APPENDIX 22-C
HIGHWAYS 37 AND 37A TRAFFIC EFFECTS ASSESSMENT

Seabridge Gold Inc.

KSM PROJECT
Highways 37 and 37A Traffic Effects Assessment

SEABRIDGE GOLD

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KSM PROJECT

HIGHWAYS 37 AND 37A TRAFFIC EFFECTS ASSESSMENT

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SEABRIDGE GOLD

Seabridge Gold Inc.

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Executive Summary

The KSM Project (the Project) is owned by Seabridge Gold Inc. (Seabridge). The Project is a proposed gold, copper, silver and molybdenum mine located in the mountainous terrain of northwestern British Columbia (BC), approximately 950 km northwest of Vancouver, and approximately 65 km northwest of Stewart, BC. The Project is subject to the British Columbia *Environmental Assessment Act* (BCEAA) and the *Canadian Environmental Assessment Act* (CEAA).

This report meets the requirements of the Section 13 order issued by the BC Environmental Assessment Office (BCEAO) on September 29, 2011, which amended the Section 11 order issued on November 6, 2009. The Section 13 order requires Seabridge to assess the potential effects arising from the transport of people, goods and materials, including, but not limited to fuel, hazardous cargos and explosives along access roads and Highway 37 between the proposed Project site and its junction with Highway 16 at Kitwanga. This report focuses on potential effects of Project-related traffic travelling on highways 37 and 37A. The use of existing and proposed access roads to the Project site will be assessed in Seabridge's Application for an Environmental Assessment Certificate / Environmental Impact Statement (Application/EIS).

This report has considered the input from government, Nisga'a Nation, and First Nations as a result of Traffic Working Group meeting was held on July 9, 2012 in Terrace, BC and in subsequent correspondence (Appendix F).

The KSM Highways 37 and 37A Traffic Assessment Study Area (the Study Area) encompasses approximately 300 km of Highway 37 from the Eskay Creek Mine access road junction, southeast to its junction with Highway 16 in Kitwanga; and approximately 65 km of Highway 37A from Meziadin Junction to the District of Stewart. The Study Area includes 500 metres on either side of the highways.

A risk assessment methodology is used to estimate the likelihood or probability of potentially adverse environmental effects resulting from increased Project-traffic within the Study Area, and is complementary to methods used in Application/EIS where significance determinations are made. Risk assessment methods are commonly used in land use and resource management planning, and when assessing risks associated hazards, accidents and malfunctions.

Valued Components (VCs) are those parts of the biophysical or human environment deemed important based on social values or scientific concerns. Potential traffic-associated risks to the VCs are identified for each environmental topic and selected for further analysis. Potential risks are then characterized by: (1) the likelihood, ranging from rare to certain; and (2) the severity, ranging from negligible to catastrophic. Potential effect/risk ratings were characterized post-mitigation for the following topics:

- Socio-economics;
- Fish and Aquatic Habitat;
- Terrestrial Ecosystems;
- Wetlands;
- Noise;
- Climate and Air Quality;
- Human Health; and
- Heritage.

Figure 1 summarizes the conclusions of potential risks associated with Project-related traffic. Effects resulting from normal Project traffic activities range in likelihood from rare to certain, with a predominant expectation of minor severity. For example, highway transportation activities are certain to affect ambient air quality because all vehicles will require fuel to operate. The maximum amount of traffic engine combustion will occur during operation, but the contribution of Criteria Air Contaminants (CACs) from engine combustion to ambient air quality is expected to be minor. Or in another example, the potential effect of direct mortality to wildlife (bears and birds) caused by vehicle collisions on highways 37 and 37A could occur during all Project phases, but is expected to be of minor severity.

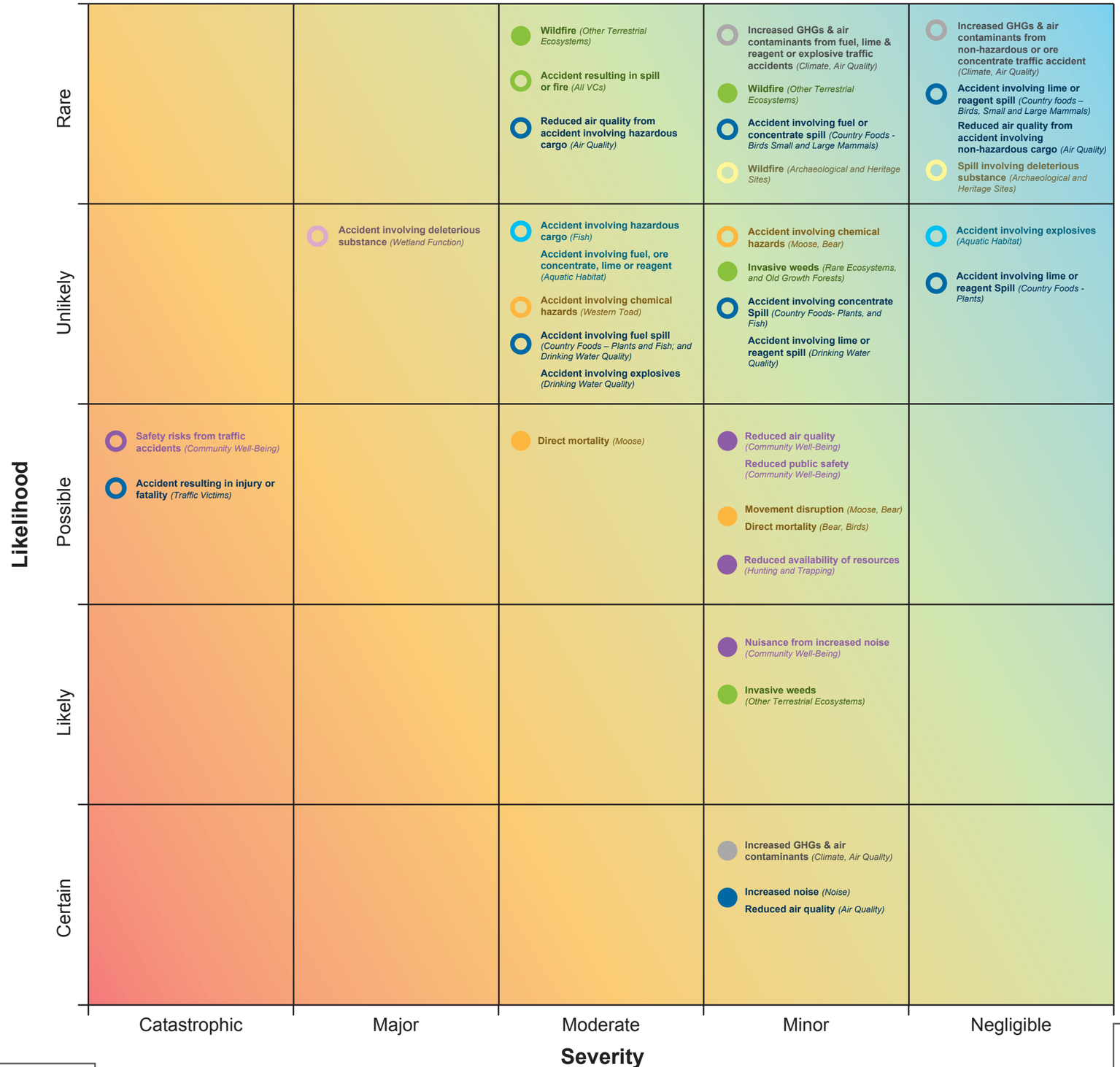
In order to assess the potential effects of increased traffic on direct mortality of moose, a population viability assessment was conducted using a population dynamics model of the Nass moose population. A moose vehicle collision model was imbedded into the population dynamics model to emulate the fraction of moose mortality that could be explained by the current level of vehicle collisions. Results indicate that the addition of traffic from the KSM project is projected to cause an additional <1% mortality to the moose population at the current population size, a mortality rate that does not predict a substantial decline. After mitigation, it is possible that vehicle/moose collisions will occur resulting in direct mortality due to increased traffic on the highways (particularly Highway 37), and severity is expected to be moderate (Figure 1).

A British Columbia Ministry of Transportation and Infrastructure (BC MOTI) collision prediction model was used to predict the annual number of collisions on highways 37 and 37A associated with the additional traffic volumes expected for each of the Project phases. The analysis for this model utilized historical police data on traffic accidents in the Study Area between 1996 and 2011. The potential for Project-related traffic accidents is expected to be rare. Potential social and environmental risks from traffic accidents are expected to be rare and unlikely occurrences (Figure 1).

Effects of traffic accidents characterized as possible and catastrophic are those resulting in human injury or death, while unlikely accidents with major/moderate severity are those that involve the potential release of hazardous cargo or deleterious substances into the environment (Figure 1). For example, wetland function could be compromised if a hazardous cargo spill extends beyond the road surface, resulting in the deposition of deleterious substances into a wetland.

A summary of Project-specific mitigation and management actions is provided in this document. The objective of these measures is to minimize potential harm to people and the environment. These actions are included in Seabridge's Traffic and Access Management Plan, Dangerous Goods and Hazardous Materials Management Plan, Emergency Response Plan (for emergencies other than spills), and Spill Prevention and Emergency Response Plan, all of which are included in the Project's Application/EIS. A more detailed framework for monitoring risk mitigations, and adapting actions if required, is included in the Application / EIS.

Finally, the analysis of cumulative risk of the KSM Project combined with highway traffic effects from other present and reasonably foreseeable future projects is included. The cumulative effects assessment shows that, assuming other projects adopt similar mitigation measures as the KSM Project, the likelihood and severity of risks to VCs should not increase beyond the incremental risk posed by the KSM Project, despite potential increases in traffic along highways 37 and 37A.



Project Traffic	Traffic Accidents	Topic
●	○	Socio-economics and Land Use
	○	Fish and Aquatic Habitat
●	○	Wildlife
●	○	Terrestrial Ecosystems
	○	Wetlands
●	○	Climate and Air Quality
●	○	Human Health
	○	Heritage

Risk Rating

High Risk (detailed management plan required)

Low Risk (manage with best practices)

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Figure 1

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Assessment of Potential Risks Associated with Project-related Traffic (by Topic)

KSM PROJECT
HIGHWAYS 37 AND 37A TRAFFIC EFFECTS ASSESSMENT

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Appendix F. Working Group Comment Tracking Table

Glossary and Abbreviations

Abbreviations used in this document are defined where they are first used. The following list will assist readers who may choose to review only portions of the document.

% HA	Percent Highly Annoyed
µg/m^3	Micrograms per cubic metre
AADT	Annual Average Daily Traffic
AANDC	Aboriginal Affairs and Northern Development Canada
AMS	Arrow Mining Services Inc.
BC	British Columbia
BCEAA	British Columbia *Environmental Assessment Act*
BCEAO	British Columbia Environmental Assessment Office
BC MFML	British Columbia Ministry of Forests, Mines and Land
BC MOTI	British Columbia Ministry of Transportation and Infrastructure
Bioaccumulate	To build up within the tissues of living organisms
BMP	Best Management Practice
CAC	criteria air contaminant
CAPMoN	Canadian Air and Precipitation Monitoring Network
CCME	Canadian Council of Ministers of the Environment
CEAA	*Canadian Environmental Assessment Act*
CMHC	Canada Mortgage and Housing Corporation
CPM	Collision prediction model
CPPI	Canadian Petroleum Products Institute
CRA	Cumulative Risk Assessment
CWB	Community Well-being
dB	Decibels
EA	environmental assessment
EB	Empirical Bayes
FSR	Forestry Service Road
GHG	greenhouse gas
HA	High Annoyance
IARC	International Agency for Research on Cancer
ICBC	Insurance Corporation of British Columbia

ICMI	International Cyanide Management Institute
IUCN	International Union for the Conservation of Nature
LKI	Landmark Kilometre Inventory
LRMP	Land and Resource Management Plan
LOS	Level of Service
MAWTP	Mine Area Water Treatment Plant
MSDS	Materials Safety Datasheet
NWA	Nass Wildlife Area
pc/h	Passenger cars per hour
PDO	Property Damage Only
PVA	Population Viability Analysis
RAAD	Remote Access to Archaeological Data
RAU2	Rural Arterial Undivided Two-Lane
SADT	Summer Average Daily Traffic
SARA	*Species at Risk Act*, 2002
Seabridge	Seabridge Gold Inc.
SRMP	Sustainable Resource Management Plan
TDG	Transportation of Dangerous Goods
the Project	the KSM Project
the Study Area	The Highways 37 and 37A Traffic Effects Assessment Study Area
TMF	Tailing Management Facility
TRIM	Terrain Resource Information Management
UWR	Ungulate Winter Range
VC	Valued Component
VHF	Very High Frequency
WARS	Wildlife Accident Reporting System
WHA	Wildlife Habitat Area
WHMIS	Workplace Hazardous Materials Information System

1. Introduction

1.1 OVERVIEW

Seabridge Gold Inc. (Seabridge) is proposing to develop the KSM Project (the Project), a gold, copper, silver and molybdenum mine located in the mountainous terrain of northwestern British Columbia (BC), approximately 950 km northwest of Vancouver, and approximately 65 km northwest of Stewart, BC. The Project is subject to the British Columbia *Environmental Assessment Act* (BCEAA) and the *Canadian Environmental Assessment Act* (CEAA).

The KSM Highways 37 and 37A Traffic Effects Assessment meets the requirements of the Section 13 order issued by the BC Environmental Assessment Office (BCEAO) on September 29, 2011, which amended the Section 11 order issued on November 6, 2009. The Section 13 order requires Seabridge to assess the potential effects arising from the transport of people, goods and materials, including, but limited to fuel, hazardous cargo and explosives along access roads and Highway 37 between the proposed Project site and its junction with Highway 16 at Kitwanga. This report focuses on the potential effects of Project-related traffic travelling on highways 37 and 37A and addresses the Section 13 order (Appendix A) requirement to assess the potential effects on the Nisga'a Nation, and the Tahltan, Gitanyow, and Gitxsan Nation (including the Skii km Lax Ha) First Nations within the Project transportation corridor. The results will also be relevant to non-Aboriginal people who may be affected by Project traffic along highways 37 and 37A. The use of existing and proposed access roads off of these two main transportation corridors (highways 37 and 37A) to the Project site will be assessed in Seabridge's Application for an Environmental Assessment Certificate.

Traffic-related issues and concerns have been a part of Project discussions since initiation of the environmental assessment (EA) process and through the pre-Application stage. Issues raised by Nisga'a Nation, First Nations, local governments, and federal and provincial agency representatives include:

- concern about the potential increase in wildlife mortality levels on Highway 37 as a result of increased traffic;
- concern about potential effects on traditional medicine along the haul route;
- concern about emissions generated from trucking ore to Stewart, and accidents and malfunctions;
- inclusion of transportation routes in the spatial boundary for the Project;
- request to report Project-related traffic estimates; and
- concern about Project traffic cargo such as acid solvents, explosives and other dangerous materials/hazardous cargo.

This report has considered the input from government, Nisga'a Nation, and First Nations as a result of Traffic Working Group meeting was held on July 9, 2012 in Terrace, BC and in subsequent correspondence. Appendix F details the comments provided, Seabridge's responses, and where applicable provides a reference to relevant sections in the report.

This document is organized into the following sections:

- **Project Description:** A description of highways 37 and 37A, summary of historical traffic on these highways, an overview of the proposed Project and transportation requirements during construction, operation, closure and post-closure, and projected traffic volumes from the Project.
- **Vehicle Accidents on highways 37 and 37A:** A description of vehicle accident statistics and an analysis predicting the potential for traffic-related accidents.
- **Effects and Risk Assessment Methods:** A step-by step explanation of the risk assessment methods, including definitions for transportation-specific risk ratings, used to assess potential effects of traffic on environmental and socio-economic Valued Components (VCs).
- **Assessment of the Potential Risks of Project Traffic:** An assessment of potential risks related to Project traffic following the methods described in the Effects and Risk Assessment Methods section, grouped by assessment topic (i.e., Socio-economics, Fish and Aquatic Habitat, Wildlife, Terrestrial Ecosystems, Wetlands, Noise, Climate and Air Quality, Human Health, and Heritage). "Project Traffic" is used to describe planned Project traffic activities.
- **Summary of the Potential Risks of Traffic Accidents:** A risk assessment approach that evaluates the probability and severity of potential effects of accidents and malfunctions for each assessment topic. Traffic Accidents are divided into "**off-road**" and "**on-road**" accidents. "On-road" refers to a traffic accident where vehicles remain on the travelled part of the road, while "off-road" refers to accidents that result in a vehicle leaving the travelled part of the road.
- **Summary of Mitigation and Environmental Management:** A description of mitigation objectives and actions that apply specifically to the proposed highway haul route.
- **Cumulative Risk Assessment:** An assessment of risk from the proposed Project from highway traffic and accidents combined with highway traffic effects from other present and reasonably foreseeable future projects.
- **Summary of Highway Traffic Effects Assessment:** A summary of the findings and conclusions of this study and the risk ratings for Project-related traffic by assessment topic.

1.2 SCOPE

The Highways 37 and 37A Traffic Effects Assessment Study Area (the "Study Area") encompasses approximately 300 km of Highway 37 from the Eskay Creek Mine Access Road junction, southeast to its junction with Highway 16 in Kitwanga; and approximately 65 km of Highway 37A from Meziadin Junction to the District of Stewart. The Study Area includes a 500 metre buffer on either side of the highways (Figure 1.2-1).This assessment considers the potential effects of Project-related traffic within the Study Area for the phases of the Project:

- construction (5 years);
- operation (51.5 years);
- closure (3 years); and
- post-closure (250 years).

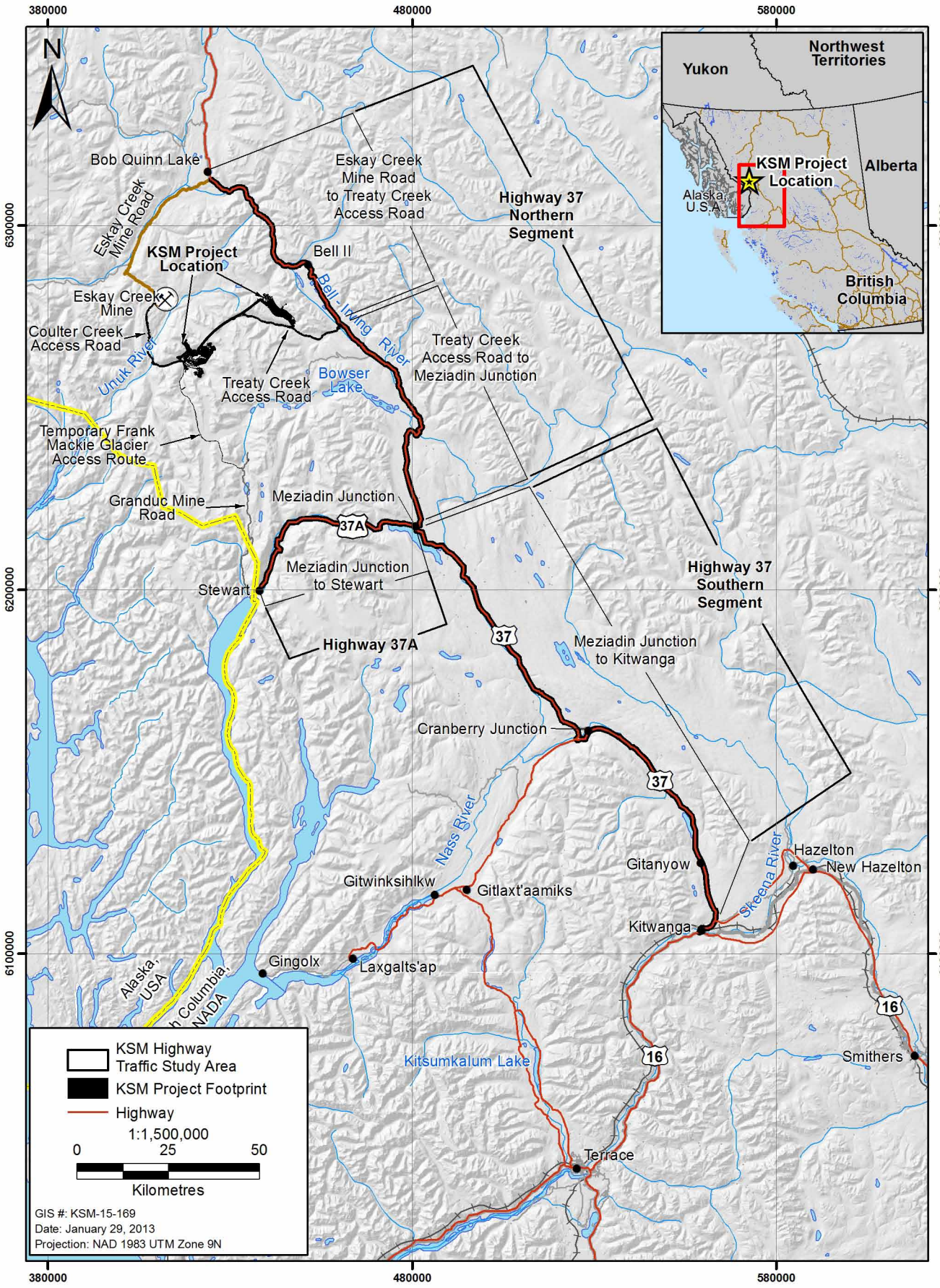

Figure 1.2-1

KSM Project Traffic Study Area

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2. Project Description

2.1 HIGHWAYS 37 AND 37A DESCRIPTION

Highway 37, a provincial highway, runs 725 km through northwestern British Columbia, travelling north from the Kitwanga Junction to Junction 37, where it meets the Alaska Highway in the Yukon Territory. Along the way, it passes through Meziadin Junction, Bell II, Bob Quinn Lake, Iskut, Dease Lake, and Good Hope Lake.

Highway 37 is one of only two overland routes to Alaska and it connects a number of small settlements in the region. The highway was first developed as a logging and mining road, and paved in the 1970s. Improvements including road straightening and widening to the Highway have been made in in recent years.

Highway 37A, also a provincial highway, branches westward from Highway 37 at Meziadin Junction and terminates at Stewart, BC, near Hyder, Alaska.

As described in Section 1.2, the Study Area includes Highway 37 from the Eskay Creek Mine Access Road junction, southeast to junction with Highway 16; and Highway 37A from Meziadin Junction to the District of Stewart (Figure 1.2-1).

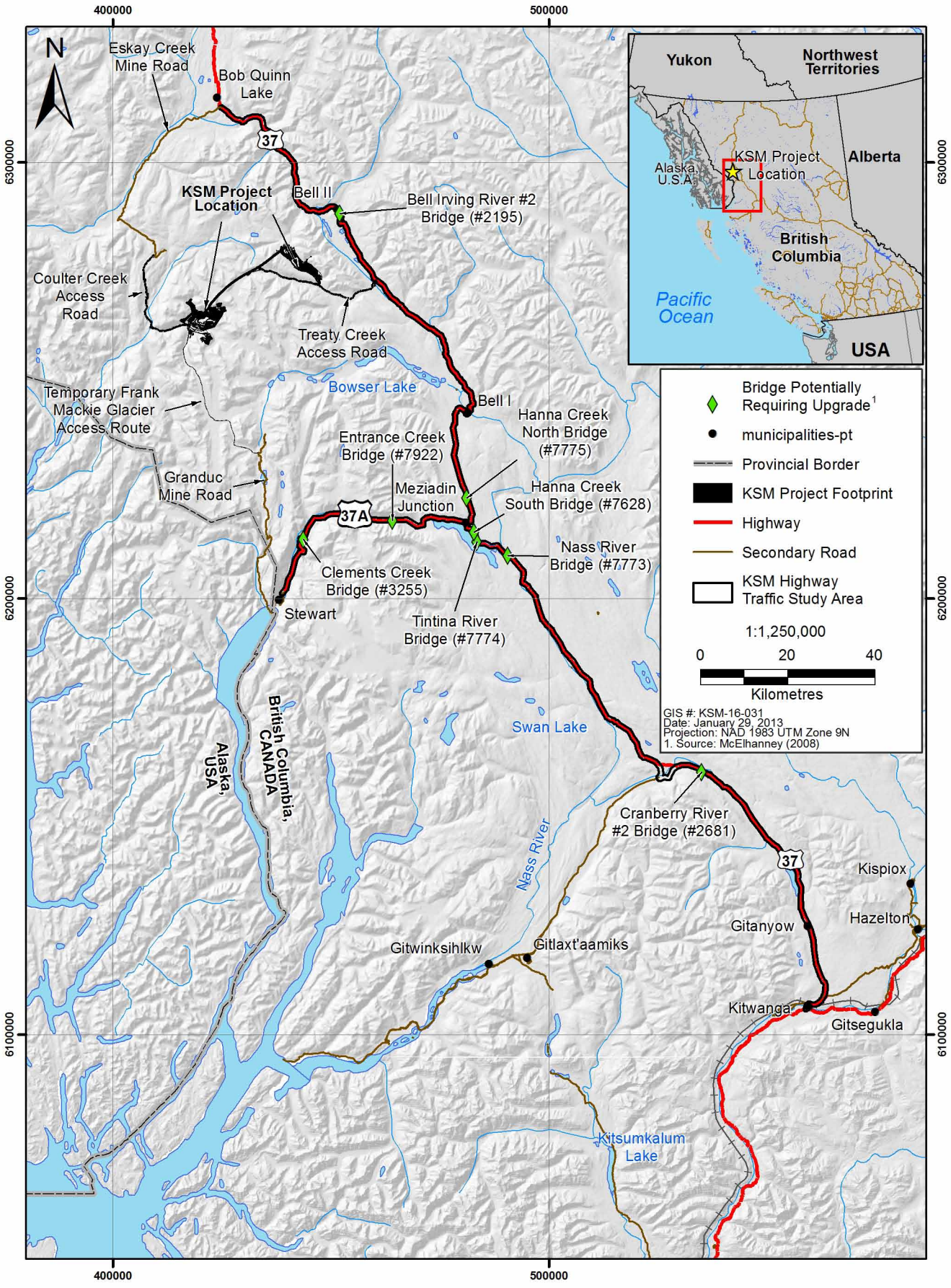
2.1.1 Highway Condition

Highway 37 is suitable for a range of vehicle types. Most of the road is hard-surfaced (either paved or seal-coated), although there are some gravelled sections north of Iskut. The speed limit ranges from 80 to 100 km/h, and is 90 km/h from Meziadin Junction to the Yukon border (S. Applegate, pers. comm., 2012). Most of the Highway is double-lane, although lane markings may not be present and single-lane bridges are common.

Road conditions depend on the season and the weather; potholes and broken seal coat are common year-round. The British Columbia Ministry of Transportation and Infrastructure (BC MOTI) is responsible for repairs and improvements to Highway 37. Construction and maintenance occurs throughout the year, and is mainly focused on the southern half of the Highway. The Highway is sanded and cleared of snow in the winter, and gravelled sections are graded in the summer (BC MOTI 2011c).

