5-F: Addendum Caribou Incremental and Cumulative Encounter Rates for Expansion Project

Appendix 5-F - Caribou Incremental and Cumulative Encounter Rates

Whale Tail Pit - Expansion Project

Submitted to:

Nunavut Impact Review Board

Submitted by:

Agnico Eagle Mines Limited – Meadowbank Division

Prepared by:

Golder Associates Ltd.

Appendix 5-F Caribou Encounter

1896037

November 2018

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TABLES

FIGURES

5-F-1 INTRODUCTION

During the April 28 to May 2, 2017 Technical Session for the Whale Tail Project (Approved Project), additional summary of caribou encounters with development zones of influence (ZOIs) and residency time within ZOIs was requested by the Kivalliq Inuit Association (KivIA) and the Government of Nunavut (GN). Agnico Eagle Mines Limited (Agnico Eagle) made commitments (numbers 9, 10) to provide this analysis for the Beverly, Ahiak, Lorillard, and Wager Bay caribou herds on their spring, fall, and winter seasonal ranges (Golder 2017). The results of Golder (2017) showed that very few Ahiak and Beverly collared caribou interact with the Approved Project. For the Expansion Project, only collar data from the Lorillard and Wager Bay herds were used because these herds showed the highest potential to interact with Approved Project and Expansion Project. This approach provides a conservative assessment of simulated development ZOI encounters and residency times. The methods and results of collared caribou cumulative encounters and residency times with development ZOIs are provided in the following sections.

5-F-2 METHODS

5-F-2.1 Collar Data

Since 1996, satellite telemetry has been used to describe movements of numerous barren-ground caribou herds across their annual ranges. For many of the herds in Nunavut and Northwest Territories, initially as few as four transmitting collars were deployed in 1996, after which time the number of collars has varied among years (Table 1). In general, the caribou satellite data were based on a duty cycle that varied from every approximately 7 days to every 1 day, and became more frequent during more recent years.

Starting in 2006, transmitters were also programmed to transmit at 1-day intervals to better describe post-calving movements. In 2009, the frequency of locations was increased to approximately every three hours during the summer to autumn period. When multiple locations were obtained for an individual caribou during a single day, the best location each day was used as classified by on-board collar software. To support the analyses requested by KivIA and GN, the GN committed to provide Agnico Eagle with collar data for the Ahiak, Beverly, Lorillard, and Wager Bay caribou herds. The analysis completed during the Approved Project regulatory process demonstrated that the ranges for Ahiak and Beverly collared caribou do not overlap with the Approved Project. Thus, for comparison with the Expansion Project, only Lorillard and Wager Bay collared caribou were used. On behalf of the GN, Caslys Consulting Ltd. (Caslys) provided collar location data for the Lorillard (1998 to 2018) and Wager Bay (1999 to 2018) herds and seasonal range definitions (Table 2). The number of collars available varies seasonally, annually and by herd due to collaring effort, mortality, and battery longevity.

Within a Geographic Information System (GIS) platform, movement paths were created per animal, season and year by joining sequences of successive locations for each herd. Because the frequency of satellite collar locations has increased during the last eight years, the number of segments (distance intervals or partial paths) between successive locations for each animal has also increased.

Table 1: Available Number of Collared Caribou per Year, Season, and Herd

Year	Spring		Fall		Winter	
	Lorillard	Wager Bay	Lorillard	Wager Bay	Lorillard	Wager Bay
1998	1	-	2	-	1	-
1999	2	-	8	1	2	-
2000	7	1	9	6	7	1
2001	9	6	7	4	9	6
2002	7	4	10	3	7	4
2003	10	3	12	12	10	3
2004	12	11	9	10	12	11
2005	8	8	3	3	8	8
2006	3	3	-	1	3	3
2007	-	1	-	-	-	1
2008	-	-	-	-	-	-
2009	-	-	-	1	-	-
2010	-	1	-	1	-	1
2011	-	1	8	2	-	1
2012	8	2	5	1	8	2
2013	5	1	5	-	5	1
2014	5	-	2	-	5	-
2015	2	-	5	2	2	-
2016	5	2	12	6	5	2
2017	12	5	6	3	12	5
2018	19	11	-	-	5	3

Table 2: Seasonal range length for the Lorillard and Wager Bay Caribou Herds Considered in the Assessment

Herd	Spring (days)	Fall (days)	Winter (days)
Lorillard	Apr 5 to May 28 (53)	Sep 22 to Dec 15 (115)	Dec 16 to Apr 4 (109)
Wager Bay	Apr 1 to May 29 (58)	Sep 22 to Dec 15 (115)	Dec 16 to Mar 31 (105)

5-F-2.2 Cumulative Effects Scenarios

Sources of information on the location and duration of known past and existing and potential future developments, such as permit inventories and contaminated sites, were used to create development scenarios in combination with assumed ZOIs for different development types (Table 3). Point disturbances originated from spreadsheet databases of land use permits (except for campgrounds, contaminated sites, mines, and parks), so the locations are not precise. While land use permits are generally issued for five-year spans, information on the duration or seasonality of activity within that five years (or if development proceeded at all) is not recorded by any agency in the NWT or Nunavut. Thus, it was assumed that all developments were active throughout the entire year for all five years following issuance, with the exception of winter roads, which were assumed to be active only in winter. Because permit data does not describe the footprint of developments, the physical area of the footprint was assumed

(Table 3). Linear disturbances originated from Nunavut Planning Commission permitting information and CanVec. Actual footprints (polygons) were used for mines and communities.

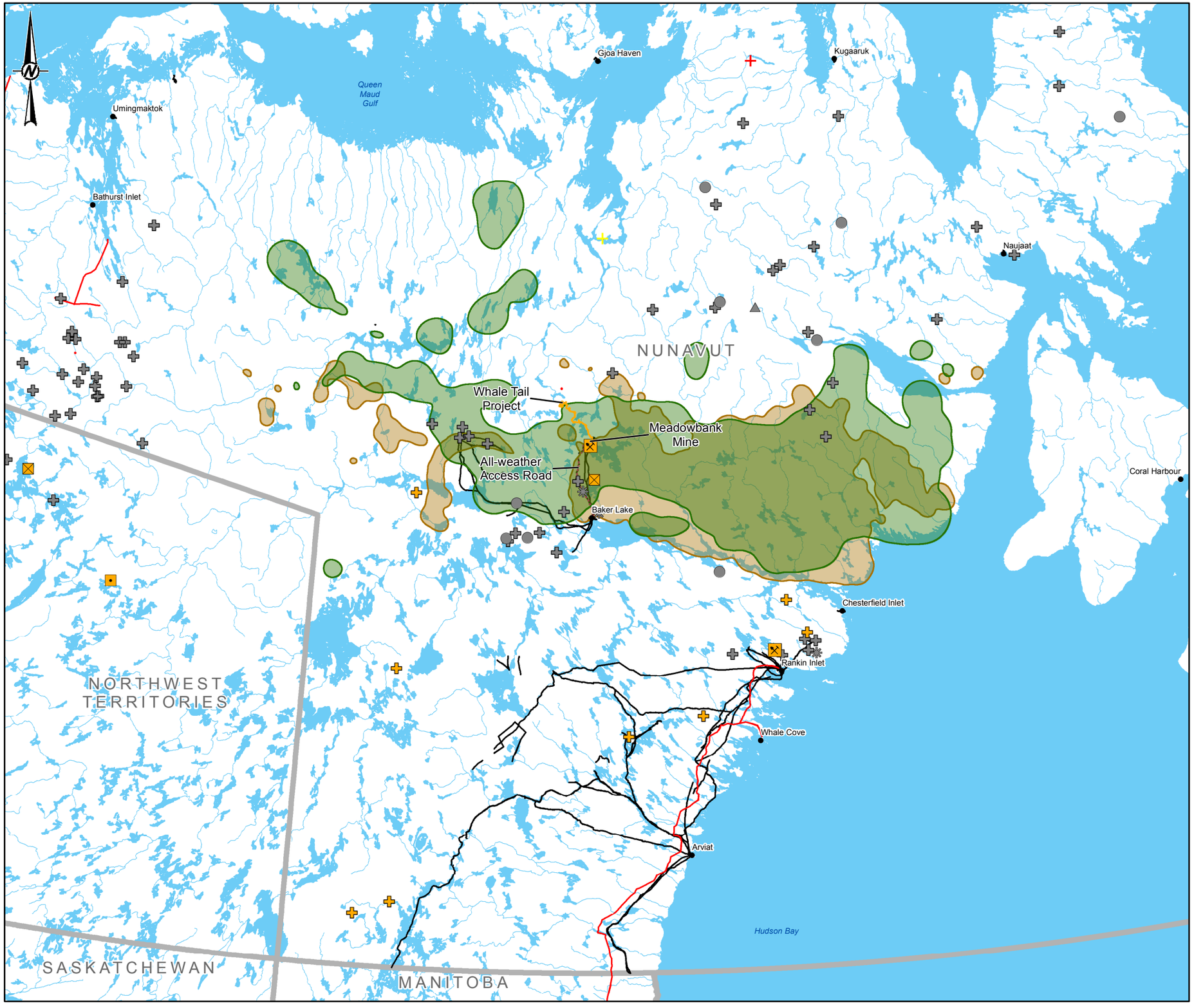
Table 3: Types of Developments, Footprints and Assumed Zones of Influence in the Assessment

Development Type	Feature Type	Footprint Buffer (m)	Zone of Influence (km)
Camp	point	25	1
Community	polygon	actual	15
Contaminated Site, High	point	200	0
Contaminated Site, Med	point	200	0
Fuel Storage	point	25	0
Mine	polygon	actual	15
Mineral Exploration	point	500	5
Miscellaneous	point	25	1
Quarrying	point	25	5
Research Projects	point	25	1
Territorial Campground	point	25	1
Tourism/Caribou Hunting & Fishing	point	25	5
Tourism/Fishing	point	25	5
All-Season Road	line	20	5
Winter Road	line	20	5

Reasonably Foreseeable Developments

Cumulative effects assessment should include all other human activities that affect the environment, including past, present, and reasonably foreseeable future projects (MVEIRB 2004). Although there is uncertainty in predicting which projects proceed to development, it is a necessary exercise to investigate possible future scenarios from a cumulative effects perspective.

For the purposes of this assessment, it is assumed that each of the reasonably foreseeable developments (RFDs) listed below are carried forward to full development, and their effects have spatial and temporal overlap with effects from the Project. Seasonal ranges were based on 95% kernel density estimates (KDE) for each herd and season (see Table 2). The seasonal KDEs were based on the default search radius, which has been shown to overestimate range (Gitzen and Millspagh 2003; Gitzen et al. 2006) and so was used as a conservatism to maximize cumulative effects. The number and type of RFDs in each seasonal range are shown in Figures 1 to 8. Note that for projects that have not yet been developed, locations have been estimated from publicly available information.



