area in ELCA2[2,4]	
					2 km		5 km		10 km		15 km			
	km²	%	km²	%	km²	%	km²	%	km²	%	km²	%	km²	%
High	18.7	53.9	48.1	42.6	42.6	44.5	117.9	49.4	308.7	52.2	481.7	50.3	849.1	46.4
Moderate	9.8	28.1	37.8	33.5	43.6	45.5	102.8	43.1	235.5	39.9	381.5	39.8	718.5	39.2
Low	6.2	18.0	26.9	23.9	9.6	10.0	17.8	7.5	47.2	8.0	94.5	9.9	263.0	14.4
Total	**34.7**	**100.0**	**112.8**	**100.0**	**95.8**	**100.0**	**238.6**	**100.0**	**591.5**	**100.0**	**957.7**	**100.0**	**1,830.6**	**100.0**

Notes:

[1] Habitat value rankings for caribou are provided in Table 11.8 of the EIS. Existing anthropogenic areas are included in the rankings as low-quality habitat.

[2] PA = Project Area and includes the mine site plus access road and 20m buffer; ELCA = Ecological Land Classification Area and indicates the areal extent of detailed habitat information for the Project. Habitat availability in the PA and ELCA are also found in Table 11.9 of the EIS.

[3] ELC coverage of the 10 km and 15 km ZOIs is 98% and 85%, respectively; coverage is 100% in all other areas.

[4] Percent of habitat represents the area covered by the ELCA only and does not infer habitat distribution for those areas where there are gaps in the ELCA.

4.4 CALF MORTALITY

Through review of the EIS by regulators and the public, questions and concerns have been raised regarding the potential effect of the Project on calf mortality and whether this potential effect was fully assessed in the EIS. On the Island of Newfoundland, the decline in caribou populations since the year 2000 was precipitated by a combination of food limitation and high calf mortality, primarily a result of coyotes (Government of NL 2015). Increases in calf mortality (either through direct interaction with the Project, or indirectly) has the potential to affect caribou populations (i.e., Buchans and Grey River herds).

Calf mortality could be directly affected by the Project through interaction with mine infrastructure (e.g., becoming trapped in a pit) or equipment or vehicle collision. As it is anticipated that caribou will demonstrate avoidance of the Project and will not migrate through the site, risk of mortality through interaction with the pits or heavy equipment is considered low. The amount of overlap between the assessed herds and the Project Area is small (Bucans herd: less than 1% of range; Grey River: less than 2% of range; Gaff Topsails: less than 1% of range; La Poile: no overlap) (see Table 11.16 in EIS). Given this limited overlap, the mitigations that will be in place during migration and the limited time that animals will be migrating, the Project-related risk of direct mortality resulting from vehicular collision on the access road and the site roads is considered low for the Buchans and Grey River herds and negligible for the Gaff Topsails and La Poile herds.

The Project could affect calf mortality indirectly through changes in movement patterns, which could reduce body condition and increase predation or hunting rates. Increased calf mortality resulting from Project related change in movement will be most likely for the Buchans herd, which has a migration corridor overlapping the mine site (see Table 4.1 for additional information on the three potential migration scenarios for the Buchans herd in consideration of predicted Project effects). Calf mortality could increase if caribou continue to migrate through the mine site, as they could be subject to reduced body condition resulting from increased stress and increased energetic cost (e.g., increased rate of movement through the site; less time spent foraging while moving through site). Avoidance of the site also has the potential to increase calf mortality as changes in migration patterns (including location or paths) could increase stress and reduce forage availability, leading to reduced body condition. Use of alternate migration paths or failure to migrate could increase calf mortality if avoidance of the Project causes caribou to use areas with higher predation risk, or prolongs the amount of time that caribou spend in areas where predation risk is greater.

Calf mortality could also be affected through changes in mortality risk as Project features and habitat altered by the Project could increase predation rates. Disturbance can alter habitat by causing a shift to alternate habitat types that are selected by moose. Project-related change in habitat could increase moose abundance which in turn could increase predator abundance, leading to higher predation rates on caribou. Predation is the primary cause of caribou calf mortality on the Island of Newfoundland with approximately 90% of calf deaths attributed to predation (Lewis and Mahoney 2014). While the current adult caribou mortality rate is thought to be similar to historical rates, the decrease in calf survival since the mid-1990s is due to an increase in predation (Government of NL 2015).

Section 2.1 of this report describes the approach to the caribou assessment. Change in calf mortality was fully assessed as an indirect mortality risk in Section 11.5.3 of the EIS and contributed to the determination of a significant residual effect for caribou.

4.5 COMBINED AND CUMULATIVE EFFECTS

Various regulatory and public comments and IRs received on the EIS were related to the combined (within Project) and/or cumulative (in combination with similar effects from other projects and activities) effects on caribou. Section 11.5 of the EIS evaluated effects of Project activities and components on caribou focusing on three main effects pathways: change in habitat, change in movement, and change in mortality risk. Although the EIS discussed linkages between these effects pathways, there has been a greater emphasis on the interconnectedness of these effects through the EIS review process. Section 5.0 of this report presents a herd-specific effects analysis emphasizing the interconnectedness of effects pathways resulting in combined effects on caribou.

Section 20.8.4 of the EIS describes the pathways of potential cumulative effects resulting from the Project and past, present, and future activities / projects that are predicted to contribute to cumulative effects on caribou (including mining and exploration, forestry, hunting, outfitting, trapping, fishing, off-road vehicles, hydroelectric developments, and existing linear features). As indicated in Table 20.14, the Project's contribution to cumulative effects is predicted to be high, primarily due to predicted effects of the Project on change in movement for Buchans herd caribou.

Figure 4.1 below shows the extent of existing and planned disturbance footprints within the RAA with a 500 m radius buffer around the footprints to represent the area of direct (alteration/loss) and indirect (sensory disturbance) effects on caribou habitat. The disturbances considered for this assessment were: linear features (roads and transmission lines), mineral claims, aquaculture sites, hydroelectric operations and forestry cut blocks since 1990. Smaller disturbances such as outfitter and recreational cabins were not considered. Figure 4.1 therefore presents the geographic extent of potential cumulative effects of the Project with other existing and planned development on caribou habitat within the RAA. The area of disturbance within the overall range of the four assessed caribou herds is quantified in Table 4.4. The contribution of the Project to the disturbed area is provided in parentheses for linear features (Marathon access road) and mineral claims (Marathon mineral claim).

The Amended Recovery Strategy for the Woodland Caribou (*Rangifer tarandus caribou*), Boreal population, in Canada (ECCC 2020) identifies a disturbance management threshold of 65% for a local population to be self-sustaining – i.e., 65% of undisturbed habitat is available to provide a measurable probability (60%) for a local population to be self-sustaining. Although caribou on the Island of Newfoundland are not considered part of the Boreal population (listed as Threatened) in Canada (COSEWIC 2014), the federal *Species at Risk Act* has recently (February 2021) been amended to include the Newfoundland population of caribou on Schedule 1 as a species of Special Concern (Government of Canada 2021). As such, guidance provided in the amended recovery strategy for the boreal population of caribou provides some guidance that can be useful for interpreting the importance of potential Project and cumulative effects on the Newfoundland population of caribou.

With the Project, the minimum percentage of undisturbed habitat ranges from approximately 40% for the Gaff Topsails herd to more than 94% for the La Poile herd. The Buchans and Grey River herd undisturbed caribou habitat availability are 77% and 85% respectively (Table 4.4). Based on the guidance provided in ECCC (2020), the quantity of undisturbed habitat available for caribou from the Buchans, Grey River, and La Poile herds is sufficient to provide a measurable probability for the population to be self-sustaining. The high percentage of disturbance in the range of the Gaff Topsails herd, which has minimal overlap (0.4 km^2) with the Project, is largely attributable to previous forest harvesting activities (28%) and existing roads and transmission lines (23%). The analysis used to determine habitat changes related to forestry assumed complete avoidance of all cut areas since 1990, which is conservative as various forest seral stages will provide some habitat value prior to full maturity, the point at which it will be described as undisturbed. These estimates are also conservative as the analysis assumes that the entirety of all existing mineral claim areas are, or will be, disturbed. However, these areas are not all likely to be developed, but if they are the disturbance within these areas will likely be a fraction of each claim area (i.e., the amount of disturbed habitat is highly overestimated).

As indicated in the EIS, there is no overlap of the Project with seasonally important ranges for the La Poile. For Gaff Topsails, the overlap is negligible (0.4 km^2) and affects only the winter seasonal range (see Table 11.16 in the EIS). Together, the Project has little to no overlap with the La Poile and Gaff Topsails ranges. For the Buchans herd, where an estimated 77% of the range is undisturbed, the Project is predicted to increase the amount of disturbance by approximately 2%. For the Grey River Herd, where an estimated 85% of the herd range is undisturbed, the Project is predicted to increase the amount of disturbance by approximately 1%.

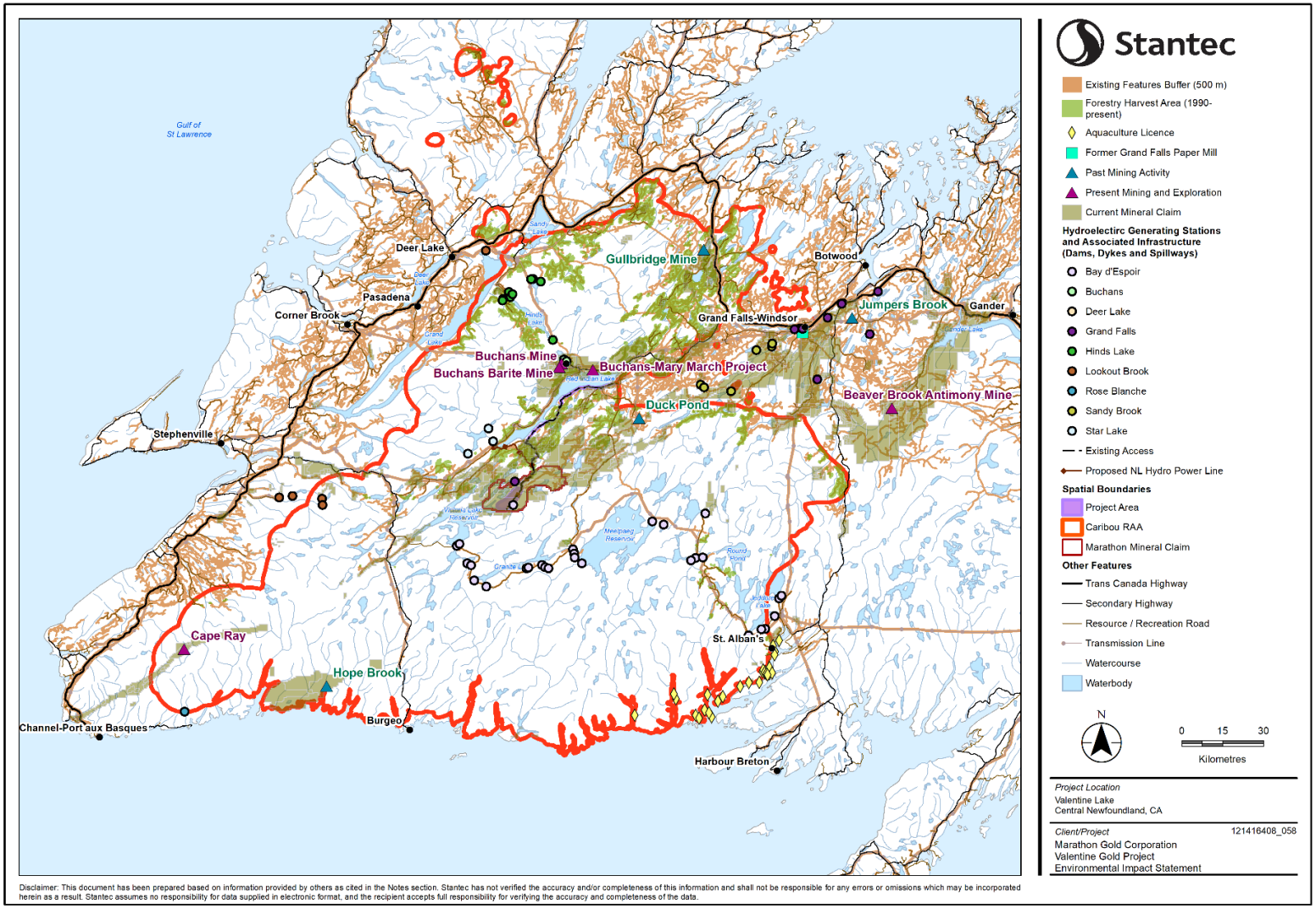


Figure 4-1 Extent of Existing and Planned Anthropogenic Disturbance Footprints

Table 4.4 Area and Percent of Existing and Planned Anthropogenic Disturbance Footprints within Caribou Herd Ranges

Caribou Herd	Kernel Range (km^2)[A]	Area (km^2) and Percent (%) of Existing and Planned Disturbance Footprints in the RAA within the Range of the Assessed Caribou Herds										Estimated Disturbance Area (Project contribution to total)[C]		Minimum % Undisturbed Habitat within Herd Range
		Linear Features[B] (Project contribution to total)[C]		Mineral Claims[D] (Project contribution to total)[C]		Licensed Aquaculture Sites[E]		Hydroelectric Operations[F]		Forest Harvesting[G]				
		Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	
Gaff Topsails	5,684.9	1,292.1 (0.4)	22.7 (<0.1)	509.9 (-)	9.0 (-)	-	-	4.7	0.1	1,591.1	28.0	3,397.8 (0.4)	59.8 (<0.1)	40.2
Buchans	15,649.6	1,236.0 (100.3)	7.9 (0.6)	1,296.3 (240.0)	8.3 (1.5)	5.05	<0.1	29.1	0.2	995.7	6.4	3,562.2 (340.3)	22.8 (2.2)	77.2
Grey River	15,456.3	886.5 (33.7)	5.7 (0.2)	903.7 (131.7)	5.8 (0.9)	1.71	<0.1	22.0	0.1	506.7	3.3	2,320.5 (165.4)	15.0 (1.1)	85.0
La Poile	11,183.2	149.7 (-)	1.3 (-)	452.7 (-)	4.0 (-)	0.53	<0.1	5.5	<0.1	16.1	0.1	624.5 (-)	5.6 (-)	94.4

Notes:

[A] 95% kernel range estimate based on 2005-2018 (Buchans) and 2006-2013 (Gaff Topsails, Grey River and La Poile) telemetry data

[B] Includes roads and transmission lines plus a 500m buffer. The existing access road associated with the Project is included in the total.

[C] Value in parentheses shows the Project contribution to total disturbed area.

[D] Includes all developed and undeveloped claims and assumes that all habitat within the claim area is disturbed (i.e., is an overestimate of the disturbance footprint). The Project footprint (mine site) is included in the total

[E] Includes site location plus a 500m buffer

[F] Includes dams, dykes and spillways plus a 500m buffer

[G] Includes forest harvesting activities since 1990 (plus 500m buffer) and considered the length of time (~40 years) for forests to regenerate on the Island of Newfoundland (Hébert and Weladji 2013) and that caribou in Newfoundland will use younger aged stands (Mahoney and Virgl 2003), albeit with potentially higher risk of predation (Faille et al. 2010, Wittmer et al. 2006).

5.0 SUMMARY OF EFFECTS TO THE ASSESSED CARIBOU HERDS

As discussed in Section 2.1 of this report, the EIS analyzed effects of the Project on caribou considering three effect pathways: change in habitat, change in movement, and change in mortality risk (Table 2.1). While these effects were assessed as separate pathways, there are linkages between them. For example, a change in habitat (both directly through a physical change in habitat and indirectly through sensory disturbance) could lead to a change in caribou movement and/or change in mortality risk. In recognition of IRs and comments received on the EIS in relation to the linkages between effects pathways and differences in Project interactions with different caribou herds, summaries of effects are presented below for each of the assessed caribou herds. The following information is provided for additional context and does not change the assessment of Project-related effects on caribou.

5.1 SUMMARY OF EFFECTS TO THE BUCHANS HERD

Although the Project Area overlaps less than 1% of the Buchans herd seasonal ranges, this caribou herd has the greatest interaction with the Project Area largely because of a Project overlap with the primary migration corridor Project effects on caribou habitat include direct loss of habitat through clearing, and indirect effects from sensory disturbance associated with Project activities. Approximately 28.5 km^2 of caribou habitat will be directly affected in the Project Area through site preparation. Additionally, approximately 57.3 km^2 of high and moderate-value caribou habitat will be indirectly affected through sensory disturbance within a 500 m ZOI surrounding the Project Area. Effects of sensory disturbance are expected to extend beyond the 500 m, but to a lesser extent than within the 500 m buffer and with effects varying by location, season, habitat, terrain, and type, duration, and intensity of disturbance. A change in habitat will affect forage availability arising from direct change (e.g., land clearing), indirect change due to avoidance related to sensory disturbance (e.g., noise from mining activities), or change in habitat suitability (e.g., dust on plants along access road). These changes could lead to a reduction in body condition, which could affect population size through reduced reproductive rates and increased adult and calf mortality. Mitigation measures to reduce habitat change and sensory disturbance to caribou are discussed in Section 6 of this report. Marathon is committed to working with regulators, Indigenous groups, and stakeholders to implement initial mitigation measures, undertake follow-up and monitoring activities, and adapt mitigation measures as necessary to avoid or reduce Project-related adverse effects on caribou and caribou habitat. Residual Project effects for change in habitat for the Buchans herd are predicted to be low in magnitude.

The Project is assessed as an obstacle to caribou movement. The effects of individual components and related mitigation measures were taken into consideration in determining a significant adverse residual effect of the Project on caribou. Individual Project components (e.g., open pits, waste rock piles, and the haul road) can contribute to Project effects on caribou movement and may be linked to changes in mortality risk in different ways. The following information is provided for additional context, however, does not change the conclusions in the EIS pertaining to caribou.

- Open pits – the Marathon pit overlaps the main migration path of the Buchans herd and is expected to act as a physical obstacle to caribou movement. There is also the potential for individual caribou to be injured or trapped in the open pit, but more likely that they will avoid the open pit because of sensory disturbance during construction and operations (e.g., human presence, equipment noise, dust). The open pits will be partially developed during construction, but not fully developed in terms of total surface area until several years into Project operation. Following completion of mining, the pits will be flooded (i.e., become pit lakes) and therefore will not return to baseline condition following mine rehabilitation and closure. As the Marathon pit cannot be relocated, the effect of the open pit on the main migration path, and hence the migration corridor, will be permanent.