It is anticipated that some bridge crossings along highways 37 and 37A will require upgrading in order to accommodate vehicle equipment loads for the Project (Wardrop 2011). A study conducted by McElhanney (2008) identified potential issues with the following bridge sites which fall within the Study Area (see Figure 2.1-1):

- Clements Creek Bridge (#3255);
- Entrance Creek Bridge (#7922);
- Bell Irving River Bridge # 2 (#2195);
- Hanna Creek North Bridge (#7775);
- Hanna Creek South Bridge (#7628);
- Nass River Bridge (# 7773);
- Cranberry River Bridge #2 (#2681);
- Tintina River Bridge (#7774).



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Highway Bridge Sites Requiring Upgrading

Figure 2.1-1

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While some of these bridge sites in the McElhanney report were identified as being scheduled for upgrading in 2009, or requiring further field investigation, no upgrades to these bridges have been completed, and only one upgrade (Nass River Bridge #7773) is currently being undertaken, scheduled to be completed at the end of March, 2013 (S. Applegate, pers. comm., 2012). Additionally, recent extreme weather events (notably in September of 2011) are known to have washed out bridge and crossing structures along Highway 37. These events may have resulted in additional work being required to bridge crossings along Highway 37.

2.1.2 Highway Services

There are limited services along Highway 37 (Table 2.1-1). There are no services along Highway 37A.

Table 2.1-1. Highway 37 Services

Location	Distance (South to North)	Facilities
Kitwanga	0 km	Gas, diesel, minor repairs, restaurant
Gitanyow	24 km	Gas, diesel, groceries
Bell II	249 km	Gas, diesel, minor repairs, restaurant
Tatogga	392 km	Gas, diesel, restaurant (summer only)
Iskut	405 km	Gas, diesel, groceries
Dease Lake	480 km	Gas, diesel, repairs, groceries, propane
Jade City	595 km	Gas and diesel
Good Hope Lake	629 km	Gas, diesel, store
Junction 37 and Alaska Highway	727 km	Gas, diesel, minor repairs and restaurant

Source: BC MOTI (2011c).

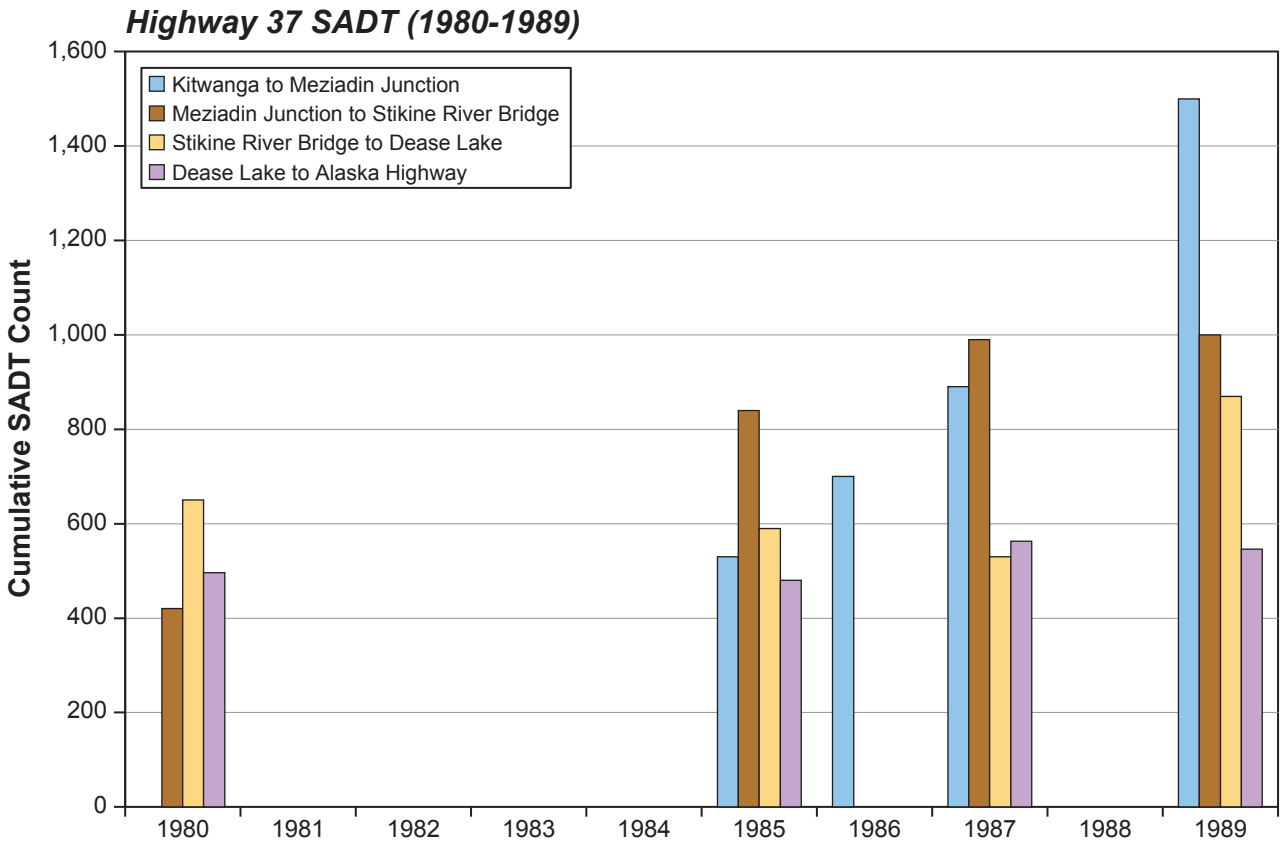
Fuel, basic supplies, and restaurant facilities are available at the Kitwanga Junction. Meziadin Junction used to offer fuel, food, and a campground; however, these facilities have been closed for the past few years. Bell II has accommodation, a restaurant, and a gas bar. Heading north, the next services are in Iskut, Tatogga and Dease Lake.

2.1.3 Historical Traffic

Traffic data collected between 1985 and 2001 for four segments of Highway 37 (Kitwanga to Meziadin Junction, Meziadin Junction to Stikine River Bridge, Stikine River Bridge to Dease Lake and Dease Lake to Alaska Highway) are available through the BC MOTI database (BC MOTI 2011e). The data set between 1980 and 1985 is limited because the data was not collected for the entire highway or throughout the year. After 2001, most non-permanent traffic counters along Highway 37 were not used, except for a counter near Meziadin Junction in 2005, 2008 and 2010.

1980 to 1989

Traffic counts indicate that the highest traffic levels occurred in the southern section of Highway 37 during the 1980s. However, these data were not collected along the entire highway, nor were they collected every year (Figure 2.1-2). During this period, traffic counts were conducted in July and August to create a Summer Average Daily Traffic (SADT) count, measured in one-way trips. The SADT count likely represents the highest annual traffic volume along the highway, since peak traffic levels are typically in the summer. Traffic counts include recreational, resource, and commercial traffic; however, the data does not distinguish between the three. Data were either not available or not collected on some sections of the highway during this period. Due to a lack of available traffic data, 1981 to 1984 and 1988 counts are not considered here (BC MOTI 2011e).



Note: Where gaps are present, data is unavailable for those years.
Source: BC MOTI 2011d.

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Summer Average Daily Traffic on Highway 37, 1980 to 1989

Figure 2.1-2

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SADT counts on the Highway 37 between Kitwanga and Meziadin Junction increased every year from 1985 to 1989. In 1989, the peak daily traffic count reached approximately 1,500. Between Meziadin Junction and the Stikine River Bridge, north of Iskut, SADT counts ranged from 840 to 1,100 (BC MOTI 2011e).

Traffic north of the Stikine River Bridge was on average 22% less than traffic on the southern portions of the highway (BC MOTI 2011e).

1990 to 1999

Between 1990 and 1999, traffic volume along Highway 37 remained high, continuing the steady increase that began in the 1980s (Figures 2.1-3a and 2.1-3b). Summertime traffic patterns fluctuated from year to year, but overall Annual Average Daily Traffic (AADT) counts, starting in 1994, remained relatively consistent and slightly lower than SADT counts. Generally, the highest counts occurred at the south end of the route between Kitwanga and Meziadin Junction. Traffic along the northern sections steadily increased from 1990 to 1995. Traffic volume along the entire stretch of the highway rose in the mid-1990s, and then dropped from 1996 to 1999 (BC MOTI 2011e).

In 1992, 1994, and 1995, a significant increase in traffic was noted between the Stikine River Bridge and Dease Lake. An average 944 SADT was measured over 1994 and 1995, 47% higher than the average along that section in the 1990s (BC MOTI 2011e). Forestry traffic may have been a contributor to these increases (see Section 2.1.3.2).

2000 to 2011

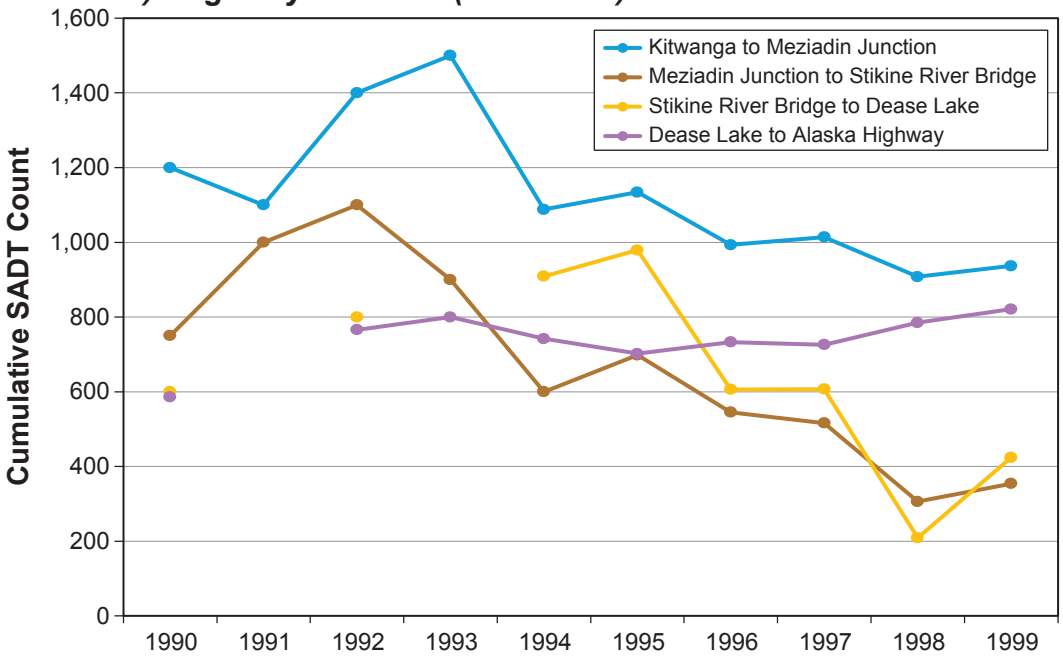
After 2001, non-permanent traffic counters were not used along Highway 37. The only permanent counter along the route, found along the southern segment at the junction of highways 16 and 37, does not provide an accurate count for Highway 37 traffic. However, periodic traffic counts for the northern section of the highway taken in 2005 and 2008 north of Meziadin Junction, and in 2006 north of Dease Lake (Table 2.1-2 and Figures 2.1-4a and 2.1-4b), serve as approximate indicators of traffic trends along the route (BC MOTI 2011e).

Table 2.1-2. Highway 37 Annual Average Daily Traffic and Summer Average Daily Traffic by Year

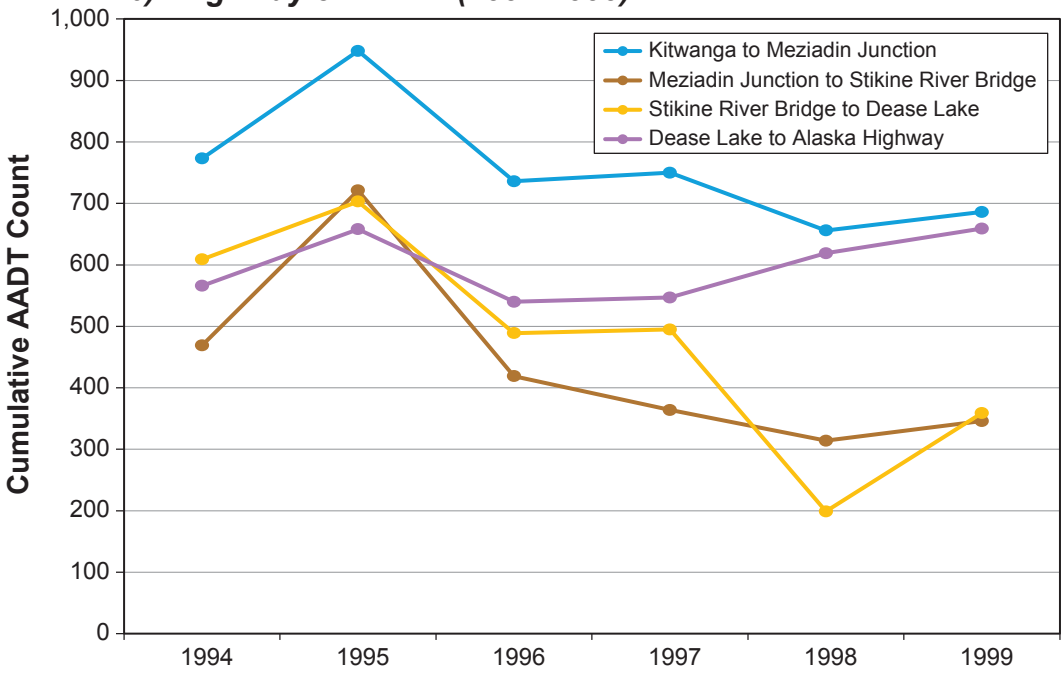
	Southern Segment		Northern Segment	
Year	AADT Count	SADT Count	AADT Count	SADT Count
2000	698	851	469	593
2001	707	854	405	510
2002	-	-	-	-
2003	-	-	-	-
2004	918	1,182	-	-
2005	816	1,111	238	356
2006	795	1,171	-	-
2007	838	-	-	-
2008	740	1,011	224	378
2009	760	-	-	-
2010	709	977	210	-
2011	828	1,104	-	-

- : No data
Source: BC MOTI (2011e)

a) Highway 37 SADT (1990-1999)



b) Highway 37 AADT (1994-1999)



Note: Where gaps are present, data is unavailable for those years.
Source: BC MOTI 2011d.

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Summer Average Daily and Annual Average Daily Traffic on Highway 37, 1990 to 1999

Figure 2.1-3

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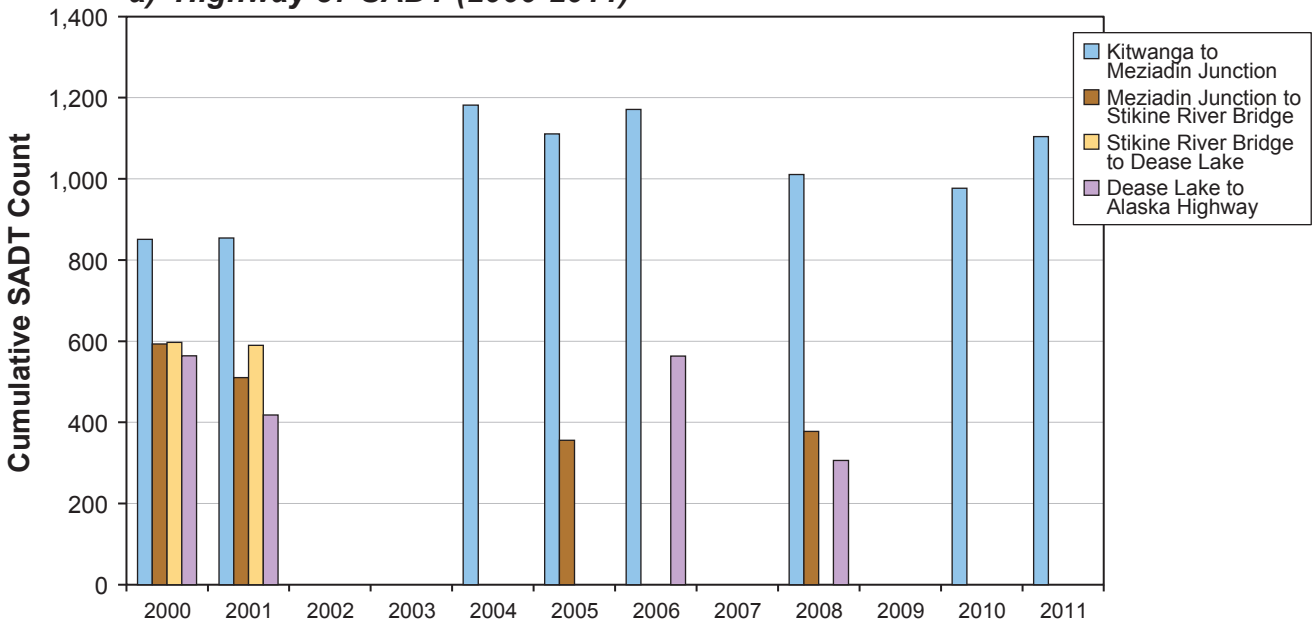
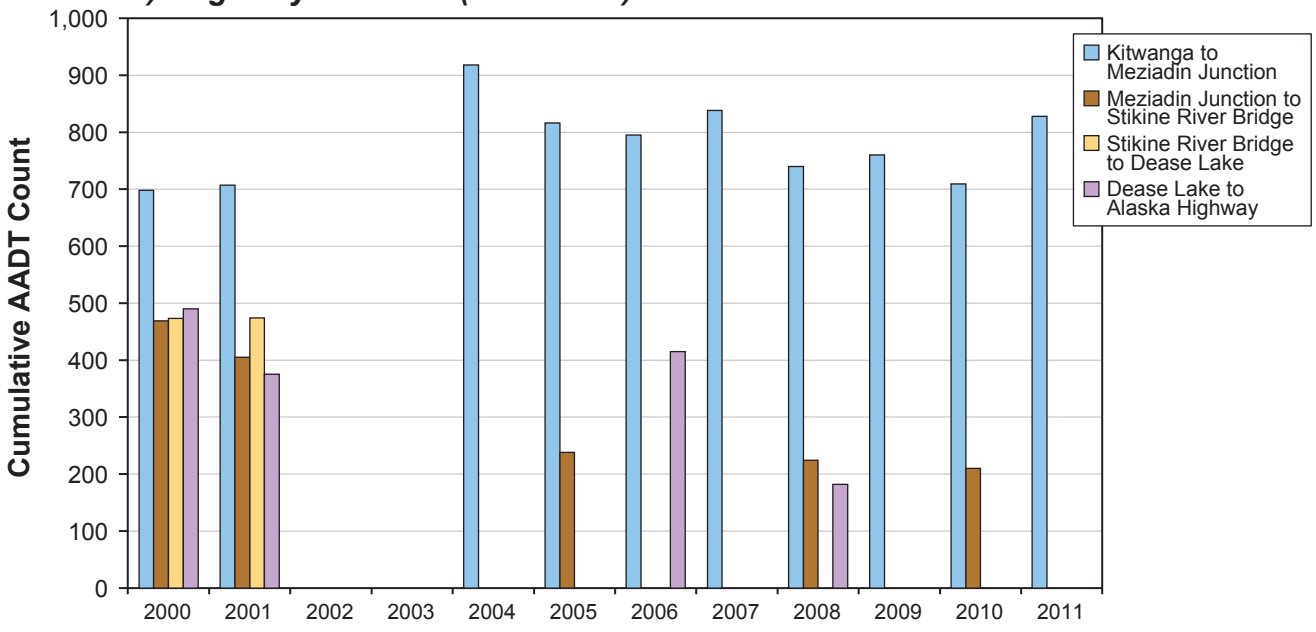
a) Highway 37 SADT (2000-2011)



b) Highway 37 AADT (2000-2011)



Note: Where gaps are present, data is unavailable for those years.
Source: BC MOTI 2011d.

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Summer Average Daily and Annual Average Daily Traffic on Highway 37, 2000 to 2011

Figure 2.1-4

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Overall, traffic levels were lower in the 2000s than in the previous decades. Traffic patterns were very similar, with more vehicles recorded between Kitwanga and Meziadin Junction than elsewhere (Table 2.1-2). Traffic volume increased during the summer between the Stikine River Bridge and Dease Lake.

2.1.3.1 Mining Haul Traffic

Recently, mining haul traffic along highways 37 and 37A has occurred from the Eskay Creek Mine (north of Meziadin Junction) and the Huckleberry Mine (south of Meziadin). Both mines hauled product to the port of Stewart. Until the spring of 2008, four or five haul trucks from the Eskay Creek Mine and about ten trucks from the Huckleberry Mine travelled the highway each day (AMS, pers. comm., 2010). The Eskay Creek Mine ceased production in the spring of 2008.

Highway 37

Arrow Mining Services Inc. (AMS) has provided haul services for mine projects in the region over the past several decades and it is expected to provide similar services for the KSM Project. AMS uses "B-Train" type side dump trailers that have a total payload of approximately 40 tonnes (AMS, pers. comm., 2010).

Data were collected in 2010 from AMS, who provided haul services for Barrick Gold's Eskay Creek and Imperial Metal's Huckleberry mine in the region during their operation between 2000 and 2009. Table 2.1-3 summarizes AMS data for the Eskay Creek and Huckleberry mines based on three haul routes. These two mines generally operated year round.

Table 2.1-3. Mining Average Annual Daily Traffic by Route

	Eskay Creek Mine		Huckleberry Mine
Destination	**Stewart**	**Highway 16**	**Stewart**
Highway 37 Section	**Bob Quinn Lake Area/Meziadin Junction**	**Bob Quinn Lake Area/Kitwanga**	**Kitwanga/ Meziadin Junction**
2000	6	9	15
2001	6	13	20
2002	6	13	19
2003	9	12	19
2004	9	14	16
2005	4	11	18
2006	3	5	17
2007	2	4	14
2008	0	1	9
2009	0	0	10

Note: Bob Quinn Lake Area refers to the Eskay Creek Mine road/Highway 37 junction.
Source: AMS (pers. comm., 2010).

The Eskay Creek Mine used two haul routes along Highway 37: from the Highway 37 junction with Eskay Creek Mine road to Meziadin Junction, and from the Highway 37 junction with the Eskay Creek Mine road to Kitwanga. The Huckleberry Mine used one haul route from between Kitwanga and Meziadin Junction to Stewart. Based on AMS's total haul traffic figures for these routes an AADT was calculated for each route (Table 2.1-4). Figure 2.1-5 is a synthesis of these routes, calculating cumulative traffic for each section of Highway 37.

Table 2.1-4. Combined Annual Average Daily Traffic from Eskay Creek and Huckleberry Mines on Highway 37

	Bob Quinn Lake /Meziadin		Kitwanga/Meziadin Junction	
Year	Mining Haul AADT	% of total AADT	Mining Haul AADT	% of total AADT
2000	15	3%	24	3%
2001	19	5%	32	5%
2002	19	-	32	-
2003	21	-	31	-
2004	23	-	30	4%
2005	15	6%	30	4%
2006	8	-	23	3%
2007	5	-	18	2%
2008	1	1%	11	1%
2009	0	-	10	1%

Note: Bob Quinn Lake Area refers to the Eskay Creek Mine road/Highway 37 junction.
Source: AMS (pers. comm., 2010).
- : Data not available, only periodic traffic counts were taken in 2005 and 2008 north of Meziadin Junction.

Mining haul traffic between 2000 and 2009 was concentrated along the Kitwanga to Meziadin Junction segment of Highway 37. Mining traffic generally peaked between 2001 and 2005 while both Eskay Creek and Huckleberry mines were in full operation. By 2006 Eskay Creek Mine had slowed production, and the mine closed in 2008 (BC MEMPR 2012). During these periods, mine haul traffic accounted for between 1 and 5% of total traffic along the Kitwanga to Meziadin Junction segment of Highway 37, and between 1 and 6% of the overall traffic AADT from Bob Quinn Lake area to Meziadin Junction (Table 2.1-3). Huckleberry Mine traffic is expected to continue as the life of the mine is being extended from 2014 to 2021 (Imperial Metals Corp. 2012). Additional mining-related traffic in 2010 included Yukon Zinc's Wolverine Mine in the Yukon, which began hauling to the port of Stewart along highways 37 and 37A at an estimated rate of 18 one-way trips per day (Tobin 2009).

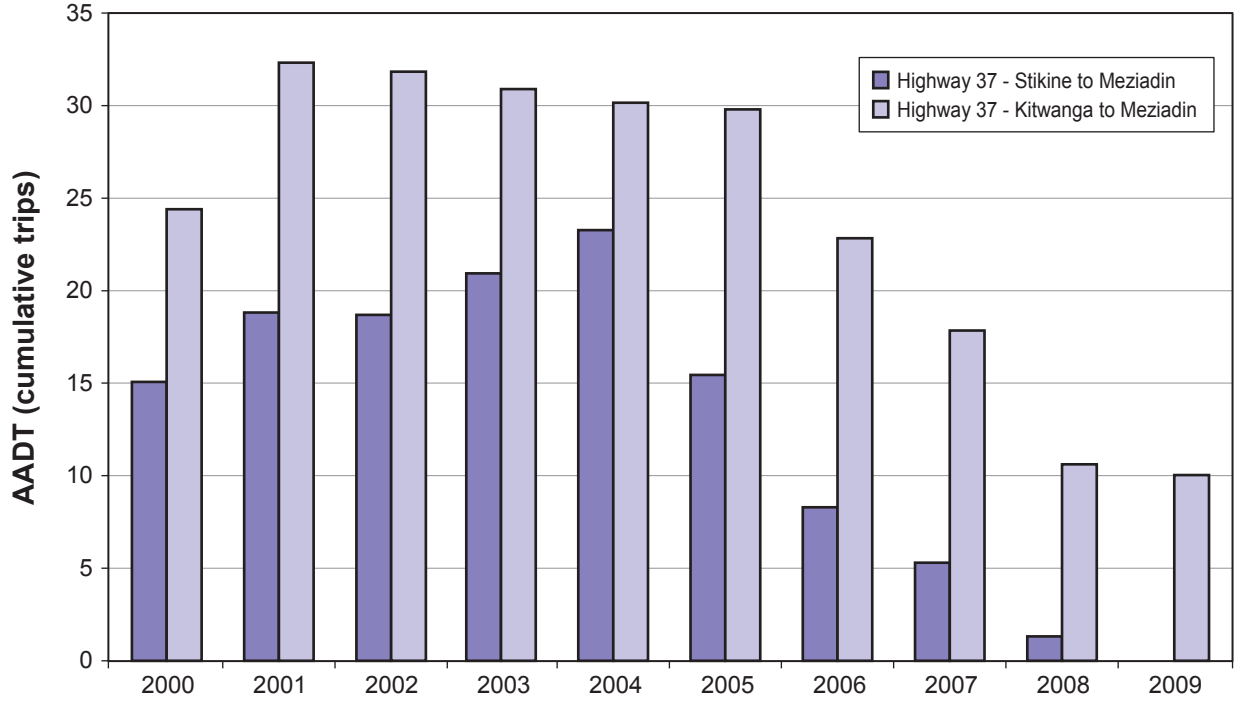
Highway 37A

Combined traffic from the Eskay Creek and Huckleberry mines along Highway 37A is presented in Figure 2.1-6. Based on the cumulative AADT of AMS's haul trucks along Highway 37A, an average of 24 one-way trips were made between 2000 and 2006 (AMS, pers. comm., 2010). Haul traffic began declining in 2007 when the last haul by AMS was recorded from the Eskay Creek Mine. In 2009, a total of 10 one-way trips per day were made from the Huckleberry Mine along Highway 37A. Between 2000 and 2008, haul traffic along Highway 37A accounted for between 4 and 7% of overall AADT along the route (Table 2.1-5).