LEGEND

- POPULATED PLACE

PAST AND PRESENT DEVELOPMENTS

- CAMP, INACTIVE
- CONTAMINATED SITE, HIGH
- CONTAMINATED SITE, MEDIUM
- FUEL STORAGE, INACTIVE
- MINE, ACTIVE
- MINERAL EXPLORATION, ACTIVE
- MINERAL EXPLORATION, INACTIVE
- MISCELLANEOUS, INACTIVE
- QUARRYING, INACTIVE
- TOURISM/CARIBOU HUNTING & FISHING, ACTIVE
- TOURISM/FISHING, ACTIVE
- ALL-WEATHER ACCESS ROAD
- ALL-SEASON ROAD
- WINTER ROAD
- WATERCOURSE
- LORILLARD CARIBOU SPRING SEASONAL RANGE
- LORILLARD CARIBOU FALL SEASONAL RANGE
- BASE DEVELOPMENTS
- PROJECT DEVELOPMENT
- RFD DEVELOPMENT
- PROVINCIAL/TERRITORIAL BOUNDARY
- WATER BODY

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REFERENCE(S)

1. BASE DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
DATUM: NAD 83 PROJECTION: CANADA LAMBERT CONFORMAL CONIC

CLIENT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED:
MEADOWBANK DIVISION

PROJECT

WHALE TAIL PIT - EXPANSION PROJECT

TITLE

DEVELOPMENT IN THE SPRING AND FALL RANGES FOR THE LORILLARD HERD

CONSULTANT

GOLDER

YYYY-MM-DD	2018-11-05
DESIGNED	DC
PREPARED	ANK
REVIEWED	DC
APPROVED	CD

PROJECT NO.	PHASE	REV.	FIGURE
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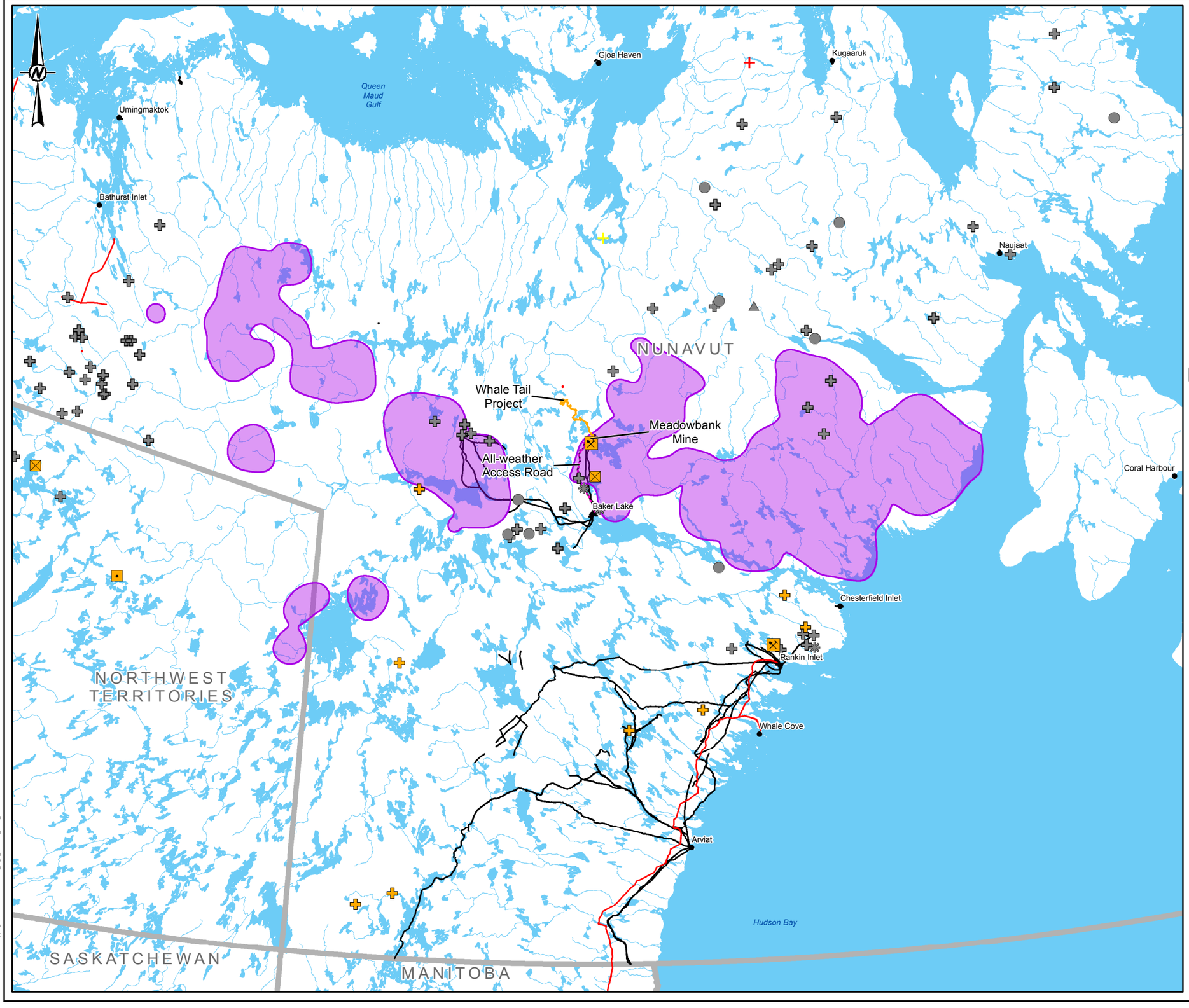

LEGEND

- POPULATED PLACE

PAST AND PRESENT DEVELOPMENTS

- CAMP, INACTIVE
- CONTAMINATED SITE, HIGH
- CONTAMINATED SITE, MEDIUM
- FUEL STORAGE, INACTIVE
- MINE, ACTIVE
- MINERAL EXPLORATION, ACTIVE
- MINERAL EXPLORATION, INACTIVE
- MISCELLANEOUS, INACTIVE
- QUARRYING, INACTIVE
- TOURISM/CARIBOU HUNTING & FISHING, ACTIVE
- TOURISM/FISHING, ACTIVE
- ALL-WEATHER ACCESS ROAD
- ALL-SEASON ROAD
- WINTER ROAD
- WATERCOURSE
- LORILLARD CARIBOU WINTER SEASONAL RANGE
- BASE DEVELOPMENTS
- PROJECT DEVELOPMENT
- RFD DEVELOPMENT
- PROVINCIAL/TERRITORIAL BOUNDARY
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AGNICO EAGLE

AGNICO EAGLE MINES LIMITED:
MEADOWBANK DIVISION

PROJECT

WHALE TAIL PIT - EXPANSION PROJECT

TITLE

DEVELOPMENT IN THE WINTER RANGE FOR THE LORILLARD HERD

CONSULTANT

GOLDER

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PREPARED	ANK
REVIEWED	DC
APPROVED	CD

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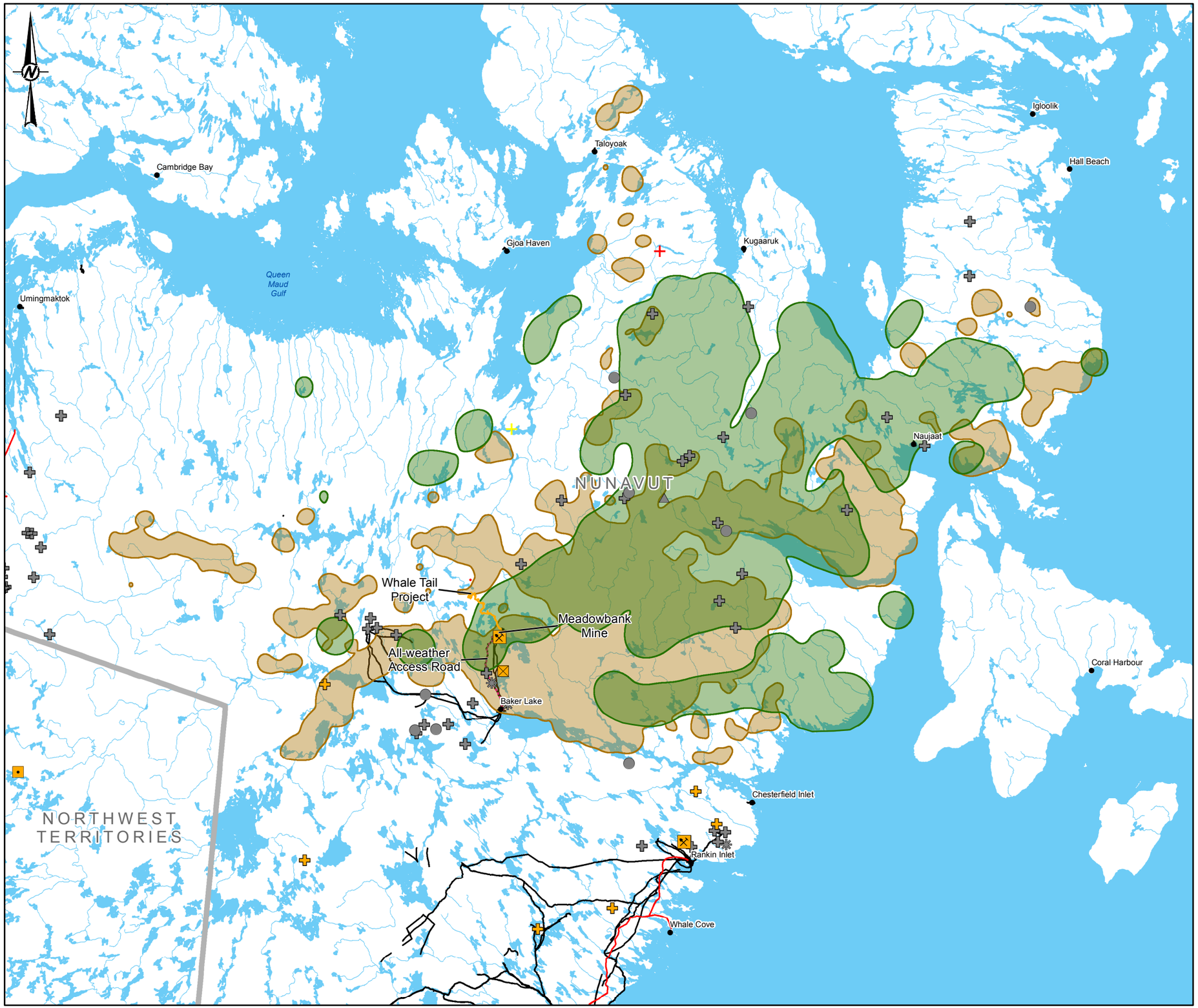

LEGEND

- POPULATED PLACE

PAST AND PRESENT DEVELOPMENTS

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- MINERAL EXPLORATION, INACTIVE
- MISCELLANEOUS, INACTIVE
- QUARRYING, INACTIVE
- TOURISM/CARIBOU HUNTING & FISHING, ACTIVE
- TOURISM/FISHING, ACTIVE
- ALL-WEATHER ACCESS ROAD
- ALL-SEASON ROAD
- WINTER ROAD
- WATERCOURSE
- WAGER BAY CARIBOU SPRING SEASONAL RANGE
- WAGER BAY CARIBOU FALL SEASONAL RANGE
- BASE DEVELOPMENTS
- PROJECT DEVELOPMENT
- RFD DEVELOPMENT
- PROVINCIAL/TERRITORIAL BOUNDARY
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AGNICO EAGLE MINES LIMITED:
MEADOWBANK DIVISION

PROJECT
WHALE TAIL PIT - EXPANSION PROJECT

TITLE
DEVELOPMENT IN THE SPRING AND FALL RANGES FOR THE WAGER BAY HERD

CONSULTANT
GOLDER

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REVIEWED	DC
APPROVED	CD

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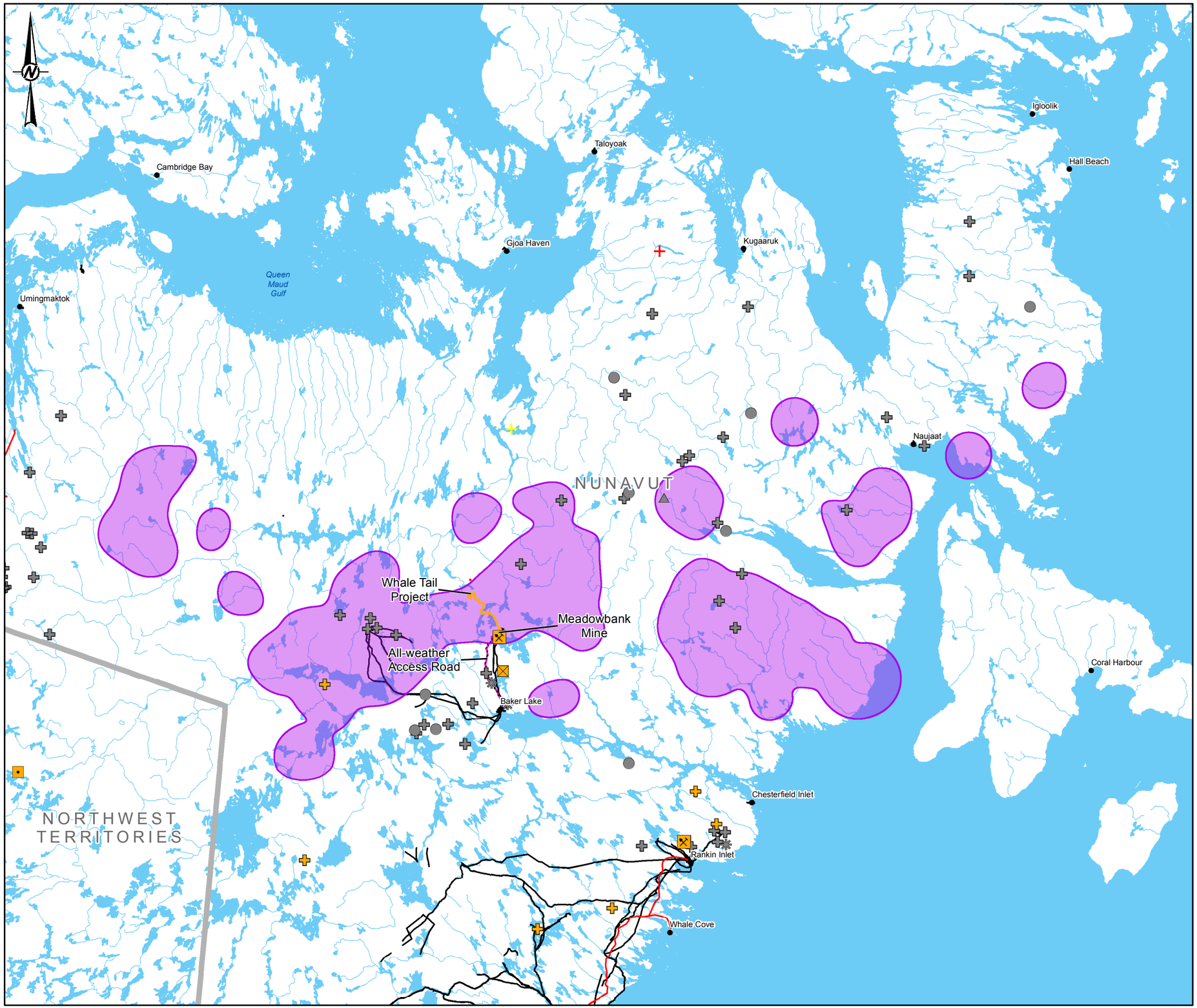