- Waste rock pile – the planned location of the Marathon waste rock pile overlaps the main migration path of the Buchans herd and is expected to act as a physical obstacle to caribou movement. The waste rock pile will be developed over several years using slopes and benches that individually are about 10 m tall, and when complete will collectively be approximately 110 m tall and have a footprint of approximately 1.5 km^2. When a bench is finished in one area, the horizontal bench and downhill slope will be covered with overburden / organics and revegetated. As part of detailed Project design, Marathon will consider options to move or relocate portions of the Marathon waste rock pile to the south of the Marathon pit. This may reduce the width of the Project footprint in relation to the main migration path, potentially allowing rehabilitation of a portion of the path following mine closure. The waste rock pile is assumed to be a permanent obstacle to caribou movement, but with the mitigation identified above (i.e., possibly relocating a portion of the waste rock pile to the south of the pit) there is potential for a portion of the effect associated with the waste rock pile to be reversible following mine closure.

- Site haul road – the site haul road to the Marathon open pit area overlaps the main migration path of the Buchans herd. Traffic on this road within the mine site during operations will be substantial, with many daily trips between site features as part of open pit mining activities. At peak operation, the volume of haul traffic between the Marathon open pit, waste rock piles, stockpiles, and ore pad is estimated at 1,090 return trips every 24 hours. Peak operation will occur once milling and processing have begun, which is anticipated to commence in 2023. Project effects associated with the construction phase (i.e., change in habitat, change in movement, and change in mortality risk) will have occurred before peak operation begins. It is expected that caribou will demonstrate avoidance of the Project in response to initial construction activities and the propensity to migrate through the mine site during peak operations will be low to negligible. While there is the potential for collisions between vehicles and caribou on the haul road, risk is expected to be low given anticipated avoidance (2 km to 14 km) of the Project by caribou (Weir et al. 2007; Polfus et al. 2011; Boulanger et al. 2012; Leblond et al. 2013; Johnson et al. 2015; Eftestøl et al. 2019). To mitigate the risk of increased mortality, activities in the Marathon pit area that may result in sensory disturbance to migrating caribou (e.g., blasting, loading, hauling) will be reduced or ceased while caribou are migrating along the path and within a set distance from the site (e.g., 10 km north or south). The extent of the activity reduction, and the conditions regarding caribou migration proximity will be determined in consultation with NLDFFA-Wildlife Division and based on the ongoing baseline data collection and future monitoring during construction and operations. The site haul road will be rehabilitated to similar pre-development

conditions, meaning that the effect of the site haul road on change in movement is predicted to be reversible.

- Existing access road – the Buchans herd seasonal home ranges overlap with approximately 10 km of the existing access road, or 3 km^2 based on the road length plus a 500 m buffer. Because the access road exists at baseline, its use by the Project will not contribute to further direct habitat change or fragmentation. There is a risk of vehicle collision with caribou crossing the existing access road (i.e., increased mortality risk). To mitigate this risk, vehicle traffic will be reduced by transporting employees to the site by bus and Project vehicles will be required to comply with posted speed limits in all areas, with additional speed restrictions implemented during caribou migration periods. Additionally, sensory disturbance will be reduced by managing the transportation of workers and materials to/from the site through a Traffic Management Plan. Project-related effects from increased use of the access road are expected to be reversible.

- Power line – Newfoundland and Labrador Hydro (NL Hydro) is planning to construct a power line from the Star Lake Generating Station to a new proposed terminal station at Valentine Lake to provide electrical power to the Valentine Gold Project. Construction and operation of this proposed power line is subject to a separate provincial environmental assessment process which is ongoing at the time of preparation of this report (https://www.gov.nl.ca/ecc/projects/project-2136/). Within the Project Area, the proposed power line route will be aligned with the existing access road. Therefore, construction of the power line will not incrementally add to linear density, nor further fragment the habitat, in the Project Area. There will however be a relatively small incremental loss of habitat associated with construction of the power line through widening of the existing linear feature, where required. As indicated in the EA Registration for the Star Lake to Valentine Gold Transmission Line TL 271 Project, effects associated with the power line will be mitigated by reducing the amount of new disturbance and retaining or maintaining vegetation to the extent practicable through all components and Project phases. Following decommissioning, effects of the power line are predicted to be reversible (NL Hydro 2021).

Analysis of available telemetry data indicated that based on the Utilization Distribution there is up to a 55% likelihood that collared caribou would occur in moderate to high use areas of the migration corridor within the Project Area. The analysis also identified lesser-used migration paths within the corridor, indicating that there is natural variability in the choice of paths used among years and individual caribou. Within the Buchans herd, caribou response to Project effects may similarly vary. Section 4.1.1 describes three potential migration scenarios which may occur due to Project development:

1. Caribou may continue to migrate through the mine site which could lead to reduced body condition and direct mortality from interaction with mine infrastructure or vehicles and sensory disturbance. It is anticipated that Project infrastructure (e.g., open pits, waste rock piles) will be an obstacle to migration. In combination with sensory disturbance associated with Project activities, it is expected that most caribou will exhibit reduced use of the mine site and migration through the mine site will be unlikely.

2. Caribou may avoid the mine site and select migration paths that are external to the mine site. Migration along alternate paths due to avoidance of the mine site could lead to reduced body condition and increased mortality risk through increased predation or hunting pressure. The Caribou Alternate Migration Pathway Analysis undertaken for the Project (Appendix A) illustrates the relative cost of identified alternate spring and fall migration pathways that are external to the preferred migration path for each of the ZOIs examined.

3. Caribou may fail to migrate, resulting in caribou remaining year-round in the same area. As discussed in Section 4.1.2, this scenario is considered unlikely. Implications of a failure to migrate include a reduction in body condition and increased mortality risk through increased predation. The distribution of Buchans caribou that fail to migrate may overlap the seasonal ranges of other herds. Should some Buchans caribou remain on the winter range year-round, they could potentially overlap with the ranges of the La Poile and Grey River herds between the fall and spring. If some Buchans caribou remain on the summer grounds and fail to migrate to the south coast for winter, they could have some overlap with the ranges of the Gaff Topsails herd (in all seasons) and Grey River herd (between the calving and post-calving rearing seasons). This could increase the abundance of caribou on the Gaff Topsails and Grey River ranges during the periods of overlap. Research on caribou population decline on the Island of Newfoundland (i.e., Buchans, Grey River, La Poile and Middle Ridge herds) found that high-caribou density at the population peak limited the availability of preferred forage (Schaefer et al. 2016). While the caribou population of the Island of Newfoundland remains below its peak level in 2000 (Government of NL 2015), forage may be slow to regenerate following overgrazing. Lichen regenerates slowly (McMullin and Rapai 2020) and may take more than 20 years to recover following disturbance (Théau et al. 2005). As such, the capacity of caribou range to support the addition of animals (e.g., influx of Buchans caribou onto the Gaff Topsails, Grey River or La Poile range) is unknown.

These scenarios have the potential to reduce body condition or increase mortality risk, either directly (e.g., collision) or through an increase in predation or possibly hunting pressure. The long-term outcome of each of these scenarios could result in reduced recruitment or survival rates, which could have overall potential adverse effects on the population size and trend of the Buchans herd.

Measures outlined in Table 6.1 include a commitment to reduce or pause activities that may result in sensory disturbance to caribou during critical periods (e.g., suspending mining activities such as drilling, blasting, and hauling of ore and waste in the Marathon pit area during migratory periods). Reducing mining activities during critical periods has been shown to be an effective mitigation measure for other ungulates. Eftestøl et al. (2019) found that reindeer avoided a mine area within 1.5 km during high activity periods (e.g., blasting, equipment in operation), but resumed some use of that area within 2.5 days of those activities ceasing.

Caribou mortality risk may be directly affected by interactions with mine infrastructure (e.g., caribou becoming trapped in pit), through collisions with heavy equipment during site preparation and mining activities, or through collisions with vehicles on the haul road, site roads, or existing access road. Direct change in mortality risk associated with Project activities (e.g., vehicle collision, collision with heavy

machinery) are assessed qualitatively based on the likelihood of caribou interaction with Project infrastructure and equipment.

Indirect sources of mortality are also assessed qualitatively and include indirect effects on mortality risk attributable to the overlap between the Project and a primary migration path of the Buchans herd. Specifically, a change in movement (Section 4.1.1 above, also Section 11.5.2 in the EIS) has potential implications on the timing, movement rate, use of stopover sites during migration, or location of migration paths, which can result in increased energetic demands. Potential long-term effects of increased energetic demands include a decrease in body condition, pregnancy rate, calving success, and/or caribou recruitment (Section 11.5.2.2 in the EIS). Thus, the risk from a change in movement and potential changes in survival, calving success, and recruitment includes potential adverse effects on the population size and trend of the Buchans herd. Mitigation measures (Section 6) will reduce the risk of direct mortality from Project activities. The residual effects on the Buchans herd are predicted to be low in magnitude for change in mortality risk.

5.2 SUMMARY OF EFFECTS ON THE GREY RIVER HERD

The Project Area overlaps with spring migration/pre-calving, calving, and post-calving rearing seasonal ranges of the Grey River herd (Section 11.5.1.2 of the EIS). Overlap of the mine site with the spring migration/pre-calving and post-calving rearing ranges is less than 1.5 km^2, and overlap with the calving range is approximately 27 km^2. Calving is understood to be a sensitive period for caribou as they may be particularly susceptible to disturbance at this time (e.g., Cameron et al. 1979; Cameron et al. 1992; Dyer et al. 2001; Nellemann et al. 2001; ECCC 2020). Direct effects of the mine site on change in habitat (e.g., habitat loss) will affect approximately 11.8 km^2 (2% of the 50% kernel) to 27.3 km^2 (<1% of the 95% kernel) of the calving range of the Grey River herd calving range (Section 11.5.1.2 of the EIS [Table 4.4]). The remainder of the calving areas are south west of the Project, or dissipated in smaller areas throughout the RAA (see Figure 11-9 in the EIS). Calving habitat will also be indirectly affected by sensory disturbance arising from Project-related activities. Approximately 57 km^2 of high- and moderate-value caribou habitat will be indirectly affected within the 500 m ZOI around the Project Area. The June 2020 aerial survey observed nine caribou within the Project's LAA (i.e., within 1 km of the mine site and 500 m of the access road) (Figure 2-1).

Predicted indirect effects on caribou habitat due to sensory disturbance are expected to extend beyond the 500 m ZOI, with potential effects decreasing with increasing distance from the Project Area. Section 4.3 provides additional information on potential ZOIs, or areas of avoidance by caribou, associated with the Project.

The mechanisms that cause caribou to avoid mines and other types of anthropogenic disturbance such as power lines and roads are not fully understood but may include visual and other sensory disturbance such as noise and dust (Boulanger et al. 2012, 2021) as well as perceived changes in habitat resulting from construction activities. The literature is highly variable regarding the extent of ZOIs for caribou (e.g., Boulanger et al. 2021). Responses are also variable but can include a shift in individual home ranges to avoid overlap with the disturbed area (e.g., MacNearney et al. 2016), seasonal avoidance (e.g.,

Boulanger et al. 2012), alteration of behaviors and group sizes in the vicinity of the disturbance (e.g., Weir et al. 2007), and a change in the timing and direction of migration (e.g., Mahoney and Schaefer 2002).

Caribou from the Grey River herd may respond to the Project by shifting their calving range to avoid overlap with the disturbed area (i.e., they may move beyond the 500 m ZOI assessed in the EIS). Johnson et al. (2020) observed reduced use of habitat by female caribou in northern Alaska within 5 km of an energy development project during the calving period. On the Island of Newfoundland, Weir et al. (2007) found that caribou avoided areas within 4 km during construction and operation of the Hope Brook Gold Mine, with decreased group size at distances between 4 km and 6 km. This effect was observed year-round but was most prominent during the pre-calving and calving seasons. Studies that looked at the extent of avoidance behaviour in caribou reported reduced habitat use within the ZOI, but not complete abandonment of the area.

Table 5.1 provides additional information on the amount of calving range of the Grey River herd within potential ZOIs from the mine site (i.e., 1 km, 5 km, 10 km, and 15 km). Habitats within potential ZOIs may have reduced use or avoidance by Grey River herd caribou during calving, particularly the smaller ZOIs that are expected to have the most sensory disturbance. However, complete avoidance at the full extent of the ZOIs assessed is not expected. Habitats within potential ZOIs are anticipated to be recoverable following closure of the Project.

Table 5.1 Overlap Between Calving Range of Collared Caribou from the Grey River Herd within the Mine Site and Potential Zones of Influence

Calving Range Kernel Density	Mine Site		Potential Zone of Influence (Distance from Mine Site)							
			2 km		5 km		10 km		15 km	
	Area (km^2)	% of Range	Area (km^2)	% of Range	Area (km^2)	% of Range	Area (km^2)	% of Range	Area (km^2)	% of Range
50%	11.8	2%	39.6	5%	100.7	13%	194.3	25%	203.0	26%
95%	27.3	<1%	74.2	2%	168.0	4%	361.7	8%	577.2	13%

Notes:
1 Kernel density estimates for the Grey River herd is based on telemetry data from 2006-2013
2 The estimated calving range overlaps with the mine site only (i.e., there is no overlap with the existing site access road)
3 Percent of range is of the total estimated calving range

Avoidance of the Project Area can have adverse effects on the Grey River herd if caribou shift into areas with reduced availability of preferred forage and/or increased risk of predation. Reduced forage availability could reduce body condition, leading to smaller calves and subsequent increased vulnerability to predation (Weir et al. 2014). This could affect the Grey River population size through reduced reproductive rates and increased adult and calf mortality. High- and moderate-value caribou habitat comprises approximately 80 to 90% of habitats available within 15 km of the mine site, which suggests that preferred forage is available within the assessed ZOIs. The amount of overlap between the assessed ZOIs and the calving range of the Grey River herd range from 5-26% of the 50% kernel and from 2-13% of the 95% kernel (Table 5.1). The relative amounts of high, moderate, and low-value habitat in the ZOIs are similar to those in the ELCA.

Grey River caribou may also experience increased levels of stress within Project-related ZOIs with potential effects decreasing with increasing distance from the mine site. Stress hormones in caribou may increase with exposure to anthropogenic disturbance (Freeman 2008; Wasser et al. 2011; Renaud 2012; Ewacha et al. 2017; Plante et al. 2020), and have been associated with reduced body condition, survival, reproductive rates, and with increased susceptibility to parasites or disease (Hughes et al. 2009; Escribano-Avila et al. 2013; Hing et al. 2016). Prolonged exposure to stress could potentially lead to poor body condition and potentially lower survival and reproductive rates which would affect the Grey River population size and trend.

Mitigation to limit habitat loss and reduce sensory disturbance to caribou are included in Section 6. Due to the limited overlap of the Grey River herd with the Project, effects on the Grey River herd are predicted to be low in magnitude for change in habitat.

The Grey River herd moves between seasonal ranges (Figure 11.9 in EIS) but is not considered a migratory herd and does not have a distinct migration corridor. Avoidance of the Project is unlikely to cause a shift in the distribution of Grey River caribou as discussed in Section 4.1. As stated in the EIS, the residual effect on change in movement for the Grey River herd is predicted to be adverse but low in magnitude, given the limited overlap of their summer range with the Project, and is not expected to adversely affect the population size and trend of the Grey River herd through mechanisms such as reduced body condition or increased calf mortality. As there is the potential for individual Grey River caribou to interact with the Project, mitigation to limit effects on caribou movement (e.g., facilitating the crossing of roads and mine infrastructure) would also serve to reduce Project effects on individual animals from the Grey River herd.

The Project could affect mortality risk for the Grey River herd. Coyote and black bear, predators which are considered the leading cause of calf mortality on the Island of Newfoundland (Weir et al. 2014), occur within the Project Area (Chapter 12 of the EIS). Additionally, moose have been confirmed near the mine site, with more than 230 detections recorded during the remote camera program in 2019 and 2020 (Chapter 12 of the EIS). In areas where primary prey species (e.g., moose) distribution overlaps caribou distribution, high moose abundance can support higher predator densities, which leads to increased predation of caribou (Section 11.5.3.1 of the EIS). The combined presence of coyote, black bear, and moose near the Project Area could potentially increase the mortality risk for the Grey River herd. As the Project has the potential to change habitat and the abundance of both predators (e.g., bear and coyote) and other prey species (e.g., moose), the predation risk to Grey River caribou may be affected. There is limited overlap with the Grey River calving range, therefore limiting the potential effect of increased predation from habitat changes (i.e., selection of regenerating habitat. Residual effects of the Project on the Grey River herd are predicted to be low in magnitude for change in mortality risk. Mitigation measures (Section 6) related to Project activities (e.g., sensory disturbance from light and noise) will benefit animals in the Grey River herd.

5.3 SUMMARY OF EFFECTS ON THE GAFF TOPSAILS HERD

As demonstrated in Section 4.5 of this report (Table 4.4), there is a high percentage of disturbed habitat in the range of the Gaff Topsails herd, with only approximately 40% of undisturbed habitat remaining

within the herd's range (based on conservative assumptions as outlined in Section 4.5 which likely overestimate the degree of disturbance). The high percentage of disturbance is largely attributable to previous forest harvesting activities (28%) and existing roads and transmission lines (23%). Based on guidance provided in The Amended Recovery Strategy for the Woodland Caribou (*Rangifer tarandus caribou*), Boreal population, in Canada (ECCC 2020), the quantity of undisturbed habitat available for caribou in the Gaff Topsails herd may not be sufficient to provide a measurable probability for the population to be self-sustaining.

The Gaff Topsails herd has limited range overlap with the Project Area (0.4 km^2), although given the degree of disturbance the herd is already experiencing within its range, it is important to consider potential Project interactions and contribution to habitat alteration. Only the winter range for the Gaff Topsails overlaps with the Project Area, which is attributable only to the 500 m ZOI associated with a section of the existing access road that is approximately 40 km from the mine site. The overlap is approximately 0.4 km^2 (or less than 1% of the winter range) (Table 11.16 in EIS). Project-related change in habitat is expected to have a limited effect on body condition, adult and calf mortality, and calving rate. While an interaction between Gaff Topsails caribou and the Project Area is unlikely, Section 6 includes mitigation intended to limit direct and indirect change in habitat for caribou. With implementation of the mitigation measures, the residual Project effects on the Gaff Topsails herd are predicted to be low in magnitude for change in habitat and are not expected to affect its population size or trend.

Telemetry data for the Gaff Topsails herd were explored in preparation for the assessment (Section 11.2.1.3 of the EIS). Although the Gaff Topsails herd demonstrated a shift in distribution between summer and winter ranges, the summer and winter ranges had a high degree of overlap. Additionally, both the summer and winter ranges occurred north of the Project and did not overlap with the mine site. Consequently, changes to herd dynamics such as recruitment rate and adult and calf mortality rates are expected to be limited because of the low degree of overlap between the Gaff Topsails herd and the Project Area (i.e., overlap with the existing access road only). Project effects on the movement of the Gaff Topsails herd are predicted to be negligible and changes to the population size and trend are not anticipated. Residual effects of the Project on the Gaff Topsails herd are predicted to be negligible in magnitude for change in movement.