2.1.3.2 Forestry Traffic

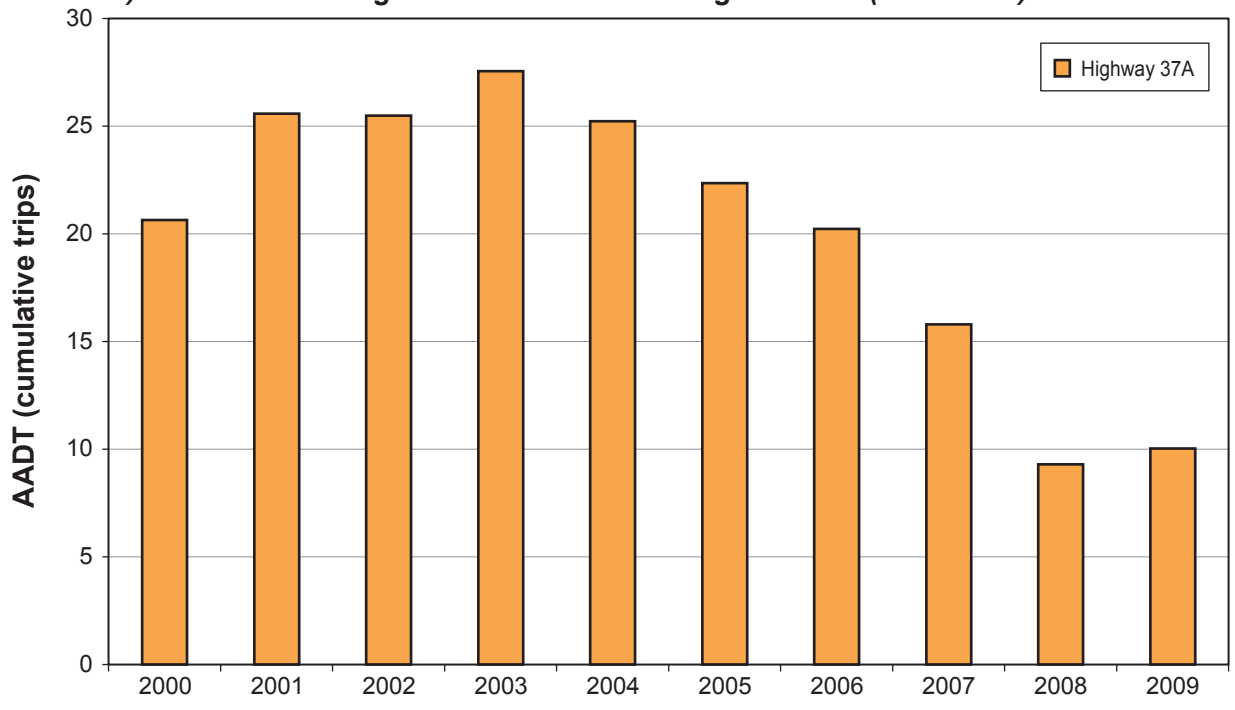
Forestry hauling information was collected from the BC Ministry of Forests, Mines and Lands (BC MFML 2010a, 2010b). There are no available historical data regarding the number of forestry haul trucks on Highway 37. To determine the contribution of forestry haul traffic to historical SADT, estimates were derived from the total volume (in cubic metres) of wood scaled within the Kalum Forest District between 1995 and 2009. This only includes forestry trucks from the Skeena Stikine Forest District, and the former Kispiox Forest District (G. Olsen, pers. comm., 2011). The forestry trucks included in these data would have travelled along highways 37 and 37A to various sites, travelling from the Brown Bear Forestry Service Road (FSR), north of Meziadin Junction into Stewart.

a) Combined Mining Traffic for Arrow Mining Services (2000-2009)



Source: AMS (Pers. Comm., 2010).

b) Combined Mining Traffic for Arrow Mining Services (2000-2009)



Source: AMS (Pers. Comm., 2010).

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Combined Annual Daily Traffic from Eskay Creek and Huckleberry Mines on Highways 37 and 37A

Figure 2.1-5

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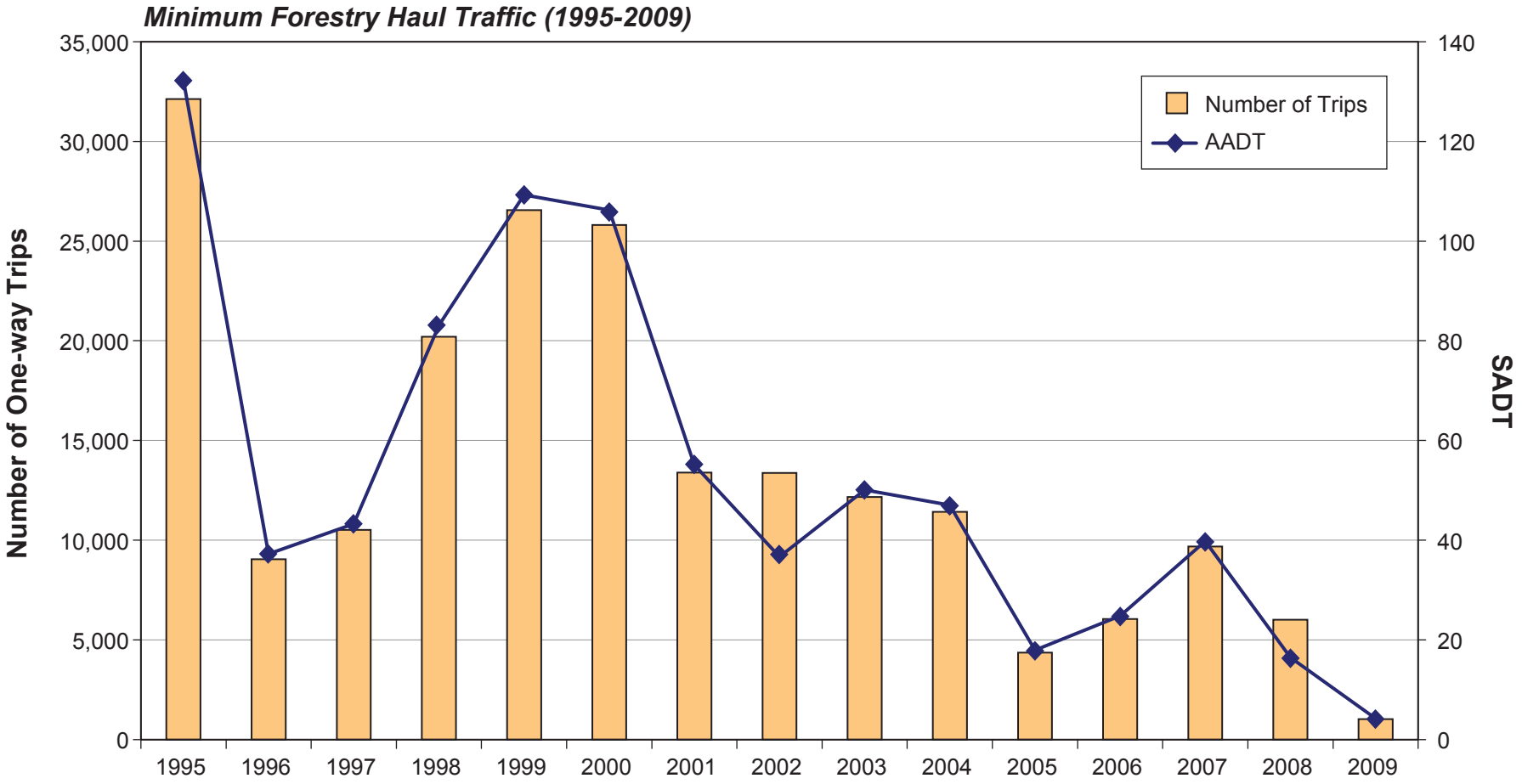

Note: SADT represents forestry harvest season in the Stewart area, which occurs between late-November and mid-March, and late-June and mid-October.
Source: BC MFML 2010.

Figure 2.1-6

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Minimum Forestry Haul Traffic from Brown Bear Forest Service Road to Stewart between 1995 and 2009

Figure 2.1-6

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Table 2.1-5. Combined Annual Average Daily Traffic from Eskay Creek and Huckleberry Mines on Highway 37A

	Highway 37A	
Year	Mining Haul AADT	% of Total AADT
2000	21	4%
2001	26	6%
2002	25	-
2003	28	-
2004	25	-
2005	22	7%
2006	20	-
2007	16	-
2008	9	4%
2009	10	-

Source: AMS (pers. comm., 2010).
- : Data not available as permanent traffic counters along Highway 37A were removed in 2001.

Since traffic figures are estimates based on overall volume of wood scaled, they may be considered the approximate minimum number of forestry haul trips for each year along this route. Other logging traffic not accounted for in these data may include logging trucks that were scaled elsewhere that may have driven on highways 37 and 37A, and logging traffic travelling between the Yukon border and Smithers, which has accounted for up to approximately 30 to 40 truckloads of processed timber per year (Rescan 2010a).

Through the 1990s, raw log transport between the Brown Bear FSR and Stewart was a significant contributor to highway traffic. Harvesting in the region typically occurs from late November through to mid-March, and from late June to mid-October. Freezing and thawing periods were not included as forestry roads are unusable during these periods. Peak periods for forestry haul traffic occurred in the late 1990s. During this time, between 10,000 and 16,000 loads were transported each year (Figure 2.1-6). By 2001, a downturn in the regional forestry industry resulted in a significantly lower volume of haul traffic. This trend continued through the 2000s, with an average 8,600 one-way trips annually between 2001 and 2009. The slowest year to date is 2009, with 1,020 one-way trips, and an AADT of 3 (Figure 2.1-6). Forestry traffic was approximately 16 and 38% of overall AADT during peak years, but less than 10% during slow forestry years (Table 2.1-6). A decline in the Japanese timber export market in 1996 and 1997 resulted in a significantly lower volume of traffic (G. Olsen, pers. comm., 2011).

2.1.3.3 Commercial Traffic

Highway 37

A number of commercial carriers have operated in northwestern BC over the past 30 years, including Lindsay's Cartage and Storage, Canadian Freightways and Bandstra Transportation Systems. Commercial haul traffic includes goods, heavy equipment, container shipping and mining services; however, Bandstra has not hauled industrial mining shipments since the 1990s (Van Essen, pers. comm.). Currently, Canadian Freightways and Bandstra are the most active carriers along the Highway 37 corridor. Over the past ten years Bandstra has provided an average of two regularly scheduled trips to Stewart and two to Dease Lake per week. Peak years during this period were 2007 and 2008, which averaged one round trip per day along Highway 37, with a maximum of six round trips per day. Increased traffic during these two years was primarily associated with development related to the Galore Creek mining project (Van Essen, pers. comm.).

Table 2.1-6. Forestry Haul Traffic as a Percentage of Overall Summer Average Daily Traffic on Highways 37 and 37A

Year	Forestry Haul SADT	Percent of Total SADT[1] Highway 37, Meziadin to Stikine	Percent of Total SADT[1] Highway 37A
1995	132	18%	16%
1996	37	9%	6%
1997	43	12%	6%
1998	83	26%	34%
1999	109	32%	38%
2000	106	23%	19%
2001	55	14%	10%
2002	37	-	-
2003	50	-	-
2004	47	-	-
2005	18	8%	-
2006	25	-	-
2007	40	-	-
2008	16	7%	-
2009	4	-	-

[1]SADT represents forestry harvest season in the Stewart area, which occurs between late-November and mid-March, and late-June and mid-October.
- Data not available, only periodic traffic counts were taken in 2005, and 2008 north of Meziadin Junction.

Highway 37A

Through the 2000s, Bandstra Transportation Systems averaged two scheduled shipments per week to Stewart (Van Essen, pers. comm.). Other commercial carriers in the region include Canadian Freightways.

2.1.3.4 Average Commercial Truck Speed

BC MOTI conducted a study on the speeds of heavy long-distance commercial trucks on provincial highways between 2004 and 2005 (BC MOTI 2006). Satellite tracking data revealed that average speeds were approximately 80 km/h in uncongested rural areas of the province, and typically lower (as low as 25 km/h) in urban areas. Commercial truck traffic was found to travel at approximately 80% of the posted speed limit. The average posted speed along Highway 37 between Kitwanga and the Yukon border was just above 80 km/h, while observed average truck speeds were approximately 70 km/h in 2004 and 65 km/h in 2005. Just recently, the speed limit on Highway 37 from Meziadin Junction to the Yukon border has been increased to 90 km/h (S. Applegate, pers. comm., 2012)

2.1.4 Highway Capacity

The capacity of a highway is reached when the Level of Service (LOS) reaches a rating of "E"[1] A report conducted by McElhanney for the Project (2011, Appendix B), based on traffic volume data collected in 2008, and using methodologies outlined in the Highway Capacity Manual (TRB 2000), estimated that the capacity of Highway 37 for a representative segment of highway (rolling terrain and 40% of length

[1] LOS for a highway is rated, in descending quality, as "A" (highest), "B", "C", "D" and "E"(lowest), based on criteria such as the percentage of time a driver is immediately behind another vehicle, the two-way hourly volume (measured in vehicles per hour), and the two-way flow rate (pc/h). See Table 2 in Appendix B for further details.

no-passing) is a two-way volume of 1,260 passenger cars per hour (pc/h), or 630 pc/h in each direction[2]. Commercial trucks are equivalent to 2.5 passenger cars, modifying the capacity to 504 commercial vehicles per hour two-way or 252 commercial vehicles per hour one-way. Highway 37 operated at LOS "A" based on data collected in both 1992 and 2008. It was predicted that peak hour traffic volumes would have to increase by 300% over 2008 volumes (73 pc/h) for the highway to be downgraded to LOS "B". In other words, Highway 37 has significant excess capacity available.

2.2 KSM PROJECT OVERVIEW

The Project intends to mine four mineral deposits: Kerr, Sulphurets, Mitchell and Iron Cap, which contain significant amounts of gold, copper, silver and molybdenum. The Project footprint will consist of two distinct and geographically separate areas: the Mine Site, and the Process Plant and Tailing Management Area (PTMA).

The Mine Site is located in the drainage basin of Sulphurets Creek, a tributary of the Unuk River. It will be accessed via the existing Eskay Creek Mine road and the new, 34-kilometre Coulter Creek access road. Mining operations will include open pit mining of the Kerr, Sulphurets and Mitchell pits, and underground mining of the Mitchell and Iron Cap deposits later in operation. Ore from the Mine Site will be conveyed through 23 km twin tunnels to the Process Plant. Waste rock will be stored near the open pits. Surface water that contacts disturbed areas will be collected via a Water Storage Pond and treated at a Water Treatment Plant, as appropriate.

The PTMA will be located in the upper Teigen Creek/Treaty Creek valley; both of these creeks flow into the Bell-Irving River. A new road along Treaty Creek and North Treaty Creek will connect the Process Plant to Highway 37. The Process Plant will process up to 130,000 tonnes of ore per day to produce approximately 1,200 tonnes of concentrate daily, which will be trucked to the Port of Stewart. The tailing will be pumped to the TMF. The TMF has capacity to hold all of the estimated 2.3 billion tonnes of tailing that will be produced over the estimated 51.5-year mine life.

2.3 TRANSPORTATION REQUIREMENTS

The Project will transport personnel, supplies, equipment and hazardous cargo including diesel fuel and lubricants, lime and reagents, explosives and concentrates, to and from the mine during the construction, operation, closure and post-closure phases. Examples of vehicles that will be used include bulk B-train trucks, and fuel tanker trucks (see Plates 2.3-1 and 2.3-2; Udovicic 2012).

The Project will use a marshalling/staging area in Smithers, BC or other nearby communities to receive and deliver equipment and supplies to the site during the construction and operation phases. Heavy equipment may be transported by transport truck, port or rail to the closest viable rail siding at Smithers, and then loaded onto transport trucks and taken to the Project site along Highway 16 or Highway 37 north to the junction of the Project access roads (Wardrop 2011).

The proposed transportation route for copper concentrate from the Project site is via highways 37 and 37A. Copper concentrate will be transported about 185 km by contract trucking firms to a storage and concentrate loading facility site near Stewart, where it will be loaded and shipped to overseas smelters in Asia (Wardrop 2011).

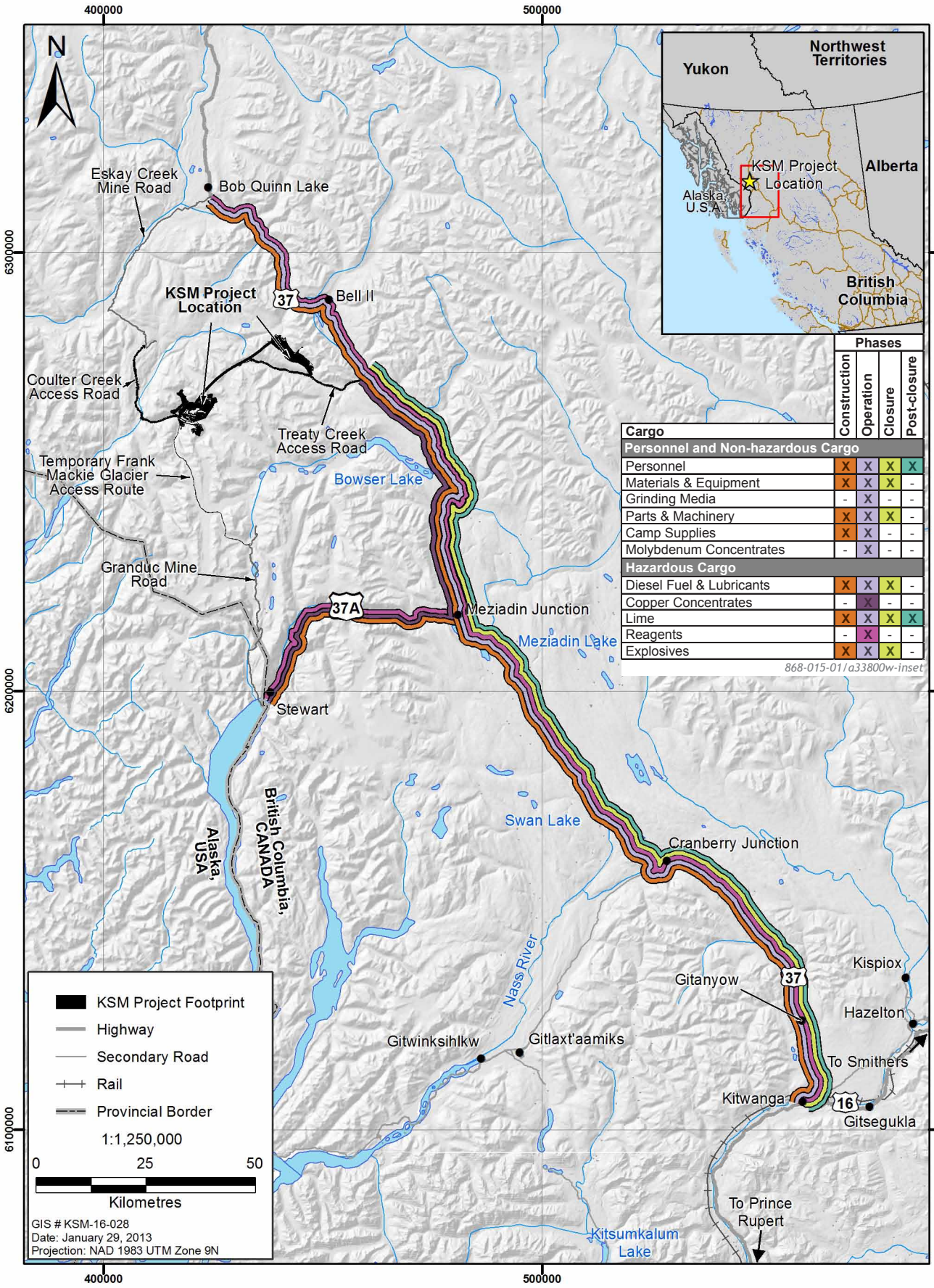
[2] For reference purposes, the base level capacity of a two-land highway assuming ideal conditions is 1,700 pc/h one-way or 3,200 pc/h for two-way scenarios.

Plate 2.3-1. Bulk B-train truck example.

Plate 2.3-2. Fuel tanker truck example.

Molybdenum concentrate will be transported in bags from the Project site via trucks along Highway 37 south and then Highway 16 west to the port of Prince Rupert. The bags will be transferred from the trucks to containers and then delivered to Fairview Terminal for loading onto an oceangoing vessel (Wardrop 2011).

Figure 2.3-1 illustrates the proposed cargo routes by Project phase, and identifies the cargo that will be transported during each phase, within the Study Area for this assessment.



Cargo	Phases: Construction	Operation	Closure	Post-closure
Personnel and Non-hazardous Cargo				
Personnel	X	X	X	X
Materials & Equipment	X	X	X	-
Grinding Media	-	X	-	-
Parts & Machinery	X	X	X	-
Camp Supplies	X	X	-	-
Molybdenum Concentrates	-	X	-	-
Hazardous Cargo				
Diesel Fuel & Lubricants	X	X	X	-
Copper Concentrates	-	X	-	-
Lime	X	X	X	X
Reagents	-	X	-	-
Explosives	X	X	X	-

Figure 2.3-1

KSM Project Traffic Study Cargo Routes

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2.4 PROJECTED TRAFFIC VOLUMES

Traffic volumes from the Project along highways 37 and 37A (measured in average annual one-way trips) were estimated by Wardrop in 2012 (Appendix C) based on the 2012 Pre-Feasibility Study (PFS) design and capital cost estimates for the Project.

Estimates were projected for the construction, operation, closure, and post-closure phases respectively, and are considered accurate at the time the report was prepared. Traffic volume estimates for the different highway segments within the Study Area were also identified (see Tables 2.4-1 through 2.4-4). For example, 48' Flat-Deck vehicles carrying infrastructure (shown in the first line of Table 2.4-1), there would be 613 one-way trips along Highway 37 from Kitwanga to Meziadin Junction. At Meziadin Junction, 218 vehicles turn and travel west along Highway 37A (to the temporary Frank Mackie Glacier access route), while 395 vehicles continue north along Highway 37 to the Treaty Creek access road junction. Of the 395 vehicles, 111 continue to the Eskay Creek Mine Road junction.

Table 2.4-1. Total Average Annual One-way Trips by Route for Construction

		Route			
Vehicle Type	**Cargo**	**Highway 37 (Eskay-Treaty Treaty-Eskay)**	**Highway 37 (Treaty-Meziadin Meziadin-Treaty)**	**Highway 37A**	**Highway 37 (Meziadin-Kitwanga Kitwanga-Meziadin)**
48' Flat-Deck	Infrastructure	111	395	218	613
Vans (Enclosed Trailers)	Infrastructure	36	132	72	204
48' Flat-Deck	Camps & Support Facilities	292	777	-	777
Vans (Enclosed Trailers)	Camps & Support Facilities	98	259	-	259
48' Flat-Deck	Mine Site	774	786	376	1,162
Vans (Enclosed Trailers)	Mine Site	258	261	126	387
48' Flat-Deck	Plant Site	-	2,380	-	2,380
Vans (Enclosed Trailers)	Plant Site	-	794	-	794
Bus & Passenger Vehicles	Crew Transport	427	861	10	871
48' Flat-Deck	Equipment	158	253	28	281
Vans (Enclosed Trailers)	Equipment	53	84	10	94
48' Flat-Deck	Materials	132	394	-	394
Vans (Enclosed Trailers)	Materials	44	132	-	132
48' Flat-Deck	Flocculant*	18	18	-	18
Bulk Tanker	Lime*	279	279	-	279
Tanker (45,000 L)	Fuel*	198	215	30	445
Vans (Enclosed Trailers)	Explosives*	5	21	10	31
Grand Total (Average Annual)		**2,883**	**8,041**	**880**	**9,121**
Total Average Annual Trips per Day**		**8**	**22**	**3**	**25**
Hazardous Materials Annual Trips per Day		**1**	**1**	**0**	**1**

Source: Wardrop 2012(Appendix C)
- is not applicable
0 is where numbers were rounded to 0
** counted in calculations for hazardous materials annual trips per day*
*** includes both hazardous and non-hazardous cargo*

Table 2.4-2. Total Average Annual One-way Trips by Route for Operation

Vehicle Type	Cargo	Route			
		Highway 37 (Eskay-Treaty Treaty-Eskay)	Highway 37 (Treaty-Meziadin Meziadin-Treaty)	Highway 37A	Highway 37 (Meziadin-Kitwanga Kitwanga-Meziadin)
Bulk B-Train	Copper concentrates*	-	13, 200	13, 200	-
Super-B Train	Molybdenum concentrates*	-	86	-	86
Vans (Enclosed Trailers)	Lime & All other reagents*	-	8,440	-	8,440
48' Flat-Deck	Grinding Media	-	2,810	-	2,810
Tanker (45,000 L)	Fuel & Lubricants*	-	2,296	-	2,296
Bus & Passenger Vehicles	Personnel, Visitors & Maintenance	-	408	-	408
Vans (Enclosed Trailers)	Camp Supplies	-	480	-	480
Super-B Trucks	Explosives*	925	925	-	925
Bulk Tanker	Lime - Water Treatment*	-	1,278	-	1,278
48' Flat-Deck	Flocculant - Water Treatment*	-	20	-	20
48' Flat-Deck	Parts & Machinery	-	1,136	-	1,136
48' Flat-Deck	Major Mine Equipment	79	79	-	79
Grand Total (Average Annual)		**1,004**	**31,158**	**13,200**	**17,958**
Total Average Annual Trips per Day**		**3**	**85**	**36**	**49**
Hazardous Materials Average Trips per Day		**3**	**36**	**18**	**18**

Source: Wardrop 2012(Appendix C)
- is not applicable
0 is where numbers were rounded to 0
** counted in calculations for hazardous materials annual trips per day*
*** includes both hazardous and non-hazardous cargo*