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AGNICO EAGLE

AGNICO EAGLE MINES LIMITED:
MEADOWBANK DIVISION

PROJECT

WHALE TAIL PIT - EXPANSION PROJECT

TITLE

DEVELOPMENT IN THE WINTER RANGE FOR THE WAGER BAY HERD

CONSULTANT

GOLDER

YYYY-MM-DD	2018-11-05
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PREPARED	ANK
REVIEWED	DC
APPROVED	CD

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Zone of Influence Encounters and Residency Time

The movement paths of each collared caribou were combined with the development layer database and associated assumed ZOIs for different types of development (Table 3). The analysis was executed each year of the study so that a caribou movement path would only have the potential to intersect the ZOIs from developments that were determined to be present and active during a given year (e.g., active mine sites and exploration permits) from 1996 to 2018. The baseline included two scenarios representing previous and existing developments (Base Case) and the Meadowbank Case (Base Case+Meadowbank). The Meadowbank Mine and associated All-weather Access Road (AWAR) were isolated from the Base Case to determine the incremental encounters and residency times associated with these specific developments. In addition, movement paths from 1996 to 2018 were used to forecast the encounter rate and residency time for the Approved Project Case (Meadowbank Case+Whale Tail Approved Project), Expansion Project Case (Meadowbank Case+Whale Tail Approved Project+Expansion Project) and RFD Case (Expansion Project Case+RFDs) for future projects not currently on the landscape. The temporal structure of these scenarios allows the incremental effects between development cases to be estimated. These include the incremental effects of the Meadowbank Mine and AWAR, Approved Project and Expansion Project to be determined from the relative difference between the Meadowbank and Base cases and the Approved Project and Meadowbank cases and the Expansion Project and Approved Project cases, respectively. The application of Expansion Project to the development landscape does not change either the Base Case of Meadowbank Case because these are restricted to previous and existing developments and are unnecessary to compare Expansion Project with Approved Project. As noted above in the development Case definitions, previous and existing developments are included in the Approved Project, Expansion Project and RFD cumulative development scenarios. As well, since the assumed ZOI did not overlap with future developments ZOIs in the RFD Case, the cumulative effects of this scenario are simply increased by the incremental effect of Expansion Project. For this reason, it is unnecessary to present this change graphically but cumulative ZOI encounters and residency times are provided in results.

The analysis was used to calculate the residency time of female caribou in ZOIs, and the encounter rates with ZOIs. Specifically, the percentage of days that caribou resided within ZOIs (i.e., residency time) of the total possible days during the exposure period (see Table 2 for seasonal exposure periods) was calculated for each individual female movement path. It was assumed that for each day in a ZOI, an animal was exposed to one disturbance event, regardless of how close it was to a development footprint or activity. To complement residency times, the number of animal encounters with ZOIs during the exposure period was also calculated for each female movement path. It was assumed that each time an animal entered a ZOI, the animal was exposed to one disturbance event (also independent of distance to disturbance). Where ZOIs of different developments overlapped they were not dissolved into a single ZOI. This meant that caribou interaction with both ZOIs were counted as two encounters as a conservatism to overestimate effects. This is a conservative approach in that the magnitude of effects in the ZOI would be expected to decrease with increasing distance from the footprint and/or activity.

5-F-3 RESULTS

5-F-3.1 Encounter Rates

5-F-3.1.1.1 Lorillard Herd

Spring Migration

Caribou paths monitored over 17 study years from 1998 to 2018 (no collar data from 2007 to 2010) were used to calculate the number of caribou encounters with ZOIs. The number of collared individuals ranged from two caribou in 1998 and 2006 to 15 caribou in 2016. The number of paths ranged from 17 paths in 1998 to 2,870 paths in 2016 for a total of 7,174 in spring.

Caribou residency times (i.e., percent time in ZOI) and encounter rates during spring migration were highly correlated with each other (Pearson r = 0.90, P <0.01) (see Section 5-F-3.2.1.1). During Base Case conditions, annual mean encounter rates ranged from no encounters per 53 days for 10 of the study years (1998 to 2002, 2012 to 2014, 2016, and 2017) to 0.5 encounters per 53 days in 2006. Mean annual encounter rates in the Base Case were low and moderately variable (mean = <0.1, SD = 0.1), and do not suggest a declining or increasing temporal trend.

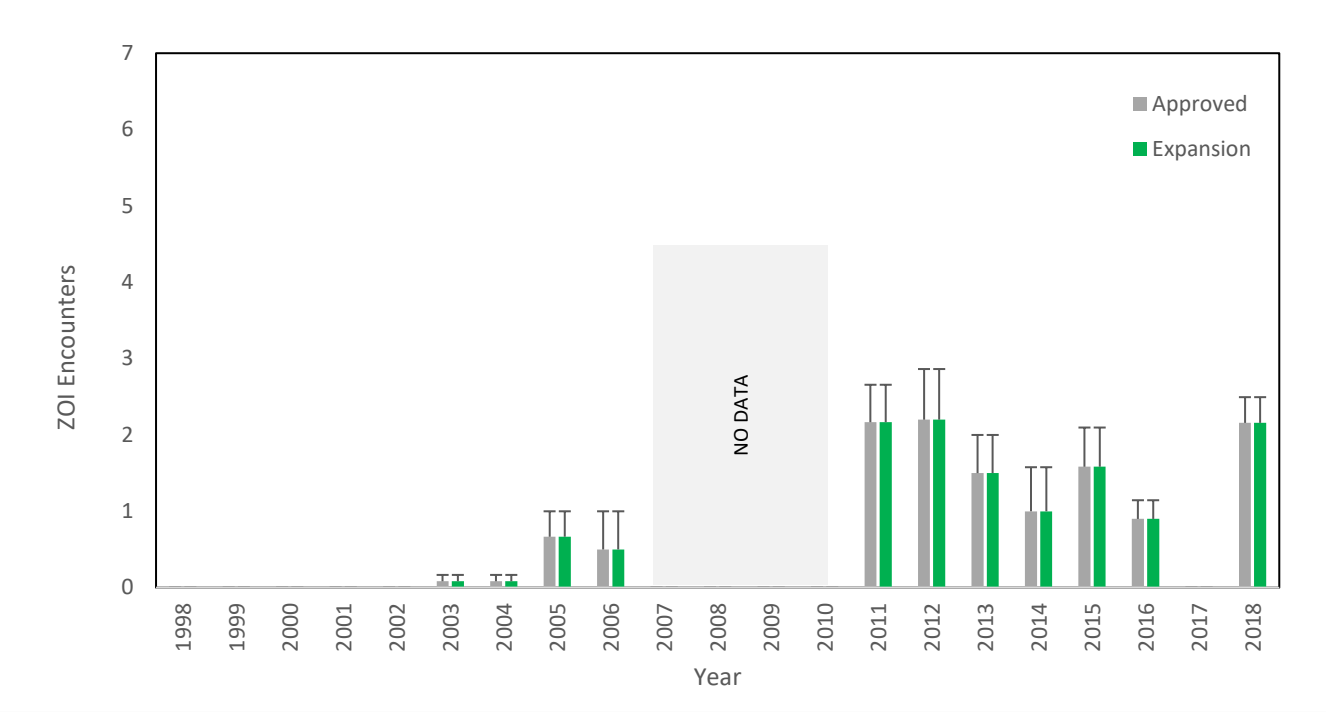
With the addition of the Meadowbank Mine and the AWAR to the spring range, the number of additional encounters ranged from no change for 1998 to 2006, and for 2017, to an increase of 1.4 encounters in 2011 per 53 days relative to the Base Case. Simulations indicated an overall annual average of 0.3 additional encounters per 115 days (SD = 0.5) relative to the Base Case

Under the Approved Project Case for the spring range, the number of additional encounters ranged from no change for 1996 to 2004, 2006, and 2017, to an increase of 2.2 encounters in 2012 relative to the Base Case. Simulations for the Approved Project Case in spring projected an annual average of 0.3 additional encounters per 53 days (SD = 0.4) relative to the Meadowbank Case. The updated results for spring 2018 collar data indicated an average of 2.2 cumulative encounters. Relative to the Approved Project Case, the Expansion Project Case indicated no additional encounters (Figure 5).

Annual encounter rates for the spring migration increased over time under conditions for the Meadowbank, and Approved Project cases. For example, under the Approved Project Case, higher encounters were noted for the period of 2011 to 2017 (mean = 1.3) versus the period of 1998 to 2006 (mean = 0.15).

The projected cumulative encounter rate with ZOIs in spring through the RFD Case was higher than the Base and Approved Project cases. Using movement data from 1998 to 2018, the simulated number of annual mean encounters ranged from 0.1 to 2.3, and averaged 0.7 (SD = 0.8) across study years.

Figure 5: Temporal Trend in Mean Encounter Rates (± SE) During Spring migration with Zones of Influence for Female Caribou in the Lorillard Herd from 1998 to 2018 for the Approved Project Case and Expansion Project Case



Fall Migration

Caribou paths monitored over 16 study years from 1998 to 2017 (no collar data 2006 to 2010) were used to calculate the number of caribou encounters with ZOIs. The number of collared individuals ranged from two caribou in 1998 and 2014 to 12 caribou in 2003 and 2016. The number of paths ranged from 34 paths in 1998 to 5,620 paths in 2016 for a total of 10,988 in fall.

Caribou residency time (i.e., percent time in zones of influence) and encounter rates during fall migration were highly correlated with each other (Pearson r = 0.97, P <0.01) (see Section 5-F-3.2.1.1). During Base Case conditions, annual mean encounter rates ranged from no encounters per 115 days for eight of the study years (1998 to 2002, 2005, 2013, and 2014) to 1.6 encounters per 115 days in 2012. The mean annual encounter rate in the Base Case was low and highly variable (mean <0.1, SD = 0.4), and do not suggest a strong declining or increasing temporal trend.