The magnitude of change in mortality risk is anticipated to be low in the construction and operation phases, and negligible to low during decommissioning, for the Gaff Topsails herd. Direct and indirect Project-related changes to mortality risk are assessed qualitatively. Direct mortality risk for caribou through interaction with Project activities is considered unlikely because of the low overlap between the Project Area and the Gaff Topsails herd range. Changes to indirect morality risk are considered unlikely because of the low amount of overlap between the Gaff Topsails herd and the Project Area (i.e., limited overlap with the existing access road and no overlap with mine site). Mitigation measures (Section 6) related to Project will reduce the risk of direct mortality.

5.4 SUMMARY OF EFFECTS ON THE LA POILE HERD

There is no overlap between the La Poile herd range and the Project Area based on available telemetry data and home range estimates (Table 11.16 in the EIS). Therefore, Project effects are expected to be

limited for the La Poile herd. Furthermore, mitigation developed primarily for the Buchans and Grey River herds would also serve to reduce potential effects on La Poile caribou should individuals alter their expected movement patterns and interact with the Project Area. While the range of the La Poile herd does not overlap the Project Area, mortality risk for this herd could be affected indirectly by the Project, as further discussed below.

As indicated above, the Project is not predicted to result in a direct or indirect change in habitat for the La Poile herd, due to the lack of spatial overlap between the La Poile herd range and the Project Area. Mitigation measures (Section 6.2.2, below) to reduce change in caribou habitat (direct and indirect) resulting from the Project would be applicable to La Poile caribou should individuals alter their expected movement patterns and interact with the Project Area. With implementation of the mitigation measures, residual Project effects on the La Poile herd are predicted to be low in magnitude for change in habitat. Residual Project effects are also not anticipated to result in a reduction in survival or body condition, or to adversely affect population size or trend.

While the La Poile herd did have some movement between seasonal ranges, the seasonal ranges maintained a high degree of overlap (Figure 11-11 in the EIS). Due to the lack of spatial overlap between the La Poile herd range and the Project Area, changes to herd dynamics such as recruitment rate, and adult and calf mortality rates, are expected to be limited. It is not anticipated that a Project-related change in movement would affect the size and trend of the La Poile population. Therefore, the Project is anticipated to have a negligible effect on change in movement.

Change in mortality risk is anticipated to be low in magnitude for the La Poile herd in the construction and operation phases, and negligible to low during decommissioning. Direct and indirect Project-related changes in mortality risk are assessed qualitatively. The likelihood of an increase in direct mortality risk through interaction with mine infrastructure or through collisions with heavy equipment or vehicles is considered unlikely because of the lack of spatial overlap between the Project Area and the La Poile herd range.

While the range of the La Poile herd does not overlap the Project Area, these caribou could be affected indirectly by the Project. The Project is anticipated to have the greatest effect on the movement of the Buchans herd. If some Buchans caribou fail to migrate and remain on their winter range year-round, they could potentially overlap with the La Poile range between late fall and spring. As the assessed herds intermix on winter range with other South Coast herds (Weir et al. 2014), year-round use of the area by Buchans caribou could reduce the forage availability for the other herds that winter in that area (e.g., La Poile). This could affect the body condition of not only the Buchans caribou, but also of the La Poile caribou.

Indirect sources of mortality also include increased risk of predation or hunting pressure. Although the Project has the potential to increase the predation rate of caribou by affecting the density of predators and primary prey species, such an effect is considered unlikely for the La Poile herd given the spatial separation between the extent of Project effects and the range of the La Poile herd. The change in mortality risk for the La Poile herd is not expected to affect the population size and trend of the herd. Mitigation measures (Section 6) to reduce the risk of direct mortality resulting from Project vehicles and equipment would be applicable to La Poile caribou should individuals alter their expected movement

patterns and interact with the Project Area. Similarly, indirect effects will be reduced by measures such as restricting access to hunters by decommissioning roads, and by prohibiting hunting on site. Mitigation to limit effects on mortality would also serve to reduce Project effects on individual animals from the La Poile herd should their ranges or activities change over time. The residual change in mortality risk for the La Poile herd is predicted to be low in magnitude.

6.0 MITIGATIVE STRATEGY AND MONITORING PLAN

The mitigation measures outlined in the EIS are based on best practices, mitigation measures used elsewhere on other similar mining projects, and from information received during consultation and engagement on the EIS. Concerns and questions related to mitigation measures for caribou were raised in several comments and IRs received during review of the EIS, particularly on matters related to:

- Noise and stress response in caribou
- Migrating caribou and the degree of obstruction posed by specific Project components during construction and operation
- Addressing the high use of the Project footprint by caribou during migration
- Targeted mitigation relating to the permeability of migratory paths through the Project Area during migration, including potential shutdowns or relocations of Project elements that could impede this pathway during migration

The following sections describe Marathon's mitigative strategy that will be implemented through the life of the Project. This includes mitigation measures presented in the EIS and additional commitments that have evolved post-EIS submission, during the EA review process, and through additional discussions with the NLDFFA-Wildlife Division. This section also presents an overview of the monitoring program that will be used to evaluate the effectiveness of mitigation measures. The mitigative strategy and monitoring plan reflects Marathon's commitment and intent to avoid or reduce adverse effects on caribou, yet acknowledges that these measures and monitoring approaches may be refined through final mine design, Project schedule and ongoing engagement with a committee of experts, Indigenous groups, and the NLDFFA-Wildlife Division.

6.1 MITIGATIVE STRATEGY

Project planning and the application of proven mitigation measures will be used to avoid or reduce adverse residual effects on caribou. Project mitigation is presented in the EIS in Chapter 2 (Section 2.7 – Environmental Management) and in Chapter 11 (Caribou). A complete summary of mitigation measures for the Project is provided in Table 23.4 of the EIS. The following information provides additional context regarding mitigation measures that were considered for the Project in general (e.g., reduce the size of the footprint) and for individual Project components (e.g., diversion fencing around the crest of pits), and the rationale, as applicable, to support their inclusion or exclusion in the EIS and subsequent mitigation, monitoring and management efforts.

To limit potential adverse effects on caribou, a mitigation hierarchy has been used to systematically evaluate mitigation opportunities for each component and phase of the Project. The mitigation hierarchy, which has been applied elsewhere for caribou (e.g., Alberta; British Columbia) is: 1) Avoid; 2) Reduce; 3) Restore; and 4) Offset. Consistent with standard practice, Marathon is focused on avoiding and reducing potential Project effects on caribou to the extent feasible, and to addressing remaining residual Project effects through restoration and possible offsetting. Generally, offsetting is used when residual effects remaining after the application of avoidance, reduction, and restoration measures are considered unacceptable. Thus, not all projects within caribou ranges in Canada have been subject to offsetting the residual effects that remain after mitigation. Currently there are no offsetting opportunities available for Marathon to lead, but Marathon is willing to discuss with NLDFFA-Wildlife Division.

Table 6.1 summarizes the mitigation hierarchy, including the mitigation measures and strategies identified in the EIS or that Marathon considered for the Project either pre- or post-EIS submission, a Project specific evaluation of each strategy, and the current status of each measure (e.g., implemented through design, dismissed, still to be discussed with NLDFFA-Wildlife Division). The proposed mitigation measures are based on published literature, industry best practices and guidelines and have been used and accepted by regulators for other mine projects that overlap with caribou herd ranges.

Marathon is committed to working with regulators, Indigenous groups, and stakeholders to implement initial mitigation measures, undertake follow-up and monitoring activities, and adapt or add mitigation measures as required to further avoid or reduce adverse Project effects on caribou. The effectiveness of mitigation measures will be evaluated through the implementation of a caribou monitoring plan.

Table 6.1 Evaluation of Mitigation Hierarchy to Reduce Potential Adverse Project Effects on Caribou

Step	Mitigation Strategy	Evaluation of Mitigation	Mitigation Status
1) Avoid Measures taken during the planning phase to avoid removal or alteration of caribou habitat types or biophysical attributes (e.g., trails)	• Do not block migratory paths that allow access to important seasonal or annual habitats (e.g., move, remove or resize / reshape components)	• Relocate or shift waste rock pile towards the northeast or southwest of Marathon pit (note that the open pit cannot be relocated and therefore related effects on the migration corridor from the physical presence of the Marathon pit are permanent) – possibility to maintain relatively small portions of the migration corridor beyond the width of the open pit (note uncertainty in how caribou will respond when area is rehabilitated) – due to adjacent habitat and topography, limited ability to reshape the waste rock pile without encroaching on fish and fish habitat and causing greater effects on wetlands – may have other environmental implications (e.g., increased haul truck travel and resulting fuel use, greenhouse gas (GHG) and air contaminant emissions)	• Mitigation dismissed
		• Split the waste rock pile so that a portion is northwest, and a portion is southwest, of the Marathon pit. – possibility to maintain relatively small portions of the migration corridor beyond the width of the open pit (note uncertainty in how caribou will respond when area is rehabilitated) – may have other environmental implications (e.g., increased haul truck travel and resulting fuel use, GHG and air contaminant emissions) – visual implications due to placement of waste rock on higher ridge – could serve as a long-term obstacle to caribou approaching the pit from the south to reduce potential to fall into the open pit (during operations) or open pit lake (post-closure) (note uncertainty in how caribou will respond when area is rehabilitated)	• Mitigation not implemented - to be reviewed with NLDFFA-Wildlife Division
		• Relocate the overburden stockpile and low-grade ore stockpile. – possibility to reduce effects on portions of the migration corridor during operations – may have other environmental implications (e.g., increased haul truck travel and resulting fuel use, GHG and air contaminant emissions) – stockpiles will be removed prior to, or as part of, rehabilitation and closure activities	• Mitigation not implemented - to be reviewed with NLDFFA-Wildlife Division
		• Relocate the tailings management facility (TMF). – is sited to reduce potential effects on Victoria Dam and fish and fish habitat – only suitable location that considers all Valued Components and long-term dam safety with respect to Victoria Dam	• Mitigation dismissed
		• Relocate access road. – no feasible road alternative that would not cross caribou migration corridor and paths – site access road has existed long before exploration started on property, was utilized for forestry access, and is and will be required by NL Hydro for access to the Victoria Dam – constructing a new access road would likely have greater adverse residual effects on caribou than using existing access road	• Mitigation dismissed
		• Relocate processing plant – Move processing plant to southwest to increase distance from primary migration paths and reducing sensory disturbances	• Mitigation implemented through design revision
		• Relocate power line. – line to be constructed, operated, and decommissioned by NL Hydro – consultations with Marathon on the design – power line to be aligned to the extent feasible with adjacent, existing roads through the primary caribou migration corridor to avoid creating a new linear corridor – no feasible route alternative that would not cross caribou migration corridor	• Mitigation dismissed
	• Consider alternative methods that result in less disturbance to caribou	• No alternative to open pit mining of the gold resource located at the Marathon pit site (most of the gold reserve associated with the Project) that would achieve the purpose and need for the Project (refer to Chapter 2 of the EIS).	• Mitigation dismissed
	• Avoid direct disturbance of undisturbed habitat	• Project footprint and disturbed areas will be limited to the extent practicable through all components and Project phases. For example, construction laydown areas will utilize the future footprint of other mine components.	• Mitigation implemented (design) / future
		• Vegetation will be maintained around high activity areas to the extent practicable, to serve as a buffer to reduce sensory disturbance.	• Mitigation will be implemented
		• In the EA registration, an additional deposit (Victory Deposit) was included for consideration; however, based on consultation with Wildlife Division regarding potential additional effects on caribou migration and/or altered migration paths, and other factors, this deposit is no longer being considered for the Project.	• Mitigation implemented

Table 6.1 Evaluation of Mitigation Hierarchy to Reduce Potential Adverse Project Effects on Caribou

Step	Mitigation Strategy	Evaluation of Mitigation	Mitigation Status
	• Implement restricted activity period to avoid disturbance during caribou migration	• Caribou activities during the migratory periods will be monitored in the vicinity of the Project through visual observation, aerial surveys, and/or telemetry data from GPS collars. – 60 telemetry collars currently being deployed (in collaboration with NLDFFA-Wildlife Division) to provide additional information (ongoing)	• Mitigation will be implemented • NLDFFA-Wildlife Division to be consulted with respect to monitoring and caribou proximity
		• Activities in the Marathon pit area that may result in sensory disturbance to caribou (e.g., blasting, loading, hauling) will be reduced or suspended while caribou are migrating within the corridor and within a set distance from the site.	• Mitigation will be implemented • NLDFFA-Wildlife Division to be consulted on conditions regarding caribou proximity
		• Project-related traffic on the access road will be further reduced during migration periods –limiting traffic by bussing employees to site, and reducing traffic speed during migration periods, other measures to mitigate effects of roads could include further decreasing traffic volumes in migratory periods such as advance planning for decreased delivery of supplies and fuel to the degree possible to reduce traffic during these periods. In addition, speed limits will be reduced, and nighttime driving avoided to the extent practicable, to further reduce sensory disturbance and risk of collisions.	• Mitigation will be implemented
		• Project features (e.g., open pits, TMF) will be monitored during migratory periods; fencing/barricades may be installed as needed around the crest of the pits or at the TMF to reduce risks to caribou. As they are created, barricades will be established along the pit highwalls for safety per the *Mining Act* and guidelines.	• Mitigation will be implemented • NLDFFA-Wildlife Division to be consulted regarding the acceptability and use of fencing
		• Hunting will be strictly prohibited on the mine site. Workers will not be permitted to hunt while staying at the accommodations camp and will not be permitted to bring firearms to site	• Mitigation will be implemented
2) Reduce Measures taken to reduce adverse effects (including direct, indirect, and cumulative effects) that cannot be completely avoided, as far as is practically feasible.	• Creation of comprehensive Caribou Monitoring Plan (CMP) to supplement the Project Environmental Protection Plan (EPP)	• Establish mitigative requirements specific to caribou to reduce Project-effects on change in habitat, change in movement, and change in mortality risk. The CMP will be included in employee and contractor induction/orientation packages. During all Project phases, the EPP will be included as part of the contract with all suppliers and contractors who will do work at the site.	• Mitigation will be implemented • NLDFFA-Wildlife Division to be consulted regarding monitoring requirements and specific mitigation included in the CMP
		• The on-site environmental team will be notified if caribou are observed within or around the mine site , including the access road. If caribou are in proximity of Project infrastructure or activities, the environmental team will investigate and determine a course of action to be taken to limit interaction and/or sensory disturbance with the animal(s) as described in the CMP. This is in addition to the temporal reduction or suspension of activities in the Marathon pit area while caribou are migrating through the migration corridor and within a set distance from the mine site). Observational data will be tracked and used to develop trends and identify high-use areas – mitigations will be adapted as applicable in accordance with the data.	• Mitigation will be implemented • NLDFFA-Wildlife Division to be consulted on conditions regarding caribou proximity
		• Identify opportunities to reduce adverse effects through an adaptive management approach from information and data obtained from the monitoring program.	• Mitigation will be implemented • NLDFFA-Wildlife Division to be consulted on adaptive management strategies
	• Prevent caribou access to the mine site	• Fully enclose the mine site. – unlikely to be substantially more effective at reducing potential adverse effects than partial diversion – could have potential effects on other wildlife and land and resource users – Wildlife Division raised concerns about fencing/barricading the site, or parts of the site, as this may compound adverse effects on caribou migration	• Mitigation dismissed with the exception of very small sections used to prevent public access to the Project Area via site roads for safety/security. These exceptions will be review with NLDFFA-Wildlife Division and Service NL-OHS Division.
	• Divert caribou away from hazards and / or through an alternate route	• Fencing or barricades will be installed as needed around the crest of the pits, and may be installed around the TMF or other Project features to limit interactions with specific components at the mine site and reduce risks to caribou (e.g., rock berms, wire fences, or snow fencing). A barricade is required along the pit crest and for any highwall areas for safety per the *Mining Act* and guidelines.	• Mitigation will be implemented • NLDFFA-Wildlife Division and NLDIET-Mines Branch to be consulted regarding the acceptability and use of barriers, including design considerations and placement

Table 6.1 Evaluation of Mitigation Hierarchy to Reduce Potential Adverse Project Effects on Caribou

Step	Mitigation Strategy	Evaluation of Mitigation	Mitigation Status
		• Create an ingress/egress area for animals at pit lake surface interfaces for mine closure (requirement of NLDIET-Mines Branch).	• Mitigation will be implemented
		• If caribou do not demonstrate avoidance of the mine site, additional measures could be implemented to discourage caribou use of the site, such as more extensive fencing around the mine or altering habitats in strategic locations to enhance alternate migration pathways.	• Adaptive Management required - to be reviewed with NLDFFA-Wildlife Division
	• Facilitate road crossings	• Breaks in snowbanks associated with snow clearing along roadways will be created at ~200 m intervals, to the extent practicable, through the migratory corridor, to provide caribou with crossing opportunities. Where feasible, breaks will be aligned on opposite sides of the road and with existing wildlife trails (where these occur).	• Mitigation will be implemented
		• Snowbanks will typically be < 1 m tall to facilitate caribou crossing roadways during spring and fall migration.	• Mitigation will be implemented
		• Install artificial crossing structures (e.g., bridges) along site roads (access and haul roads) and the existing access road. – Mitigation is generally tied to fully fenced linear corridors only, where the bridge serves as the only crossing point – NLDFFA-Wildlife Division has indicated extensive fencing is not preferred – The open pit and waste rock pose more significant obstacles, and installing crossing structures over these features is not considered feasible (see below)	• Mitigation dismissed
		• Road signage warning of caribou crossing areas will be posted at regular intervals.	• Mitigation will be implemented
		• Water management ditches will be designed to allow wildlife crossing opportunities	• Mitigation will be implemented
		• Caribou will have the right-of-way except where deemed unsafe to Project personnel. If wildlife is observed on a road, speed will be reduced and vehicle stopped, if necessary, to allow wildlife to pass leave road.	• Mitigation will be implemented
	• Facilitate crossing of mine infrastructure	• Artificial crossing structures at the Marathon pit and waste rock piles are not feasible due to the size of mine infrastructure and activities associated with open pit mining.	• Mitigation dismissed
	• Reduce effects on energetic demands	• Supplemental feeding – e.g., transplant lichen (Roturier et al. 2007; Allen 2017; Duncan 2015; Rapai et. al. 2018) or distribute caribou pellets to increase forage value on winter and calving grounds (Heard and Zimmerman 2021).	• Mitigation to be reviewed with NLDFFA-Wildlife Division
		• Increase forage value along potential alternate migration paths – Alternate migration pathways identified in a Caribou Alternate Migration Pathway Analysis undertaken for the Project are predicted to have increased energetic costs for caribou – Low certainty in identifying areas for mitigation prior to Project operation, as the alternate pathway analysis cannot predict the likelihood that caribou will use the alternate paths identified, or which ones would be used if they do	• Mitigation to be reviewed with NLDFFA-Wildlife Division
	• Reduce effects on vegetation	• Project footprint and disturbed areas will be limited to the extent practicable (design, construction, and operations).	• Mitigation has been implemented for design and will be implemented for construction and operations
		• Vegetation will be retained, promoted and maintained to the extent practicable.	• Mitigation will be implemented
		• Existing riparian vegetation will be maintained to the extent practicable through design and layout of site facilities.	• Mitigation will be implemented
		• Where crossing of wetlands (with equipment and/or vehicles) beyond the area to be cleared is unavoidable, protective layers such as matting or biodegradable geotextile or other approved materials will be used between wetland root / seed bed and construction equipment if ground conditions are encountered that create potential for rutting, admixing, or compaction.	• Mitigation will be implemented – Marathon has purchased 2,000 “bog mats” previously used for the cross-island transmission line
	• Reduce sensory disturbance from noise – mitigations to be constantly applied, with additional measures during migration periods	• The on-site environmental team will be notified if caribou are observed within or around the Project Area, including the access road. If caribou are in proximity of Project infrastructure or activities, the environmental team will investigate and determine a course of action to be taken to limit interaction and/or sensory disturbance with the animal(s) as described in the CMP. This is in addition to the temporal reduction or suspension of activities in the Marathon pit area while caribou are migrating through the migration corridor and within a set distance from the site. Observational data will be tracked and used to develop trends and identify high-use areas – mitigations will be adapted as applicable in accordance with the data.	• Mitigation will be implemented • NLDFFA-Wildlife Division to be consulted on the extent of activity reduction and conditions regarding caribou proximity