Table 2.4-3. Total Average Annual One-way Trips by Route for Closure

Vehicle Type	Cargo	Route			
		Highway 37 (Eskay-Treaty Treaty-Eskay)	Highway 37 (Treaty-Meziadin Meziadin-Treaty)	Highway 37A	Highway 37 (Meziadin-Kitwanga Kitwanga-Meziadin)
48' Flat-Deck	Infrastructure	-	221	-	221
48' Flat-Deck	Camps & Support Facilities	-	250	-	250
48' Flat-Deck	Mine Site	-	662	-	662
48' Flat-Deck	Plant Site	-	1,511	-	1,511
48' Flat-Deck	Materials	-	143	-	143
Bus & Passenger Vehicle	Personnel	-	210	-	210
Super-B Trucks	Infrastructure	-	74	-	74
Super-B Trucks	Camps & Support Facilities	-	84	-	84
Super-B Trucks	Mine Site	-	221	-	221
Super-B Trucks	Plant Site	-	504	-	504
Super-B Trucks	Materials	-	48	-	48
Super-B Trains	Lime - Water Treatment*	-	1,000	-	1,000

(continued)

Table 2.4-3. Total Average Annual One-way Trips by Route for Closure (completed)

Vehicle Type	Cargo	Route			
		Highway 37 (Eskay-Treaty Treaty-Eskay)	Highway 37 (Treaty-Meziadin Meziadin-Treaty)	Highway 37A	Highway 37 (Meziadin-Kitwanga Kitwanga-Meziadin)
48' Flat-Deck	Flocculant - Water Treatment*	-	18	-	18
Tanker (45,000 L)	Fuel*	-	888	-	888
Grand Total (Average Annual)		-	5,834	-	5,834
Total Average Annual Trips per Day**		-	16	-	16
Hazardous Materials Average Trips per Day		-	3	-	3

Source: Wardrop 2012(Appendix C)
- is not applicable
** counted in calculations for hazardous materials annual trips per day*
*** includes both hazardous and non-hazardous cargo*

Table 2.4-4. Total Average Annual One-way Trips by Route for Post-closure

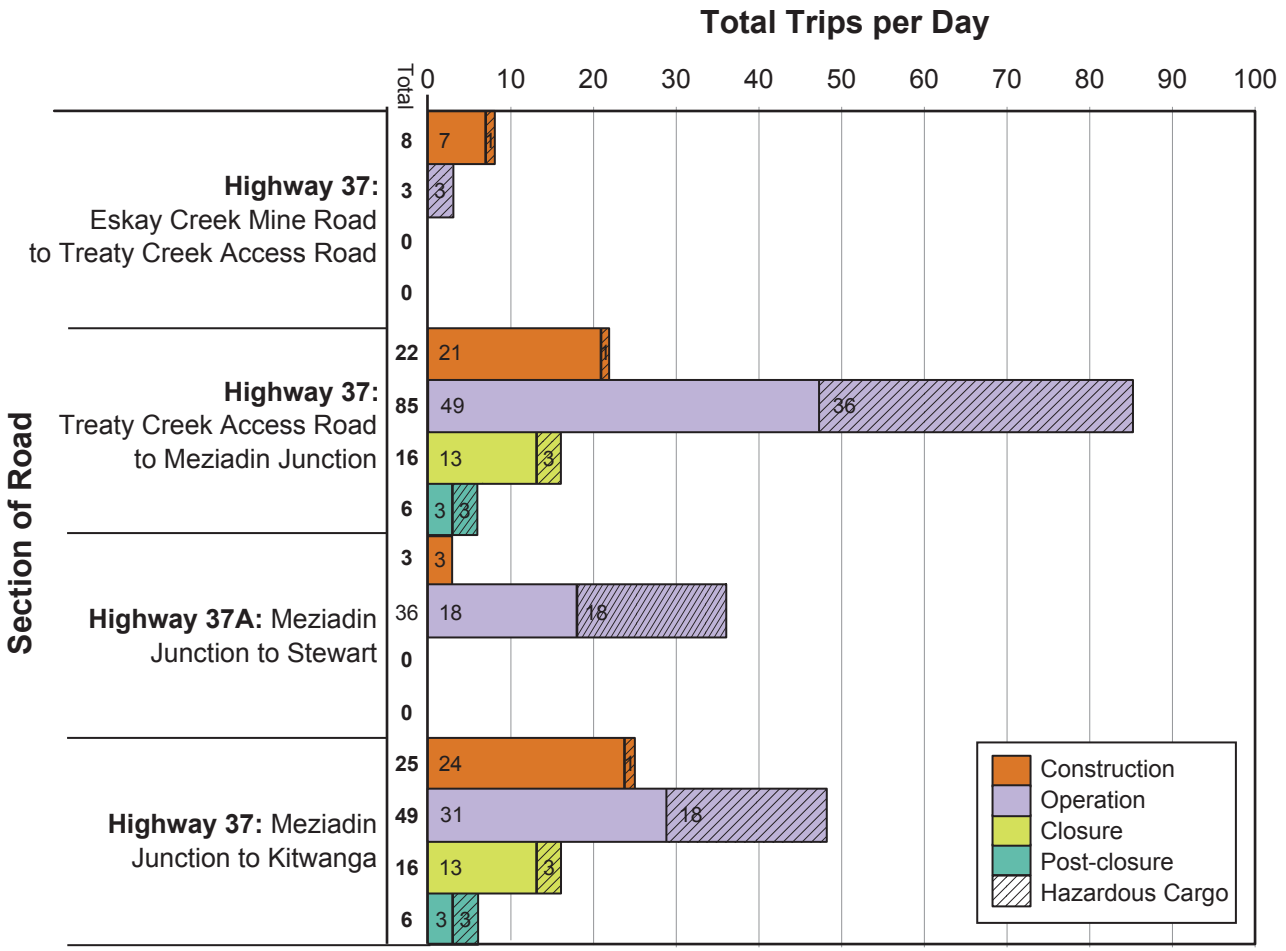
Vehicle Type	Cargo	Route			
		Highway 37 (Eskay-Treaty Treaty-Eskay)	Highway 37 (Treaty-Meziadin Meziadin-Treaty)	Highway 37A	Highway 37 (Meziadin-Kitwanga Kitwanga-Meziadin)
Bulk Truck	Lime – Water Treatment*	-	2,190	-	2,190
Lowboy Flat Deck	Sludge Haul & Maintenance Equipment	-	20	-	20
48' Flat-Deck	Flocculant – Water Treatment*	-	18	-	18
Bus & Passenger Vehicles	Personnel	-	24	-	24
Vans	Food & Misc Supplies	-	12	-	12
Tanker (45,000 L)	Fuel*	-	16	-	16
Passenger Vehicles	Visitors & Maintenance	-	8	-	8
Grand Total (Average Annual)		-	**2,288**	-	**2,288**
Total Average Annual Trips per Day**		-	**6**	-	**6**
Hazardous Average Trips per Day		-	**3**	-	**3**

Source: Wardrop 2012(Appendix C)
- is not applicable
** counted in calculations for hazardous annual trips per day*
*** includes both hazardous and non-hazardous cargo*

Estimates for all cargo types were added to obtain the total average annual traffic estimates for each Project phase. The total average annual trips per year are then divided by 365 to provide an estimate of expected trips per day along each highway segment. Figures 2.4-1 and 2.4-2 show trips per day along each segment of the two highways.

2.4.1 Construction Phase Activities

During the construction phase, equipment, materials, and supplies to build camps roads and infrastructure will be shipped to the Project site (Table 2.4-1). During the first three years of construction, the Temporary Frank Mackie Glacier access route will be used to transport equipment and materials. Traffic accessing this route will originate in Stewart, with half of the cargo being delivered to Stewart by barge, and the other half being delivered by truck (via highways 37 and 37A). During the remaining years of construction, all traffic will use the Eskay Creek Mine /Coulter Creek and Treaty Creek access roads.



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One-way Trips per Day during Each KSM Project Phase

Figure 2.4-1

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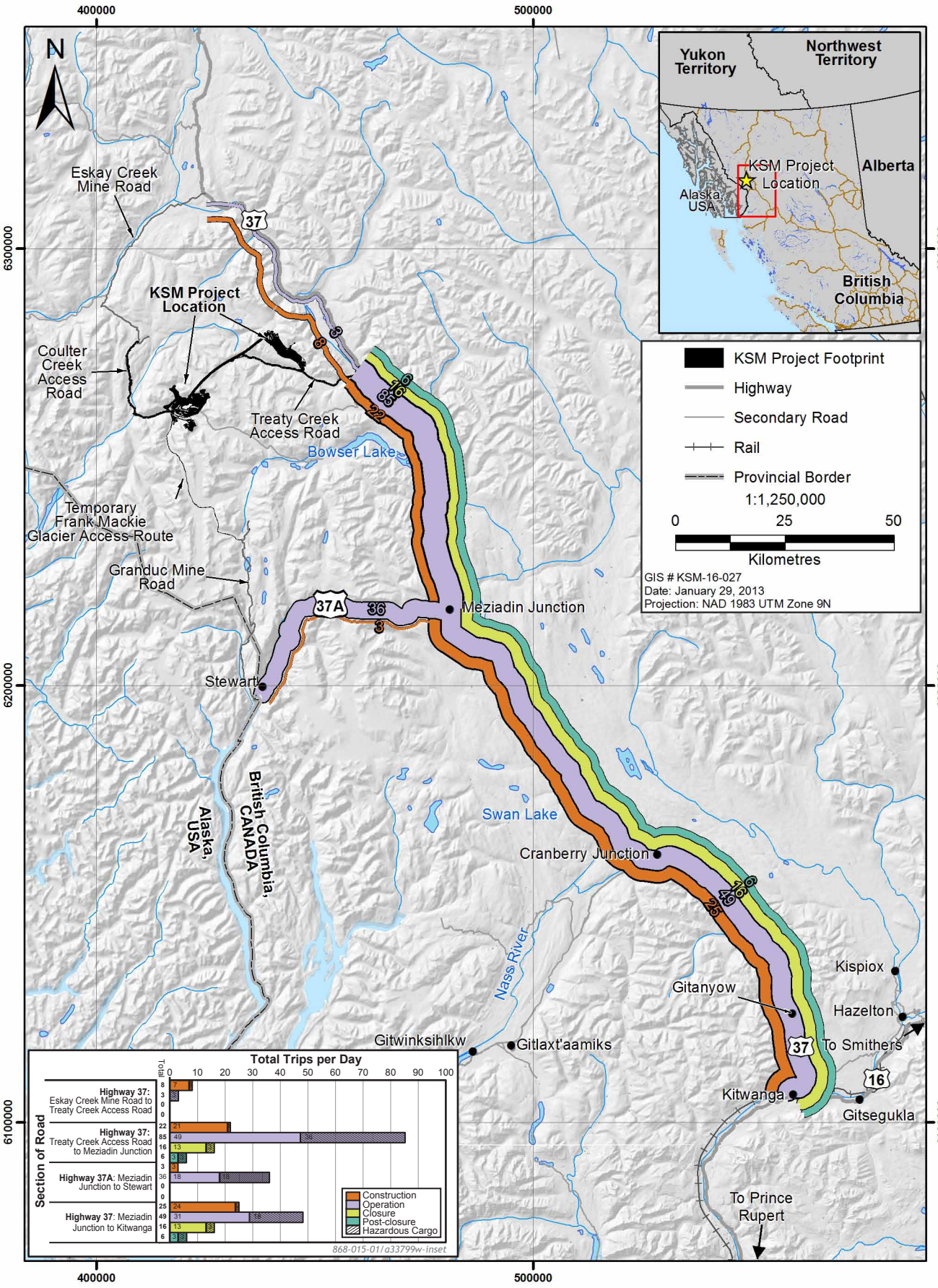

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KSM Project Traffic Study - One-way Trips per Day during each Project Phase

Figure 2.4-2

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2.4.2 Operation Phase Activities

During operation, diesel fuel and lubricants, personnel, camp supplies, lime and reagents, and parts/ machinery will be transported to the Project site via Highway 37 and along the Treaty Creek access road and, when necessary, through the Mitchell-Treaty Tunnel to supply the Mine Site. Explosives and major mine equipment required at the Mine Site will be transported via Highway 37 to the Eskay Creek Mine/Coulter Creek access roads.

Copper concentrate will be trucked in bulk form super-B trucks with a capacity of 50 tonnes to Stewart Bulk Terminals in Stewart. The heavier payload assumes the allowance of heavier loads under the provincial Bulk Haul Program (BC MOTI 2010). Molybdenum concentrate will be loaded in 2 tonne bags and transported on super-B flat deck trucks south along Highway 37 and then on to Prince Rupert. Gold and silver doré will be shipped from site via air transport for security purposes.

2.4.3 Closure Phase Activities

During closure, the Project will be decommissioned, all equipment and material except foundations will be removed, and reclamation activities will be completed. Traffic volumes for the closure phase are estimated to be approximately 70% of the traffic required to transport material/equipment during the construction phase. All traffic is expected to be via Highway 37, the Treaty Creek access road, and through the Mitchell Treaty Tunnel when access to the Mine Site is required. The Coulter Creek access road will be decommissioned and reclaimed.

2.4.4 Post-closure Phase Activities

During post-closure, traffic will move via Highway 37, the Treaty Creek access road, and through the Mitchell Treaty Tunnel when access to the Mine Site is required. Equipment, supplies and personnel will be required to continue operation of the Water Treatment Plant and the hydro facilities, as well as for monitoring and maintenance. It is assumed that activities and traffic volumes will be consistent throughout the entire post-closure phase.

2.4.5 Hazardous Cargo

In Tables 2.4-1 through 2.4-4, the average annual number of trips was further broken down to show the proportion of the traffic expected to transport hazardous cargo. The total number of trips in cargo categories considered to be hazardous (marked with a single asterisk in the aforementioned tables) were added together for each Project phase, divided by two so that empty vehicles are not counted as hazardous cargo, and then divided by 365 to show the average number of trips per day expected to be carrying hazardous cargo.

Hazardous materials to be transported throughout the life of the Project include:

- fuel and lubricants;
- concentrate (copper and molybdenum);
- lime and reagents for the Process Plant and water treatment (including flocculant); and
- explosives.

2.4.5.1 Fuel and Lubricants

Fuel will be required during construction for power generation, and throughout the life of the Project for activities like building heating, equipment operation and maintenance. Diesel fuel is assumed to be sourced from Terrace, BC, and delivered in super-B tanker trucks with a capacity of 45,000 litres per truck.

During the construction phase, fuel will be transported along Highway 37 and then via the Treaty Creek and Eskay Creek Mine/Coulter Creek access roads, as well as along Highway 37A to the Temporary Frank Mackie Glacier access road.

During the operation phase, annual traffic volumes for diesel fuel will vary from year to year, generally coinciding with mine production rates. Both diesel fuel and lubricants will be transported along Highway 37, along the Treaty Creek access road to the Plant Site, and through the Mitchell Treaty Tunnel if required at the Mine Site.

2.4.5.2 Concentrate

Copper Concentrate

During operation, hauling of copper concentrate will comprise the majority of the expected traffic volumes on the highways within the Study Area. Copper concentrate will be transported during operation from the Plant Site via the Treaty Creek access road, and along Highway 37 to Meziadin Junction, and then along Highway 37A to the Port of Stewart.

A Toxicity Characterization Leaching Procedure – EPA 1311 test was performed to determine if KSM copper concentrates are hazardous under BC MOE's Hazardous Waste Regulation (BC Reg. 63/2009). Briefly, during the EPA 1311 test, the copper concentrate was agitated in acidic extraction fluid and metal concentrations were subsequently analyzed in the extract. G&T Metallurgical Services provided a composite concentrate sample (PP3 Composite Bench Test Concentrate) obtained from two pilot test runs (PP2 and PP3); the analytical lab processed this sample as KM#2670 Bulk Concentrate to the analysis laboratory. The metal concentrations in the resulting extract were compared to Canadian Council of Ministers of the Environment (CCME) and BC water quality guidelines for the protection of aquatic life (BC MOE 2006; CCME n.d.) to detect exceedances. Leachable antimony, arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, selenium, silver, thallium, vanadium, and zinc concentrations exceeded either the CCME or the BC water quality guidelines, or both. However, environmental conditions are far less acidic than the leach test conditions and the concentrate itself is alkaline, and the EPA1311 test does not take dilution into account.

Table 2.4-5 shows the results of toxicity testing on KSM copper concentrate.

Molybdenum Concentrate

Molybdenum concentrate is assumed to be transported south from the PTMA along Highway 37 to Highway 16, and then west along Highway 16 to the port of Prince Rupert. While it is acknowledged that molybdenum concentrate is also potentially toxic, only 43 shipments of concentrate (i.e., 86 one-way trips) are anticipated per year during the operation phase. This is an anticipated average of 0.23 trips per day of molybdenum concentrate, or one trip every four or five days. In contrast, 6,600 shipments of copper concentrate per year (i.e., 36 one-way trips per day) are anticipated during operation. Due to the infrequency of transport of molybdenum concentrate, the biophysical and social risks from the transport of molybdenum concentrate are considered negligible, and are not considered further in this assessment.

2.4.5.3 Lime and Reagents

Water treatment is assumed to begin in the construction phase using temporary treatment facilities. Later during construction, the permanent Water Treatment Plant (WTP) will become operational and will continue treatment through post-closure.

Table 2.4-5. Copper Concentrate Toxicity Characterization Leaching Results Compared to Canadian Drinking Water Guidelines

TCLP Metals	Detection Limits mg/L (except pH)	Results of Analysis mg/L (except pH)	CCME Water Quality Guidelines[1] mg/L	BC Working Water Quality Guidelines (Aquatic Life) mg/L	Canadian Drinking Water Guidelines (MAC)[4] mg/L
1st Preliminary PH	0.10	5.94	N.A.	N.A.	N.A.
2nd Preliminary PH	0.10	1.42	N.A.	N.A.	N.A.
Final pH	0.10	4.95	N.A.	N.A.	N.A.
Extraction Solution Initial pH	0.10	4.93	N.A.	N.A.	N.A.
Antimony (Sb)-Leachable	1.0	< 1.0	N.G.	0.02	*0.006
Arsenic (As)-Leachable	1.0	< 1.0	0.005	0.005	0.01
Barium (Ba)-Leachable	2.5	< 2.5	N.G.	N.G.	1.00
Beryllium (Be)-Leachable	0.025	0.01	N.G.	N.G.	N.G.
Boron (B)-Leachable	0.50	0.25	1.50	1.20	*5
Cadmium (Cd)-Leachable	0.050	0.10	0.000,00457[2]	0.000,00457[2]	0.005
Calcium (Ca)-Leachable	2.0	132.00	N.G.	N.G.	N.G.
Chromium (Cr)-Leachable	0.25	< 0.125	0.001[3]	0.001[3]	0.05
Cobalt (Co)-Leachable	0.050	0.07	N.G.	0.11 (maximum), 0.004 (30-day average)	N.G.
Copper (Cu)-Leachable	0.050	25.50	0.002[2]	0.0029[2] (maximum), 0.002 (30-day average)	≤ 1
Iron (Fe)-Leachable	0.15	0.57	0.30	0.35[5], 1.0[6]	≤ 0.3
Lead (Pb)-Leachable	0.25	9.19	0.001[2]	0.004[2] (maximum and 30-day average)	0.01
Magnesium (Mg)-Leachable	0.50	8.83	N.G.	N.G.	N.G.
Mercury (Hg)-Leachable	0.0010	< 0.0010	0.000,026	0.00002 (30-day average when MeHg = 0.5% of THg)	0.001
Nickel (Ni)-Leachable	0.25	0.13	0.025[2]	0.025[2]	N.G.
Selenium (Se)-Leachable	1.0	< 1.0	0.001	0.002	0.01
Silver (Ag)-Leachable	0.25	0.13	0.0001	0.0001 (maximum), 0.00005 (30-day average)[2]	N.G.
Thallium (Tl)-Leachable	1.0	< 1.0	0.0008	0.0003	N.G.
Vanadium (V)-Leachable	0.15	0.08	N.G.	0.006	N.G.
Zinc (Zn)-Leachable	0.50	4.42	0.03	0.033 (maximum), 0.0075 (30-day average)[2]	≤ 5

[1] *CCME Water Quality Guidelines for the Protection of Aquatic Life (Freshwater)*
[2] *based on a hardness of 10 mg/L $CaCO_3$*
[3] *Guidelines presented for hexavalent chromium Cr(VI)*
[4] *Maximum acceptable concentration*
[5] *Guidelines presented short-term maximum guideline for dissolved iron concentrations*
[6] *Guidelines presented short-term maximum guideline for total iron concentrations*
** Interim MAC (discontinued by the Federal-Provincial-Territorial Committee on Drinking Water in 2003)*
N.A. = Not Applicable; N.G. = No Guideline
Grey shading indicates known exceedance of at least one guideline

The water treatment process will require lime and flocculant, which will be transported along Highway 37 and along the Eskay Creek Mine/Coulter Creek access roads to the WTP during construction. During operation, closure and post-closure, lime and flocculant will be transported to the WTP along the Treaty Creek access road and through the Mitchell-Treaty Tunnel.

Process Plant operation will use a number of reagents, detailed in Table 2.4-6, for copper, gold and molybdenum flotation, carbon-in-leach gold recovery, and cyanide recovery and destruction. These reagents will be transported along Highway 37 during the operation phase between Kitwanga and the Treaty Creek access road to the PTMA. More detailed information on lime and reagents expected to be transported to the Process Plant, including their Transportation of Dangerous Goods (TDG) rating, and the estimated number of trucks per day for each reagent, is shown in Table 2.4-6. One of the reagents, sodium cyanide, is classified as posing great danger under TDG regulations (Transport Canada n.d.). Most reagents, however, are not listed in the TDG regulations or pose only a minor danger.

2.4.5.4 Explosives

During construction, explosives will be required for bedrock excavation associated with the road alignment, borrow source development and tunnel construction. During operation, explosives will be used to break apart the rock in the open pits and the underground mines for recovery of the ore. Due to the large volumes of explosives required and the remote location of the Project, explosives will be manufactured on site. The annual volumes of explosives required for the Project varies according to production rates from year to year.

Potentially hazardous materials used to manufacture industrial explosives are Ammonium Nitrate (AN) prill, diesel fuel, initiation systems, ANFO (a combination of ammonium nitrate and fuel oil), and emulsion. During construction and operation, explosives will be transported by super-B trucks with a capacity of 40 tonnes along Highway 37 and the Eskay Creek Mine/Coulter Creek access roads to the Mine Site.

2.5 SUMMARY OF PREDICTED TRAFFIC VOLUMES

In general, historical traffic data within the Study Area is limited due to the inconsistent use of traffic counters along highways 37 and 37A (see Section 2.1.3). In many cases, data were not collected along the entire highway, nor were they collected every year. Although data availability is low, it is the best available information and it is used in this report to provide approximate indicators of traffic trends along the highways, and to estimate existing baseline traffic (Table 2.5-1).

Anticipated traffic volumes for the Project are compared to the estimated baseline traffic levels presented in Table 2.1-2. The highest percentage increase in traffic as a result of the Project is expected during Operation. A 38% increase is expected along Highway 37 between the Treaty Creek access road and Meziadin Junction, and a 15% increase is expected along Highway 37A. This is representative of the Project's copper concentrate haul route. Percentage increases along other highway segments and during the other phases of the Project range between one and ten percent. Despite the modest increases in traffic due to the Project on Highway 37 between Meziadin and Kitwanga (maximum 6% during operation), traffic baseline volumes alone are already 87% of the historical maximum. The remainder of the segments, however, will not see traffic exceeding 30% of historical maximums even with the addition of Project traffic. Traffic increases from the Project along both north and south segments of Highway 37 are well within the design capacity of the Highway.

This information is used throughout this report to assess the potential environmental and social effects of Project traffic along highways 37 and 37A.

Table 2.4-6. Projected Traffic Volumes for Process Plant Lime and Reagents

Process Plant Reagent[1]	TDG Danger Rating[4]	Description[2]	Consumption (t/year)	Trucks[3] per Year	Trucks[3] per Day	Liquid/Solid	Purity/ Concentration (to be transported)	Delivery Packaging
Sodium Hydrosulphide (NaHS)	II	Corrosive; spontaneously combustible	2,000	100	0.27	S	>70%, Solid, Flakes	1 t Bulk Bag
Sodium Cyanide (NaCN)	I	Poisonous (toxic) and infectious substance; toxic and/or corrosive (non-combustible/ water sensitive)	7,800	390	1.07	S	~98%, Solid, Briquettes	1 t tote; Boxed; 2 Plastic Layers Bag (woven polypropylene bags with a heat sealed polyethylene liner)
Sodium Silicate (Na_2SiO_3) (Sodium Metasilicate	-	High pH (Basic); non-combustible	40	2	0.01	S	>98%, Solid, Powder	25 kg Bag; Pallet
Activated Carbon	III	Flammable and combustible; on contact with water emits flammable gases	100	5	0.01	S	> 95%, Solid, Granulars	500 kg Bulk Bag
Hydrochloric Acid (HCl)	II/III	Toxic and/or corrosive (non-combustible/water sensitive)	720	36	0.10	L	33%- 35% HCl, Liquid	1 t Tote
Sodium Hydroxide (NaOH) (Caustic soda)	II	Toxic and/or corrosive (non-combustible)	5,900	295	0.81	S	> 98%, Solid, Flakes	1 t Bulk Bag
Sodium Metabisulfite (MBS)	-	Low pH (Acidic); moisture and air sensitive; non-corrosive in the presence of glass	6,000	300	0.82	S	~96%, Solid, Powder	1 t Bulk Bag
Copper Sulphate Pentahydrate ($CuSO_4.5H_2O$)	-	Air sensitive; corrosive to finely powdered metals; non-flammable	480	24	0.07	S	>96%, Dry, Powder	1 t Bulk Bag
Sulphuric Acid (H_2SO_4)	II	Corrosive; water-reactive; not combustible	22,000	1100	3.01	L	~ 96% H2SO4, Liquid	1 t Tote or Bulk Truck
PAX (potassium amyl xanthate)	II/III	Corrosive; spontaneously combustible	1,900	95	0.26	S	> 90%, Granular	1 t Bulk Bag
A208 (Diethyl Dithiophosphate)	-	Proprietary reagent	2,300	115	0.32	L	~45% Dithiophosphate	1 t Tote or Bulk Truck
3418A (Dialkyl Dithiophosphinate)	-	Proprietary reagent	380	19	0.05	L	~50% Dialkyl Dithiophosphinate	1 t Tote or Bulk Truck

(continued)

Table 2.4-6. Projected Traffic Volumes for Process Plant Lime and Reagents (completed)

Process Plant Reagent[1]	TDG Danger Rating[4]	Description[2]	Consumption (t/year)	Trucks[3] per Year	Trucks[3] per Day	Liquid/Solid	Purity/ Concentration (to be transported)	Delivery Packaging
3418A (Dialkyl Dithiophosphinate)	-	Proprietary reagent	380	19	0.05	L	~50% Dialkyl Dithiophosphinate	1 t Tote or Bulk Truck
MIBC (Methyl Isobutyl Carbinol)	III	Flammable and combustible liquids (polar/water-miscible/ noxious)	1,500	75	0.21	L	>98%	1 t Tote or Bulk Truck
Flocculant (Magnafloc 336)	-	Proprietary reagent; Slippery; low corrosivity	850	43	0.12	S	>95%	25 kg Bag; Pallet
Anti-scalant	-	Proprietary reagent; interferes with precipitation reactions	380	19	0.05	L	Liquid	1 t Tote
Fuel Oil	III	Flammable and combustible liquids (non-polar/water-immiscible)	950	23	0.06	L	Liquid	Bulk Truck
Lime (Calcium Oxide)	III	Toxic and/or corrosive (non-combustible/water sensitive)	60,000	1500	4.11	S	>90%, Solid, Granulars	Tanker Truck
Ferric Chloride ($FeCl_3$)	III	Toxic and/or corrosive (non-combustible)	70	4	0.01	S	>96%, Solid, Flakes	25 kg Bag; Pallet; or 50 kg Drums
Calcium Chloride ($CaCl_2$)	-	Normally stable; very soluble in water; not combustible; not corrosive	200	10	0.03	S	~94%, Solid, Powder	25 kg Bag; Pallet
Copper Chloride ($CuCl_2.2H_2O$)	III	Toxic and/or corrosive (non-combustible)	340	17	0.05	S	~98%, Solid, Powder	25 kg Bag; Pallet
Antifoam	-	Proprietary reagent	100	5	0.01	L	Liquid	1 t Tote
Liquid Chlorine (Sodium Hypochlorite)	II/III	Toxic and/or corrosive (non-combustible)	850	43	0.12	L	~99%, Liquid	500 L or 1,000 L Cylinder
TOTAL				4,220	11.57			

Source: Wardrop 2012 (Appendix C)

[1] Table does not include lime and flocculant to be used at the Water Treatment Plant

[2] As defined by the federal Transportation of Dangerous Goods Regulation class and/or Emergency Response Guide substance classification, or product Materials Safety Datasheet

[3] "Trucks" represents loaded trips only, rather than both loaded and empty.