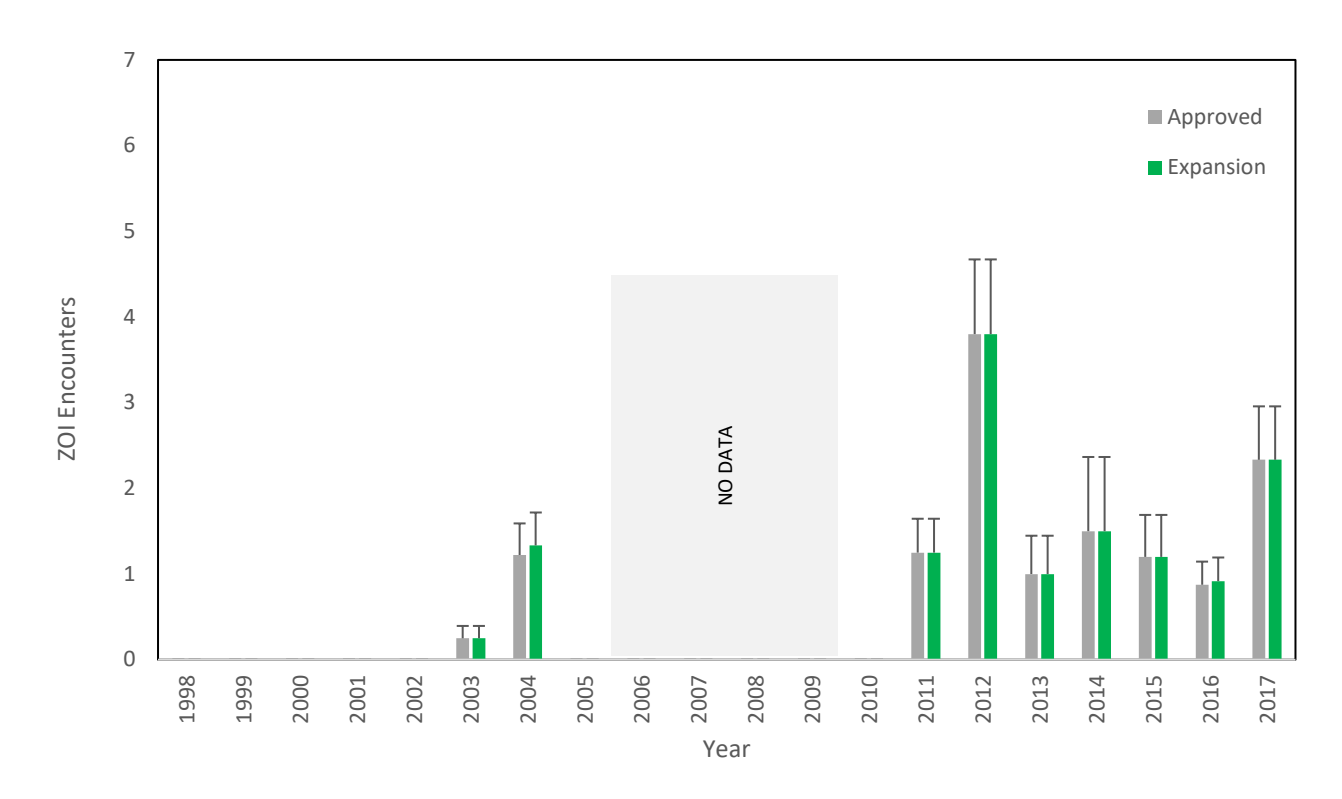
With the addition of the Meadowbank Mine and the AWAR to the fall migration range, additional encounters ranged from no change for 1998 to 2005 to an increase of 2.2 encounters in 2012 per 115 days relative to the Base Case. Simulations for the Meadowbank Case indicated an annual average of 0.4 additional encounters per 115 days (SD = 0.6) relative to the Base Case.

Under conditions of the Approved Project Case, additional encounters ranged from no change for 1998 to 2002, 2005, 2012, 2015, and 2016 to an increase of 1.3 encounters in 2004 per 115 days relative to the Meadowbank Case. Simulations for the Approved Project Case projected an annual average of 0.3 additional encounters per 115 days (SD = 0.4) relative to the Meadowbank Case. The updated results using fall 2017 collar data indicated no cumulative encounters. Relative to the Approved Project Case, the Expansion Project Case indicated an additional 0.1 encounters in 2004 and less than 0.1 encounters in 2016 (Figure 6).

Annual encounter rates for the fall migration increased over time under conditions for the Meadowbank and Approved Project cases. For example, under the Approved Project Case, higher encounters were noted for the period of 2011 to 2017 (mean = 1.6) versus the period of 1998 to 2005 (mean = 0.2). Results for the Expansion Project Case show an incremental increase of 0.1 in 2004 and less than 0.1 in 2016 and the same pattern in all other years (Figure 6).

The projected cumulative encounter rate with ZOIs in fall migration through the RFD Case was higher than the Base, Approved Project and Expansion Project cases. The simulated number of annual mean encounters ranged from 0.3 to 4.4 using movement data from 1998 to 2017, and averaged 1.1 (SD = 1.1) across study years. Annual encounter rates peaked in 2012 at 4.4 ZOI encounters.

Figure 6: Temporal Trend in Mean Encounter Rates (± SE) During Fall migration with Zones of Influence for Female Caribou in the Lorillard Herd from 1998 to 2017 for the Phase 1 Case and Phase 2 Case



Winter

Caribou paths monitored over 17 years from 1998 to 2018 (no collar data 2007 to 2011) were used to calculate the number of caribou encounters with ZOIs. The number of collared individuals ranged from a single caribou in 1998, to 12 caribou in 2004 and 2017. The number of paths ranged from 2 paths in 1998 to 2,840 paths in 2016 for a total of 12,830 in winter.

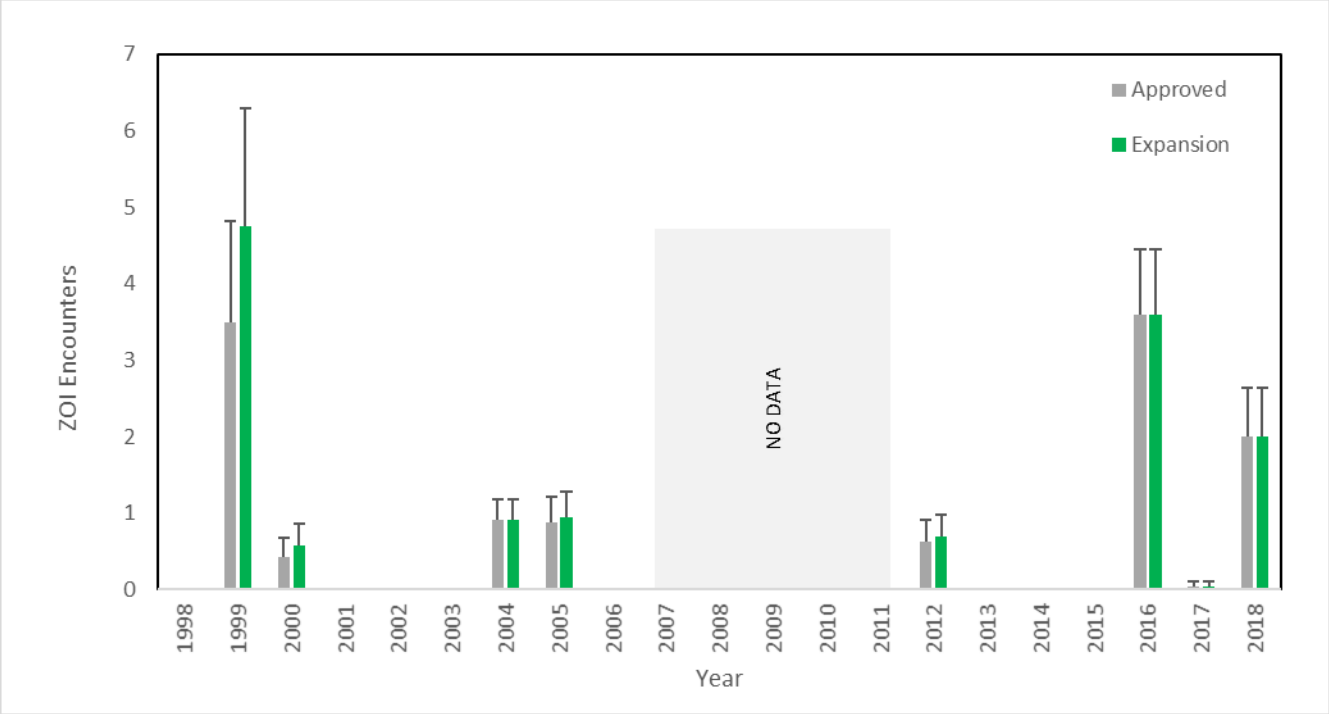
Caribou residency time (i.e., percent time in zones of influence) and encounter rates in winter were highly correlated with each other (Pearson r = 0.97, P <0.01) (see Section 5-F-3.2.1.1). During Base Case conditions, annual mean encounter rates ranged from no encounters per 109 days in nine of the study years (1998, 2001 to 2003, 2006, 2013 to 2015, and 2017) to 3.6 encounters per 109 days in 2016. The mean annual encounter rate in the Base Case was generally low and variable (mean = 0.6, SD = 1.2), and there was no evidence of a declining or increasing temporal trend in annual encounter rates.

With the addition of the Meadowbank Mine and the AWAR to the winter range, the average number of additional encounters per year ranged from no change for 1998 to 2006, and for 2012 to 2016 to less than 0.1 additional encounters in 2015 per 109 days relative to the Base Case. Simulations for the winter indicated an overall annual average of less than 0.1 additional encounters per 115 days (SD <0.1) relative to the Base Case.

Under the Approved Project Case for the winter range, the number of additional encounters per year ranged from no change for 1998 to 2003, 2006, and 2013 to 2017, to 0.8 additional encounters in 2005 per 109 days relative to the Meadowbank Case. Approved Project Case simulations for the winter range projected an annual average of 0.1 additional encounters per 109 days (SD = 0.2) relative to the Meadowbank Case. The updated results using winter 2018 collar data indicated an average of 2.0 cumulative encounters. Relative to the Approved Project Case, the Expansion Project Case indicated 1.3 additional encounters in 1999 and 0.1 in 2000, 2005, and 2012 (Figure 7). The overall incremental increase from the Expansion Project averaged 0.1 additional encounters across years.

The projected cumulative encounter rate with ZOIs in winter through the RFD Case was higher than the Base, Approved Project and Expansion Project cases. Using movement data from 1998 to 2017, the simulated number of annual mean encounters ranged from 0.0 to 4.8, and averaged 0.8 (SD = 1.4) across years. Annual encounter rates peaked in 1999 at 4.8 ZOI encounters.

Figure 7: Temporal Trend in Mean Encounter Rates (± SE) During Winter with Zones of Influence for Female Caribou in the Lorillard Herd from 1998 to 2018 for the Approved Project Case and Expansion Project Case



5-F-3.1.1.2 Wager Bay Herd

Spring Migration

Caribou paths monitored over 15 study years from 1999 to 2018 (no collar data 2007 to 2009, 2013 and 2014) were used to calculate the number of caribou encounters with ZOIs. The number of collared individuals ranged from a single caribou in 1999, 2010, and 2012 to 12 caribou in 2003. The number of paths ranged from 8 paths in 1999 to 1,312 paths in 2016 for a total of 2,874 in spring.

Caribou residency time (i.e., percent time in zones of influence) and encounter rates during spring migration were highly correlated with each other (Pearson r = 0.73, P <0.01) (Section 5-F-3.2.1.2). During Base Case conditions, annual mean encounter rates ranged from no encounters per 58 days in five of the study years (1999, 2012, and 2015 to 2017) to 2.0 encounters per 58 days in 2010. The mean annual encounter rate was very low (mean = 0.3), and moderately variable (SD=0.5), and there was no evidence of a declining or increasing temporal trend.