Table 6.1 Evaluation of Mitigation Hierarchy to Reduce Potential Adverse Project Effects on Caribou

Step	Mitigation Strategy	Evaluation of Mitigation	Mitigation Status
		• Visual surveys for caribou will be undertaken prior to blasting. During pit development, which includes near-surface blasting, the search zone will be 1 km from the blast. After the pit perimeter is developed and blasting is more than 30 m below the pit crest (whereby noise and vibrations will be reduced for receptors) the clearance zone will be 500 m buffer from the final pit perimeter. Blasting will be delayed if caribou are observed within these zones (this is in addition to the temporal reduction or suspension of activities in the Marathon pit area while caribou are migrating through the corridor and within a set distance from the site).	• Mitigation will be implemented • NLDFFA-Wildlife Division to be consulted on conditions regarding caribou proximity
		• Engines and exhaust systems of construction and mining equipment will be subject to a comprehensive equipment preventative maintenance program to maintain fuel efficiency and performance. Vehicles and heavy equipment will be regularly inspected and maintained in good working order and will be equipped with appropriate mufflers to reduce noise.	• Mitigation will be implemented
		• Where practicable in accessible areas (e.g., along cleared rights-of-way), trees and other vegetation will be left in place or allowed to grow to obstruct the view of Project facilities, reducing the change in viewshed and muffling noise.	• Mitigation will be implemented
		• Transplant larger trees to improve vegetation cover and reduce sensory disturbance	• Mitigation will be implemented
		• Vehicle traffic will be reduced by transporting employees to the site by bus.	• Mitigation will be implemented
		• Sensory disturbance associated with the transportation of workers and materials to/from the site will be managed through a Traffic Management Plan to reduce sensory disturbance.	• Mitigation will be implemented
		• Project vehicles will be required to comply with posted speed limits in all areas, with additional speed restrictions implemented during caribou migration periods.	• Mitigation will be implemented
		• Traffic along the access road will be further reduced during migration periods.	• Mitigation will be implemented
		• Project-related air traffic will maintain a minimum ferrying distance altitude of 500 m to the extent feasible. Air traffic (helicopters) is expected to be limited and low-altitude flying is only expected to be required adjacent to a site landing area. Air traffic will be limited or suspended during caribou migration and calving periods except when used for caribou studies.	• Mitigation will be implemented
		• Since submitting the EA Registration in 2019, Marathon has relocated the high-grade ore and run-of-mine stockpiles, crusher, mill, and mine services components approximately 2 km to the west, in part to reduce noise and other sensory disturbance on caribou.	• Mitigation was implemented
	• Reduce sensory disturbance and effects on vegetation from fugitive / windblown dust	• Project vehicles on access and site roads will be required to comply with posted speed limits.	• Mitigation will be implemented
		• Vehicle traffic will be reduced by transporting employees to the site by bus.	• Mitigation will be implemented
		• Vehicles (including off-highway vehicles) used by Marathon personnel will be restricted to roads, trails, and corridors to the extent practicable.	• Mitigation will be implemented
		• The TMF will be designed and managed to reduce the area of exposed dry surfaces, where possible, to reduce the potential for windblown dust emissions.	• Mitigation will be implemented
		• Emission control technologies will be implanted where necessary to reduce air contaminant emissions.	• Mitigation will be implemented
		• All Project components will be progressively rehabilitated (including revegetation) to reduce dust emissions, including waste rock piles. Overburden and topsoil stockpiles that will be used for future rehabilitation activities will be sloped and temporarily revegetated (until utilized for site rehabilitation) to reduce dust emissions.	• Mitigation will be implemented
		• Dust suppression will be applied to roads and open-ground areas on an as-needed basis during high wind conditions or if measured ambient particulate matter concentrations are in exceedance of the Newfoundland and Labrador Ambient Air Quality Standards.	• Mitigation will be implemented
		• Water will be applied on roads as needed to mitigate dust emissions.	• Mitigation will be implemented
		• Conveyor belts at the mill will be fully enclosed to reduce dust generation and noise	• Mitigation will be implemented
		• Surfaces of topsoil and overburden stockpiles will be stabilized during extended periods between usage by means of vegetating or covering the exposed surfaces.	• Mitigation will be implemented
		• When loading stockpiles, drop heights will be reduced to be as close to the pile as possible.	• Mitigation will be implemented

Table 6.1 Evaluation of Mitigation Hierarchy to Reduce Potential Adverse Project Effects on Caribou

Step	Mitigation Strategy	Evaluation of Mitigation	Mitigation Status
	• Reduce sensory disturbance from light	• The on-site environmental team will be notified if caribou are observed within 500 m of Project activities (e.g., vegetation clearing, heavy equipment use); activities may be reduced or delayed (this is in addition to the temporal reduction or suspension of activities in the Marathon pit area while caribou are migrating through the corridor and within a set distance from the site).	• Mitigation will be implemented • NLDFFA-Wildlife Division to be consulted on the extent of activity reduction and conditions regarding caribou proximity
		• Only the amount of lighting required for safe construction and operation activities will be installed; exterior lights will be shielded from above where required.	• Mitigation will be implemented
		• Mobile and permanent lighting will be located such that unavoidable light spill from the working area is not directed toward receptors outside of the Project Area, to the extent practicable.	• Mitigation will be implemented
		• Lights will be designed to avoid excessive use of mobile flood lighting units and will be turned off when they are not required.	• Mitigation will be implemented
		• Full cut-off luminaires will be used wherever practicable to reduce glare, light trespass, and sky glow from Project lighting.	• Mitigation will be implemented
	• Reduce sensory disturbance from vibrations	• Visual surveys for caribou will be undertaken prior to blasting. During pit development, which includes near-surface blasting, the search zone will be 1 km from the blast. After the pit perimeter is developed and blasting is more than 50m below the pit crest (whereby noise and vibrations will be reduced for receptors) the clearance zone will be 500 m buffer from the pit perimeter. Blasting will be delayed if caribou are observed within these zones (this is in addition to the temporal reduction or suspension of activities in the Marathon pit area while caribou are migrating through the corridor and within a set distance from the site).	• Mitigation will be implemented • NLDFFA-Wildlife Division to be consulted on conditions regarding caribou proximity
3) Restore Measures taken to rehabilitate degraded ecosystems or restore cleared ecosystems following exposure to effects that cannot be completely avoided and/or reduced (often most applicable at end of Project, but can be applied in stages as areas no longer are required)	• Restore caribou habitat	• Plan for closure during Project design – ensuring that Project features are designed and developed such that progressive and final rehabilitation activities do not require major re-work or significant alteration of the adjacent land and environment.	• Mitigation implemented / ongoing
		• Develop a conceptual Rehabilitation and Closure Plan (RCP) as required under the *Mining Act.* – as the Project proceeds the RCP will become more prescriptive and comprehensive prior to implementation – final RCP will include specific consideration of benefit to caribou values	• Mitigation will be implemented
		• The low-grade ore stockpile, overburden, and topsoil stockpiles, haul roads, and water management features associated with the Marathon pit area will be removed and these areas rehabilitated to as close to pre-development conditions as possible.	• Mitigation will be implemented
		• Disturbed areas will be graded and/or scarified and covered with overburden and organic materials, where required; areas will be seeded (using native seed mix) to promote natural re-vegetation – part of progressive and final rehabilitation.	• Mitigation will be implemented
		• Plant vegetation, as part of progressive and final rehabilitation, that is suitable habitat for caribou (and not preferred by moose).	• Mitigation to be reviewed with NLDFFA-Wildlife Division
		• Plant mature trees to manage line-of-sight to reduce visual and noise disturbance, as required during Project construction and operation.	• Mitigation to be reviewed with NLDFFA-Wildlife Division
	• Restrict access to public by decommissioning/blocking roads	• Decommissioning and rehabilitation of roads on the mine site during closure that are not required for long-term monitoring.	• Mitigation will be implemented
	• Progressive rehabilitation (revegetation) of waste rock pile	• Waste rock piles will be progressively rehabilitated over the life of the Project; requires advance planning to determine the nature of waste rock piles upon closure. – waste rock piles will be constructed from the ground up using slopes and benches of 10 m height; when a bench is finished in one area, the horizontal bench and downhill slope will be covered with overburden / organics and revegetated	• Mitigation to be reviewed with NLDFFA-Wildlife Division
	• Re-establish natural watercourses	• Project design considers avoidance of natural watercourses, however, given the hydrologic conditions at site, total avoidance is not feasible. Natural watercourses affected by the Project will be re-established during rehabilitation and closure to the extent practicable.	• Mitigation implemented / ongoing

Table 6.1 Evaluation of Mitigation Hierarchy to Reduce Potential Adverse Project Effects on Caribou

Step	Mitigation Strategy	Evaluation of Mitigation	Mitigation Status
4) Offset These measures may be implemented after all previous steps in the mitigation hierarchy have been exhausted and residual effects are still considered unacceptable. Offsetting usually involves regulatory consultation; offset measures can be delivered in a variety of ways, but if delivered as “restorative” these are typically implemented outside of Project workspaces.	• Restore other habitats that have been previously degraded	• Restoration of degraded habitats outside of the Project footprint to offset Project residual effects. – securing areas for restoration that are not part of a Marathon Lease can be challenging (e.g., Crown land; other tenures)	• Not considered to date
	• Management actions by regulators	• Physical interventions to improve ecological conditions (e.g., altering habitat to ‘replace’ the affected habitat, reduce predation in area).	• Not considered to date; would need to be implemented by the Government of NL
		• Reduce caribou harvest to offset for potential increased mortality risk.	• Not considered to date; would need to be implemented by the Government of NL
		• Implement initiatives to reduce predation risk to caribou (e.g., coyote and black bear reduction strategies).	• Not considered to date; would need to be implemented by the Government of NL
		• Vehicle restrictions (including off-highway vehicles) in other areas (i.e., outside of the Project Area) to reduce stress on caribou during sensitive periods.	• Not considered to date; would need to be implemented by the Government of NL
		• Legislative mechanisms (e.g., establishing protected areas) to preserve ecological conditions and habitats in other areas.	• Not considered to date; would need to be implemented by the Government of NL
	• Maternal penning	• Place females in an enclosure to birth and raise young to an age when predation risk is low. – costly and poses challenges for migratory herds; intrusive measure unlikely to be considered acceptable by regulators, stakeholders and public	• Not considered to date; will likely be dismissed

6.2 FRAMEWORK FOR CARIBOU MONITORING PLAN

Effects monitoring will build on information gathered during baseline studies and will be ongoing throughout the life of the Project. Effects monitoring will aim to confirm the effectiveness of mitigation, contribute to ongoing evaluation of the overall condition of caribou within the Project Area, and help identify the potential need for adaptive management measures to further mitigate Project effects.

Marathon's CMP is currently being developed alongside the Project's EPP and will be subject to review by independent caribou experts, Indigenous groups, and the NLDFFA-Wildlife Division prior to implementation. The CMP will be a comprehensive document that will present baseline data, list all mitigations associated with caribou and caribou habitat, provide detailed monitoring and assessment programs, include provisions for external and regulatory review of monitoring data and assessment reports, identify thresholds whereby further mitigations will be implemented, and other pertinent information. The CMP is expected to be drafted by September 2021 and Marathon will consult with the reviewers and stakeholders to develop a review schedule. A general framework for the CMP is described in the following sections.

The monitoring component of the CMP will be founded on four key questions that will focus efforts to understand both the effectiveness of mitigation and overall relationship between the Project and condition of caribou within the Project Area. The four key questions are:

1. Have the behaviours of the Buchans herd changed as a result of the Project?	1a. Timing of migration 1b. Numbers of animals moving through the area 1c. Alternate pathways being used (i.e., using different habitats, paths, and lay-over sites) 1d. Duration of migration (i.e., are they moving through the Project Area more quickly or slowly?)
2. Have the home ranges of the Buchans and Grey River herds changed proximate to the Project?	2a. Have seasonal ranges changed as compared to baseline? 2b. Have calving ranges changed as compared to baseline?
3.Have the herd populations changed as a result of the Project?	3a. Are there changes in cow/calf ratio and spring classification (Buchans and Grey River)? 3b. Are there changes in the Buchans herd population estimates?

4.Are caribou directly interacting with the Project and, if so, how?	4a. Recording of observations on-site (number, timing, frequency, locations) 4b. Recording of observations on access road (number, timing, frequency, locations) 4c. Recording of direct Project-related mortalities on site or along access road (number, timing, locations)

Additionally, some mitigations applicable to caribou (e.g., programs to reduce dust, light, and noise emissions) will be captured through other monitoring efforts. As an example, light or noise emissions may cause sensory disturbance and result in behavioural changes in caribou. These emissions and applicable mitigation would be captured in atmospheric monitoring programs and used to assess behavioural changes in caribou. Linking the various Project mitigations and monitoring efforts to caribou is not feasible at this stage of the EA process; however, Marathon is committed to taking a holistic approach to mitigation, monitoring, managing, adapting and reporting that will be further developed under an overall Environmental Management System (that is currently being developed)

The EIS stated that the residual adverse effect of change in movement for the Buchans herd is predicted to be significant. This movement relates primarily to the Buchans herd, which migrates seasonally through the Project Area. However, based on the baseline studies, it is also acknowledged that the Grey River herd calving grounds overlap the Project and therefore will also be considered through the monitoring efforts, (i.e., GPS collars on Grey River herd animals). As described in Section 11.2.2.1 of the EIS there are limited anticipated interactions between the Project and the Gaff Topsails and LaPoile herds. Therefore, targeted monitoring programs for these two herds are not currently planned.

6.2.1 Monitoring Approaches, Tools, and Technologies

Marathon is committed to long-term monitoring of mitigation effectiveness and Project effects on caribou. The monitoring program will be overseen by a committee of stakeholders and experts who will review monitoring methods and results and provide ongoing recommendations to Marathon to improve or adjust the monitoring program. Currently, Marathon is committed to implementing the following monitoring approaches, tools, and technologies to understand mitigation effectiveness and Project effects:

- Maintenance and monitoring of 60 GPS-enabled caribou collars deployed in the RAA by NLDFFA-Wildlife Division on both the Buchans and Grey River herd animals
- Wildlife cameras placed within the LAA, and proximate to the Project area, to supplement the collar data
- On-site caribou observations will be collected in a systematic manner to further inform how animals are interacting with the Project and responding to the implemented mitigations
- Systematic aerial surveys, to be coordinated with the NLDFFA-Wildlife Division, will be undertaken for population and calving studies
- Other studies that may be determined supportive of the on-going and future monitoring program.

Wildlife collars allow for longer term and larger scale monitoring of individual animals as they move across the landscape and, assuming there are adequate numbers of collars to represent the herd, provide insight into broader herd behaviour. Long term data sets will allow comparisons to be made to baseline conditions. In some cases, the same animal will have a collar for an extended period; however, sometimes new animals will need to be collared to keep the number of active collars at a level that is sufficient for understanding what is occurring on the landscape (e.g., mortality signals will be sent from collars which could lead to further investigation to determine cause of death as either natural or through predation). Marathon will continue to work directly with NLDFFA-Wildlife Division to deploy and maintain collars. The collars currently in use allow for a variety of remote programming options. As the specific monitoring protocols and procedures are created for the CMP, the collar capabilities will be used to refine data capture as seasonally and spatially appropriate to inform management responses when necessary. This real time data collection, while only a sample of what is occurring within the herd, is expected to represent broader patterns and is a common approach used in many wildlife studies.

The remote camera placements established with NLDFFA-Wildlife Division in 2021 will establish baseline and the reference point information for classifying animals, groups and herd composition moving through the Project Area. Additionally, if the predicted effects of the Project are realized and caribou begin to use alternate migratory paths (which should be identifiable from collar data), cameras will be added and/or redeployed to monitor the alternate paths. While cameras allow for a broader “picture” of herd use, they are spatially restricted to the field of view. Camera data will be time-stamped and used to classify the migrating animals by group size and composition, in addition to providing data on time of travel through each camera location.

Focused field surveys and general observations will further supplement remote data capture techniques with real time observations at the mine site and along the access road. Area Staff and contractors who regularly visit the mine site will receive an orientation package, of which one component will include the detection and recording of wildlife observations. During the migratory and calving periods, targeted surveys near the active mine site will be scheduled to confirm the absence of caribou prior to blasting. Opportunistic observations, such as from bus drivers on the access road, will be collected over time and could influence further road-associated mitigations if patterns become evident (e.g., if animals are repeatedly observed feeding or crossing near a certain section of road).

Aerial surveys will be planned and undertaken with the NLDFFA-Wildlife Division to systematically gather information on herd populations and determine caribou group size and composition including the number of cow-calf pairs (i.e., classification) proximate to the Project. The surveys will target specific areas through coordination with NLDFFA-Wildlife Division.

6.2.1.1 Spatial Considerations

Similar to the approach used to develop the EIS baseline, the CMP will function at various spatial scales to reflect the seasonal ranges and habitats of the herds with which the Project may interact. Marathon will use an area-based matrix (Table 6.2) to direct specific management actions, based on information being gathered from the CMP (i.e., management thresholds). The thresholds will be set conservatively to initiate action prior to threshold exceedence. The intensity of mitigation measures and monitoring efforts will decrease from most intense within the active operational areas on-site, to less intense at a regional scale.