[4] TDG Danger Rating: I = Great Danger; II = Medium Danger; III = Minor Danger; - = Not Listed.

Table 2.5-1. Estimated Traffic Volume Increases on Highways 37 and 37A Resulting from the KSM Project

	Route/Phase															
	Highway 37 (Eskay to Treaty) North Segment				Highway 37 (Treaty to Meziadin) North Segment				Highway 37A				Highway 37 (Meziadin to Kitwanga) South Segment			
	Construction	Operation	Closure	Post-closure	Construction	Operation	Closure	Post-closure	Construction	Operation	Closure	Post-closure	Construction	Operation	Closure	Post-closure
Estimated Existing Baseline Traffic*	224	224	224	224	224	224	224	224	244	244	244	244	799	799	799	799
KSM Project Traffic	8	3	0	0	22	85	16	6	3	36	0	0	25	49	16	6
Total (Baseline + KSM)	232	227	224	224	246	309	240	230	247	280	244	244	824	848	815	805
Projected Percentage Increase	4%	1%	0%	0%	10%	38%	7%	3%	1%	15%	0%	0%	3%	6%	2%	1%
Historical Maximum Traffic	1014	1014	1014	1014	1014	1014	1014	1014	917	917	917	917	917	917	917	917
Percentage of Historical Maximum	23%	22%	22%	22%	24%	30%	24%	23%	27%	31%	27%	27%	90%	92%	89%	88%
Percentage of Highway 37 Capacity[1]	3.8%	3.7%	3.7%	3.7%	4.0%	5.1%	3.9%	3.8%	n/a	n/a	n/a	n/a	13.6%	14.0%	13.4%	13.3%

[1] *Based on Highway 37 modified capacity of 252 commercial vehicles per hour one-way (equivalent to 252 one-way trips per hour) or 6,048 one-way trips per day.*

Note: Given that traffic volumes in the 1990s were substantially high, existing baseline traffic was calculated as the average AADT from 2004 to 2011.

3. Vehicle Accidents on Highways 37 and 37A

3.1 HISTORICAL VEHICLE ACCIDENT STATISTICS

Police data for vehicle collisions along Project-relevant segments of highways 37 and 37A are available from 1996 to 2011. Both traffic volumes and accidents have been generally decreasing since 1996. Traffic accidents for this time period are summarized in Figure 3.1-1, and Tables 3.1-1 and 3.1-2.

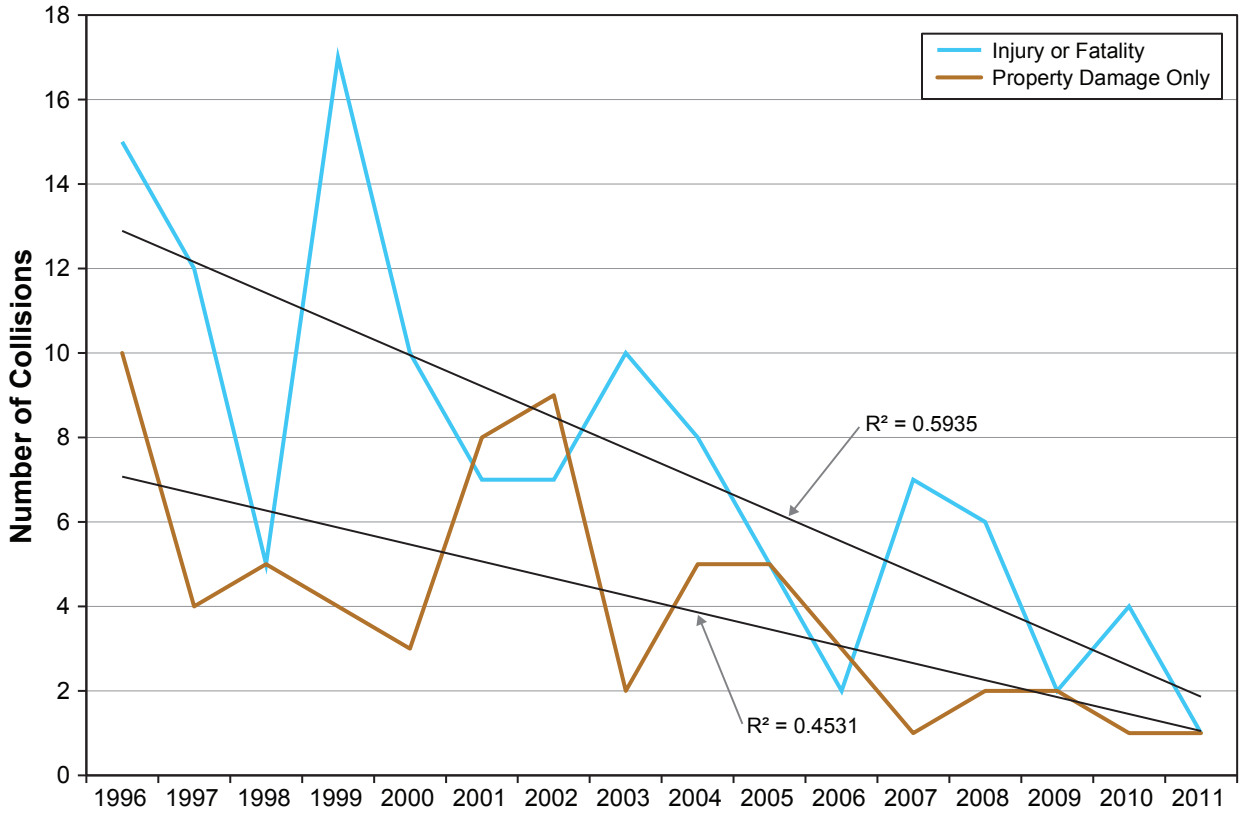
Table 3.1-1. Vehicle Collisions on Highway 37 between Bob Quinn Camp and Kitwanga

Crash Counts	Severity		
Year	Injury or Fatality	Property Damage Only	Total
1996	15	10	25
1997	12	4	16
1998	5	5	10
1999	17	4	21
2000	10	3	13
2001	7	8	15
2002	7	9	16
2003	10	2	12
2004	8	5	13
2005	5	5	10
2006	2	3	5
2007	7	1	8
2008	6	2	8
2009	2	2	4
2010	4	1	5
2011	1	1	2
Grand Total	**118**	**65**	**183**

Source: ICBC (2011a)

Data are derived from police reports and do not include collisions where police were not notified.[3] Collisions are recorded on provincial highways using the Landmark Kilometre Inventory (LKI). The LKI are highway segments defined by the BC MOTI. A segment may consist of one or both sides (directions) of a highway.

[3] ICBC generally has more comprehensive collision data than the police, as the insurance company is typically contacted even when police are not notified about a traffic accident. However, the quality of ICBC data is dependent on the insured individual's report. Many submitted reports lack accurate information about the exact location of the collision. In most instances ICBC does not know the exact location of collisions on highways outside of cities, and the collision is classified as being located at the nearest major town. As such, available ICBC data are very limited and only report a fraction of the collisions reported by the police for the same period. Cross-referencing individual collision incidents reported in ICBC and police data is not possible. The use of both data sets may therefore result in double counting. Consequently, only historical police data (provided by ICBC) is considered and analyzed in this report.



Note: R^2 = % trend line.
Source: ICBC (2011).

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Vehicle Collisions on Highway 37 between Bob Quinn Camp and Kitwanga

Figure 3.1-1

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Table 3.1-2. Vehicle Collisions on Highway 37A between Stewart and Meziadin Junction

Crash Counts	Severity		
Year	Injury or Fatality	Property Damage Only	Grand Total
1996	0	0	0
1997	3	3	6
1998	2	1	3
1999	0	0	0
2000	1	1	2
2001	1	2	3
2002	1	3	4
2003	1	0	1
2004	1	0	1
2005	0	0	0
2006	0	0	0
2007	0	0	0
2008	0	0	0
2009	0	0	0
2010	0	0	0
2011	0	0	0
Grand Total	**10**	**10**	**20**

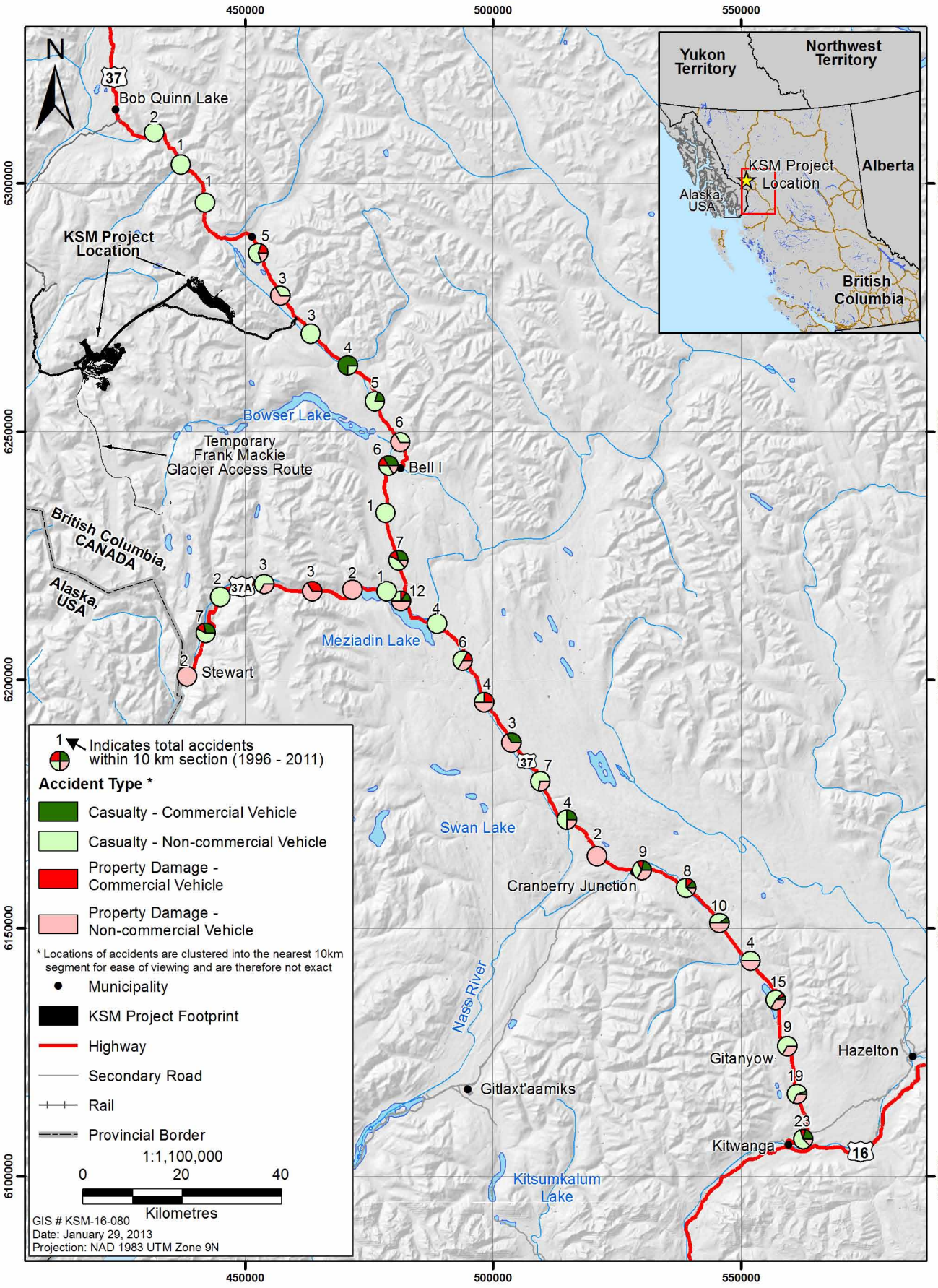
Source: ICBC (2011b)
Note: Accidents occurring inside the town of Stewart are outside the scope of this study and are not included in these data. There were no police-reported accidents between 2004 and 2011 (ICBC 2011b).

Of the 183 accidents that occurred along the relevant section of Highway 37, 34 (19%) involved a commercial vehicle. Of the 20 reported accidents along Highway 37A, four (20%) involved a commercial vehicle (ICBC 2011a, 2011b).

3.1.1 Vehicle Collision Location Analysis

Historical traffic accidents (1996-2011) along both highway segments are mapped in Figure 3.1-2. Recorded LKI segments in the police data were geocoded and plotted within contiguous 10 km sections of the highways. Over the past 15 years, police reported vehicle collisions have occurred across the entire length of the two highway segments (37 and 37A); however, accidents are concentrated around settlements and near highway junctions and turn-offs. This is unsurprising as traffic accident risks tend to be higher at intersections and in areas of higher use.

The highest proportion of vehicle collisions occurred between Kitwanga and Gitanyow on Highway 37, as depicted in Figure 3.1-3. The southern segment of Highway 37 (Kitwanga to Meziadin Junction) experienced higher daily traffic counts than the northern segment (Meziadin Junction to Stikine River Bridge) between 1996 and 2011. This higher volume of traffic combined with the locations of Kitwanga and Gitanyow on the highway likely contributed to the higher number of vehicle collisions.



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Locations of Vehicle Collisions on Highways 37 and 37A, 1996 to 2011

Figure 3.1-2

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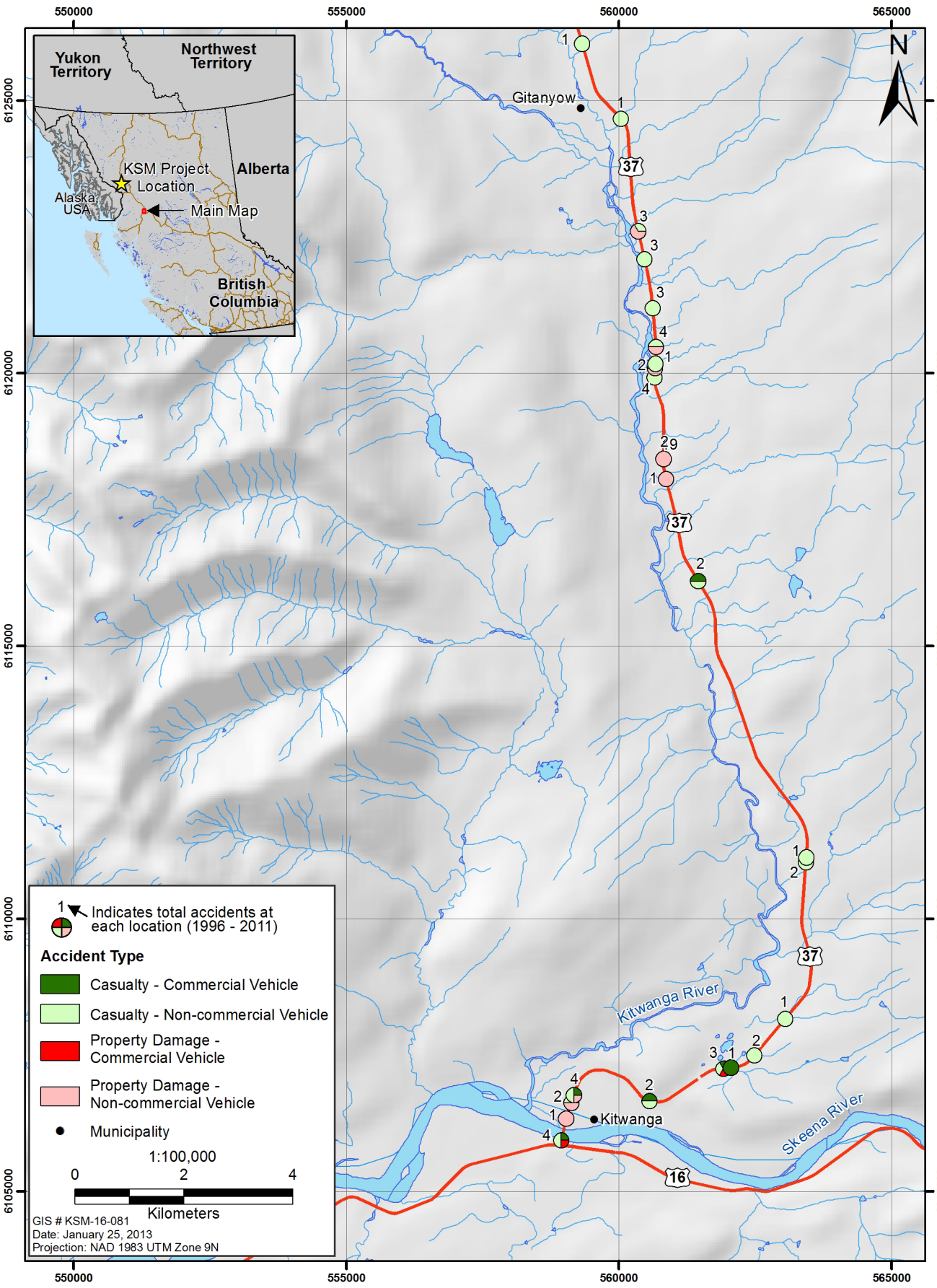

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Locations of Vehicle Collisions on Highway 37 between Kitwanga and Gitanyow, 1996 to 2011

Figure 3.1-3

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3.1.2 Seasonal Vehicle Collision Analysis

Annual vehicle collisions by season are depicted in Figure 3.1-4 (Highway 37) and Figure 3.1-5 (Highway 37A). Most traffic accidents along both highway segments have typically been concentrated during the summer months (June-August; ICBC 2011a, 2011b). This corresponds with higher average daily traffic counts on the highways. Consistent average daily traffic counts are available between 1996 and 2001 for both highway segments, and then intermittently for segments of Highway 37 following this period (Figure 3.1-4 and Figure 3.1-5).

3.1.3 Collisions by Vehicle Type and Road Location

Vehicle collisions by type (commercial and non-commercial) and road position (on- or off-highway) are depicted in Figures 3.1-6 and 3.1-7, along with the available daily traffic counts. The majority of vehicle collisions involve non-commercial vehicles, and a small fraction of commercial vehicle collisions involved an "off-road incident", where the vehicle left the travelled part of the road.

Between 1996 and 2011, the average accident rate for commercial vehicles was 0.0016% for Highway 37, and 0.0002% for Highway 37A.[4] The average accident rate for non-commercial vehicles, on the other hand, was 0.007% on Highway 37 and 0.0011% on Highway 37A. In other words, there were 77% fewer traffic accidents involving commercial vehicles than non-commercial vehicles on Highway 37, and 81% fewer commercial vehicle traffic accidents on Highway 37A compared to non-commercial vehicles. Historical accident rates per 100,000 vehicles (both commercial and non-commercial) for Highways 37 and 37A are provided in Tables 3.1-3 and 3.1-4, respectively.

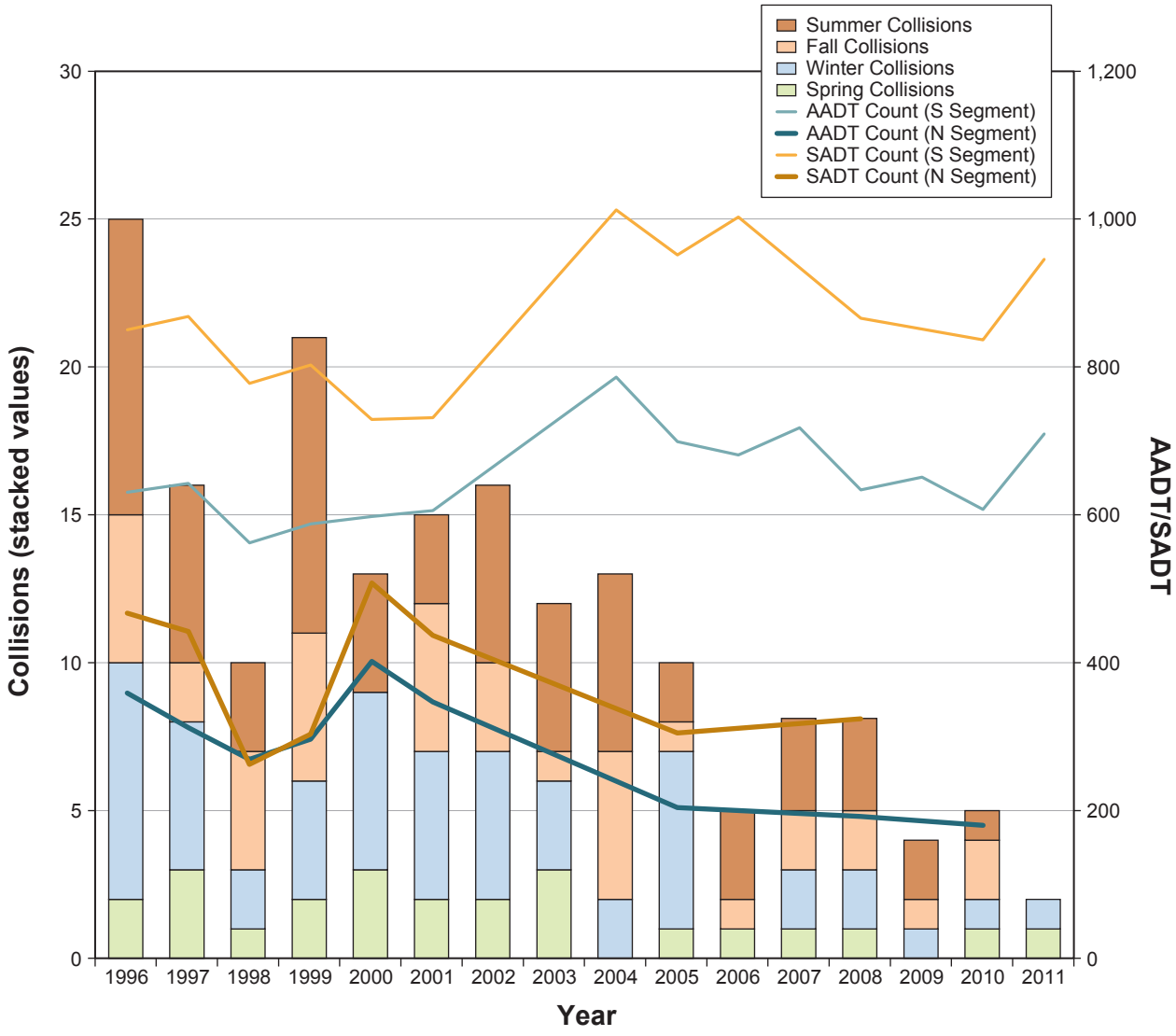
3.1.4 Contributing Factors in Vehicle Collisions

The BC Motor Vehicle Branch (2007) describes the following top contributing factors in commercial (heavy and light) vehicle accidents (as a percentage of total commercial vehicle collisions), in order of magnitude:

- driver inattentiveness;
- speed;
- road conditions;
- driver error/confusion;
- failing to yield right of way; and
- following too closely.

In other words, unsafe driving practices and road conditions are largely to blame for the majority of accidents in British Columbia. Neither the amount of traffic, nor the type of vehicle, nor even the working condition of the vehicle plays any significant role in contributing to accidents in the province.

[4] Accident rates (collisions per 100,000 vehicles) were calculated by dividing the number of vehicle accidents in a year by that year's annualized average AADT (an average of the southern and northern segment was used if both counts were available, if not just the southern segment count was used) and multiplying by 100,000. An average of the accident rates for the period 1996-2011 for each highway was then calculated. After 2001, the AADT count on Highway 37A was terminated and only intermittently recorded along some segments of Highway 37. Where there were gaps in historical data, AADT was extrapolated from available data using excel, where viable.



Available data for AADT and SADT is intermittent after 2001.