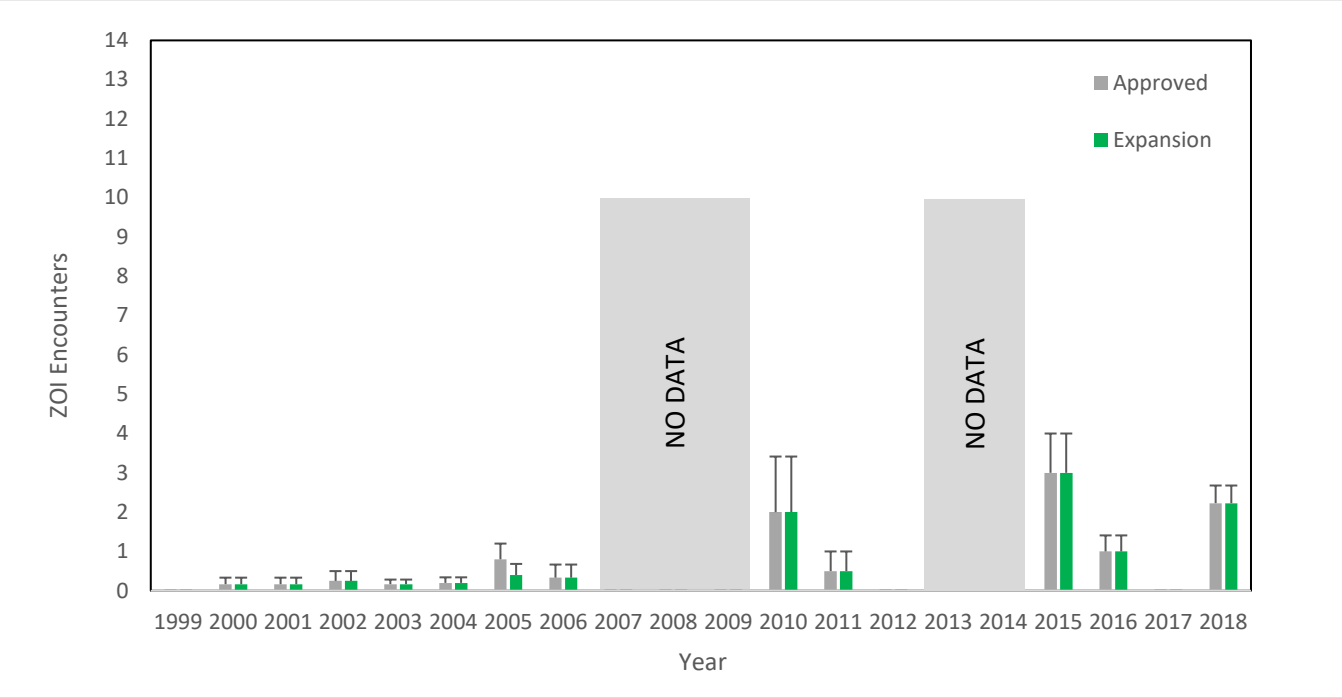
With the addition of the Meadowbank Mine and the AWAR to the spring range, the annual average number of additional encounters in spring ranged from no change for study years between 1999 to 2012, and for 2017, to an increase of 2.3 encounters in 2015 per 58 days (SD = 0.6) relative to the Base Case. Simulations for encounters under the Meadowbank Case in spring indicated an annual average of 0.2 additional encounters per 58 days (SD = 0.6) relative to the Base Case.

Under the Approved Project Case for the spring range, the annual average number of additional encounters in spring ranged from no change for 1999 to 2004, 2006, 2010 to 2012, and 2017 to an increase of 0.7 encounters in 2015 per 58 days (SD = 0.2) relative to the Meadowbank Case. Simulations for the Approved Project Case in spring projected an annual average of 0.1 additional encounters per 58 days (SD = 0.2) relative to the Meadowbank Case.

The updated results using spring 2018 collar data indicated an average of 2.2 cumulative encounters. Relative to the Approved Project Case, the Expansion Project Case indicated no additional encounters (Figure 8).

The projected cumulative encounter rate with ZOIs in spring through the RFD Case was higher than the Base Case but unchanged in comparison to the Approved Project and Expansion Project Case. Using movement data from 1999 to 2017, the simulated number of mean annual encounters ranged from 0.2 to 3.0, and averaged 0.6 (SD = 0.9) across study years. Annual encounter peaked in 2015 at 3.0 encounters.

Figure 8: Temporal Trend in Mean Encounter Rates (± SE) During Spring migration with Zones of Influence for Female Caribou in the Wager Bay Herd from 1999 to 2018 for the Approved Project Case and Expansion Project Case



Fall Migration

Caribou paths monitored over 15 study years from 1999 to 2017 (no collar data 2007, 2008, 2013, and 2014) were used to calculate the number of caribou encounters with ZOIs. The number of collared individuals ranged from a single caribou in 1999, 2000, 2009, 2010, and 2012 to 12 caribou in 2003. The number of paths ranged from 17 paths in 1999 to 2,834 paths in 2012 for a total of 4,824 in fall.

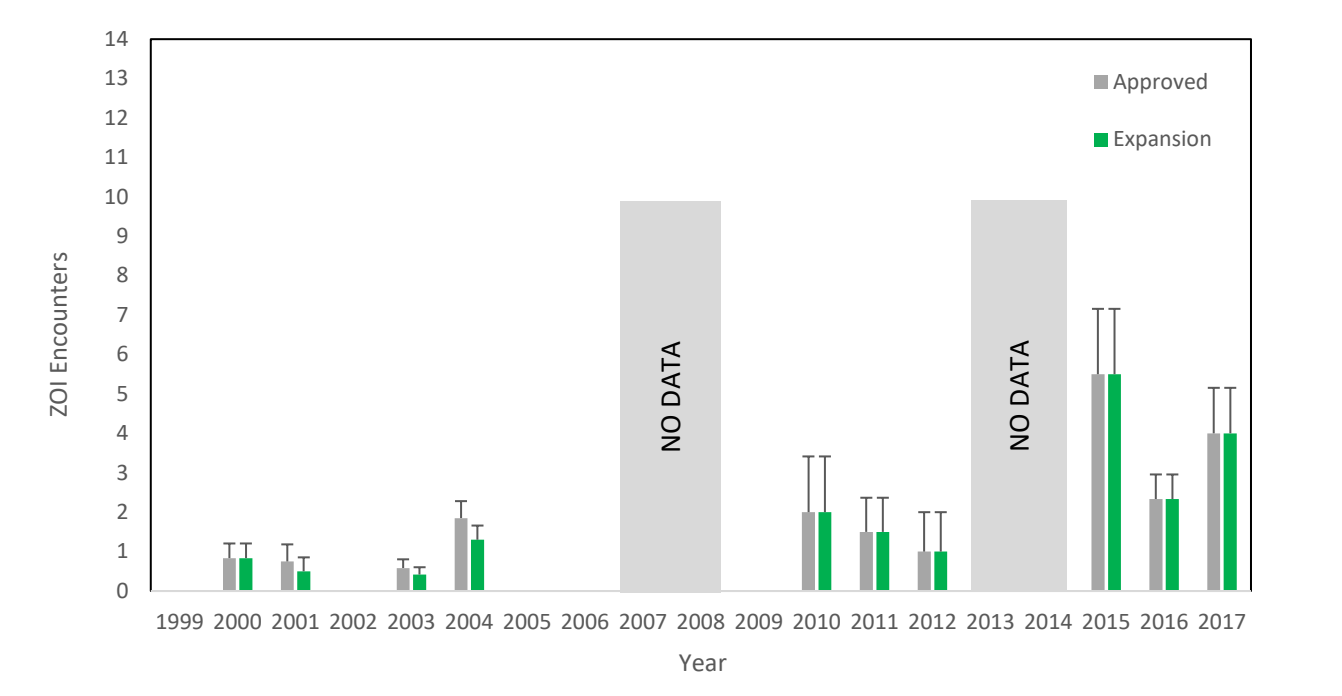
Caribou residency time (i.e., percent time in zones of influence) and encounter rates during fall migration were highly correlated with each other (Pearson r = 0.96, P <0.01) (see Section 5-F-3.2.1.2). During Base Case conditions, annual mean encounter rates ranged from no encounters per 115 days for five of the study years (1999, 2002, 2005, 2006, and 2009) to 2.0 encounters per 115 days in 2010. The mean annual encounter rate was low and moderately variable (mean = 0.6, SD = 0.7), and there was no evidence of a strong declining or increasing temporal trend.

With the addition of the Meadowbank Mine and the AWAR to the fall migration range, analysis of the average number of additional encounters resulted in no change for all study years between 1999 and 2011 to an increase of 4.0 encounters in 2015 relative to the Base Case. Simulations for the Meadowbank Case in fall migration indicated an annual average of 0.4 additional encounters per 115 days (SD = 1.1) relative to the Base Case.

Under the Approved Project Case for the fall migration range, analysis of the average number of additional encounters resulted in no projected change for 1999, 2002, 2005, 2006, 2009, 2010, 2012, 2015, and 2016 to an increase of 1.6 encounters in 2004 relative to the Meadowbank Case. Approved Project Case simulations for the fall migration projected an annual average of 0.2 additional encounters per 115 days (SD = 0.4) relative to the Meadowbank Case. The updated results using fall 2017 collar data indicated an average of 4.0 cumulative encounters. Relative to the Approved Project Case, the Expansion Project Case indicated no additional encounters (Figure 9).

The projected cumulative encounter rate with ZOIs in fall migration through the RFD Case was higher than the Base, Approved Project and Expansion Project cases. Using movement data from 2000 to 2016, the simulated number of annual mean encounters ranged from 0.6 to 6.0 and averaged 1.3 (SD = 1.6) across study years. Annual encounter peaked in 2015 at 6.0 encounters.

Figure 9: Temporal Trend in Mean Encounter Rates (± SE) During Fall migration with Zones of Influence for Female Caribou in the Wager Bay Herd from 1999 to 2017 for the Approved Project Case and Expansion Project Case



Winter

Caribou paths monitored over 15 study years from 2000 to 2018 (no collar data 2008, 2009, 2014, and 2015) were used to calculate the number of caribou encounters with ZOIs. The number of collared individuals ranged from a single caribou in 2000, 2007, 2010, 2011, and 2013 and 2006 to 11 caribou in 2004. The number of paths ranged from 2 paths in 2013 to 2,317 paths in 2017 for a total of 4,611 in winter.

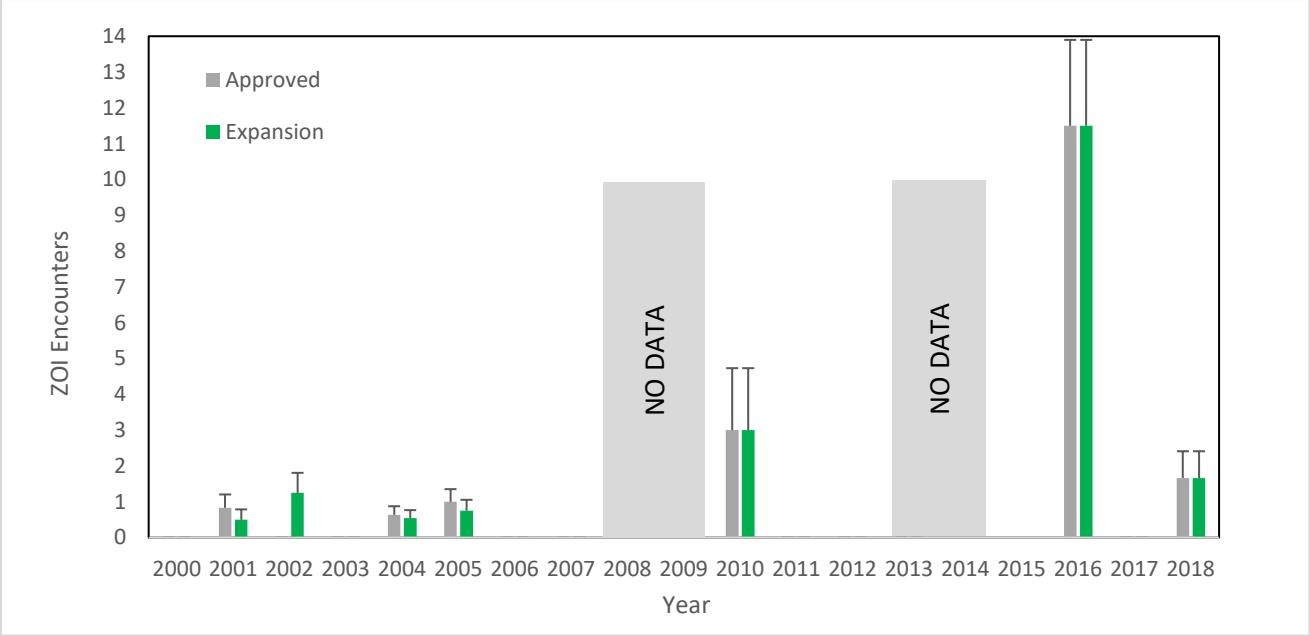
Caribou residency time (i.e., percent time in zones of influence) and encounter rates in winter were highly correlated with each other (Pearson r = 0.99, P <0.01) (see Section 5-F-3.2.1.2). During Base Case conditions, annual mean encounter rates ranged from no encounters per 105 days for nine of the study years (2000, 2002, 2003, 2006, 2007, 2011 to 2013, and 2017) to 11.5 encounters per 105 days in 2016. The mean annual encounter rate in the Base Case was moderate in magnitude and highly variable (mean = 1.1, SD =3.1). There was a relatively high encounter rate (11.5) estimated for 2016.

With the addition of the Meadowbank Mine and the AWAR to the winter range, there was no change in encounter rates relative to the Base Case.