The area-based distances were informed by existing guidance (e.g., Environment Canada 2011), published research (e.g., Polfus et al. 2011; Boulanger et al. 2012; Plante et al. 2018; Vanlandeghem et al. 2021), and management standards (e.g., Nalcor 2013; Golder 2016; Emera 2017).

Each area has specific management objectives for both the Project and caribou. Additionally, anticipated monitoring outcomes based on mitigations are intended to inform the development of thresholds for further management actions.

Table 6.2 Proposed Area-based Management Matrix

Area	Area Name and Distance	Marathon Caribou Management Objective
Area I	Adjacent to active site infrastructure 0 - 50 m	Active mine site. Mining activities are on-going, other than seasonal (i.e., caribou migrations) and maintenance suspensions. Caribou pass through safely and quickly. Caribou are actively discouraged from being this close to mining activities. Marathon does not want caribou lingering in Area I. Aversive conditioning may be considered in consultation with NLDFFA-Wildlife Division. Mitigation in place primarily for caribou safety (e.g., possible fencing at pit crest). Monitoring may indicate that caribou use the active site infrequently.
Aree II	Within Project Area plus 500 m buffer	Adjacent/peripheral to main site activities. Includes access to the primary mining areas. Mitigation in place to enable safe and uninterrupted passage through the Project Area (e.g., traffic speeds reduced, temporal reductions in mining activities, active scans of blast zone prior to blasting). Monitoring may indicate that active site is mostly avoided through behavioural responses (e.g., some movement pathways shift, stop-over periods are different).
Area III	Approaching site, beyond Project Area plus 500 m boundary out to 10 km	Approaching the adjacent/active mine site. Project interface overlaps with other users in the area (e.g., recreational users and possibly outfitters, NL Hydro activities, public roads). Mitigation measures related to Marathon activities in place to reduce effects of traffic and far-reaching sensory disturbances (e.g., reduced speed, reduced spread of light emissions). Monitoring may indicate that caribou behaviours (e.g., movement pathways, stop-over periods, group compositions) are similar to baseline conditions. With time, anticipate few behavioural indicators of active mine site in area.
Area IV	Region > 10 km	Regional Assessment Area No Project-specific mitigations. Province may implement hunting reductions in area. Monitoring may result in no evidence from caribou behavioural indicators or population metrics of active mine in the area.

6.2.1.2 Temporal Considerations

Marathon's purchase and ongoing maintenance and monitoring of 60 GPS-enabled caribou collars reflects the commitment to understand how the Project may affect caribou. Baseline studies have identified the times of year when caribou are more likely to interact with the Project, and therefore the frequency and intensity of monitoring will be reflective of those key periods. During non-critical periods, data from collars may be viewed on a bi-weekly basis, whereas during critical periods data may be

reviewed every 4-6 hours. Mortality notifications will be transmitted as they occur as the collars are set-up to send mortality signals.

The conclusions of the EIS indicate that due to the overlap between the Project and the migration corridor, the residual effect on change in movement for the Buchans herd is predicted to be high in magnitude and likely to occur (Section 2.2 of this report). With implementation of mitigation measures, and given the described uncertainties, the residual adverse effect of the Project on caribou is predicted to be significant. The timing of migration through the Project Area in the spring (April 1 – May 19) and fall (Nov 1 – Dec 15) are well established patterns generally from animals on the Island of Newfoundland, with herd specific timing that may vary from year to year through the Project Area. During these critical periods, some operations within Areas I, II and III (Table 6.2) will be modified to mitigate predicted Project effects (Table 6.1).

Historic collar data indicate that the Grey River herd use an area south of the Victoria reservoir during the spring migration/pre-calving and calving period. The calving grounds are on the south side of Victoria Lake Reservoir; however, the 95% kernels include some of the Project Area. During the calving period from May 20 to June 20, Grey River caribou collars will be monitored frequently to assess proximity to the Project. Marathon staff will be on alert within the Project Area and advise of caribou (not herd specific), pregnant cows and/or calves observed within the Project Area + 500 m (Area II). Appropriate management responses will be determined in consultation with NLDFFA-Wildlife Division.

6.2.2 Monitoring and Management Plans

As described in Chapter 2, Section 2.7.3 of the EIS, a series of Environmental Management Plans, including an Environmental Protection Plan (EPP), will be developed under the overarching Environmental Management System and will encompass the environmental regulatory requirements and commitments made for the Project. In consultation with NLDFFA-Wildlife Division, a comprehensive Caribou Monitoring Plan will be developed alongside the Project's EPP. This plan will include mitigation specific to reducing Project-effects on change in habitat, change in movement, and change in mortality risk for caribou, and it will be included in employee and contractor induction/orientation packages. In response to comments from the Wildlife Division, and the requirements to provide additional detail on how mitigation measures identified in Section 6.1 will be monitored, this section identifies preliminary monitoring approaches and management responses to be further refined in consultation with NLDFFA-Wildlife Division prior to implementation and throughout the life of the Project.

Table 6.3 illustrates the approach Marathon will use to monitor the various mitigation measures related to caribou. This monitoring plan framework is still under development as the environmental assessment and Project planning processes, which are still ongoing, may result in new and/or modified measures. For each mitigation measure, at least one specific element will be monitored to determine the effectiveness of the mitigation, using the proposed approaches listed in the table. Conservative monitoring thresholds for each mitigation are proposed, whereby management actions will be triggered prior to threshold exceedence. This adaptive approach will allow Marathon to realize its commitment to reduce potential Project effects on caribou in the area and to monitor the effectiveness of mitigation and accuracy of EIS predictions. Potential management actions may include further refinement of a given mitigation (e.g.,

decreased traffic volumes in migratory periods) or may result in innovative approaches based on new information.

As noted in Table 6.3, an Air Quality Management Plan will also be developed and implemented as part of the EPP and will specify the mitigation measures for the management and reduction of air emissions (including noise, light, and particulates) during Project construction and operation. Dust, noise, and light monitoring programs will be undertaken, and the results of these monitoring programs will be available to inform Project effects on caribou and potentially identify the need for additional mitigation measures.

The EPP and CMP will be included as part of the contract with all suppliers and contractors who will undertake work at the site throughout all Project phases. The EPP and the CMP will be completed in consultation with applicable regulators.

Section 3.5 of this report identifies baseline programs that have been completed thus far or are planned to commence in 2021.

Marathon will continue to engage with the NLDFFA-Wildlife Division with respect to ongoing monitoring programs, and it is anticipated that these monitoring programs will continue and will be adapted as required over the life of the Project (including during closure and post-closure monitoring). Table 6.3 consolidates the EIS commitments for mitigations, outlines monitoring approaches and establishes preliminary thresholds that are set conservatively to initiate action prior to threshold exceedance. This table will form the basis of the long term CMP.

Table 6.3 Preliminary Caribou Monitoring Approach

#	Mitigation Measure	Approach to Monitoring	Monitoring Thresholds
1	Project footprint and disturbed areas will be limited to the extent practicable.	• Comparison of detailed engineering design to construction Project footprint	• Actual disturbed area is greater than design footprint
2	Water management ditches will be designed to allow wildlife crossing opportunities.	• Collar data • Remote cameras • On-site observations	• Evidence that animal crossings are being obstructed by ditches
3	Vegetation will be maintained around high activity areas to the extent practicable.	• Comparison to design Project footprint	• Disturbed area is greater than design footprint
4	Caribou activities during the migratory periods will be monitored in the vicinity of the Project.	• Collar data • Remote cameras • On-site observations	• Recorded Project-related mortality • Stop-over times trending towards measurable [a] deviation from baseline • Trending towards significant reduction in migration through or around Project Area to seasonal habitats • Trending towards measurable deviations in composition of groups as compared to baseline • Trending towards measurable deviations in the number of migrant caribou • Recorded Project-related mortality
5	Activities in the Marathon pit area that may result in sensory disturbance (e.g., light, noise, vibration) to caribou will be reduced or ceased while caribou are migrating through the corridor and within a set distance from the site.	• Monitoring approach to be developed as part of the Air Quality Management Plan	• Measurable elements for light and noise will be developed as part of the Air Quality Management Plan– these may be incorporated into caribou models • Caribou behaviours (i.e., timing of migration, numbers of animals moving through, alternate pathways being used, duration of migration trending towards measurable deviations) during migration as compared to baseline • Trending towards measurable deviations in composition of groups as compared to baseline • Trending towards measurable deviations in the number of migrant caribou

Table 6.3 Preliminary Caribou Monitoring Approach

#	Mitigation Measure	Approach to Monitoring	Monitoring Thresholds
6	Traffic along the access road will be further reduced during migration periods. Project vehicles will be required to comply with posted speed limits, with additional speed restrictions implemented during migration.	• Monitoring of traffic • Collar data (temporal focus of crossing roads)	• During migratory period, traffic not to exceed 80% total non-migratory period volume.
7	Project features (e.g., open pits, TMF) will be monitored during migratory periods; to reduce risks to caribou, fencing/barricades may be installed as needed around the crest of the pits or at the TMF.	• Collar data • Remote cameras • On-site observations • Recording of observations on-site (number, timing, frequency, locations)	• Trending towards measurable reduction in migration through or around Project Area to seasonal habitats • Trending towards measurable change in composition of groups as compared to baseline • Trending towards measurable change in the number of migrant caribou • Recorded Project-related mortality at or near Project feature •
8	Key aspects of the management plan will be included in employee and contractor induction/orientation packages. During all Project phases, the EPP will be included as part of the contract with all suppliers and contractors who will conduct work at the site.	• Records of EPP training and distribution • Staff completion of Wildlife Observation Forms	• Indication / evidence that some staff or contractors did not receive EPP orientation (audits)
9	Develop a protocol for reporting caribou sightings to the on-site environmental team and the NLDFFA-Wildlife Division.	• Recording of observations on-site, on the access road, and direct Project interactions (caribou on or within a Project feature, mortality)	• Indication / evidence that caribou or predators have been observed yet not reported
10	Fencing or barricades will be installed as needed around the crest of the pits and may be installed around the TMF or other Project features to limit interactions with specific components at the mine site and reduce risks to caribou.	• Recording of observations on-site • Recording of direct Project related mortalities • Collar data – time of movement through site	• Recorded Project-related interaction or mortality at or near Project feature •

Table 6.3 Preliminary Caribou Monitoring Approach

#	Mitigation Measure	Approach to Monitoring	Monitoring Thresholds
11	Install a barrier adjacent to pit crests (high walls)..	• Recording of observations on-site • Recording of direct Project-related mortalities • Collar data	• Recorded Project-related mortality at or near Project feature • Significant reduction in migration through or around Project Area to seasonal habitats
12	Create an ingress/egress area for animals at pit lake surface interfaces for mine closure (requirement of NLDIET).	• Recording of observations on access road • Collar data	• Recorded Project-related mortality at or near Project feature post-closure
13	Breaks in snowbanks created through road clearing will be created at ~200 m intervals, to the extent practicable, to provide caribou crossing opportunities.	• Recording of observations on access road	• Impediments identified showing caribou unable to safely move through site • Observation of caribou unable to cross roads due to snowbanks
14	Snowbanks will typically be <1 m tall to facilitate caribou crossing during spring and fall migration.	• Recording of observations on access road	• Impediments identified showing caribou unable to safely move through site • Observation of caribou unable to cross roads due to snowbank height
15	Where feasible, breaks in snowbanks will be aligned on opposing sides and with existing wildlife trails, where they occur, to facilitate caribou crossing.	• Recording of observations on access road	• Impediments identified showing caribou unable to safely move through site • Observation of caribou unable to cross roads due to snowbanks
16	Road signage warning of caribou crossing areas will be posted at regular intervals.	• Audit of signage on access road • Seasonally increased communications delivered to all staff • Seasonally targeted staff communications are delivered	• No evidence of increased number and placement of seasonal signs on roads • Audit/follow-up on employee orientation and understanding
17	Supplemental feeding – e.g., transplant lichen or distribute caribou pellets to increase forage value on winter and calving grounds.	• Collar and camera data indicate alternate pathways being used • Collar data to assess seasonal ranges	• Trending towards measurable deviations in migration through or around Project Area to seasonal habitats • Trending towards significant deviations in composition of groups as compared to baseline • Trending towards measurable deviations in the number of migrant caribou • Trending towards measurable deviations in seasonal ranges as compared to baseline

Table 6.3 Preliminary Caribou Monitoring Approach

#	Mitigation Measure	Approach to Monitoring	Monitoring Thresholds
18	Increase forage value along potential alternate migration paths.	• Collar and camera data indicate alternate pathways being used	• Trending towards measurable deviations in migration through or around Project Area to seasonal habitats • Trending towards measurable deviations in composition of groups as compared to baseline • Trending towards measurable deviations in the number of migrant caribou
19	Vegetation will be retained and maintained around all activity areas to the extent practicable.	• On-site verification of design Project footprint	• Disturbed area is greater than design footprint
20	Existing riparian vegetation will be maintained to the extent practicable.	• On-site verification of design Project footprint	• Disturbed area is greater than design footprint
21	Where crossing of wetlands beyond the area to be cleared is unavoidable, protective layers such as matting or biodegradable geotextile or other approved materials will be used between wetland root / seed bed and mobile equipment if ground conditions are encountered that create potential for rutting, admixing or compaction.	• On-site verification, operating procedure manuals. • Periodic spot checks	• Evidence that vehicles are travelling outside defined work areas, roads, and corridors without using proper procedures and environmental protection
22	Movement of equipment / vehicles will be restricted to defined work areas and roads, and specified corridors between work areas.	• On-site verification, operating procedure manuals. • Periodic spot checks (environmental inspections/audits)	• Evidence that vehicles are travelling outside defined work areas, roads, and corridors without using proper procedures and environmental protection
23	The on-site environmental team will be notified if caribou are observed within 500 m of Project activities (e.g., vegetation clearing, heavy equipment use); activities may be reduced or delayed (this is in addition to the temporal reduction or suspension of activities in the Marathon pit area while caribou are migrating along the path and within a set distance from the site). This data will be tracked and used to develop trends and identify high-use areas – mitigations will be adapted as required in accordance with the data.	• Collar data to define timing of migration • Collar data indicate animals approaching / moving through the site • Recording of observations on-site • Environmental monitors completing site surveys	• Environmental staff are not immediately informed of sightings when caribou are within 500 m of Project infrastructure

Table 6.3 Preliminary Caribou Monitoring Approach

#	Mitigation Measure	Approach to Monitoring	Monitoring Thresholds
24	Visual surveys for caribou will be undertaken prior to blasting. During pit development, the search zone will be 1 km from the blast. After the pit perimeter is developed and blasting is more than 50m below the pit crest, the clearance zone will be a 500m buffer from the pit perimeter. Blasting will be delayed if caribou are observed within these zones.	• Environmental monitors and mining personnel clearing blast zone • Recording of observations on-site	• Evidence that blasting occurred prior to confirmation of complete observation protocols (to be developed)
25	Best practices from Blaster's Handbook (ISEE 2011) and Environmental Code of Practice for Metal Mines (ECCC 2009) will be followed to reduce and monitor noise emissions during blasting.	• Assessment of adherence with best practices (blasting audits, and blast monitoring – vibrations) • Noise monitoring program to be developed as part of the Air Quality Management Plan	• Evidence that best practices are not being followed • Vibrations recorded are higher than thresholds set (thresholds to be determined, based on distance from blast) • Noise monitoring thresholds to be developed as part of the Air Quality Management Plan
26	Engines and exhaust systems of construction and mining equipment will be subject to a comprehensive equipment preventative maintenance program to maintain fuel efficiency and performance. To reduce emissions, equipment and vehicle idling times, and cold starts will be reduced to the extent possible. Marathon will develop an idling policy to this effect	• Maintenance will be documented and records retained for all heavy equipment • Spot checks to audit conformance with policy	• Evidence that maintenance records are not being properly recorded • Evidence that policies are not being followed
27	Vehicles and heavy equipment will be regularly inspected and maintained in good working order and will be equipped with appropriate mufflers to reduce noise.	• All vehicle maintenance will be documented and records retained for all heavy equipment	• Evidence that maintenance records are not being properly recorded
28	Vehicles will use existing roads / trails while operating at the mine site.	• On-going operating procedure established in training • Roads and trails network reviews to assess for conformance	• Evidence of non-conformance

Table 6.3 Preliminary Caribou Monitoring Approach

#	Mitigation Measure	Approach to Monitoring	Monitoring Thresholds
29	Where practicable in accessible areas (e.g., along cleared rights-of-way), trees and other vegetation will be left in place or allowed to grow to obstruct the view of Project facilities, reducing the change in viewshed and muffling noise.	• On-site verification of design Project footprint	• Disturbed area is greater than design footprint
30	Vehicle traffic will be reduced by transporting employees to the site by bus.	• On-going operating procedure established during employee orientation • Non-staff traffic will be monitored	• Limited occupancy vehicles vs high occupancy vehicle ratios will be established to reflect operational procedures
31	To reduce the risk of caribou-vehicle collisions, caribou will have right-of-way except where deemed unsafe to Project personnel. If wildlife is observed on a road, speed will be reduced and vehicle stopped, if necessary, to allow wildlife to leave road.	• On-going operating procedure (communications / training for all drivers) • Recording of observations on the access road • Collar data and observations to inform when animals are moving into Project Area	• Project-related traffic along access road resulting in mortality
32	Sensory disturbance associated with the transportation of workers and materials to/from the site will be managed through a Traffic Management Plan to reduce sensory disturbance.	• On-going operating procedure (communications / training for all drivers) • Monitoring of traffic volumes	• No overall traffic reduction during migratory seasons • Drivers arriving on site have not received EPP communications package / training
33	Project vehicles will be required to comply with posted speed limits in all areas, with additional speed restrictions implemented during caribou migration periods.	• On-going operating procedure (communications / training for all drivers) • Observations of non-compliance with speed restrictions • Collar data, observations to inform when animals are moving into Project Area	• Evidence of Project vehicle infractions of posted speed limits
34	Project-related air traffic will maintain a minimum ferrying distance altitude of 500 m to the extent feasible.	• On-going operating procedure communicated to companies flying into site	• Evidence of infractions of flight restrictions, unless unsafe to be flying at that altitude
35	The TMF will be designed and managed to reduce the area of exposed dry surfaces, where possible, to reduce the potential for windblown dust emissions.	• Design intent and on-going operating procedure • Dust monitoring program to be developed as part of the Air Quality Management Plan	• Air quality thresholds will be developed as part of the Air Quality Management Plan • Measured against design and operational intent