Source: BC MOTI 2010, 2012 and ICBC 2011

Definitions:

Summer: June, July, August
Fall: September, October, November
Winter: December, January, February
Spring: March, April, May

AADT: Annual Average Daily Traffic
SADT: Summer Average Daily Traffic

Southern (S) Segment: Kitwanga to Meziadin Junction
Northern (N) Segment: Meziadin Junction to Stikine River Bridge

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Seasonal Vehicle Collisions on Highway 37 between Kitwanga and Bob Quinn Lake

Figure 3.1-4

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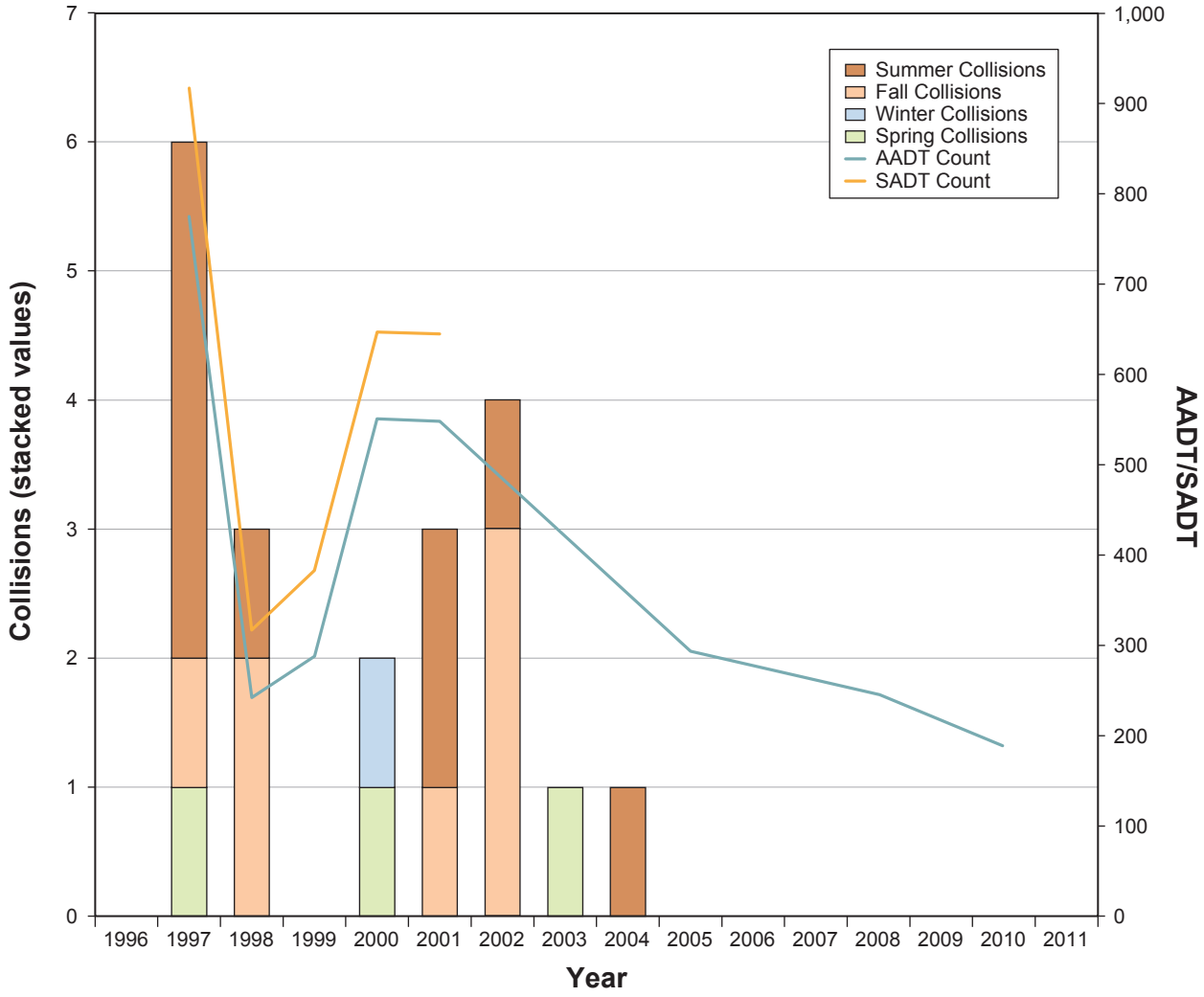

Available data for AADT and SADT is intermittent after 2001.

Source: BC MOTI 2010, 2012 and ICBC 2011

Definitions:

Summer: June, July, August
Fall: September, October, November
Winter: December, January, February
Spring: March, April, May

AADT: Annual Average Daily Traffic
SADT: Summer Average Daily Traffic

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Seasonal Vehicle Collisions on Highway 37A

Figure 3.1-5

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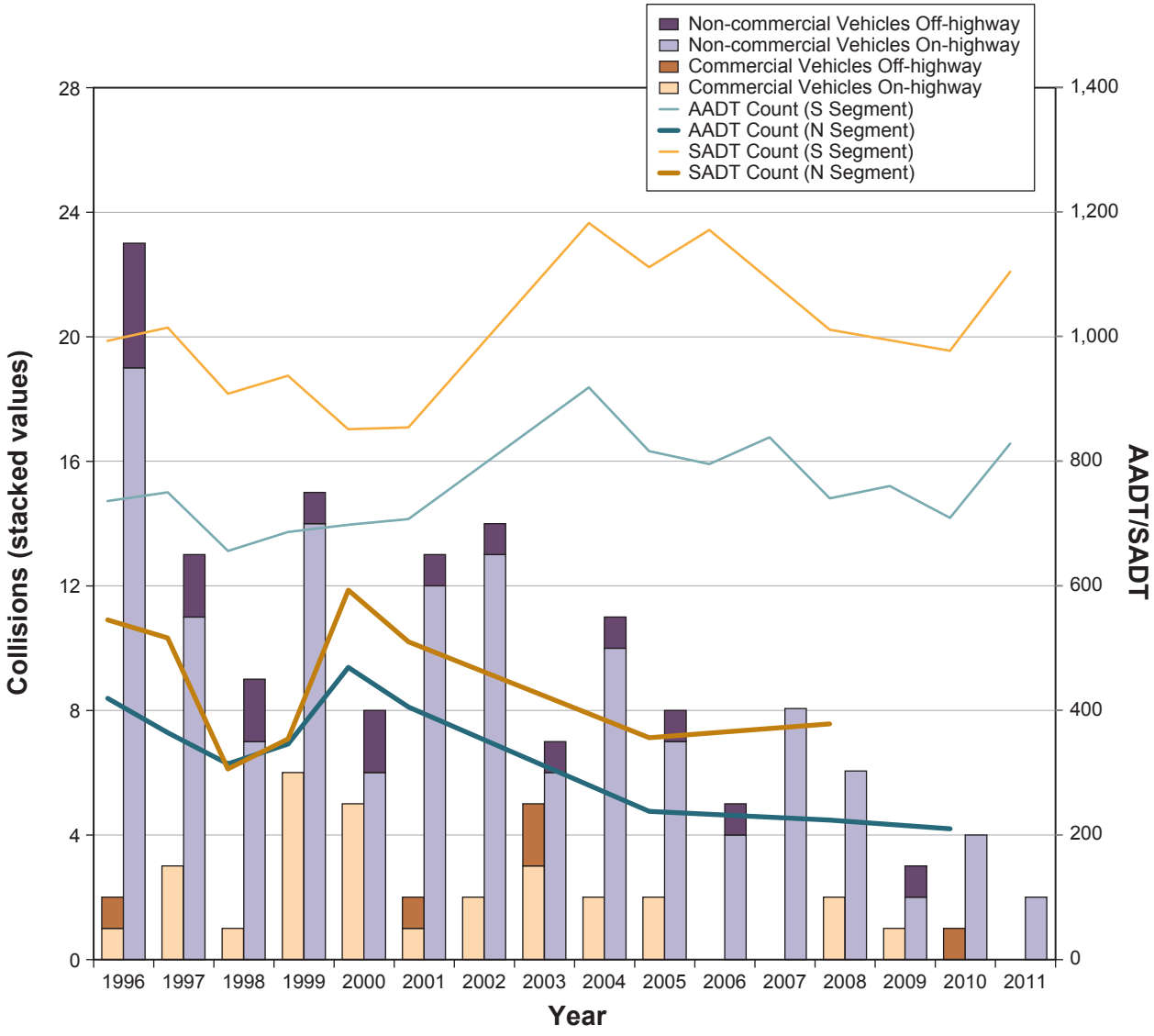

Available data for AADT and SADT is intermittent after 2001.

Source: BC MOTI 2010, 2012 and ICBC 2011

Definitions:

AADT: Annual Average Daily Traffic
SADT: Summer Average Daily Traffic

Southern (S) Segment: Kitwanga to Meziadin Junction
Northern (N) Segment: Meziadin Junction to Stikine River Bridge

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Collisions by Vehicle Type on Highway 37 between Kitwanga and Bob Quinn Lake

Figure 3.1-6

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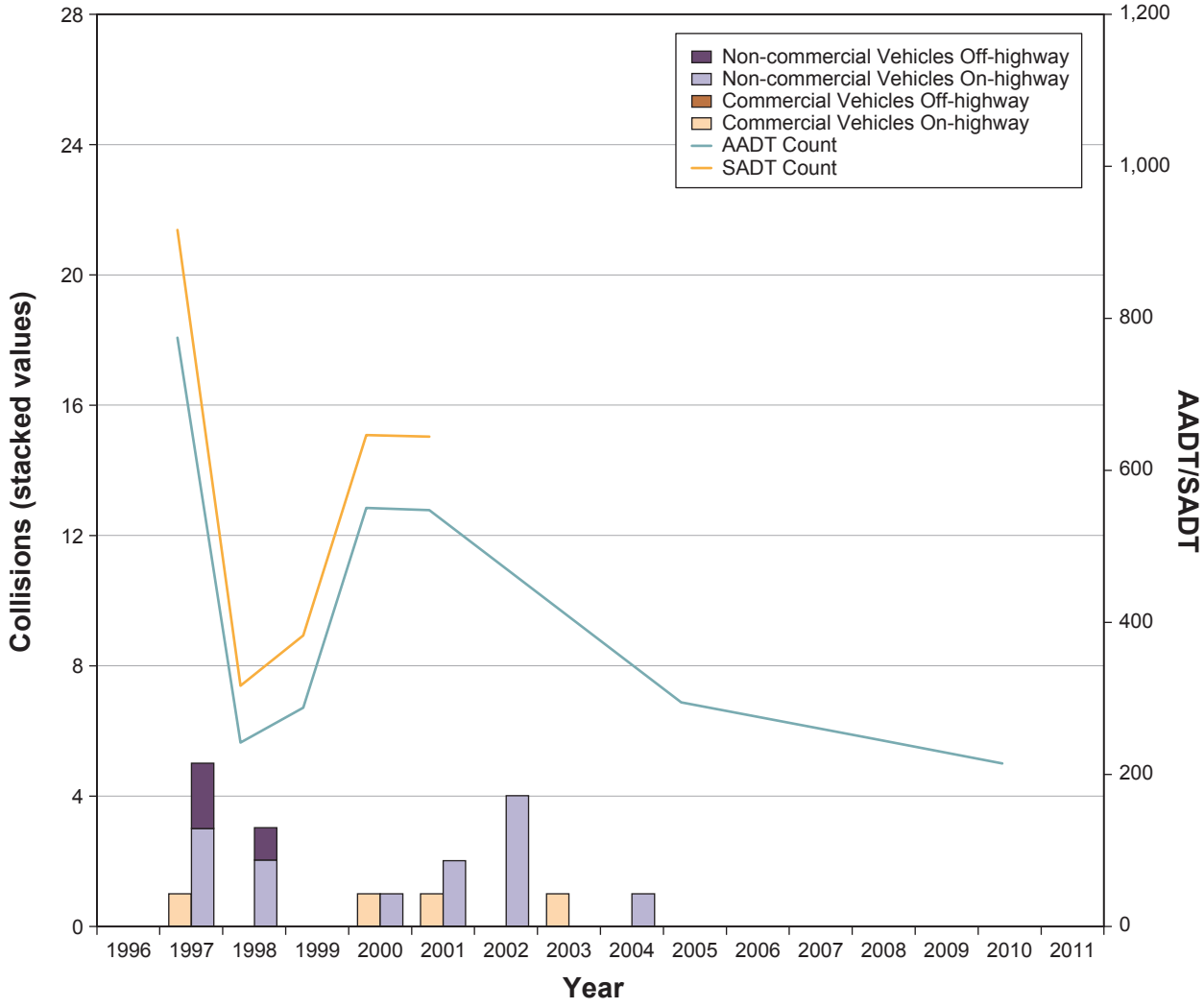

Available data for AADT and SADT is intermittent after 2001.

Source: BC MOTI 2010, 2012 and ICBC 2011

Definitions:

AADT: Annual Average Daily Traffic
SADT: Summer Average Daily Traffic

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Collisions by Vehicle Type on Highway 37A On- and Off-highway

Figure 3.1-7

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Table 3.1-3. Annual Collisions per 100,000 Vehicles on Highway 37 between Kitwanga and Bob Quinn Lake

Year	AADT (S Segment)	AADT (N Segment)	Annualized Average AADT	Total Collisions		Collisions/100,000 Vehicles	
				Commercial Vehicles	Non-commercial Vehicles	Commercial Vehicles	Non-commercial Vehicles
1996	736	419	210,788	2	23	0.9	10.9
1997	750	364	203,305	3	13	1.5	6.4
1998	656	314	177,025	1	9	0.6	5.1
1999	686	346	188,340	6	15	3.2	8.0
2000	698	469	212,978	5	8	2.3	3.8
2001	707	405	202,940	2	13	1.0	6.4
2002	n/a	n/a	n/a	2	14	n/a	n/a
2003	n/a	n/a	n/a	5	7	n/a	n/a
2004	918	237*	210,766	2	11	0.9	5.2
2005	816	238	192,355	2	8	1.0	4.2
2006	795	226*	186,300	0	5	0.0	2.7
2007	838	220*	193,138	0	8	0.0	4.1
2008	740	224	175,930	2	6	1.1	3.4
2009	760	209*	176,884	1	3	0.6	1.7
2010	709	210	167,718	1	4	0.6	2.4
2011	828	198*	187,276	0	2	0.0	1.1
Average collisions per 100,000 vehicles						1.0	4.7
Average Rate of Collision						0.0016%	0.0068%

Notes:
n/a - not available
AADT - Annual Average Daily Total traffic count
** Extrapolated from available data.*

Table 3.1-4. Annual Collisions per 100,000 Vehicles on Highway 37A

Year	AADT	Annualized AADT	Total Collisions		Collisions/100,000 Vehicles	
			Commercial Vehicles	Non-commercial Vehicles	Commercial Vehicles	Non-commercial Vehicles
1996	608	221,920	0	0	0.0	0.0
1997	775	282,875	1	5	0.4	1.8
1998	242	88,330	0	3	0.0	3.4
1999	288	105,120	0	0	0.0	0.0
2000	551	201,115	1	1	0.5	0.5
2001	548	200,020	1	2	0.5	1.0
2002	n/a	n/a	0	4	n/a	n/a
2003	n/a	n/a	1	0	n/a	n/a

(continued)

Table 3.1-4. Annual Collisions per 100,000 Vehicles on Highway 37A (completed)

			Total Collisions		Collisions/100,000 Vehicles	
Year	AADT	Annualized AADT	Commercial Vehicles	Non-commercial Vehicles	Commercial Vehicles	Non-commercial Vehicles
2004	318*	116,070	0	1	0.0	0.9
2005	295	107,675	0	0	0.0	0.0
2006	277*	101,105	0	0	0.0	0.0
2007	256*	93,440	0	0	0.0	0.0
2008	248	90,520	0	0	0.0	0.0
2009	215*	78,475	0	0	0.0	0.0
2010	190	69,350	0	0	0.0	0.0
2011	174*	63,510	0	0	0.0	0.0
Average collisions per 100,000 vehicles					0.1	0.5
Average Rate of Collision					0.0002%	0.0011%

Notes:
n/a - not available
AADT - Annual Average Daily Total traffic count
** Extrapolated from available data.*

3.2 COLLISION PREDICTION MODELLING

Collision prediction models (CPMs) were used to predict the annual number of collisions on highways 37 and 37A with increased traffic volume expected during all Project phases. CPMs like the one used for this assessment, are used because the relationship between collision frequency and exposure is frequently non-linear (Sayed and de Leur 2008). CPMs are regression models that estimate collision frequency by capturing systematic relationships between collisions, traffic volumes, and road geometry (Sayed and de Leur 2008).

3.2.1 Methodology

The CPM methodology used for this study was developed specifically for British Columbia highways by Sayed and de Leur (2008), and was adopted by BC MOTI (2009).

Three data elements were required for CPM development. The first was a classification of the highway segments; based on the BC MOTI Classification System, both Highway 37 and Highway 37A were classified as Rural Arterial Undivided Two-lane (RAU2) highways (BC MOTI 2009). The second step was to collect AADT volumes for each highway segment. Traffic volumes for highways 37 and 37A were obtained from BC MOTI (2011e). As discussed in Section 2.1, data for these routes have been collected intermittently since 2001, so historical traffic volumes from 1996 to the present were used in the analysis. The third step was to obtain historical collision data for both roads, which were provided by the Insurance Corporation of British Columbia (ICBC 2011a; 2011b; Section 3.1).

Two different sets of model variables were used to predict: (1) collisions resulting in property damage only (PDO); and (2) severe collisions resulting in human injury or casualty. The variables developed for RAU2 roads are presented in Table 3.2-1.

Table 3.2-1. Collision Prediction Model Variables for Rural Arterial Undivided Two-lane Roads

Collision Type	Model Variables			
	α_0	α_1	α_2	k
PDO	0.005706	0.7523	0.9222	2.138
Severe	0.005242	0.7279	0.9403	2.167

Source: Sayed and de Leur (2008).

A preliminary CPM was developed using the following segment model form (Sayed and de Leur 2008):

$$E(\Lambda) = a_o V_1^{a_1} L_1^{a_2}$$

where $E(\Lambda)$ = collision frequency
L = highway segment length
V = segment AADT
a_0, a_1, a_2 = model parameters (as shown in Table 2.5-1)

The historical collision data delineated the specific LKI segment where each collision occurred. The relevant historical AADT data separated traffic on Highway 37 into two segments, the northern segment comprising Meziadin Junction to the Stikine River Bridge (LKI 3730 and 3740), and the southern segment comprising Kitwanga to Meziadin Junction (LKI 3710 and 3720). For this reason, separate CPMs were developed for the northern and southern segment of Highway 37. Highway 37A (LKI 3725) was modeled as a single segment (BC MOTI 2011b).

The preliminary CPMs were then calibrated for the specific roadways using an Empirical Bayes (EB) refinement to consider the historical collision data, yielding more accurate, location-specific predictions. The EB refinements were calculated using the following equation (Sayed and de Leur 2008):

$$EB_{\text{safety estimate}} = \alpha \times prediction + (1 - \alpha) \times observed$$

where $\alpha = \frac{k}{k + prediction}$
$observed$ = observed number of collisions
$prediction$ = predicted number of collisions from preliminary CPM
k = model dispersion parameter (as shown in Table 2.5-1)

The CPMs and their location-specific EB refinements were then applied to the increases to current traffic volumes expected on highways 37 and 37A as a result of the Project during each phase. These traffic estimates are summarized in Table 3.2-2.

Table 3.2-2. Project-related Annual Increases to Traffic Volumes

Project Phase	Average Annual Trips per Day for Project Traffic per Highway Segment		
	Highway 37 North Segment	Highway 37 South Segment	Highway 37A
Construction	22	25	3
Operation	85	49	36
Closure	16	16	0
Post-closure	6	6	0

The CPMs were also applied to the cumulative increases to current traffic volumes expected on highways 37 and 37A as a result of other human actions during the KSM operation phase (the period of highest Project-related traffic volumes). These traffic estimates are summarized in Section 8.3.2.

3.2.2 Limitations of the Models

The effectiveness of the CPMs was limited by the historical data available for the highway segments in question. As is discussed in Section 2.1.3, data for these routes have only been collected intermittently since 2001.

Moreover, it is important to acknowledge the limitations inherent in the models themselves. Many factors that affect collision frequency—such as driver error and weather conditions (and others, as listed in Section 3.1.4)—cannot be accounted for in a CPM. The CPMs can reliably predict the probable mean number of collisions on the highway segments *over time*; however, collisions in any specific year may be higher or lower than the model predictions due to the aforementioned variables. Therefore, the modelling results are used cautiously as broad indicators of probable collision frequency during the Project phases.

3.2.3 Project-specific Results

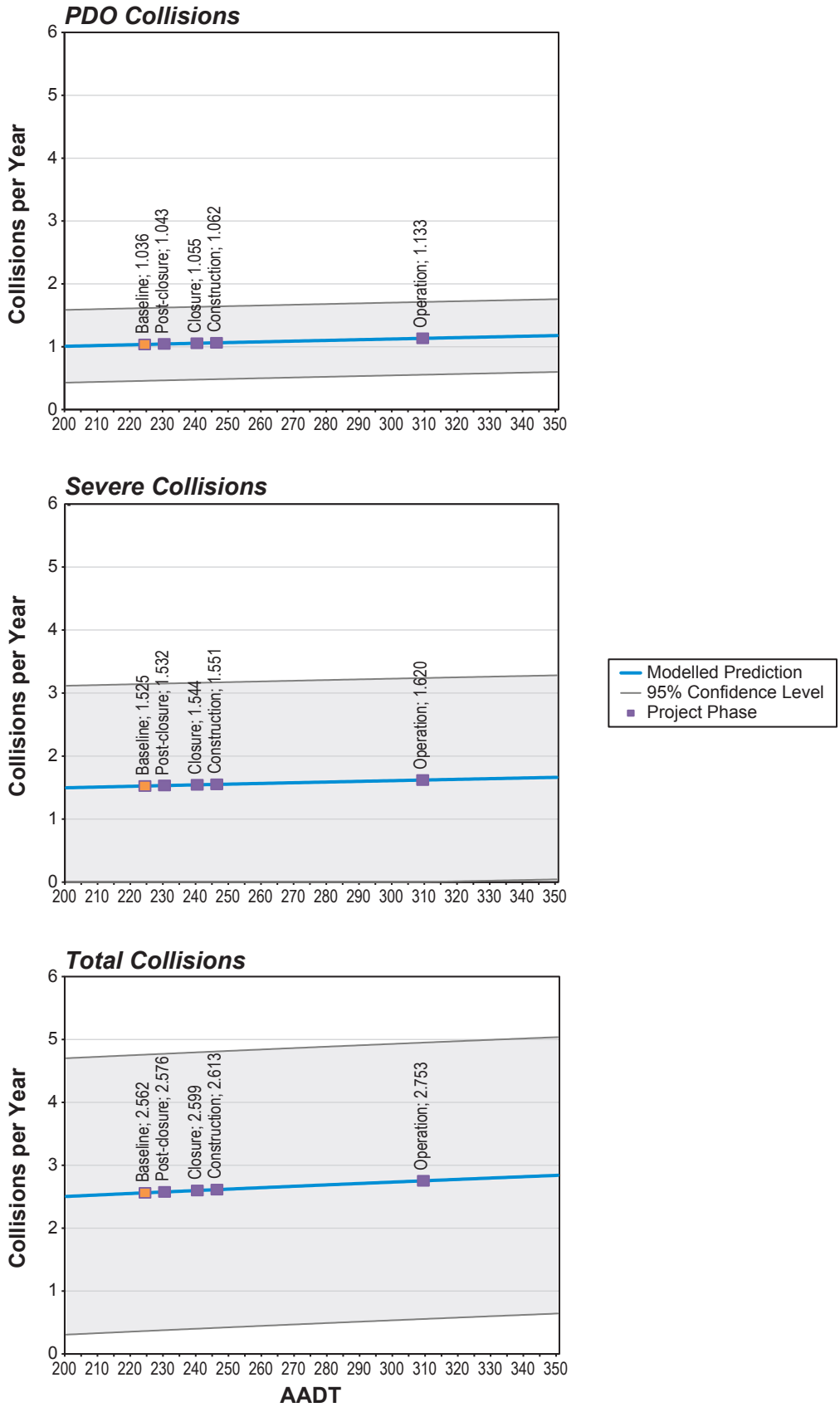
The results of the Project-specific CPM analysis are presented in Figures 3.2-1 to 3.2-3. The difference in predicted collisions between baseline conditions and the Operation phase (the Project phase with the highest traffic volumes) is summarized in Table 3.2-3.

Table 3.2-3. Predicted Number of Collisions per Year – Baseline vs. Project Operation Phase

Collision Type	Highway 37 North Segment			Highway 37 South Segment			Highway 37 A		
	Baseline	Operation	Change	Baseline	Operation	Change	Baseline	Operation	Change
PDO	1.036	1.133	+0.097	3.693	3.714	+0.021	0.973	1.012	+0.039
Severe	1.525	1.620	+0.095	5.889	5.915	+0.026	1.016	1.061	+0.045
Total	**2.561**	**2.753**	**+0.192**	**9.582**	**9.629**	**+0.047**	**1.989**	**2.073**	**+0.084**

The predicted number of annual collisions is not substantially higher in any Project phase than predictions based on current road traffic. The highest number of Project-related collisions predicted by the model occurs during the Operation phase. On the northern segment of Highway 37 during the Operation phase, a total increase of 0.192 collisions (0.097 PDO collisions and 0.095 severe collisions) per year is predicted. The southern segment of Highway 37 is predicted to experience a total increase of 0.047 collisions (0.021 PDO collisions and 0.026 severe collisions) per year during the Operation phase. The greatest predicted change to Highway 37A also occurs during the Operation phase: a total increase of 0.084 collisions (0.039 PDO collisions and 0.045 severe collisions) per year.

For all road segments in all other Project phases, an increase of less than 0.02 collisions per year is predicted.