Under the Approved Project Case for the winter range, analysis of additional encounters relative to the Meadowbank Case resulted in a range of no change for 2000, 2002, 2003, 2006, 2007, 2010 to 2013, 2016, and 2017, to an increase of 0.7 encounters in 2005. Approved Project Case simulations projected an annual average of 0.1 additional encounters per 105 days (SD = 0.2) relative to the Meadowbank Case. The updated results using fall and winter 2018 collar data indicated an average of 1.7 cumulative encounters. Relative to the Approved Project Case, the Expansion Case indicated no additional encounters (Figure 10).

The projected cumulative encounter rate with ZOIs in winter through the RFD Case was higher than the Base and Approved Project and Expansion Project cases. Using movement data from 2000 to 2017, the simulated number of annual mean encounters ranged from 0.8 to 11.5, and averaged 1.4 (SD = 3.0) across study years.

Figure 10: Temporal Trend in Mean Encounter Rates (± SE) During Winter with Zones of Influence for Female Caribou in the Wager Bay Herd from 2000 to 2018 for the Approved Project Case and Expansion Project Case



5-F-3.2 Residency Time

5-F-3.2.1.1 Lorillard Herd

Spring Migration

Caribou paths monitored over 17 study years from 1998 to 2018 (no collar data 2007 to 2010) were used to calculate the residency time within ZOIs. The number of collared individuals ranged from two caribou in 1998 and 2006 to 15 caribou in 2016.

From 1998 to 2018 (Base Case), Lorillard caribou resided in ZOIs for an average of 0.1 days (SD = 0.5 days) or 0.2% of their time during the spring migration period (n = 126 paths). No time was spent by female caribou in ZOIs during 1998 to 2002, 2012 to 2014, and 2016 to 2017. When there was an interaction, the amount of time spent by female caribou in ZOIs ranged from 0.1% in 2005 to 2.0% in 2006. There was no evidence of a declining or increasing temporal trend for the Base Case.

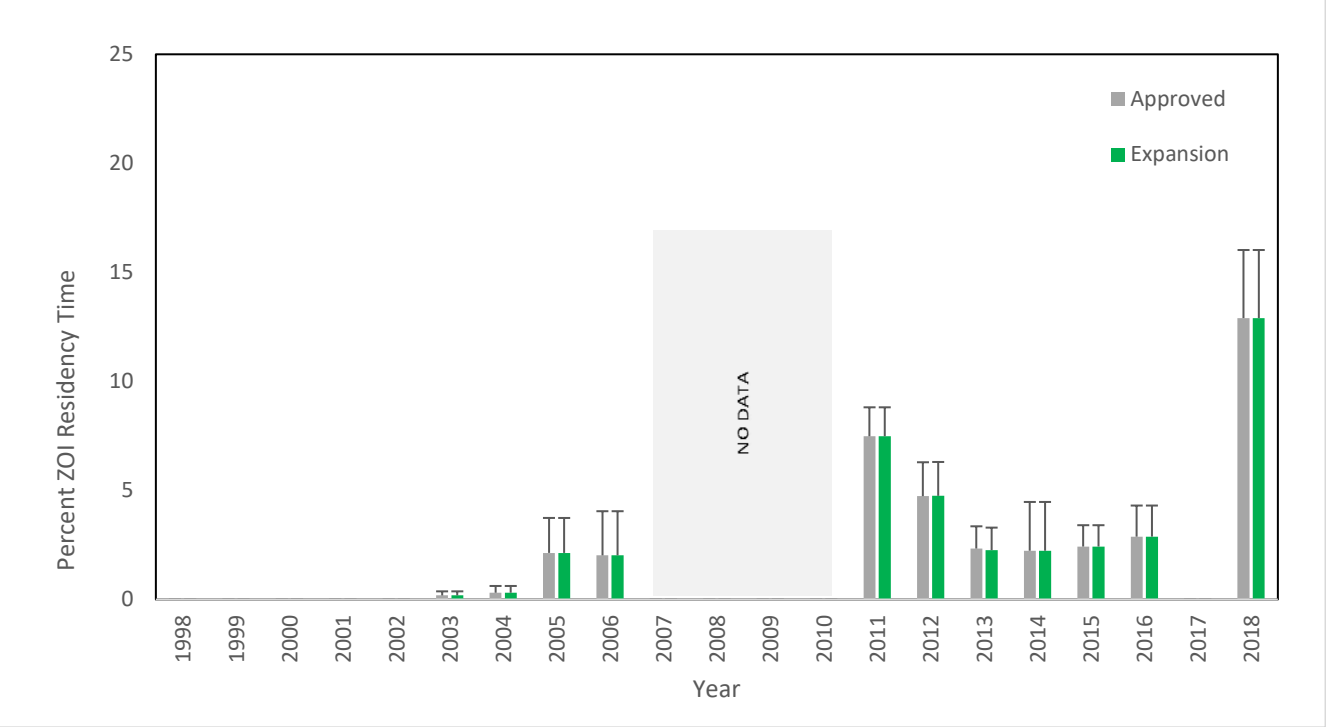
With the addition of the Meadowbank Mine and the AWAR to the spring range, the amount of time spent in ZOIs ranged from no change for 1998 to 2006, and 2017, to 3.6 additional days (or 6.8%) in 2011 per 53 days relative to the Base Case. The overall mean incremental change in residency time was 0.6 days (or 1.1%) for the Meadowbank Case.

Relative to the Meadowbank Case, there were no incremental changes in projected residency times for 1998 to 2004, 2006, 2011, and 2015 to 2017 for the Approved Project Case. Maximum incremental change was 0.8 days or 1.6% in 2014. The overall average amount of time female caribou spend in ZOIs is projected to increase by 0.2 days (or 0.4%) during the spring migration period for the Approved Project Case. The updated results using spring 2018 collar data indicated caribou spent an average of 6.8 days (12.9%) in cumulative ZOIs. Relative to the Approved Project Case, the Expansion Project Case resulted in no increase in the amount time collared caribou spent in development ZOIs (Figure 11).

Simulations with the RFD Case projected that caribou reside in ZOIs for an average of 0.9 days (SD = 2.1) or 1.7% of their time during the spring migration period. No time was spent by female caribou in ZOIs per 53 days in 1998 to 2002, and in 2017. When there was an interaction, residency time in ZOIs ranged from 0.2% in 2003 to 7.5% in 2011.

Important to note that results for the Meadowbank, Approved Project, Expansion Project and RFD simulations showed an increasing trend in residency time over time. For example, there were higher residency times for the period of 2011 to 2018 (mean = 3.2%) versus 1998 to 2006 (mean = 0.5%) for the Approved Project Case.

Figure 11: Temporal Trend in Mean Encounter Rates (± SE) During Spring migration with Zones of Influence for Female Caribou in the Lorillard Herd from 1998 to 2018 for the Approved Project Case and Expansion Project Case



Fall Migration

Caribou paths monitored over 15 study years from 1998 to 2017 (no collar data from 2006 to 2010) were used to calculate the residency time within ZOIs. The number of collared individuals ranged from two caribou in 1998 and 2014 to 12 caribou in 2003 and 2016.

From 1998 to 2016 (Base Case), Lorillard caribou resided in ZOIs for an average of 0.5 days (SD = 1.3 days) or 0.5% of their time during the fall migration period (n = 97 paths). No time was spent by female caribou in ZOIs during 1998 to 2002, 2005, and 2013 to 2014. When there was an interaction, the amount of time spent by female caribou in ZOIs has ranged from 0.04% in 2011 to 4.9% in 2012. There was no evidence of a declining or increasing temporal trend.

With the addition of the Meadowbank Mine and the AWAR to the winter range, the amount of time spent in ZOIs ranged from no change from 1998 to 2005 to 2.1 additional days (or 1.8%) in 2014 per 115 days relative to the Base Case. The overall mean incremental change was 0.4 days (or 0.4%)

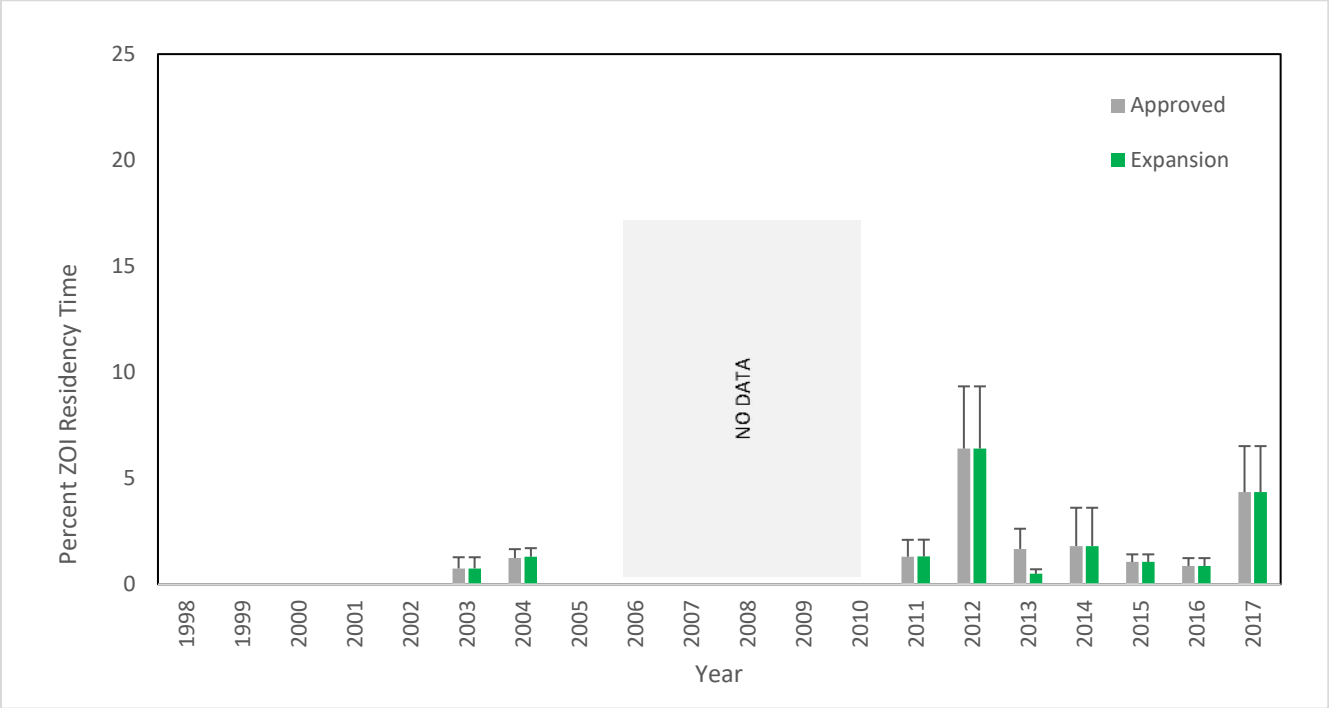
Relative to the Meadowbank Case, the incremental change in residency time for the Approved Project Case ranged from no change for 1998 to 2002, 2005, 2012, and 2014 to 2016, to 1.8 additional days (or 1.5%) in 2013. The overall average amount of time female caribou spend in ZOIs is projected to increase by 0.3 days or 0.2% during the fall migration period for the Application Case. The updated results using fall 2017 collar data indicated caribou spent an average of 4.9 days (4.3%) in cumulative ZOIs. Relative to the Approved Project Case, the Expansion Case resulted in no increase in the amount time collared caribou spent in development ZOIs (Figure 12).

Important to note that results for the Meadowbank and Approved Project case simulations showed an increasing trend over time, and that temporal trends for the Approved Project case were marginally stronger. There were higher

residency times for the period of 2011 to 2017 (mean = 2.2%) versus 1998 to 2006 (mean = 0.3%) for the Approved Project Case.

Simulations with the RFD Case projected that caribou reside in ZOIs for an average of 1.4 days (SD = 1.7) or 1.2% of their time during the fall migration period. No time was spent by female caribou in ZOIs per 115 days in 2000 to 2002, and 2005. When there was an interaction, residency time in ZOIs ranged from 0.4% in 1999 to 6.5% in 2012.

Figure 12: Temporal Trend in Mean Encounter Rates (± 95% Upper Interval) During Fall migration with Zones of Influence for Female Caribou in the Lorillard Herd from 1998 to 2017 for the Approved Project Case and Expansion Project Case



Winter

Caribou paths monitored over 16 study years from 1998 to 2018 (no collar data 2007 to 2011) were used to calculate the residency time in ZOIs. The number of collared individuals ranged from a single caribou in 1998, to 12 caribou in 2004 and 2017.