Table 6.3 Preliminary Caribou Monitoring Approach

#	Mitigation Measure	Approach to Monitoring	Monitoring Thresholds
36	Emission control technologies will be employed where necessary to reduce air contaminant emissions.	• Ambient air quality and noise monitoring programs will be implemented throughout the life of the Project, as required and in accordance with Project permitting and conditions of approval.	• Air quality thresholds will be developed as part of the Air Quality Management Plan
37	All Project components will be progressively rehabilitated (including revegetation) to reduce dust emissions, including waste rock piles and overburden/topsoil stockpiles.	• On-going operating procedure, efforts can be compared to proposed footprint • Annual reports on all rehabilitation activities	• Air quality thresholds will be developed as part of the Air Quality Management Plan • Inspection/audit of areas available for progressive rehabilitation • Inspection/audit of progressively rehabilitated areas indicating rehabilitation not completely successful (signs of erosion, vegetation not growing, etc.)
38	Dust suppression will be applied to roads and open-ground areas on an as-needed basis during high wind conditions or if measured ambient particulate matter concentrations are in exceedance of the Newfoundland and Labrador Ambient Air Quality Standards.	• Dust monitoring program to be developed as part of the Air Quality Management Plan	• Air quality thresholds will be developed as part of the Air Quality Management Plan
39	The application of dust suppressants other than water to roads as an alternative option to watering will be considered in consultation with NLDECCM.	• Dust monitoring program to be developed as part of the Air Quality Management Plan	• Air quality thresholds will be developed as part of the Air Quality Management Plan
40	When loading stockpiles, drop heights will be reduced to be as close to the pile as possible.	• Dust monitoring program to be developed as part of the Air Quality Management Plan	• Air quality thresholds will be developed as part of the Air Quality Management Plan
41	Surfaces of topsoil and overburden stockpiles will be stabilized during extended periods between usage by means of vegetating or covering the exposed surfaces.	• Operating procedure • Environmental monitors completing inspections	• Annual report on revegetation activities and stockpile management does not indicate progress
42	Conveyors will be covered to reduce fugitive dust emissions.	• Design intent and on-going operating procedure • Dust monitoring program to be developed as part of the Air Quality Management Plan	• Air quality thresholds will be developed as part of the Air Quality Management Plan

Table 6.3 Preliminary Caribou Monitoring Approach

#	Mitigation Measure	Approach to Monitoring	Monitoring Thresholds
43	Project lighting will be limited to that which is necessary for safe and efficient Project activities.	• Design intent and on-going operating procedure • Periodic spot checks (audits) • An overall approach to monitoring light to be developed as part of the Air Quality Management Plan	• Measured against design intent; expectations not being met • Light thresholds will be developed as part of the Air Quality Management Plan
44	Lights will be designed to avoid excessive use of mobile flood lighting units and will be turned off when they are not required.	• Design intent and on-going operating procedure • An overall approach to monitoring light to be developed as part of the Air Quality Management Plan Periodic spot checks (audits)	• Measured against design intent, expectations not being met • Light thresholds will be developed as part of the Air Quality Management Plan
45	Mobile and permanent lighting will be located such that unavoidable light spill from the working area is not directed toward receptors outside of the Project Area, to the extent practicable.	• Design intent and on-going operating procedure • An overall approach to monitoring light to be developed as part of the Air Quality Management Plan Periodic spot checks	• Measured against design intent, expectations not being met • Light thresholds will be developed as part of the Air Quality Management Plan
46	Lights will be designed to avoid excessive use of mobile flood lighting units and will be turned off when they are not required.	• Design intent and on-going operating procedure • An overall approach to monitoring light to be developed as part of the Air Quality Management Plan Periodic spot checks (audits)	• Measured against design intent, expectations not being met • Light thresholds will be developed as part of the Air Quality Management Plan
47	Full cut-off luminaires will be used wherever practicable to reduce glare, light trespass and sky glow from Project lighting.	• Design intent and on-going operating procedure • An overall approach to monitoring light to be developed as part of the Air Quality Management Plan	• Measured against design intent, expectations not being met • Light thresholds will be developed as part of the Air Quality Management Plan
48	Hunting will be strictly prohibited on the mine site. Workers will not be permitted to hunt while staying at the accommodations camp and will not be permitted to bring firearms to site.	• On-going operating procedure	• Evidence of non-conformance will be addressed on site with applicable individuals

Table 6.3 Preliminary Caribou Monitoring Approach

#	Mitigation Measure	Approach to Monitoring	Monitoring Thresholds
49	Wildlife-vehicle collisions, near misses or observations of wildlife (caribou, moose) road mortality on site roads and/or involving Project vehicles on the access road will be reported to the on-site environmental team and the– NLDFFA - Wildlife Division.	• Reporting of all observations onsite and on the access road • Immediate reporting of any direct Project related mortality or near-miss incident	• Regular reports not delivered on agreed-upon schedule • Delayed notification of Project-related mortality or near-miss • Evidence of interactions not reported
50	Plan for closure during Project design – ensuring that Project features are designed and developed such that progressive and final rehabilitation activities do not require major re-work or significant alteration of the adjacent land and environment.	• Design intent • Compliance with Regulatory Guidance	• Non-compliance with Rehabilitation and Closure Plan (RCP)[b]
51	Develop a conceptual Rehabilitation and Closure Plan (RCP) as required under the *Mining Act.*	• Design intent • Compliance with Regulatory Guidance	• Non-compliance with RCP
52	The overburden and topsoil stockpiles, haul roads, and water management features associated with the Marathon pit area will be removed and these areas rehabilitated to as close to pre-development conditions as possible.	• Design intent • Compliance with Regulatory Guidance	• Non-compliance with RCP
53	Disturbed areas will be graded and/or scarified and covered with overburden and organic materials, where required; areas will be seeded (using native seed mix) to promote natural re-vegetation – part of progressive and final rehabilitation.	• Design intent • Annual reports on all rehabilitation activities	• Non-compliance with RCP
54	Plant vegetation, as part of progressive and final rehabilitation, that is suitable habitat for caribou (and not preferred by moose).	• Design intent • Annual reports on all rehabilitation activities • Appropriate species selection to be determined through consultation with NLDFFA-WD	• Non-compliance with RCP
55	Plant (transplant) trees to manage line-of-sight to reduce visual and noise disturbance, as required during Project construction and operation.	• Design intent to remove as little vegetation as is possible • Annual reports on all rehabilitation activities	• Non-compliance with RCP

Table 6.3 Preliminary Caribou Monitoring Approach

#	Mitigation Measure	Approach to Monitoring	Monitoring Thresholds
56	Decommissioning and rehabilitation of roads on the mine site during closure that are not required for long-term monitoring.	• Design intent – operations will define schedule • Annual reports on all rehabilitation activities	• Non-compliance with RCP
57	Waste rock piles will be progressively rehabilitated over the life of the Project; requires advance planning to determine the nature of waste rock piles upon closure.	• Design intent – operations will define schedule • Annual reports on all rehabilitation activities	• Non-compliance with RCP
58	Natural watercourses affected by the Project will be re-established during rehabilitation and closure to the extent practicable.	• Design intent – operations will define schedule • Annual reports on all rehabilitation activities	• Non-compliance with RCP

Notes:
[a] Where the phrase “trending towards measurable deviations” is used in this table, it refers to a trend in the data that points towards a statistically significant change compared to baseline data. The trend will become the trigger for further action, not the point at which a statistically significant difference is measured.
[b] Rehabilitation and Closure Plan has not yet been developed

6.2.3 Adaptive Management

Marathon is proposing an adaptive management framework that allows for adjusting mitigation measures in response to monitoring results. The adaptive management framework establishes a process to evaluate monitoring outcomes relative to desired goals, which in this respect, is to limit potential adverse effects of the Project on caribou migration and populations in the Project Area to an acceptable level. While construction activities related to site development will result in full footprint development in some areas of the site, the largest Project components (e.g., the open pits, waste rock piles, overburden and ore stockpiles, TMF) will only be partially developed during construction and will not be fully developed until several years into Project operations. It is anticipated that follow-up and monitoring activities completed during the construction and early development period will provide valuable information on changes in caribou movement with respect to the Project and on the effectiveness of initial mitigation measures. This information will then be used to determine if adjustments to mitigation measures, or the adoption of new mitigation measures, should be applied. With the proposed mitigation measures (Table 6.3) and the implementation of an adaptive management framework to address the effects of vegetation clearing, site preparation, and operation, the risk of direct mortality is predicted to be low.

An adaptive management framework for evaluating mitigation effectiveness is used in many environmental protection and conservation projects. The premise of adaptive management is to use a cycle of planning, implementation, monitoring, and analysis / learning to systematically determine whether mitigation is effective relative to the goal(s), while allowing for adjustments to mitigation when monitoring results indicate that the goal(s) is not being achieved. Marathon is committed to working with regulators, Indigenous groups, and stakeholders to implement initial mitigation measures, undertake follow-up and monitoring activities, and adapt mitigation measures as applicable to reduce Project-related effects on caribou migration and population.

Marathon's conceptual adaptive management framework will include the basic elements of Plan, Act, Monitor, Assess, and Revise, which function together under a feedback system with the intent of achieving the defined goal(s) as stated in the CMP. The basic elements are summarized as follows:

- Plan: states the goal and is supported by measurable targets and performance measures.
- Act: the 'doing' of specific actions, such as implementing one or more mitigation measures.
- Monitor: seeks to collect data/information on the performance measures and to report on those measures in respect of the targets.
- Assess: allows for evaluation of the effectiveness of a mitigation measure in terms of meeting the target. Typically, measures that meet or exceed the target will result in no change to the Plan, whereas measures that do not meet the target will be reviewed in detail to identify the root cause of the deficiency and to identify adjustments or corrective measures to meet the target. The Assess element can include consultation and engagement regarding monitoring results and proposed corrective actions.
- Revise: the process of implementing changes, as necessary, that were identified in the Assess element. The Revise element circles back to the Monitor and Assess elements as part of understanding whether the corrective actions are effective at achieving the stated goal.

7.0 CONCLUSIONS

The information presented in this report does not change the conclusion of the assessment in the EIS, however it does provide additional context for the effects assessment and the future implementation of mitigation measures and monitoring plans. As discussed, the effects of the Project on the Buchan's herd migration, including the potential for the Project to present an obstacle to caribou migration, has been characterized as high in magnitude. The potential residual effect of the Project on caribou was predicted to be significant in recognition of a high magnitude characterization and the potential for the Project to threaten the long-term persistence or viability of the Buchans herd. Within the context of environmental assessment, the prediction of a significant adverse residual effect (i.e., one that remains following application of mitigation) is the highest level of importance and gravity that can be placed on a potential Project effect. It fully acknowledges the need for careful consideration and development of meaningful monitoring and adaptive management planning, and for ongoing consultation and cooperation with regulators and stakeholders.

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APPENDIX A

Caribou Alternate Migration Pathway Analysis

Valentine Gold Project: Caribou Alternate Migratory Pathway Analysis

Report

March 23, 2021

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VALENTINE GOLD PROJECT: CARIBOU ALTERNATE MIGRATORY PATHWAY ANALYSIS

Table of Contents

LIST OF TABLES

LIST OF FIGURES

Abbreviations

COSEWIC	Committee on the Status of Endangered Wildlife in Canada
dBBMM	Dynamic Brownian bridge movement models
EIS	Environmental Impact Statement
ELC	Ecological Land Classification
EOSD	Earth Observation for Sustainable Development
GIS	geographic information system
km	kilometres
km^2	square kilometres
LCP	Least-cost path
m	metres
Marathon	Marathon Gold Corporation
UD	Utilization Distribution
ZOI	zone of influence

1.0 INTRODUCTION

Marathon Gold Corporation (Marathon) is proposing to develop and operate an open pit gold mine near Valentine Lake, located in the central region of the Island of Newfoundland. The Valentine Gold Project (the Project) includes the mine site where Project infrastructure will be located, and an access road which is an existing road to the mine site that will be upgraded and maintained by Marathon as part of the Project. The Buchans herd of woodland caribou (*Rangifer tarandus*) migrate through the Project Area bi-annually as they travel from calving grounds in central Newfoundland in spring to wintering grounds on the south coast. The Buchans herd is designated as Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (COSEWIC 2014) and has recently undergone population declines thought to be the result of a complex set of interactions including predation and food limitation (Government of NL 2015).

Stantec Consulting Ltd. (Stantec) completed a migration analysis of the Buchans herd as part of the Environmental Impact Statement (EIS) for the Project. Dynamic Brownian bridge movement models (dBBMM) were used to estimate utilization distributions (UD) for GPS-collared caribou during the spring and fall migration periods (Chapter 10 in Marathon 2020). The results of the dBBMM identified that the Project Area directly overlaps with the primary migration corridor that is currently used by over half of collared caribou within the Buchans herd. The Project has the potential to disrupt the main migration corridor and cause caribou to select alternative migration pathways that may be less suitable, which could ultimately cause a change in recruitment or survival; the full scope of residual effects is discussed in the EIS (Marathon 2020).

During regulatory review of the EIS, questions were raised regarding potential implications of the Project overlapping with the main migratory pathway for the Buchans herd. To address these questions, Stantec undertook a least-cost path (LCP) analysis to predict potential alternate migratory pathways that may be used by the Buchans herd during spring and fall migrations during Project activities, identify the habitat types within alternate migratory routes, and estimate changes in energetic costs based on distance travelled.

2.0 METHODS

2.1 STUDY AREA

The Project is in the Central Region of the Island of Newfoundland, approximately 60 kilometres (km) southwest of Millertown, Newfoundland and Labrador. The Project Area includes the immediate area in which Project activities and components occur and is comprised of a mine site and access road. The mine site includes the area where Project infrastructure will be located, and the access road is an existing road to the site, plus a 20 metre (m) wide buffer on either side. The Study Area includes the migratory range of the Buchans herd, and surrounding areas where potential alternate migration routes are most likely to occur (Figure 2-1).

2.2 OVERALL APPROACH

LCP analyses were used to estimate alternate migratory pathways for the Buchans herd during spring (April 1 – May 19) and fall (November 1 – December 15) migration periods[1]. LCP analyses model the relative energetic cost for an animal to move between locations. The LCP analysis is processed within a geographic information system (GIS) using a raster dataset wherein each raster cell is assigned a resistance value that represents the cost of movement associated with characteristics of the cell (e.g., landcover, terrain) (Etherington 2016). The LCP analysis identifies a single best path by choosing the combination of cells that sum to the least resistance (i.e., lowest cost) with the shortest distance between locations (Adriaensen et al 2003).

Potential alternate migratory pathways for the Buchans herd were estimated during spring and fall migration assuming a zone of influence (ZOI) around the mine site of 1 km, 5 km, 10 km, and 15 km. The zones of influence used for this analysis were selected to encompass a range of potential caribou avoidance distances reported for mine sites within the literature (see Table 11.14 in Marathon 2020). A 'baseline' movement pathway was predicted by running the LCP analysis with no ZOI to serve as a comparable baseline for alternate pathways. The actual ZOI for the Project will depend on several factors such as the intensity and duration of Project disturbance, topography, habitat type, and the timing of the disturbance (Marathon 2020). For each season and ZOI, LCPs were modelled under two scenarios, 1) frozen conditions, and 2) unfrozen conditions, to account for differences in seasonal use of water bodies. Migratory caribou are known to select ice and avoid open water when travelling across or near large water bodies (LeBlond et al. 2016). Given the inter-annual variability in the timing of both caribou migration and ice availability, large water bodies within the Project area may be frozen or unfrozen at the time of migration.

[1] The dates used to bound the spring and fall migration periods apply generally to caribou on the Island of Newfoundland and were obtained from Emera (2013)

Methods

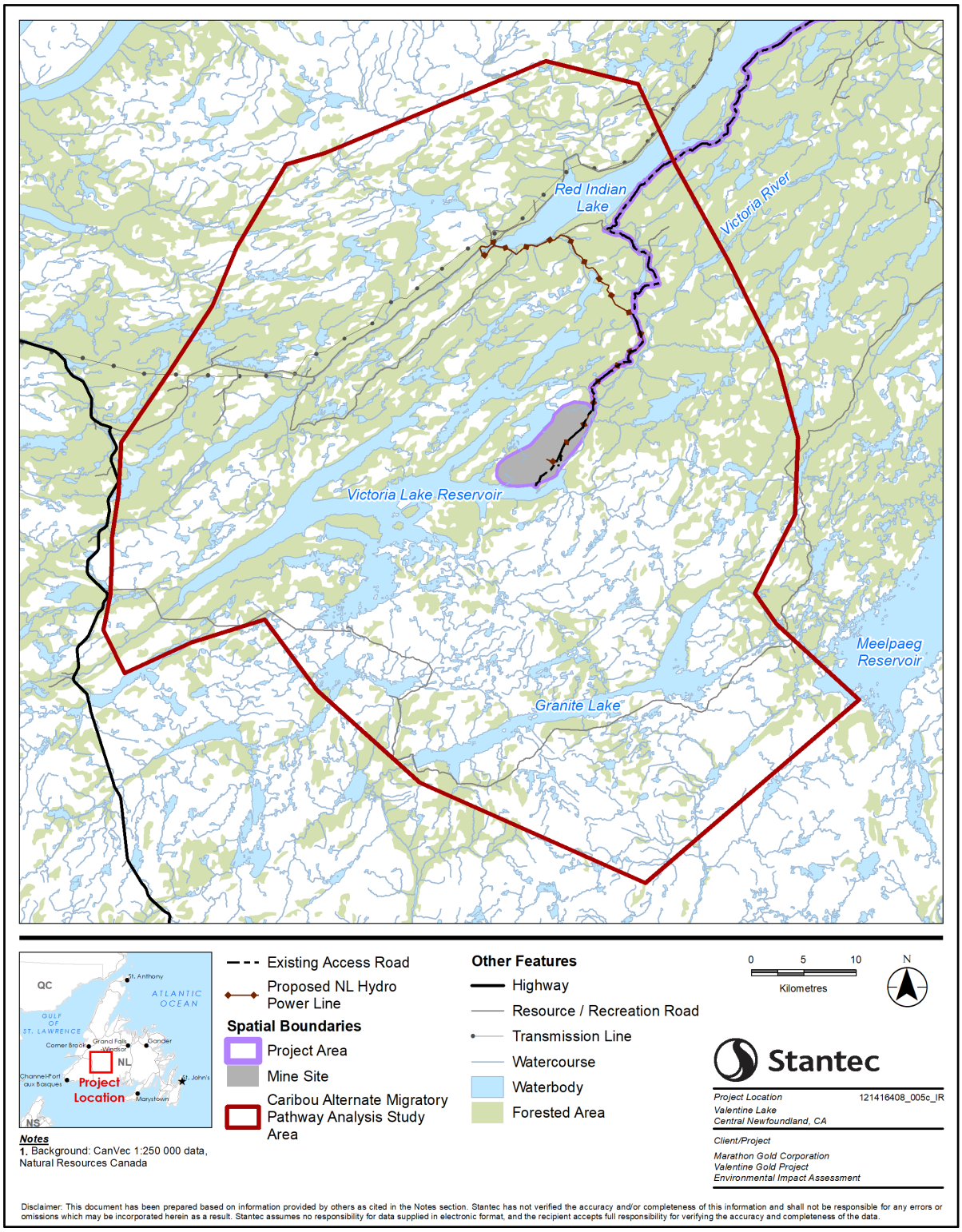

Figure 2-1 Caribou Alternate Migratory Pathway Analysis Study Area

2.3 GEOSPATIAL DATA

In the EIS, 12 habitat types within the Project Area were mapped using Ecological Land Classification (ELC) data (Marathon 2020). The coverage of ELC data was limited to a relatively small area outside the Project Area (Figure 11-3; Marathon 2020), and therefore did not cover the spatial extent needed for the LCP analyses over all ZOIs. Subsequently, habitat types for the LCP analyses were mapped using 17 landcover classes using data from the Earth Observation for Sustainable Development (EOSD) of Forests (Canadian Forest Service 2006) and spatial data for harvested forests and anthropogenic features including roads, cabins, transmission lines, and hydroelectric data retrieved from the Government of Newfoundland databases (Government of NL 2020a, 2020b, 2020c, 2020d). The available spatial data for habitat types within the Study Area could not be combined with the ELC data as methods of delineation were not comparable. Consequently, the habitat value ranks assigned to ELC habitat types in the EIS do not directly link to the EOSD habitat data. For this reason, the value of habitat types for caribou movement used in this analysis were ranked using resistance values that are informed by the dBBMM, as described below.