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Predicted Number of Collisions per Year on Highway 37 North - Baseline Annual Average Daily Traffic vs. Project Phases

Figure 3.2-1

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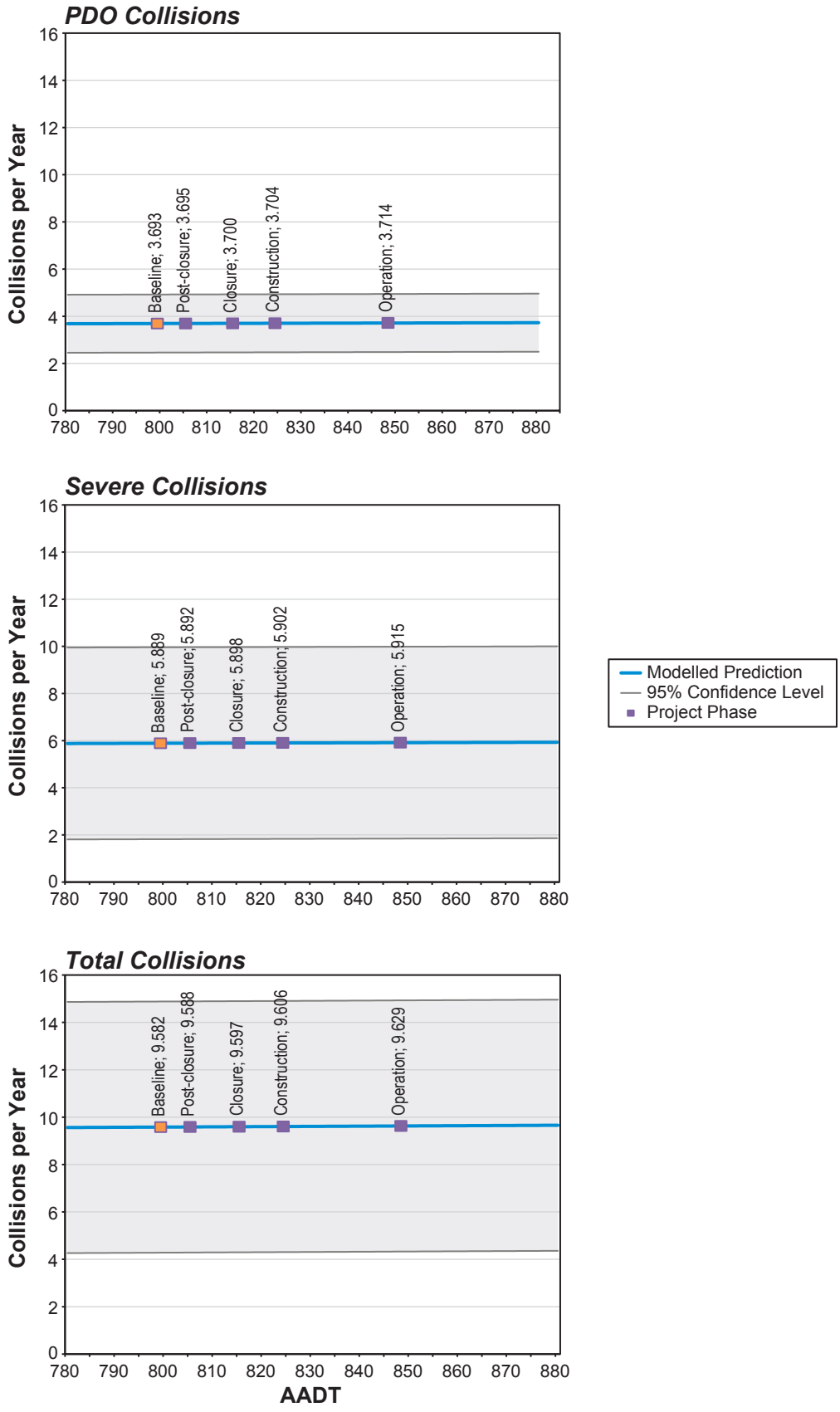

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Predicted Number of Collisions per Year on Highway 37 South - Baseline Annual Average Daily Traffic vs. Project Phases

Figure 3.2-2

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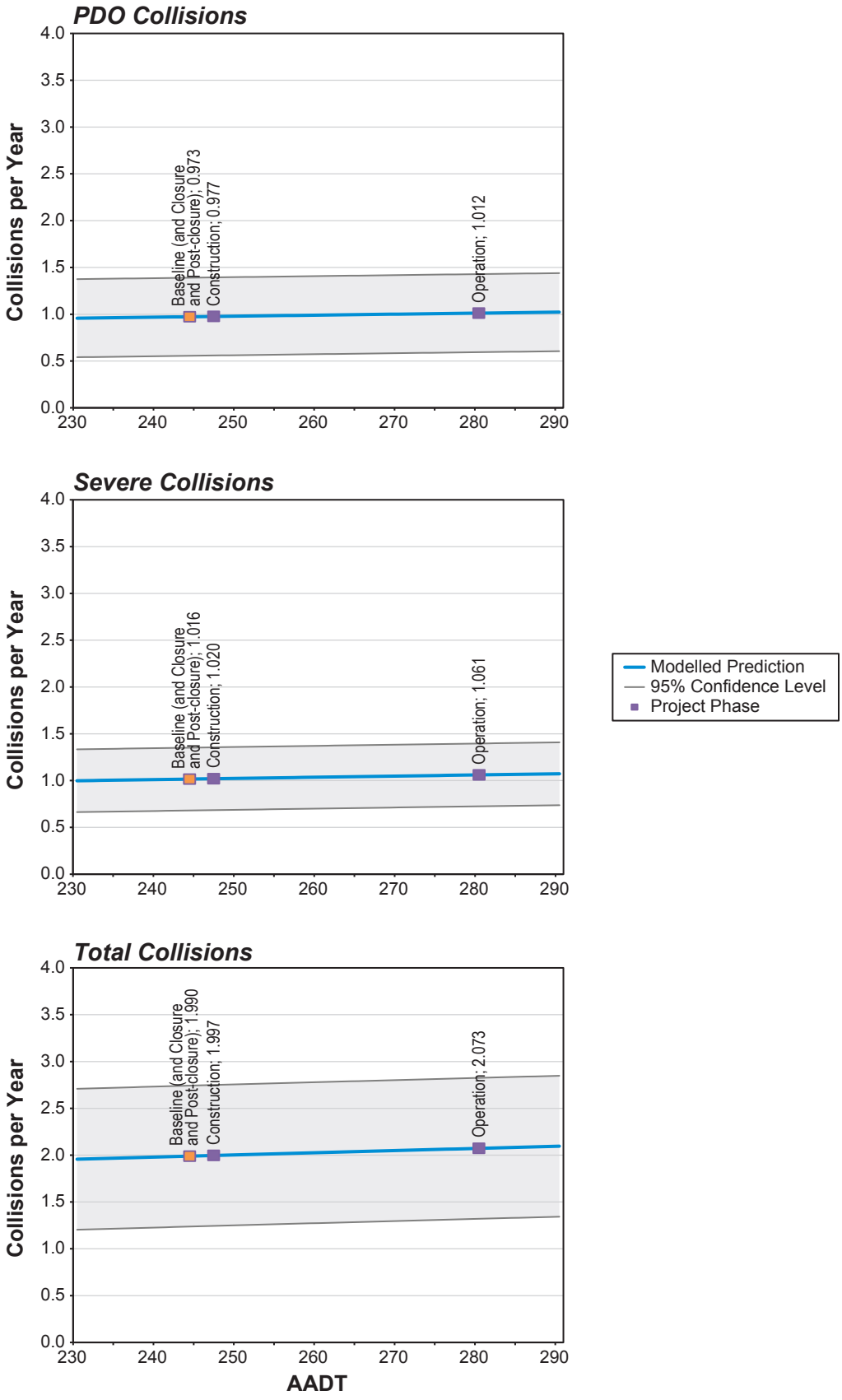

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Predicted Number of Collisions per Year on Highway 37A - Baseline Annual Average Daily Traffic vs. Project Phases

Figure 3.2-3

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4. Effects and Risk Assessment Methods

4.1 INTRODUCTION

This chapter describes the methods used to assess potential risks and effects associated with Project traffic on highways 37 and 37A. A risk assessment methodology is used to estimate the likelihood or probability of potentially adverse environmental effects resulting from increased Project-traffic within the Study Area, and is complementary to methods used in Application/EIS where significance determinations are made. The risk assessment approach does not make significance determinations, but is systematic, and can be applied to a variety of situations, both quantitative and qualitative. Risk assessment methods are commonly used in land use and resource management planning, and when assessing risks associated hazards, accidents and malfunctions.

The results of the risk assessment are presented in Chapter 5, grouped by major assessment topic (i.e., socio-economic, fish and aquatic habitat, wildlife, terrestrial ecosystems, wetlands, noise, climate and air quality, human health, and heritage). Each topic-specific assessment considers two scenarios:

1. **Risks of "Project traffic";** risks associated with normal, intended Project operation activities. Project traffic may include "all traffic", or be further broken down into "hazardous" and "non-hazardous" cargo or by specific cargo types (e.g., concentrates, lime and reagents, etc.), as appropriate for the topic being discussed.
2. **Risks of "traffic accidents";** risks associated with unintended events, may be divided into "**off-road**" and "**on-road**" accidents. "On-road" refers to a traffic accident where vehicles remain on the travelled part of the road, while "off-road" refers to accidents that result in a vehicle leaving the travelled part of the road. Traffic accidents may include "all traffic", or be further broken down into "hazardous" and "non-hazardous" cargo or by specific cargo types (e.g., concentrates, lime and reagents, etc.), as appropriate for the topic being discussed**.**The results of the potential risk of traffic accidents are then summarized in Chapter 6.

The risk assessment of potential effects for each topic comprises the following three steps:

1. **Baseline Data Overview:** Summarize environmental and socio-economic baseline information for the Study Area (Figure 1.2-1);
2. **Issue scoping**: Define the scope of the assessment using the following approach in sequence:
    a) **Assessment topic scoping:** Project traffic and traffic accident scenarios are considered in relation to assessment topics. Scenarios with potential for traffic-related risks to the environmental topic are carried forward into the risk assessment ("scoped-in"), while those topics that are not expected to be affected are excluded from further consideration ("scoped-out"). A clear rationale for either choice is provided.
    b) **Valued Component scoping:** Within each scoped-in assessment topic from the previous exercise, specific VCs are identified for further analysis.
    c) Identify potential traffic/Valued Component interactions: If the scoped-in traffic types and VCs from the preceding two exercises have potential to interact, the VCs are carried forward into the risk analysis.

3. **Risk analysis:** Potential risks to the VCs identified during issue scoping are characterized, as follows:

    a) **Risk identification:** for each VC, potential risks are identified and described

    b) **Risk mitigation:** for each potential risk, the mitigation measures proposed by the proponent are described; and

    c) **Risk characterization:** taking mitigation measures into consideration, the likelihood and severity of any realized risks are characterized.

These three steps are described in more detail in Sections 4.2 to 4.4 and depicted in Figure 4.1-1.

4.2 BASELINE DATA OVERVIEW METHODS

The risk assessment described in this document considers the potential effects of Project-related traffic within the Study Area. As a first step in the risk assessment for each of the assessment topics, relevant information about existing biophysical and socio-economic conditions in the Study Area is briefly summarized.

4.3 ISSUE SCOPING METHODS

The risk assessment uses a scoping process to focus on Project traffic with real or perceived potential to pose an environmental or human risk. The scoping process for this risk assessment is informed by land use interviews, information provided by Nisga'a Nation, and First Nations, issues identified during stakeholder consultations, and professional judgement.

Three steps are used to define the scope of the assessment: (1) assessment topic scoping, (2) VC scoping, and (3) identification of potential traffic/VC interactions.

4.3.1 Assessment Topic Scoping Methods

For each assessment topic, scoping begins with broadly identifying the risk potential associated with each traffic type under two scenarios: (1) in the context of Project traffic and (2) in the context of traffic accidents. An identical list of traffic types is used to populate a matrix for each scenario, an example of which is shown in Example Table 4.3-1, where the example of wetlands is used. If a potential risk associated with a particular traffic type was identified, that cell in the matrix is marked and the potential risk was considered further in the next scoping stage. Scoping-in at this stage does not necessarily indicate that there is a confirmed risk associated with that traffic type, but that further analysis is necessary to assess the potential risk in the context of expected Project traffic. A clear rationale is identified for scoping-in some traffic types and excluding others.

4.3.2 Valued Component Scoping Methods

VCs are those parts of the biophysical or human environment deemed important based on social values or scientific concerns. For assessment topics where potential risks associated with traffic are selected for further analysis, as described in Section 4.3.1, relevant potentially affected VCs are identified. For both scenarios (i.e., Project traffic and traffic accidents), a list of potential VCs is generated, drawing from stakeholder consultations and the professional judgement of topic specialists. This list is then used to populate another matrix table, an example of which is shown in Table 4.3-2 using wetlands. The VCs are then selected for (or excluded from) the risk assessment, with a clear rationale provided for either decision. Scoping-in at this stage of the scoping exercise means that a VC is carried forward for further analysis.

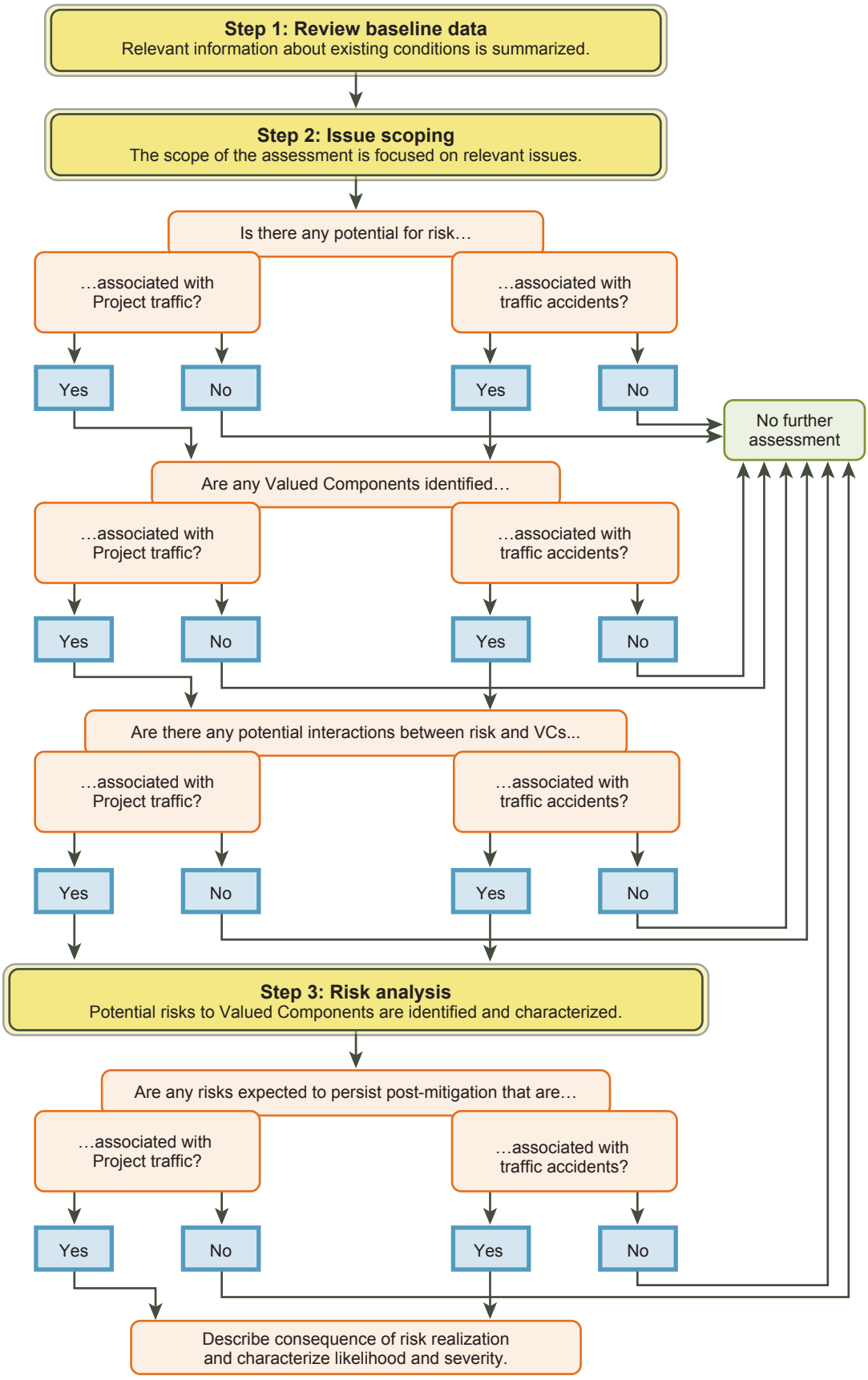

Figure 4.1-1

Risk Assessment Flow Chart

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Table 4.3-1. Assessment Topic Scoping Matrix (Example)

Traffic Type	Potential Risk?	Rationale for Selection/Exclusion
Project traffic		*This assessment is for the use of existing roads; alterations, upgrades, or maintenance to the road are not considered. Thus, no Project traffic/wetland interactions are expected given that wetlands will not be altered.*
Personnel and non-hazardous cargo		
Personnel	*No*	
Materials, equipment, and supplies	*No*	
Hazardous cargo		
Diesel fuel and lubricants	*No*	
Concentrates	*No*	
Lime and reagents	*No*	
Explosives	*No*	
Traffic accidents		*Traffic accidents have the potential to affect wetlands if accidents occur in or near wetlands, as hydrocarbon contamination may result.*
Personnel and non-hazardous cargo		
Personnel	*Yes*	
Materials, equipment, and supplies	*Yes*	
Hazardous cargo		
Diesel fuel and lubricants	*Yes*	
Concentrates	*Yes*	
Lime and reagents	*Yes*	
Explosives	*Yes*	

Table 4.3-2. Identification and Rationale for Valued Component Selection/Exclusion Matrix (Example)

	Identified by[1]				Selected for…[2]		
VC	AG	G	P/S	O	Normal Project Traffic?	Traffic Accidents?	Rationale for Selection/Exclusion
Wetland Extent	*X*	*X*		*X*	*No*	*No*	*Extent is affected by direct footprint interactions. As this assessment is based on use of existing highways, potential effects to extent are not expected.*
Wetland Function	*X*	*X*		*X*	*No*	*Yes*	*The use of existing highways will not affect wetlands ability to continue to perform the functions they currently provide; this VC was therefore scoped out. Traffic accidents have the potential to affect wetland function if vehicle crashes or spills occur in wetlands.*

[1] *"X" indicates that the corresponding group (AG = Aboriginal Group, G = Government, P/S = Public/Stakeholder, or O = Other) has identified the VC as an issue; "-" indicates that the group did not identify the VC as an issue.*
[2] *"Yes" indicates that the VC is selected for further analysis; "No" indicates that the VC is excluded from further analysis.*

VCs included in the assessments must meet the following criteria:

- There is spatial overlap between the study area and the VC.
- There is temporal overlap between the Project life span and the VC.
- There is a real or perceived likelihood—as identified by stakeholders or topic specialists—that Project traffic could pose a risk to the VC.

4.3.3 Methods for Identification of Potential Traffic/Valued Component Interactions

The traffic types and VCs identified in the preceding two steps are then used to populate two axes of a potential interactions matrix, an example of which is shown in Table 4.3-3. In light of the baseline data and the assessor's professional judgement, each traffic type is re-considered. In the case of traffic accidents, on-road and off-road events are considered separately.

Table 4.3-3. Potential Traffic/Valued Component Interaction Matrix (Example)

	VCs	
Traffic Type	*Wetland Function*	*<Name of VC 2>*
Project traffic		
Concentrates	-	
Lime and reagents	-	
Traffic accidents: on-road		
Personnel	-	
Materials, equipment, and supplies	-	
Diesel fuel and lubricants	*X*	
Concentrates	*X*	
Lime and reagents	*X*	
Explosives	*X*	
Traffic accidents: off-road		
Personnel	*X*	
Materials, equipment, and supplies	*X*	
Diesel fuel and lubricants	*X*	
Concentrates	*X*	
Lime and reagents	*X*	
Explosives	*X*	

"X" indicates that a potential interaction has been identified.
"-" indicates that no potential interaction was identified.

If a traffic type does not have the potential to interact with an identified VC, that cell in the matrix is left blank. If there is a potential interaction, then that cell is marked and the interaction was examined in more detail in the risk analysis (described in Section 4.4). Proponent mitigation measures are not taken into consideration until after the scoping stage of the assessment was complete.

4.4 RISK ANALYSIS METHODS

For each assessment topic, risk analyses under the two scenarios were carried out separately. Risk analysis included three steps: (1) risk identification, (2) risk mitigation, and (3) risk characterization.

4.4.1 Risk Identification Methods

For each of the potential interactions identified at the end of issue scoping (as described in Section 4.3), potential traffic risks to VCs are identified and described. Each risk is documented as being associated with a discrete Project phase (i.e., construction, operation, closure, or post-closure) or with all phases over the Project life. Risks are also described as being associated with a particular traffic type or with all traffic types. Project phases and traffic types are grouped whenever possible. This information is used to populate the first four columns of a risk assessment matrix. A separate risk assessment matrix is filled out for each scenario (i.e., Project traffic and traffic accidents), as shown in Tables 4.4-1 and 4.4-2 using wetlands as an example.

4.4.2 Risk Mitigation Methods

Proposed measures to mitigate and manage each of the potential risks to VCs identified in the preceding step are briefly described in the fifth column of the risk assessment matrices, examples of which are shown in Tables 4.4-1 and 4.4-2. These measures are more thoroughly described in the accompanying text, if necessary.

4.4.3 Risk Characterization

Potential risks to VCs are then considered in the context of the proposed mitigation and management measures. Post-mitigation consequences of realized risks are briefly described in the final column of the risk assessment matrix, as shown in Tables 4.4-1 and 4.4-2. Two aspects of risks are characterized in the sixth and seventh columns of the risk assessment matrix: (1) the likelihood of the risk, and (2) the severity of any risks expected to persist post-mitigation. If a particular risk is judged to be fully mitigated, this is indicated in the final column and the sixth and seventh columns are left empty. In the example of wetlands, Table 4.4-1 is not required as no interaction between wetlands and Project traffic was identified in the preceding steps. Table 4.4-2 would be completed as shown in the example.

The **likelihood** of risk occurrence is evaluated and characterized using the following rating scale:

- Rare: Highly unlikely, but may occur in exceptional circumstances (i.e., there is a greater than 0% change of occurrence). This risk is not expected to be realized.
- Unlikely: Not expected, but there is a small probability that this risk will be realized.
- Possible: This risk may be realized.
- Likely: This risk will probably be realized.
- Certain: This risk is highly likely to be realized.

The **severity** of the consequence, should the risk be realized, was then evaluated and characterized using the following scale:

- negligible;
- minor;
- moderate;
- major; or
- catastrophic.

The descriptors for the severity scale are defined separately for each topic.

Table 4.4-1. Risk Assessment Matrix for Project Traffic (Example)

VC	Traffic Type	Description of Potential Risk (pre-mitigation)	Project Phase	Description of Mitigation Measures	Post-mitigation		
					Likelihood	Severity	Description of Consequence of Realized Risk
<Name of VC>	*<traffic type>*	*<description of risk>*	*<phase>*	*<description of mitigation>*	*<likelihood rating>*	*<severity rating>*	*<description of post-mitigation risk>*

Table 4.4-2. Risk Assessment Matrix for Traffic Accidents (Example)

VC	Traffic Type	Description of Potential Risk (pre-mitigation)	Project Phase	Description of Mitigation Measures	Post-mitigation		
					Likelihood	Severity	Description of Consequence of Realized Risk
Wetland Function	*All traffic types*	*deposition of deleterious substances in wetlands from:*	*All phases*	*Limit the extent of contamination; Limit the time a contaminant may be in contact with a wetland, and follow spill prevention and emergency response plans*	*Unlikely*	*Major*	*A loss of wetland function within a specific wetland or wetland complex.*

5. Assessment of the Potential Risks of Project Traffic

This chapter summarizes baseline information for a variety of disciplines, identifies potential issues and assesses potential risks associated with Project traffic on highways 37 and 37A. The assessment follows the methodology described in Chapter 4.

5.1 SOCIO-ECONOMICS AND LAND USE

5.1.1 Baseline Data Overview

The socio-economic study area falls within the Regional District of Kitimat-Stikine (RDKS) and includes the settlements of Bob Quinn Lake (north of the Eskay Creek Mine access road), Bell II, Meziadin Junction, and the villages of Gitanyow and Kitwanga (Figure 5.1-1).

Communities in this area of northwestern BC are dispersed and isolated from one another, as well as major populations and governance centres. Distances between settlements are long and it is common to travel two or more hours between communities. Isolation can also be exacerbated by the weather, as road closures can restrict access to and from communities. These factors play a large role in determining the frequency and the manner in which residents access, use and relate to much of the social, economic, and heritage environment in the region.

The Nisga'a Nation and First Nations have a physical, cultural, and historical presence within the Study Area. Approximately 32% of the RDKS's population is Aboriginal (Table 5.1-1) and most of the smaller communities along the north-south corridor of Highway 37 are predominantly Aboriginal.

Table 5.1-1. Population and Demographics — Regional District of Kitimat-Stikine

Region	Total Population (2011)	Males (2011)	Females (2011)	Median Age (2011)	Aboriginal Identity (2006)
RDKS	37,361	19,035 (51%)	18,320(49%)	40.3	12,275 (32%)
British Columbia	4,400,055	2,156,600(49%)	2,243,455 (51%)	41.9	196,070 (4.8%)

Source: Statistics Canada (2007, 2012)

The population of the RDKS has generally declined over the past decade or more, largely due to the loss of jobs (e.g., mine closures), particularly among non-Aboriginal communities. This decline is most evident in Stewart (Statistics Canada 2007). The number of males and females remains relatively balanced, and the median age is slightly below the provincial figure of 41.9.

Services vary considerably based on the size of the community. Limited services and accommodations are typical of the smaller communities. The number of recreation, health, social and educational services within the communities has declined in conjunction with a decrease in population. Primary and secondary education facilities exist in many communities, while educational facilities within certain Aboriginal communities do not extend beyond elementary school.

In addition to the highways 37 and 37A transportation corridors, the communities of Stewart and Bob Quinn are each equipped with an airstrip. Small emergency landing strips exist in the area, two of which are located south of Meziadin Junction. A helicopter landing pad is located at Bell II. Mobile cellular phone coverage is unavailable north of Kitwanga.

5.1.1.1 Economic Development

The RDKS is considered one of the least economically diversified regions of the province (Horne 2009). Economic development has largely been driven by the area's abundant natural resources. The value of mining and mineral activities has been a strong contributor, and sustainable mineral development is supported by regional land use management plans (BC ILMB 2000a, 2004). However, lack of infrastructure, isolated communities, small populations, long winters and long travel distances have constrained the level of economic development. The Northwest Transmission Line is expected to facilitate the growth of the mining industry in the area, which will bring new economic opportunities to the northwest region.

In 2006, unemployment within the RDKS was approximately 14% (Statistics Canada 2007). Unemployment in the region has usually been above the provincial average, which was 6% in 2006. The recent global economic downturn has also led to a slowing of economic activity within the region.

Employment in logging and mining led to the development of most non-Aboriginal communities in the RDKS, with most forestry activity occurring south of Bell II (BC MOFR 2010b). There are a number of past and current mine operations in the region, as well as mines currently under development or in the planning phase. Past mine operations include Golden Bear gold mine, Snip gold-silver mine, Premier gold-silver mine, Granduc copper mine, Eskay Creek gold-silver mine, and Kitsault molybdenum mine. Current mine and/or exploration developments include the Galore Creek copper-gold mine, Red Chris copper-gold mine, as well as a number of smaller-scale jade mines. Proposed mine projects include the Kutcho copper-zinc mine, Schaft Creek copper-gold-molybdenum-silver mine, and Arctos Anthracite coal mine, as well as the re-opening of the Kitsault molybdenum mine.

Tourism in the region draws tourists from around the world and has grown in recent years. Tourism activities include guide outfitting, hunting, fishing, heli-skiing, and backcountry recreation opportunities. Residents in the four Nisga'a villages and the Tahltan, Gitanyow, and Gitxsan (including Skii km Lax Ha)First Nations communities are also involved in resource activities (including mining and mineral exploration), as well as construction and tourism (Rescan 2012b).[5] Public administration is typically a major employer within these communities. Nisga'a Nation and First Nations also pursue a wide range of sustenance activities (including hunting and fishing), which contribute economically, socially and culturally to their households and communities (BC ILMB 2004).

5.1.1.2 Communities

Kitwanga

Kitwanga (Gitwangak) is a small reserve located near the junction of Highway 37 and Highway 16, where the Kitwanga River runs into the Skeena River. The registered population of Kitwanga was approximately 1,216 in 2012 (AANDC 2012b). Approximately one third of the registered on-reserve Gitxsan population (33.1% or 402 people) live in Kitwanga (AANDC 2012b).

In 2006, only 50% of the population aged 15 years and over had received a high school certificate. The high school incompletion rate (50%) was more than twice the provincial rate (20%). A similar proportion of the Kitwanga population obtained trades certificates (11.8%) compared to 11% province-wide.

[5] For example, out of 22 recently surveyed Nisga'a commercial ventures, four businesses (about 20% of respondents) had worked in the mining, quarrying, oil and gas sector. Six businesses (27.3%) had worked in the construction sector, five in the forestry sector (22.7%), and another five (22.7%) in the transportation sector. Most respondents (14 or 63.6%) indicated that their businesses had worked in the tourism/accommodation/food services sector (Rescan 2012).