From 1998 to 2017 (Base Case), Lorillard caribou resided in ZOIs for an average of 1.7 days (SD = 3.0 days) or 1.5% of their time during the winter period (n = 96 paths). No time was spent by female caribou in ZOIs during 1998, 2001 to 2003, 2006, 2013 to 2015, and 2017. When there was an interaction, the amount of time spent by female caribou in ZOIs ranged from less than 0.1% in 2005 to 9.8% in 1999. There was no evidence of a declining or increasing temporal trend.

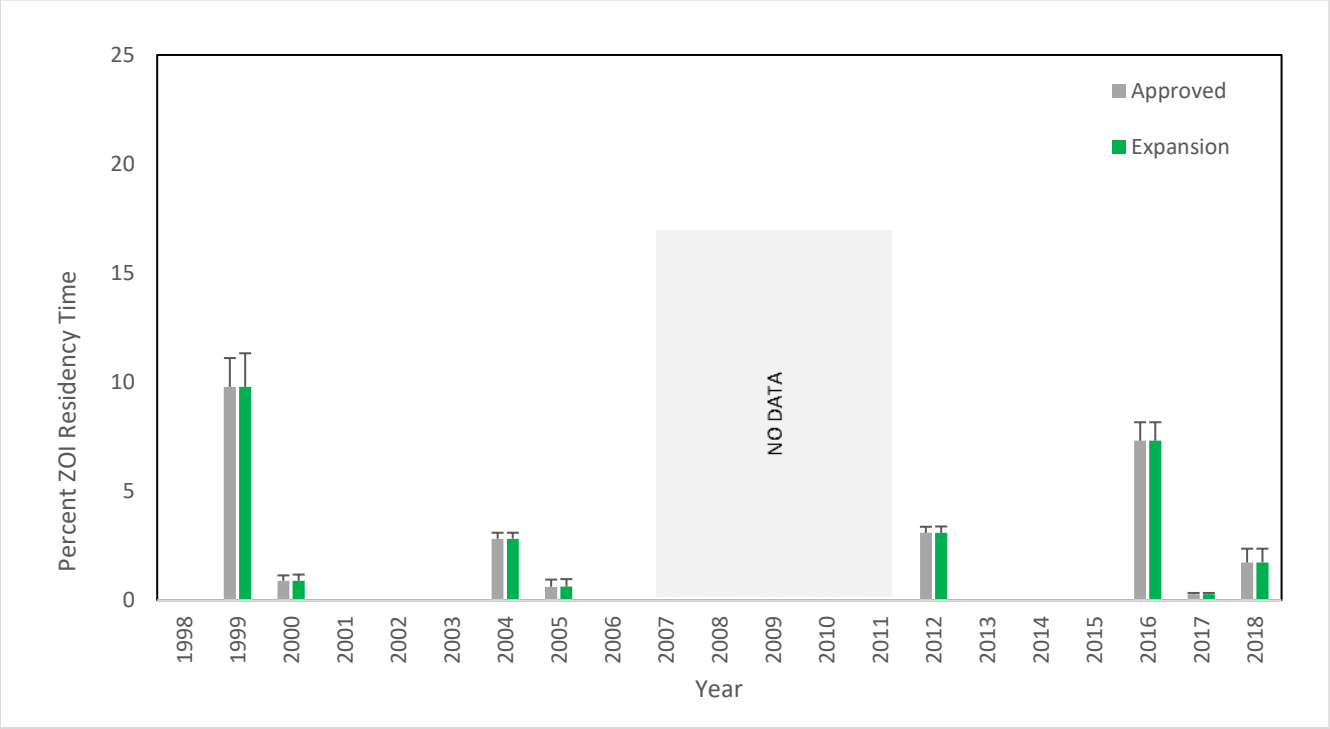
With the addition of the Meadowbank Mine and the AWAR to the winter range, the amount of time spent in ZOIs ranged from no change for 1998 to 2006, and 2012 to 2016, to 0.3 additional days (or 0.3%) in 2017 per 109 days relative to the Base Case. The overall mean incremental change in residency time was less than 0.1 days (or <0.1%) for the Meadowbank Case.

Relative to the Meadowbank Case, there were no incremental changes in residency time for 1998 to 2003, 2006, and 2013 to 2017 for the Approved Project Case. Maximum incremental change on the winter range was 0.9 days

(or 0.9%) in 2012 for the Approved Project. The overall average amount of time female caribou spend in ZOIs is projected to increase by 0.1 days or 0.1% during the winter period for the Approved Project Case. The updated results using winter 2018 collar data indicated female caribou spent an average of 1.9 days (1.7%) in cumulative ZOIs. Relative to the Approved Project Case, the Expansion Case resulted in no increase in the amount time collared caribou spent in development ZOIs (Figure 13).

Simulations for the RFD Case projected that caribou reside in ZOIs for an average of 1.8 days (SD = 3.0) or 1.7% of their time during the winter period. No time was spent by female caribou in ZOIs per 109 days in 1998, 2001 to 2003, 2006, and 2013 to 2015. When there was an interaction, residency time in ZOIs ranged from 0.3% in 2017 to 9.8% in 1999.

Figure 13: Temporal Trend in Mean Residency Time (± SE) During Winter with Zones of Influence for Female Caribou in the Lorillard Herd from 1998 to 2018 for the Approved Project Case and Expansion Project Case



5-F-3.2.1.2 Wager Bay Herd

Spring Migration

Caribou paths monitored over 15 study years from 1999 to 2018 (no collar data 2007 to 2009, 2013, and 2014) were used to calculate the residency time within ZOIs. The number of collared individuals ranged from a single caribou in 1999, 2010, and 2012 to 12 caribou in 2003.

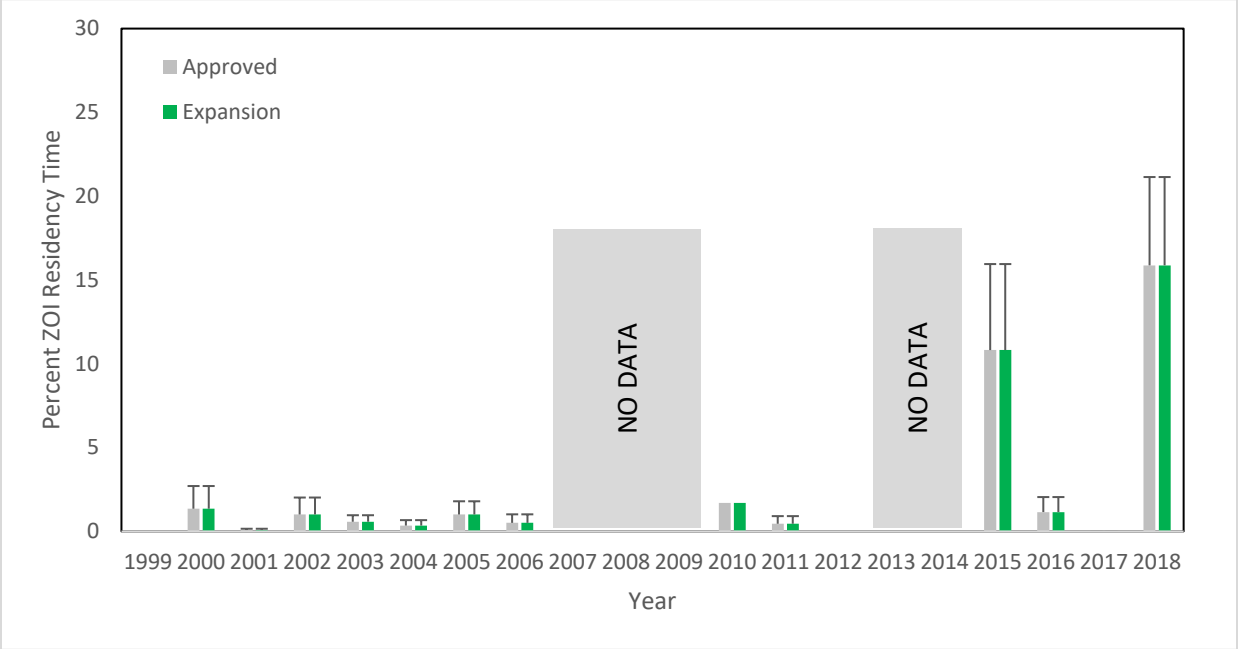
From 1999 to 2017 (Base Case), Wager Bay caribou resided in ZOIs for an average of 0.3 days (SD = 0.6 days) or 0.5% of their time during the spring migration period (n = 62 paths). No time was spent by female caribou in ZOIs during 1999, 2012, and 2015 to 2017. When there was an interaction, the amount of time spent by female caribou in ZOIs ranged from less than 0.1% in 2001 to 1.7% in 2010. There was no evidence of a strong declining or increasing temporal trend.

With the addition of the Meadowbank Mine and the AWAR to the spring range, the amount of time spent in ZOIs ranged from no change for 1999 to 2006, 2010 to 2012, and 2017, to 6.3 additional days (or 10.8%) in 2015 per 58 days relative to the Base Case. The overall mean incremental change in residency time was 0.9% (0.5 days) for the Meadowbank Case.

Relative to the Meadowbank Case, the projected average amount of time female caribou spend in ZOIs for the Approved Project Case did not change for the spring migration period. The updated results using spring 2018 collar data indicated caribou spent an average of 9.2 days (15.9%) in cumulative ZOIs. Relative to the Approved Project Case, the Expansion Project Case indicated no increase in the amount time collared caribou spent in development ZOIs (Figure 14).

Simulations with the RFD Case projected that caribou reside in ZOIs for an average of 0.8 days (SD = 2.8) or 1.4% of their time during the spring migration period. No time was spent by female caribou in ZOIs per 58 days in 1999, 2012 and 2017. When there was an interaction, residency time in ZOIs ranged from less than 0.1% in 2001 to 17.5% in 2018.

Figure 14: Temporal Trend in Mean Residency Time (± SE) During Spring migration with Zones of Influence for Female Caribou in the Wager Bay Herd from 1999 to 2018 for the Approved Project Case and Expansion Project Case



Fall Migration

Caribou paths monitored over 15 study years from 1999 to 2017 (no collar data 2007, 2008, 2013, and 2014) were used to calculate the residency time with ZOIs. The number of collared individuals ranged from a single caribou in 1999, 2000, 2009, 2010, and 2012 to 12 caribou in 2003.

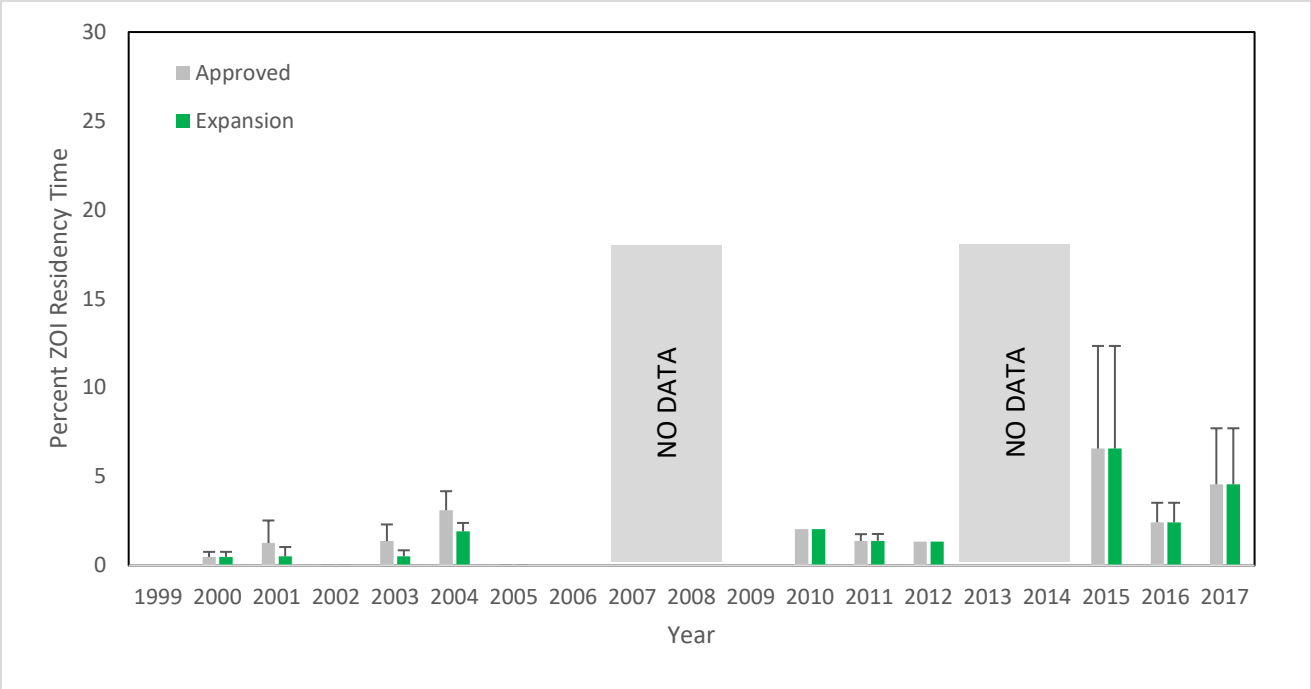
From 1999 to 2016 (Base Case), Wager Bay caribou resided in ZOIs for an average of 0.6 days (SD = 0.7 days) or 0.6% of their time during the fall migration period (n = 53 paths). No time was spent by female caribou in ZOIs during 1999, 2002, 2005, 2006, and 2009. When there was an interaction, the amount of time spent by female caribou in ZOIs ranged from 0.09% in 2001 and 2003 to 2.0% in 2010. There was no evidence of a declining or increasing temporal trend.