2.4 LEAST-COST PATH ANALYSIS

The resistance values (i.e., cost) were informed by the habitat types selected by caribou within the main movement pathways identified from the dBBMM (Marathon 2020). The proportion of each habitat type within the main movement pathways (25-50% and 50-75% UD quartiles) during spring and fall migrations from the dBBMM were extracted and transformed to create resistance values, such that high use habitat types were assigned low resistance values. The inverse proportion of habitat types were rescaled between 1 – 8 to create a resistance surface where 1 represents a low cost to movement and 8 represents a high cost to movement (Table 2.1). Through this transformation, it is assumed that the habitat types with a higher probability of selection along the main movement pathways from the dBBMM afford lower costs to movement compared to habitat types within low-use migration pathways, or paths that were not used at all.

Table 2.1 Habitat Descriptions and Resistance Value Inputs for the LCP Analysis

Habitat Types[1]	Description[1]	Spring Migration		Fall Migration	
		0.25-0.75 UD (%)[2]	Resistance Value	0.25-0.75 UD (%)[3]	Resistance Value
Coniferous sparse	10-25% crown closure; coniferous trees are 75% or more of total basal area	33.8	1.0	36.7	1.0
Wetland-Shrub	Land with a water table near/at/above soil surface for enough time to promote wetland or aquatic processes; the majority of vegetation is tall, low, or a mixture of tall and low shrub.	13.7	5.2	12.8	5.6
Water	Lakes, reservoirs, rivers, streams, or salt water.	11.3	5.7	9.5	6.2
Shrub low	At least 20% ground cover which is at least one-third shrub; average shrub height less than 2 m.	9.2	6.1	11.2	5.9
Exposed Land	River sediments, exposed soils, pond or lake sediments, reservoir margins, beaches, landings, burned areas, road surfaces, mudflat sediments, cutbanks, moraines, gravel pits, tailings, railway surfaces, buildings and parking, or other non-vegetated surfaces.	7.2	6.5	6.8	6.7
Coniferous open	26-60% crown closure; coniferous trees are 75% or more of total basal area.	6.5	6.6	7.8	6.5
Coniferous dense	Greater than 60% crown closure; coniferous trees are 75% or more of total basal area.	5.5	6.9	4.9	7.1
Wetland-Herb	Land with a water table near/at/above soil surface for enough time to promote wetland or aquatic processes; the majority of vegetation is herb	3.2	7.3	3.4	7.4
Rock/Rubble	Bedrock, rubble, talus, blockfield, rubbley mine spoils, or lava beds.	2.4	7.5	0.9	7.8
Mixedwood open	26-60% crown closure; neither coniferous nor broadleaf tree account for 75% or more of total basal area.	1.6	7.7	2.1	7.6
Wetland-Treed	Land with a water table near/at/above soil surface for enough time to promote wetland or aquatic processes; the majority of vegetation is coniferous, broadleaf, or mixed wood.	1.2	7.8	0.9	7.8
Shrub tall	At least 20% ground cover which is at least one-third shrub; average shrub height greater than or equal to 2 m.	0.7	7.9	0.6	7.9

Table 2.1 Habitat Descriptions and Resistance Value Inputs for the LCP Analysis

Habitat Types[1]	Description[1]	Spring Migration		Fall Migration	
		0.25-0.75 UD (%)[2]	Resistance Value	0.25-0.75 UD (%)[3]	Resistance Value
Mixedwood dense	Greater than 60% crown closure; neither coniferous nor broadleaf tree account for 75% or more of total basal area	0.4	7.9	0.4	7.9
Broadleaf dense	Greater than 60% crown closure; broadleaf trees are 75% or more of total basal area.	0.2	8.0	0.2	8.0
Broadleaf sparse	10-25% crown closure; broadleaf trees are 75% or more of total basal area.	0.2	8.0	0.2	8.0
Broadleaf open	26-60% crown closure; broadleaf trees are 75% or more of total basal area.	0.0	8.0	0.0	8.0
Herb	Vascular plant without woody stem (grasses, crops, forbs, gramminoids); minimum of 20% ground cover or one-third of total vegetation must be herb.	0.0	8.0	0.0	8.0
Harvested forest	Forests that are regenerating as a result of harvesting.	1.4	7.7	0.1	8.0
Anthropogenic	Roads, cabins, transmission lines, hydroelectric infrastructure.	0.4	8.0	0.3	8.0

Notes:

1 Habitat types and definitions from Earth Observation for Sustainable Development of Forests (Canadian Forest Service 2006); harvested forest and anthropogenic habitat types from the Government of Newfoundland databases (Government of NL 2020a, 2020b, 2020c, 2020d).

2 Proportion habitat types within the main movement pathways (25-50% and 50-75% UD quartiles) from the dBBMM (Marathon 2020) during spring migration

3 Proportion habitat types within the main movement pathways (25-50% and 50-75% UD quartiles) from the dBBMM (Marathon 2020) during fall migration

Complete barriers were set to null (i.e., infinite resistance). Each ZOI was classified as a complete barrier, under the assumption that caribou will entirely avoid each ZOI around the mine site. Classifying the ZOIs as complete barriers is a conservative measure; within the literature, caribou avoidance of mine sites is observed at varying degrees within a ZOI which depends on several factors including season, habitat, and the intensity or type of disturbance. For example, Boulanger et al. (2021) identified yearly and spatial variation in the ZOI for caribou around mines site that is influenced by the annual variation in habitat selection, available forage, perceived level of disturbance, and drought. Caribou avoidance may also be influenced by memory, learning, and social behavior; not all caribou within a study area will exhibit the same degree of avoidance. Although the ZOI for mine sites vary among studies, caribou have been documented to reduce their use of habitat within 2 km to 14 km of mines (e.g., Weir et al. 2007; Polfus et al. 2011; Boulanger et al. 2012; Johnson et al. 2015).

Large waterbodies including Victoria Lake Reservoir, Red Indian Lake, and Meelpaeg Lake were classified as complete barriers in the unfrozen scenarios under the assumption that caribou would circumnavigate open water instead of swimming across. Narrow portions of these lakes (i.e., <1 km) were not included as barriers. Slopes greater than 38° were considered adverse to caribou movement and classified as complete barriers (McNay and McKinley 2007).

The start and end locations for the LCP analysis were identified using the 20-50% and 50-75% UD quartiles along the migration route termini identified in the EIS (Marathon 2020). The LCP analysis assumes that caribou would begin migration from these locations and follow the LCP between these points. As the LCP analysis creates a single pixel width output (25 m), the resistance raster was resampled to 300 m using a bilinear technique in ArcGIS to create a potential migration corridor that is biologically relevant.

For each LCP produced, the proportion of each habitat type, total path length, and total path cost were calculated; values for spring and fall migration paths were summed to produce annual migration values. The path cost for each ZOI was divided by the cost of the baseline LCP to get the relative increase in cost for each alternate pathway.

3.0 RESULTS

The baseline LCP (i.e., no ZOI) was compared to the movement pathways identified by the dBBMM during spring (Figure 3-1) and fall (Figure 3-2) migration periods for congruence. Generally, the baseline LCP movement pathway and the dBBMM results had a high degree of similarity, suggesting that caribou are currently migrating along the shortest, least cost path, and that the additional LCP analyses can serve as reasonable predictors of potential alternate migration pathways. In spring, the baseline LCPs for frozen and unfrozen conditions generally followed the same route as the main movement pathway from the dBBMM for the first part of the migration, then moved east of the dBBMM route through the mine site; the unfrozen scenario LCP follows the dBBMM route more closely in the latter portion of the migration, whereas the frozen scenario LCP crosses Red Indian Lake (Figure 3-1). In fall, the baseline LCPs for frozen and unfrozen conditions followed a similar pattern to spring; the pathways followed the same route as the main movement pathway from the dBBMM for most of the migration except where the pathways move east of the dBBMM route near the first part of the migration, with the frozen scenario LCP crossing Red Indian Lake.

The LCP analyses predicted alternate pathways for each ZOI under frozen and unfrozen conditions during spring migration (Figure 3-3) and fall migration (Figure 3-4). In spring, the alternate pathways navigate around the east side of the mine site at increasing distances with each ZOI, except at the 5 km ZOI under frozen conditions where the alternate pathway moves around the west side of the mine site across Victoria Lake Reservoir. Alternate pathways under frozen conditions are shorter in each ZOI compared to unfrozen conditions because caribou are predicted to travel directly across sections of Granite Lake, Victoria Lake Reservoir, and Red Indian Lake under frozen conditions. In fall, the alternate pathways follow similar routes around the east side of the mine site as the spring predictions for each ZOI and scenario except at the 5 km ZOI under frozen conditions where the alternate pathway moves south across Red Indian Lake and east around the mine site.

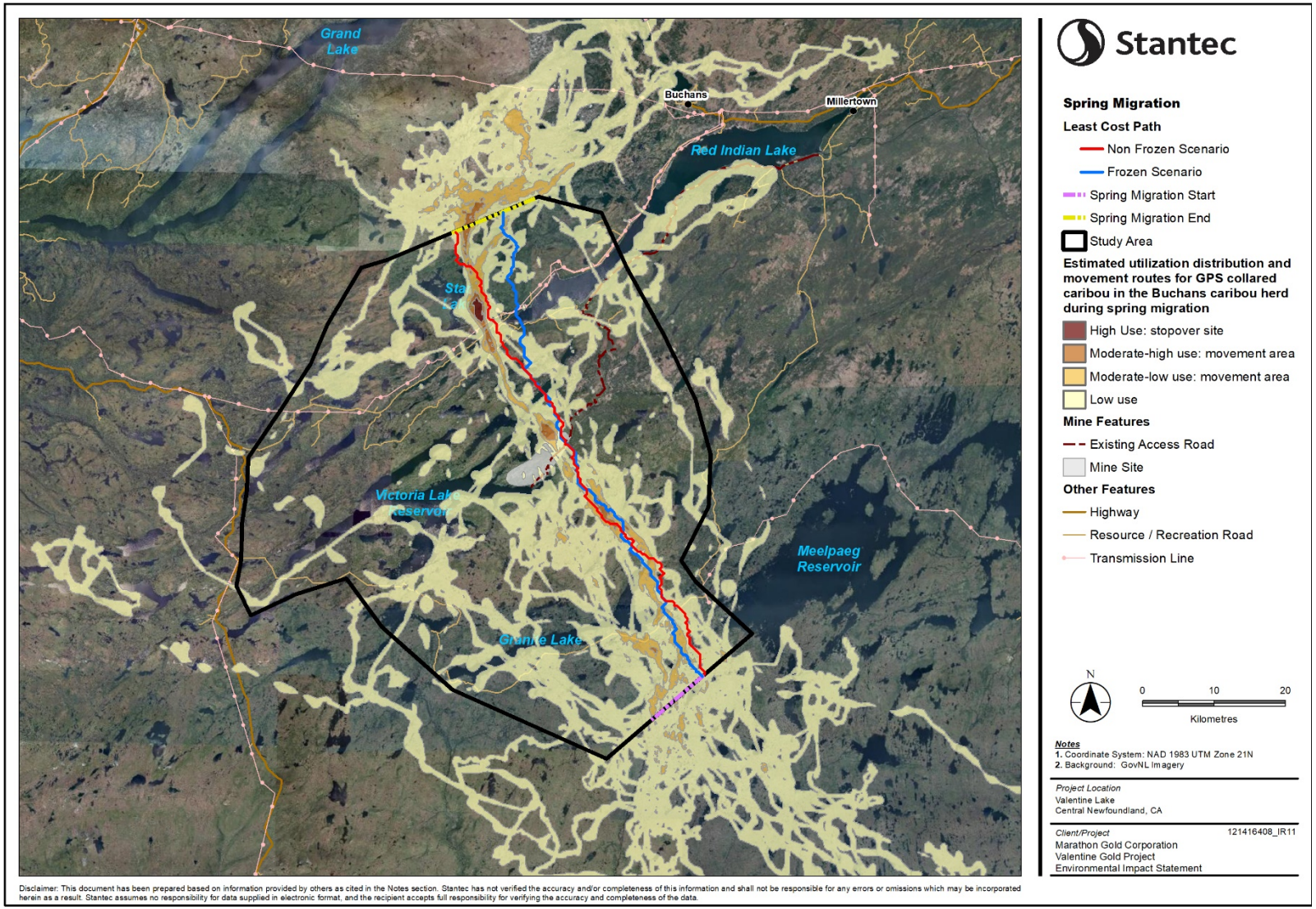

Figure 3-1 Baseline Least Cost Path and dBBMM Routes for the Buchans Herd during Spring Migration

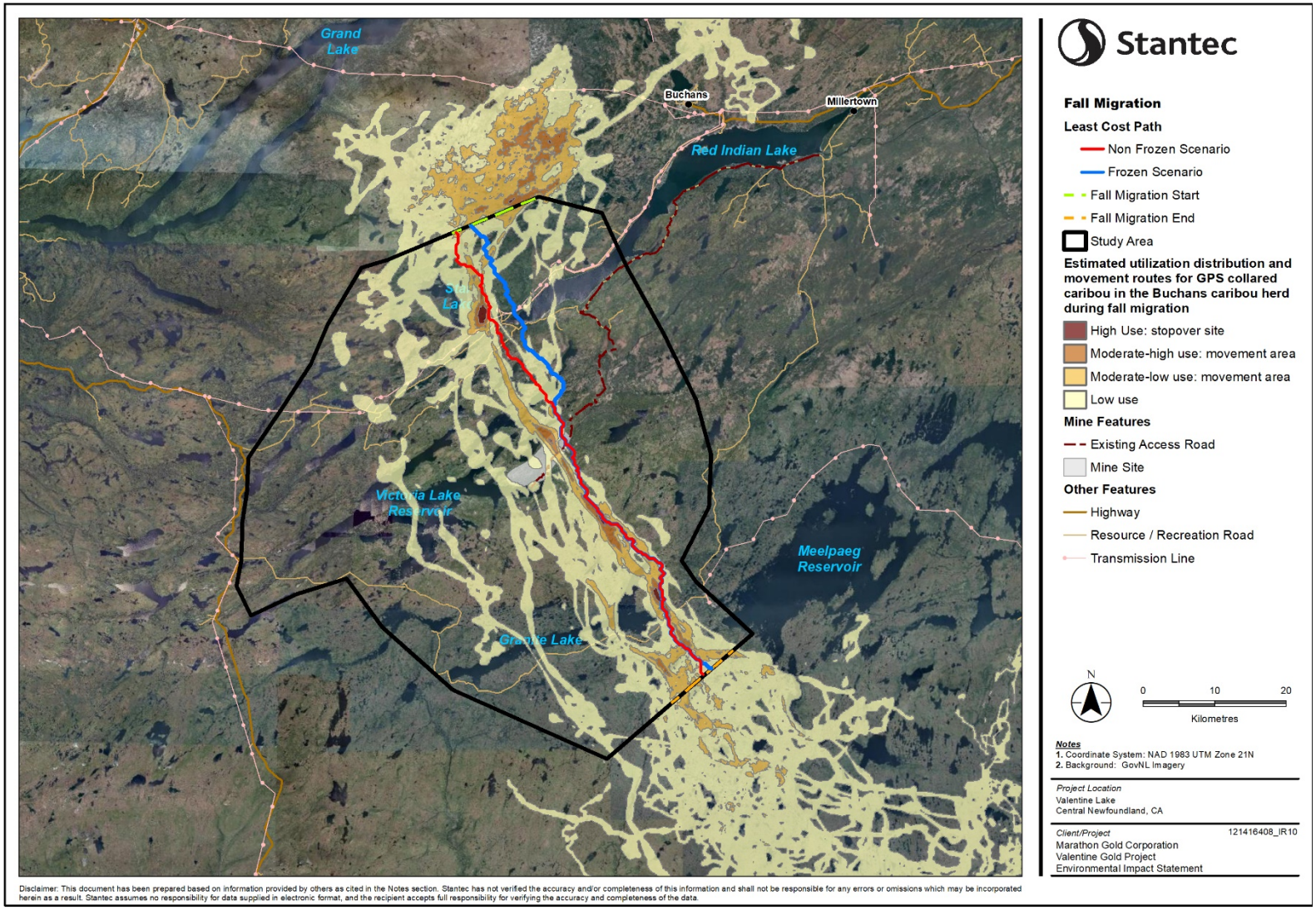

Figure 3-2 Baseline Least Cost Path and dBBMM Routes for the Buchans Herd during Fall Migration

Results

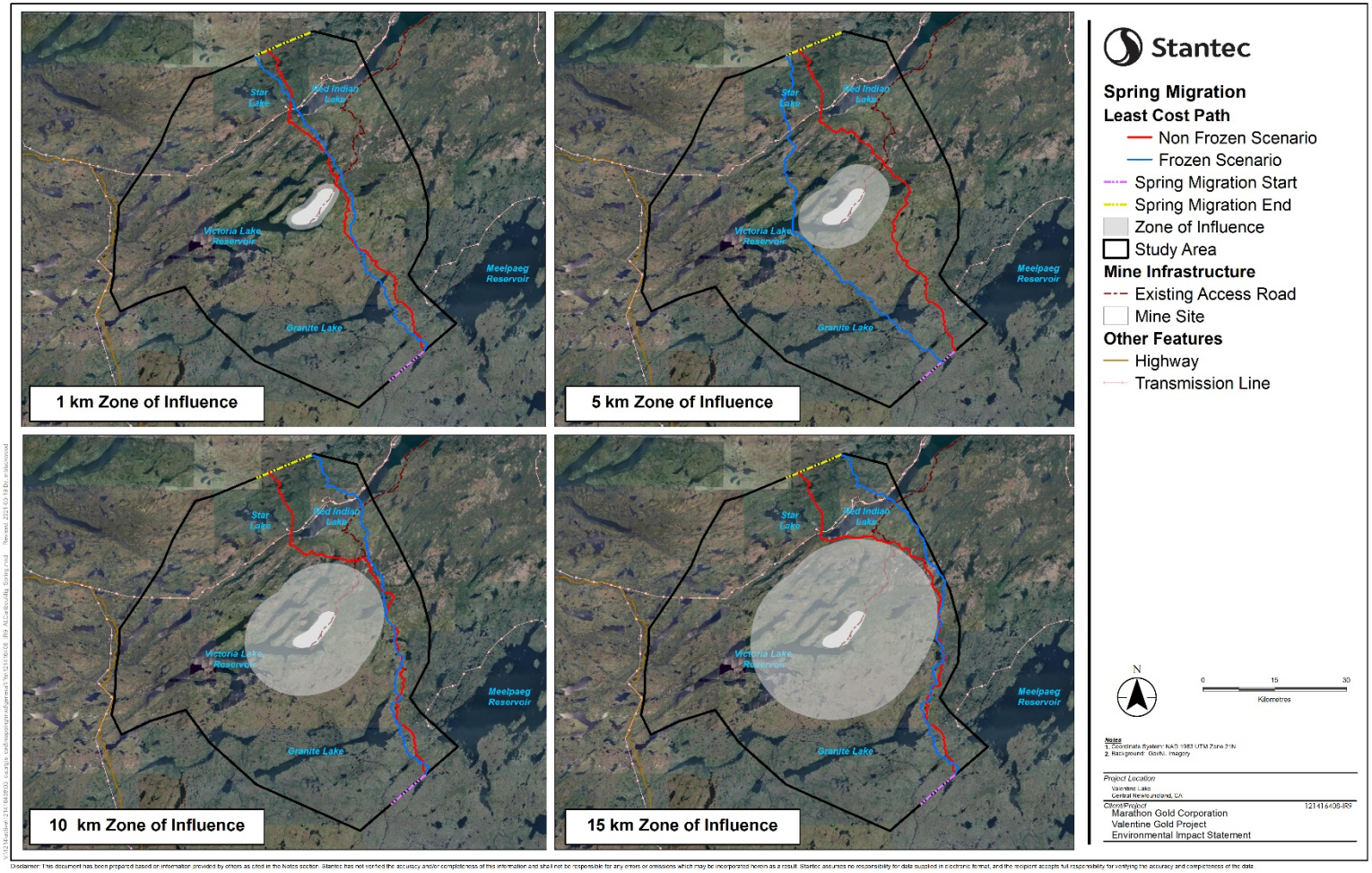

Figure 3-3 Estimated Alternative Migration Pathways for Caribou in the Buchans Herd During Spring Migration Under Frozen and Unfrozen Conditions

Results

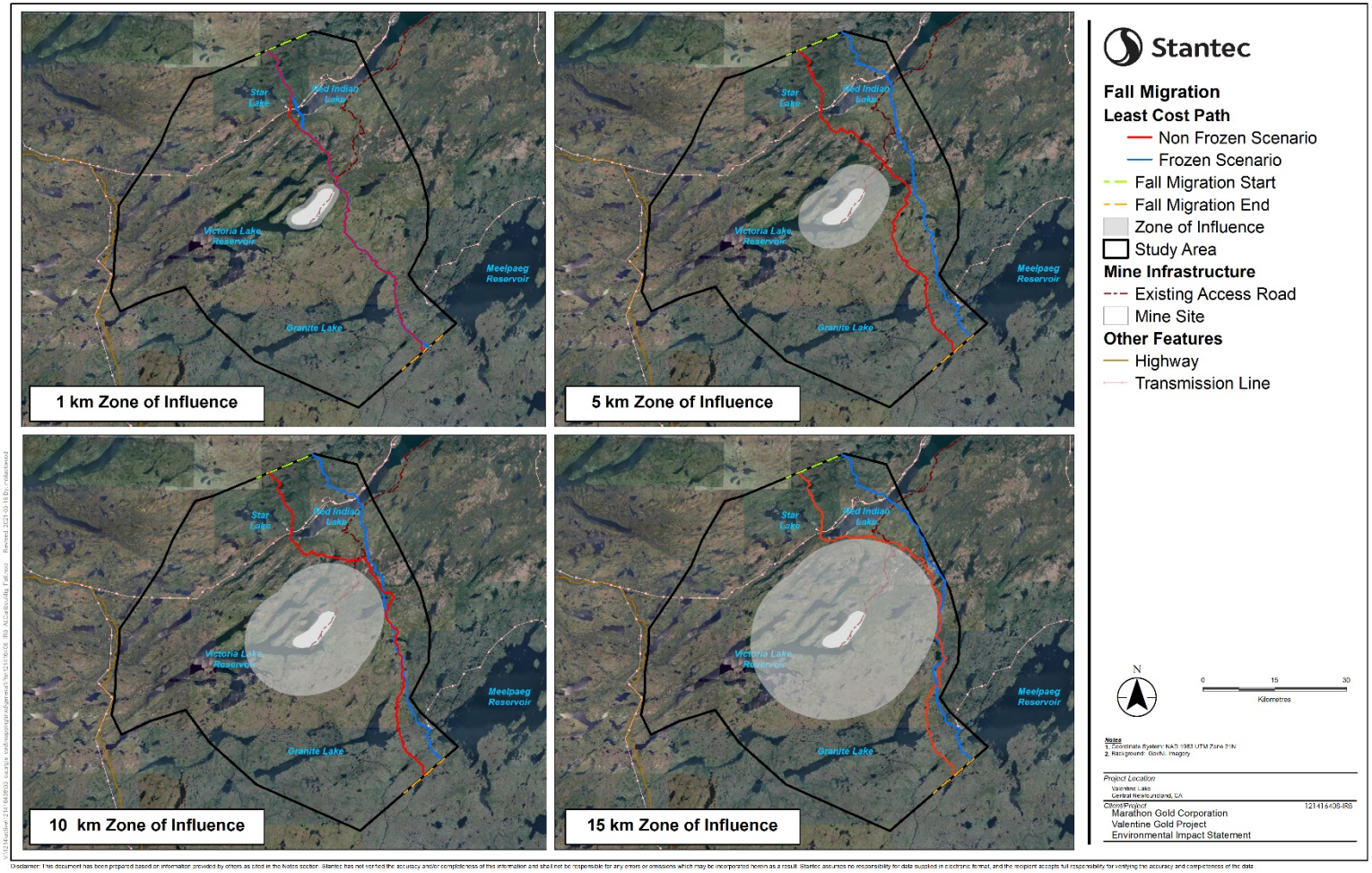

Figure 3-4 Estimated Alternative Migration Pathways for Caribou in the Buchans Herd During Fall Migration Under Frozen and Unfrozen Conditions

The annual length of potential alternate migration pathways under frozen conditions ranged from 169 km (1 km ZOI) to 183 km (15 km ZOI); caribou are predicted to migrate between 0 km and 13 km further than the estimated baseline LCP (Table 3.1). The 1 km ZOI pathways are the same length as the 0 km ZOI pathways but have slightly higher relative costs because the 1 km ZOI pathways traverse habitat types with higher resistance values than the 0 km ZOI pathways. The unitless cost value generated by the analysis ranges from 1.01 times (1 km ZOI) to 1.16 times (15 km ZOI) greater than the baseline LCP.

The length of alternate migration pathways under unfrozen conditions are longer than frozen conditions and ranged from 175 km (1 km ZOI) to 199 km (15 km ZOI); caribou are predicted to travel between 6 km to 30 km further than the estimated baseline LCP (Table 3.1). The unitless cost value generated by the analysis ranges from 1.04 times (1 km ZOI) and 1.41 times (15 km ZOI) greater than the baseline LCP.

Table 3.1 Predicted Annual Migration Length and Relative Cost for each ZOI under Frozen and Unfrozen conditions

ZOI (km)	Annual Migration[1]			
	Frozen		Unfrozen	
	Length (km)	Relative Cost	Length (km)	Relative Cost
0	169	1.00	169	1.00
1	169	1.01	175	1.04
5	176	1.04	184	1.11
10	173	1.05	191	1.18
15	183	1.16	199	1.41

NOTES:
[1] Values for spring and fall LCPs were combined.

The proportion of each habitat type within the potential alternate migratory pathways for each ZOI under frozen and unfrozen conditions is summarized in Table 3.2. The baseline LCP under frozen conditions had the highest proportion of coniferous sparse (45.8%) followed by coniferous open (12.7%), shrub low (8.4%), coniferous dense (8.1%), wetland-shrub (8.1%) and water (5.5%). The baseline LCP under unfrozen conditions had the highest proportion of coniferous sparse (44.7%) followed by coniferous open (13.3%), conifer dense (9.7%), wetland shrub (7.7%), and shrub low (7.4%). Coniferous sparse and coniferous open were the two highest proportions for each ZOI under frozen and unfrozen conditions; the proportion of coniferous sparse decreased with increasing ZOI, and the proportion of coniferous open generally increased with increasing ZOI. The proportion of harvested forest and anthropogenic disturbance increased with increasing ZOI in both frozen and unfrozen conditions. Within all ZOIs during frozen and unfrozen conditions, the relative change in the proportion of coniferous sparse and wetland-treed habitats decreased, and the proportion of mixedwood open and anthropogenic habitats increased compared to the baseline LCP.

Table 3.2 Proportion and Percent Difference of Habitat Types within the LCP Alternate Migration Pathways Relative to the Baseline LCP

Habitat Types	Frozen[1,2]					Unfrozen[1,2]				
	0 km	1 km	5 km	10 km	15 km	0 km	1 km	5 km	10 km	15 km
Coniferous sparse	45.8	44.2 (-3.5)	41.4 (-9.5)	40.7 (-11.1)	39.9 (-12.9)	44.7	43.5 (-2.8)	42.9 (-4.1)	42.9 (-4.1)	38.9 (-13.0)
Coniferous open	12.7	12.2 (-3.8)	13.5 (6.3)	14.9 (17.1)	15.3 (20.8)	13.3	13.2 (-0.8)	13.2 (-1.0)	14.2 (6.1)	15.5 (15.9)
Shrub low	8.4	8.0 (-4.9)	7.6 (-9.7)	7.4 (-12.2)	7.3 (-13.8)	7.3	7.4 (2.2)	7.9 (9.1)	7.8 (7.1)	7.5 (3.3)
Coniferous dense	8.1	10.0 (23.5)	10.4 (28.5)	9.9 (22.7)	10.4 (28.4)	9.7	10.4 (7.2)	8.0 (-17.6)	8.1 (-16.2)	9.7 (0.2)
Wetland-shrub	8.1	8.1 (-0.5)	8.0 (-1.7)	7.4 (-8.1)	8.2 (1.6)	7.7	7.9 (2.3)	8.7 (12.9)	8.1 (4.8)	8.8 (14.2)
Water	5.5	5.9 (9.0)	7.5 (36.8)	7.6 (40.2)	7.0 (28.8)	5.3	4.4 (-18.4)	5.0 (-6.3)	5.3 (-0.6)	3.4 (-36.5)
Exposed land	4.2	4.2 (-0.3)	4.0 (-6.3)	4.0 (-6.5)	4.6 (7.6)	4.3	4.7 (9.1)	5.6 (30.0)	4.6 (6.2)	5.2 (20.1)
Wetland-Herb	2.1	2.1 (-0.9)	2.4 (14.9)	2.6 (22.8)	2.6 (22.8)	1.9	2.1 (7.0)	2.3 (16.4)	2.4 (24.5)	2.6 (36.8)
Mixedwood open	1.0	1.1 (10.3)	1.2 (19.9)	1.3 (27.3)	1.1 (10.0)	0.9	1.0 (4.7)	1.4 (52.0)	1.5 (64.5)	1.4 (48.3)
Wetland-Treed	0.7	0.6 (-14.5)	0.5 (-29.2)	0.5 (-27.7)	0.5 (-30.1)	1.2	0.8 (-34.5)	0.8 (-34.4)	0.7 (-38.4)	0.6 (-50.3)
Rock/Rubble	0.6	0.6 (-7.1)	0.4 (-44.8)	0.2 (-61.1)	0.2 (-64.4)	1.0	1.1 (14.9)	1.2 (22.3)	1.0 (8.0)	1.2 (25.3)
Mixedwood dense	0.6	0.6 (14.3)	0.9 (59.3)	1.0 (79.8)	0.5 (-9.1)	0.6	0.6 (-8.2)	0.8 (22.7)	1.2 (85.8)	0.9 (32.6)
Shrub tall	0.4	0.4 (1.6)	0.3 (-19.9)	0.3 (-38.3)	0.2 (-53.1)	0.4	0.4 (2.4)	0.5 (13.5)	0.5 (14.0)	0.4 (-4.9)
Broadleaf sparse	0.3	0.1 (-46.6)	0.2 (-25.3)	0.2 (-9.7)	0.1 (-48.4)	0.2	0.1 (-21.6)	0.4 (130.2)	0.1 (-14.8)	0.2 (-11.1)
Broadleaf dense	0.2	0.2 (31.1)	0.4 (127.2)	0.5 (185.6)	0.2 (9.6)	0.3	0.2 (-23.3)	0.2 (-17.6)	0.4 (51.7)	0.3 (18.5)
Herb	0.0	0.0 (-36.6)	0.0 (-69.7)	0.0 (-100.0)	0.0 (-74.5)	0.1	0.0 (-88.0)	0.0 (-84.2)	0.0 (-85.2)	0.0 (-100.0)
Broadleaf open	0.0	0.0 (-28.6)	0.0 (-66.0)	0.0 (-100.0)	0.0 (-100.0)	0.1	0.1 (24.8)	0.1 (32.9)	0.1 (24.7)	0.1 (44.7)
Harvested Forest	0.8	0.8 (-0.5)	0.5 (-33.3)	0.8 (-5.2)	1.2 (50.7)	0.4	1.3 (259.6)	0.3 (-18.8)	0.2 (-44.4)	1.5 (335.6)
Anthropogenic	0.5	0.7 (49.9)	0.8 (73.2)	0.6 (37.3)	0.6 (41.9)	0.6	0.9 (48.1)	0.8 (31.6)	0.8 (40.9)	1.8 (209.9)
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

NOTES:

1 Values for spring and fall LCPs are combined.

2 Each cell contains a pair of values: the first value is the proportion of that habitat type, and the second value in parenthesis is the percent difference relative to baseline (i.e., 0 km).

The proportions of habitat types within the baseline and alternate migratory pathways from the LCP analyses (Table 3.2) were compared to proportions of habitat types selected within the main movement pathways from the dBBMM (Table 2.1). Conifer sparse was the habitat type with the highest proportion in the LCP analyses and dBBMM models; the LCP analyses produced paths with higher proportions of coniferous open and coniferous dense whereas the dBBMM model had higher proportions of wetland-shrub, water, and exposed land.

4.0 DISCUSSION

The LCP analysis provides conservative estimates of potential alternate migratory pathways that may be used by the Buchans herd if the Project proceeds. The results are conservative because the analyses assume that caribou will completely avoid the mine site and each ZOI tested (i.e., 1 km, 5 km, 10 km, and 15 km). The estimated increase in annual migration pathway length ranges from 0 km to 30 km and the estimated associated cost is 1.01 to 1.41 times greater than baseline. Alternate migratory pathways are likely to exist within the ZOIs as individual caribou may show varying degrees of avoidance of the Project. In other words, the ZOIs may not be complete barriers to all migrating caribou, and some caribou may choose to migrate closer to the mine site than others. For example, Plante et al. (2018) determined that caribou avoid mine sites by varying degrees, with some individuals having a 3 km ZOI and other individuals having a 21 km ZOI.

Most potential alternate migratory pathways under different ZOIs were predicted to navigate around the east side of the mine and across the mine access road; one path moved west around the mine site across Victoria Lake Reservoir based on frozen conditions. The length of alternate migration paths may be influenced by the amount of ice present on waterbodies within the Study Area, and whether caribou choose to swim across or circumnavigate open waterbodies. Baseline LCPs and alternate migratory pathways traversed primarily open habitats comprised of coniferous forest, shrub low, and wetland-shrub types. The decrease in coniferous sparse habitat with increasing ZOI suggests alternate migratory pathways contain habitat types that are less suitable for migration, which could ultimately cause a change in caribou recruitment or survival either through energetic constraints (shortages) or increased mortality risk if predators prefer habitat types that caribou would typically avoid.

LCP analyses are built upon a set of assumptions regarding the processes that influence animal movement (Sawyer et al. 2011; Chetkiewicz and Boyce 2009). Resistance values are intended to represent the suite of factors that may influence animal movement across a landscape (Adriaensen et al 2003). The strength of LCP analyses depends on the data used to inform the resistance values; constraints in the availability of data can influence the biological realism of model outputs. In this analysis, resistance values were derived from empirical data on habitat types selected by collared caribou from the Buchans herd within their migratory pathway. The LCP analyses assume that habitat types with a higher probability of selection along the current migration route afford lower costs to movement compared to habitat types within low-use migration pathways, or paths that were not used at all.

Differences in the location and habitat type proportions between the baseline LCP and the main movement pathways from the dBBMM can be explained by differences in model assumptions and

parameterization. The LCP analysis is a movement model that predicts a single optimal path between the seasonal grounds based on resistance values; the dBBMM analyzes telemetry data from collared caribou and provides a probabilistic estimate of animal occurrence between locations to identify a collection of individual movement paths that connect to high use areas (migratory stopovers) where caribou stop to forage and rest (Marathon 2020). Because the purpose of this analysis was to model caribou movement, the LCP resistance values were informed by the habitat types selected by caribou within the main movement pathways (25-50% and 50-75% quartiles) from the dBBMM; habitat values within the migratory stopover sites were not used to inform the LCP resistance values. This approach to the LCP analyses could explain why the baseline LCP does not intersect with the two stopover areas identified within and north of the Project Area. In addition, the LCP selects the most direct route with the lowest cost between locations.

As discussed in the EIS, Project effects resulting in a change in movement for the Buchans herd are predicted to be irreversible, high in magnitude, and long term in duration due to the overlap of the Project Area with the main migration corridor (Marathon 2020). The LCPs identified in this analysis provide data-driven estimates of potential alternate migratory routes. These potential alternate routes do not imply that caribou will successfully reach their seasonal grounds, as alteration to the migration route due to Project activities could result in changes to the timing of movement or movement rate and increase in energetic costs, which may ultimately cause a change in recruitment or survival.

Mitigation measures will be implemented to reduce adverse effects on caribou movement such as reducing the potential size of the ZOI by limiting mining activities during the migration period, and facilitating caribou crossing along snowbanks or ditches along potential alternate routes (Marathon 2020). The migration analyses could be refined through ongoing monitoring of collared caribou, including monitoring more individuals, to further understand the caribou movement response if the Project proceeds.

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