With the addition of the Meadowbank Mine and the AWAR to the fall migration range, the amount of time spent in ZOIs ranged from no change for 1999 to 2006, and 2009 to 2012, to 5.8 additional days (or 5.0%) in 2015 per 115 days relative to the Base Case. The overall mean incremental change in residency time was 0.5% (0.6 days) for the Meadowbank Case.

Relative to the Meadowbank Case, residency time projections for the Approved Project Case ranged from no changes for nine of the study years (1999, 2002, 2005, 2006, 2009, 2010, 2012, 2015, and 2016) to 1.5 additional days (or 1.29%) for the fall migration in 2004. The overall average amount of time female caribou spend in ZOIs is projected to increase by 0.2% or 0.3 days during the fall period for the Approved Project Case. The updated results using fall 2017 collar data indicated caribou spent an average of 5.2 (4.5%) in cumulative ZOIs. Relative to the Approved Project Case, the Expansion Project Case indicated no increase in the amount time collared caribou spent in development ZOIs (Figure 15).

Simulations with the RFD Case projected that caribou may reside in ZOIs for an average of 1.5 days (SD = 1.8) or 1.3% of their time during the fall migration period. No time was spent by female caribou in ZOIs per 115 days in 1999, 2002, 2005, 2006, and 2009. When there was an interaction with ZOIs, residency time ranged from 0.5% in 2000 to 6.6% in 2015.

Figure 15: Temporal Trend in Mean Residency Time (± SE) During Fall migration with Zones of Influence for Female Caribou in the Wager Bay Herd from 1999 to 2017 for the Approved Project Case and Expansion Project Case



Winter

Caribou paths monitored over 15 study years from 1998 to 2018 (no collar data 2008, 2009, 2014, and 2015) were used to calculate residency time within ZOIs. The number of collared individuals ranged from a single caribou in 2000, 2007, 2010, 2011, 2013 and 2006 to 11 caribou in 2004.

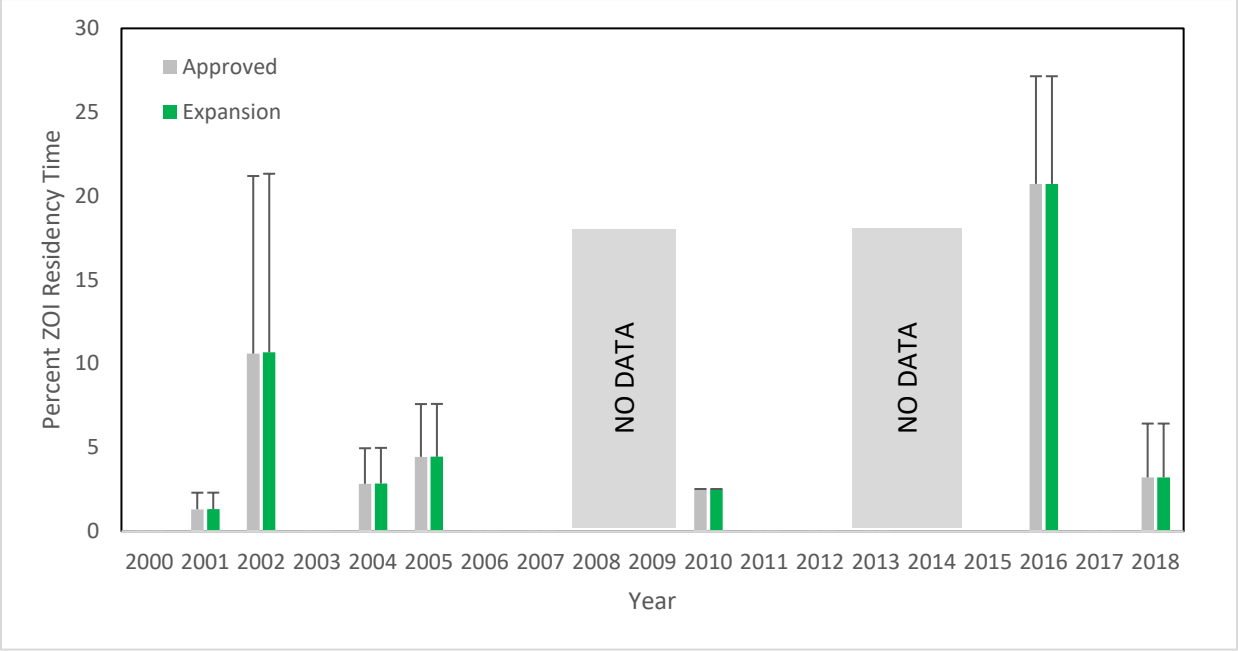
From 2000 to 2017 (Base Case), Wager Bay caribou resided in ZOIs for an average of 2.0 days (SD = 5.5 days) or 1.9% of their time during the winter period (n = 49 paths). No time was spent by female caribou in ZOIs during 2000, 2002 to 2003, 2006 to 2007, 2011 to 2013 or 2017. When there was an interaction, the amount of time spent by female caribou in ZOIs ranged from 0.4% in 2005 to 20.7% in 2016. Although there was no evidence of a strong declining or increasing temporal trend for the Base Case, residency time showed a marked increase in 2016.

With the addition of the Meadowbank Mine and the AWAR to the winter range, the amount of time spent in ZOIs remains unchanged relative to the Base Case.

Relative to the Meadowbank Case, residency time projections for the Approved Project Case ranged from no changes for ten of the study years (2000, 2003, 2006, 2007, 2010 to 2013, and 2016 to 2017) to 1.5 additional days (or 1.3%) for the fall migration in 2004. The overall average amount of time female caribou spend in ZOIs is projected to increase by 1.2 days or 1.1% during the winter period for the Approved Project Case. The updated results using fall and winter 2018 collar data indicated caribou spent an average of 2.1 days (2.0%) in cumulative ZOIs. Relative to the Approved Project Case, the Expansion Project Case indicated no increase in the amount time collared caribou spent in development ZOIs (Figure 16).

Simulations with the RFD Case projected that caribou reside in ZOIs for an average of 3.2 days (SD = 5.9) or 3.0% of their time during the winter period. No time was spent by female caribou in ZOIs per 105 days in 2000, 2003, 2006, 2007, 2011 to 2013, and 2017. Residency time in ZOIs ranged from 1.3% in 2001 to 20.7% in 2016 of the winter period.

Figure 16: Temporal Trend in Mean Residency Time (± SE) During Winter with Zones of Influence for Female Caribou in the Wager Bay Herd from 2000 to 2018 for the Approved Project Case and Expansion Project Case



5-F-4 SUMMARY

Collared caribou data from the Lorillard, and Wager Bay herds were evaluated for encounters and residency time in cumulative hypothetical ZOIs from active developments on their spring, fall, and winter seasonal ranges. The cumulative mean annual encounters in the Base and RFD case development scenarios, and the incremental changes from the Meadowbank Mine and AWAR (Meadowbank Case) and the Whale Tail Project (Approved Project Case) and the Expansion Project Case for each herd and season are summarized in Table 4.

Results for the Lorillard herd indicate an annual average incremental increase of 0.3 ZOI encounters in the spring, 0.4 in fall and 0.1 in winter for the Meadowbank Mine and AWAR from 2007 to 2017 relative to other previous and existing developments. Simulations predicted the Approved Project will increase the annual average number of encounters by 0.3 in spring, 0.3 in fall and 0.1 in winter relative to previous and existing developments and the Meadowbank Mine and AWAR. Simulations predicted an annual average of 0.1 additional encounters for the Expansion Project in winter but no additional encounters in either spring or fall. Simulated mean annual cumulative encounters in the RFD Case were predicted to be 0.7 in spring, 1.1 in fall and 0.8 in winter. The incremental mean annual increase in the number of days Lorillard caribou resided in ZOIs from 2007 to 2017 for the Meadowbank Mine and AWAR was 0.6 days in spring, 0.4 days in fall and 0.2 days in winter. Simulations for the Approved Project predicted a mean annual increase in residency by 0.2 days in spring, 0.3 days in fall and 0.1 days in winter from 1996 to 2017. Simulations predicted no additional residency time in relation to the Expansion Project. Simulated cumulative residency time through the RFD Case was predicted to be 0.9 days in spring, 1.4 days in fall and 1.8 days in winter.

For the Wager Bay herd, the incremental average increase in encounters associated with the Meadowbank Mine and AWAR ZOI from 2007 to 2017 was 0.2 encounters in spring, 0.4 in fall and no encounters in winter, relative to the Base Case. Simulations predicted that the Approved Project will increase the average number of ZOI encounters by 0.1 in spring, 0.2 in fall and 0.1 in winter relative to the Meadowbank Case. Simulations predicted no additional encounters with the Expansion Project. The projected cumulative annual mean number of ZOI encounters in the RFD Case was 0.6 in spring, 1.3 in fall and 1.4 in winter. The incremental increase in the mean annual number of days Wager Bay caribou resided in ZOIs from 2007 to 2017 for the Meadowbank Mine and AWAR was 0.5 days in spring, 0.6 days in fall and no days in winter. Simulations for the Approved Project predicted no increase in mean annual residency days for spring, an increase of 0.3 days in fall and 1.2 days in winter from 1996 to 2017. Simulations predicted no additional residency time in relation to the Expansion Project. Simulated cumulative mean annual residency time through the RFD Case was predicted to be 0.8 days in spring, 1.5 days in fall and 3.2 days in winter.

Overall, analysis of encounter rates and residency time predict that the Meadowbank Mine and AWAR, the Approved Project or the Expansion Project would result in no measurable changes to the energetic state of Lorillard and Wager Bay caribou, and no demographic consequences to the populations.

Note that ZOI encounters were overestimated by not dissolving overlapping zones of influence from different developments. In contrast residency time was not doubled when caribou were present in overlapping ZOI areas of different developments

Table 4: Summary of Hypothetical Incremental and Cumulative Indirect Effects from Development Zones of Influence in Seasonal Ranges of Lorillard and Wager Bay Caribou Herds

Herd	Season	Development Scenario									
		Base Case (cumulative rate)		Meadowbank Case (incremental rate)		Approved Project Case (incremental rate)		Expansion Project Case (incremental rate)		RFD Case (cumulative rate)	
		Mean Number of ZOI Encounters	Mean ZOI Residency Time (days)	Mean Number of ZOI Encounters	Mean ZOI Residency Time (days)	Mean Number of ZOI Encounters	Mean ZOI Residency Time (days)	Mean Number of ZOI Encounters	Mean ZOI Residency Time (days)	Mean Number of ZOI Encounters	Mean ZOI Residency Time (days)
Lorillard	Spring	<0.1	0.1	0.3	0.6	0.3	0.2	0.0	0.0	0.7	0.9
	Fall	<0.1	0.5	0.4	0.4	0.3	0.3	0.0	0.0	1.1	1.4
	Winter	0.6	1.7	0.1	0.2	0.1	0.1	0.1	0.0	0.8	1.8
Wager Bay	Spring	0.3	0.3	0.2	0.5	0.1	0.0	0.0	0.0	0.6	0.8
	Fall	0.6	0.6	0.4	0.6	0.2	0.3	0.0	0.0	1.3	1.5
	Winter	1.1	2.0	0.0	0.0	0.1	1.2	0.0	0.0	1.4	3.2

Note: Base Case and Meadowbank Case Results from Golder (2017).

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5-F-5 REFERENCES

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