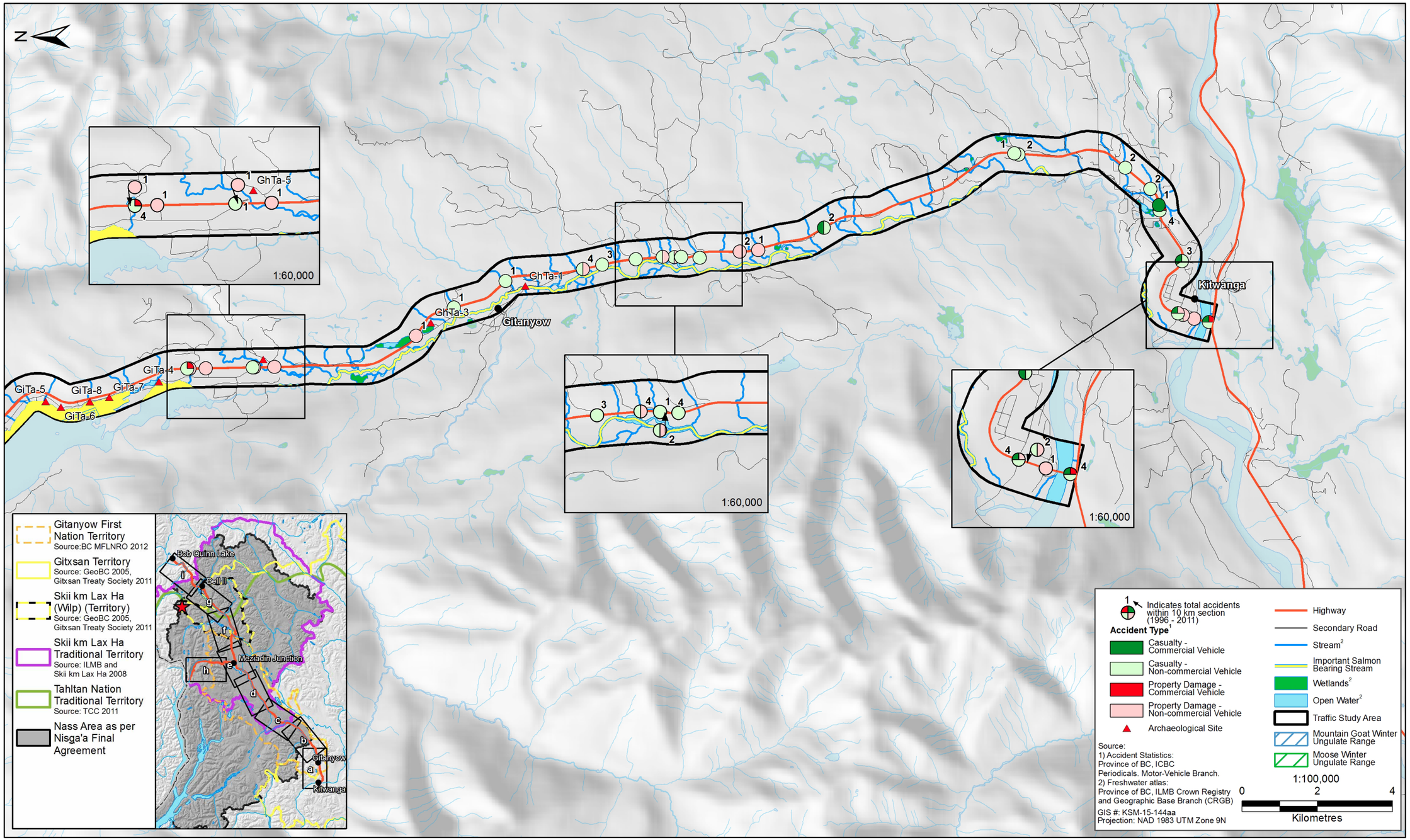

Figure 5.1-1a

SEABRIDGE GOLD
KSM PROJECT

Rescan Engineers & Scientists

Traffic Study Area Baseline Map

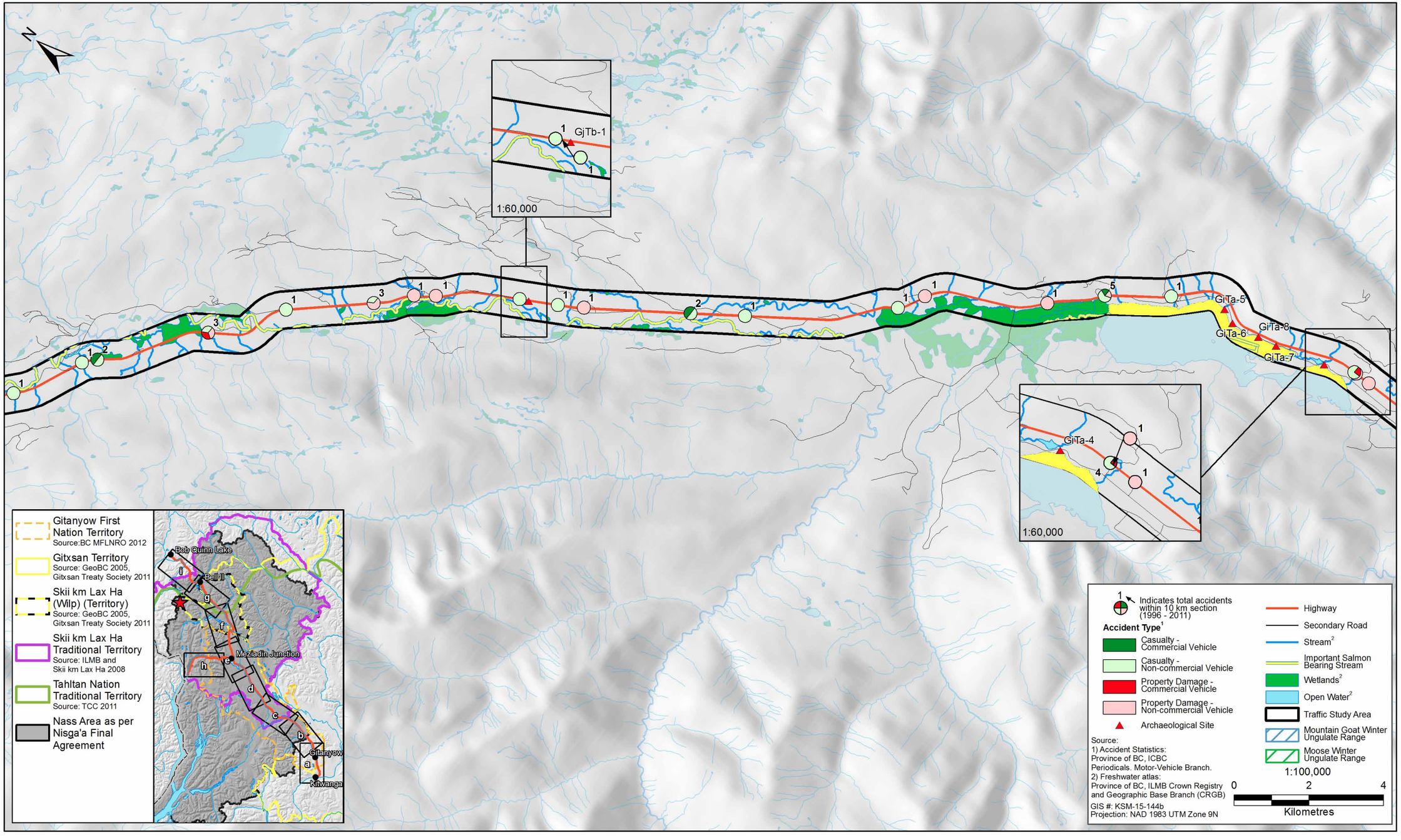

Figure 5.1-1b

SEABRIDGE GOLD
KSM PROJECT

Rescan Engineers & Scientists

Traffic Study Area Baseline Map

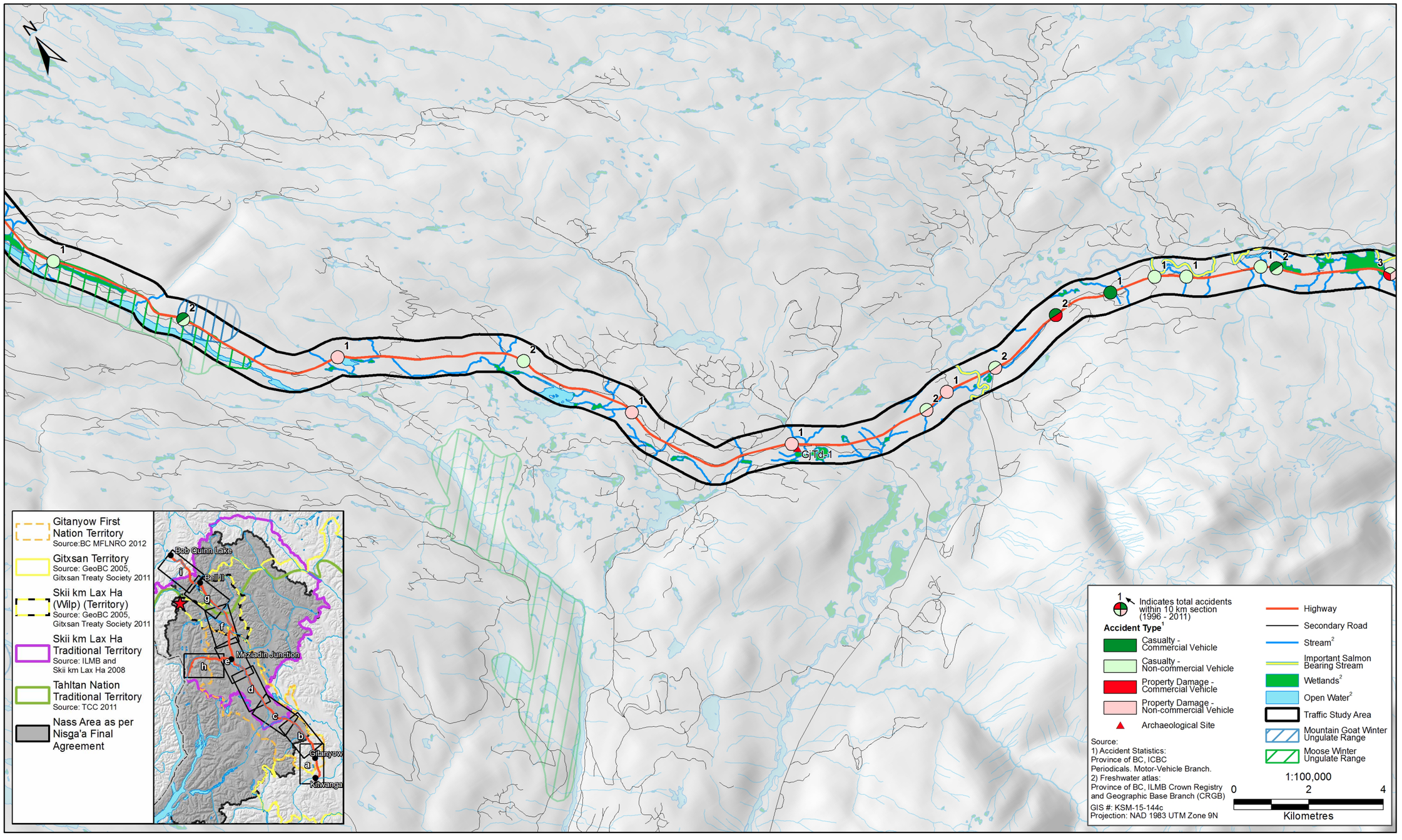

Figure 5.1-1c

SEABRIDGE GOLD
KSM PROJECT

Rescan Engineers & Scientists

Traffic Study Area Baseline Map

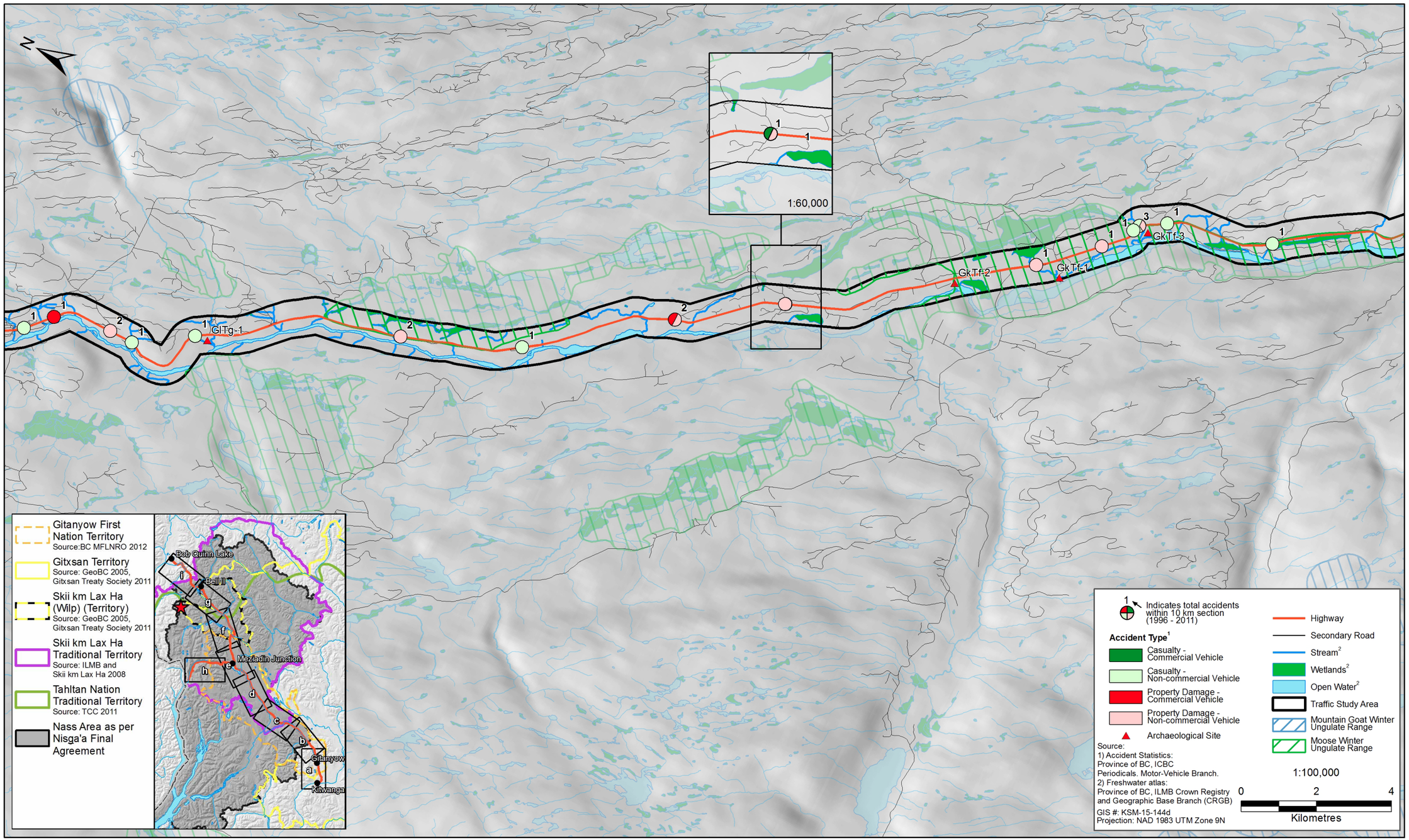

Figure 5.1-1d

Traffic Study Area Baseline Map

SEABRIDGE GOLD
KSM PROJECT

Rescan Engineers & Scientists

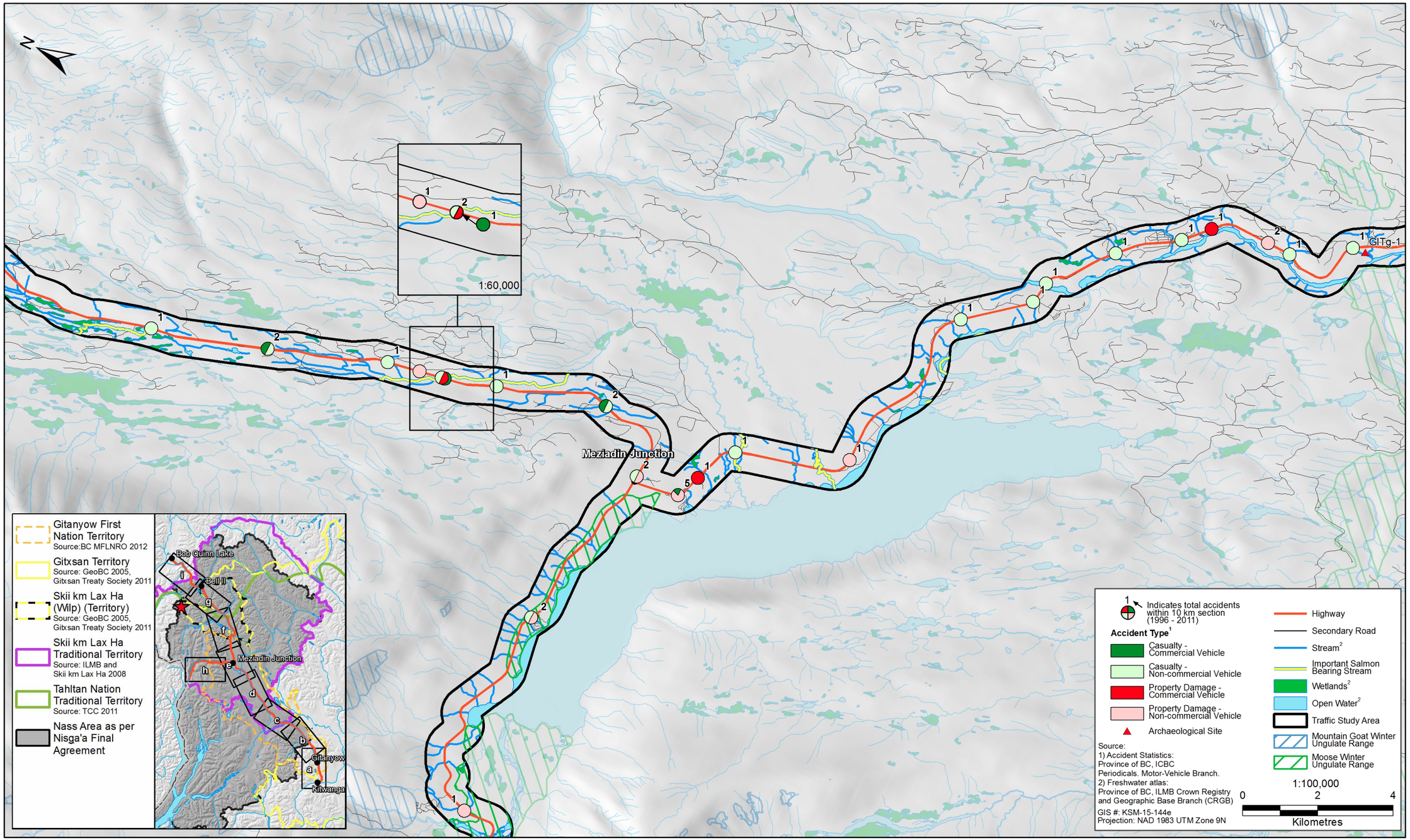

Figure 5.1-1e

SEABRIDGE GOLD
KSM PROJECT

Rescan Engineers & Scientists

Traffic Study Area Baseline Map

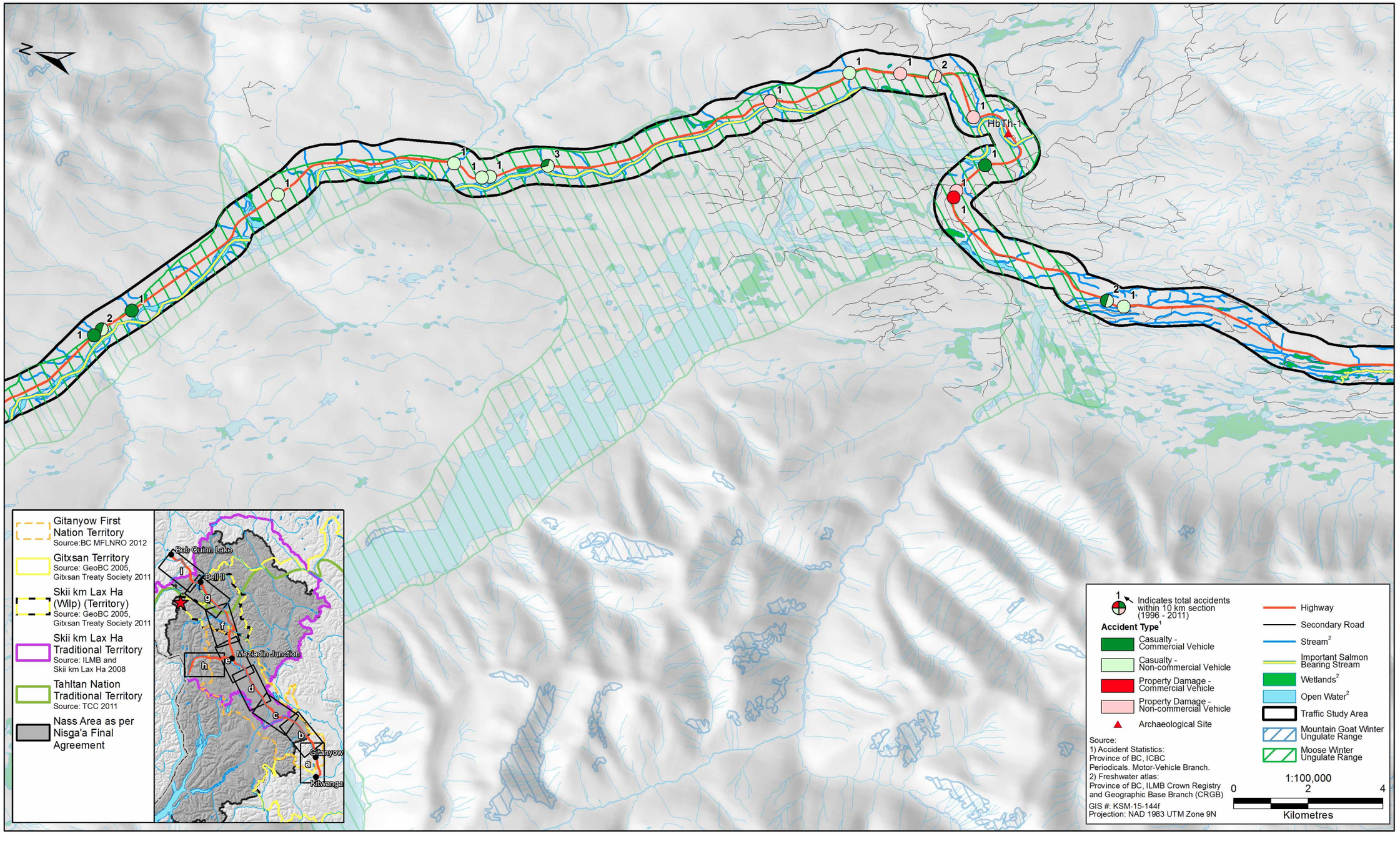

Figure 5.1-1f

SEABRIDGE GOLD
KSM PROJECT

Rescan Engineers & Scientists

Traffic Study Area Baseline Map

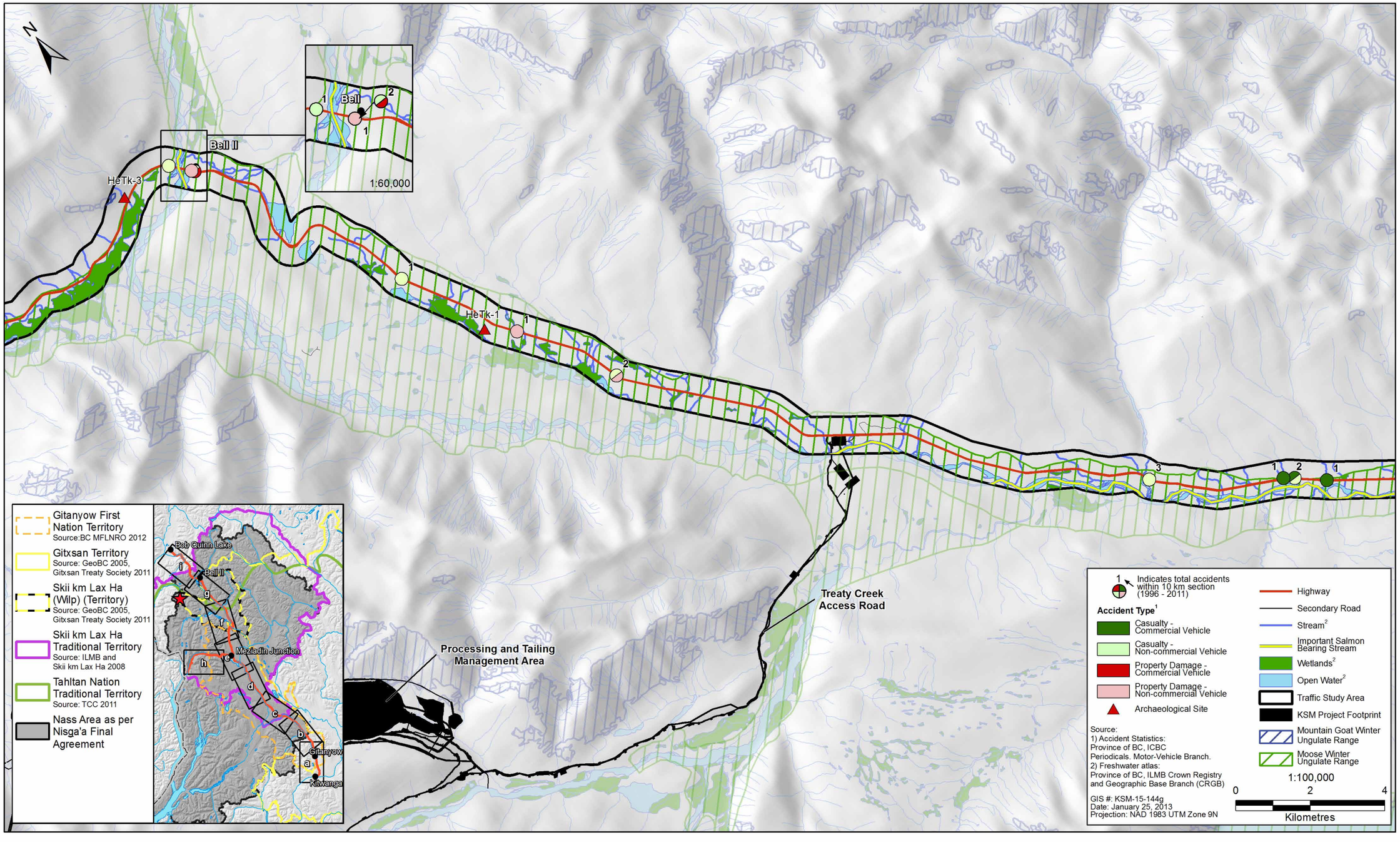

Figure 5.1-1g

SEABRIDGE GOLD
KSM PROJECT

Rescan Engineers & Scientists

Traffic Study Area Baseline Map

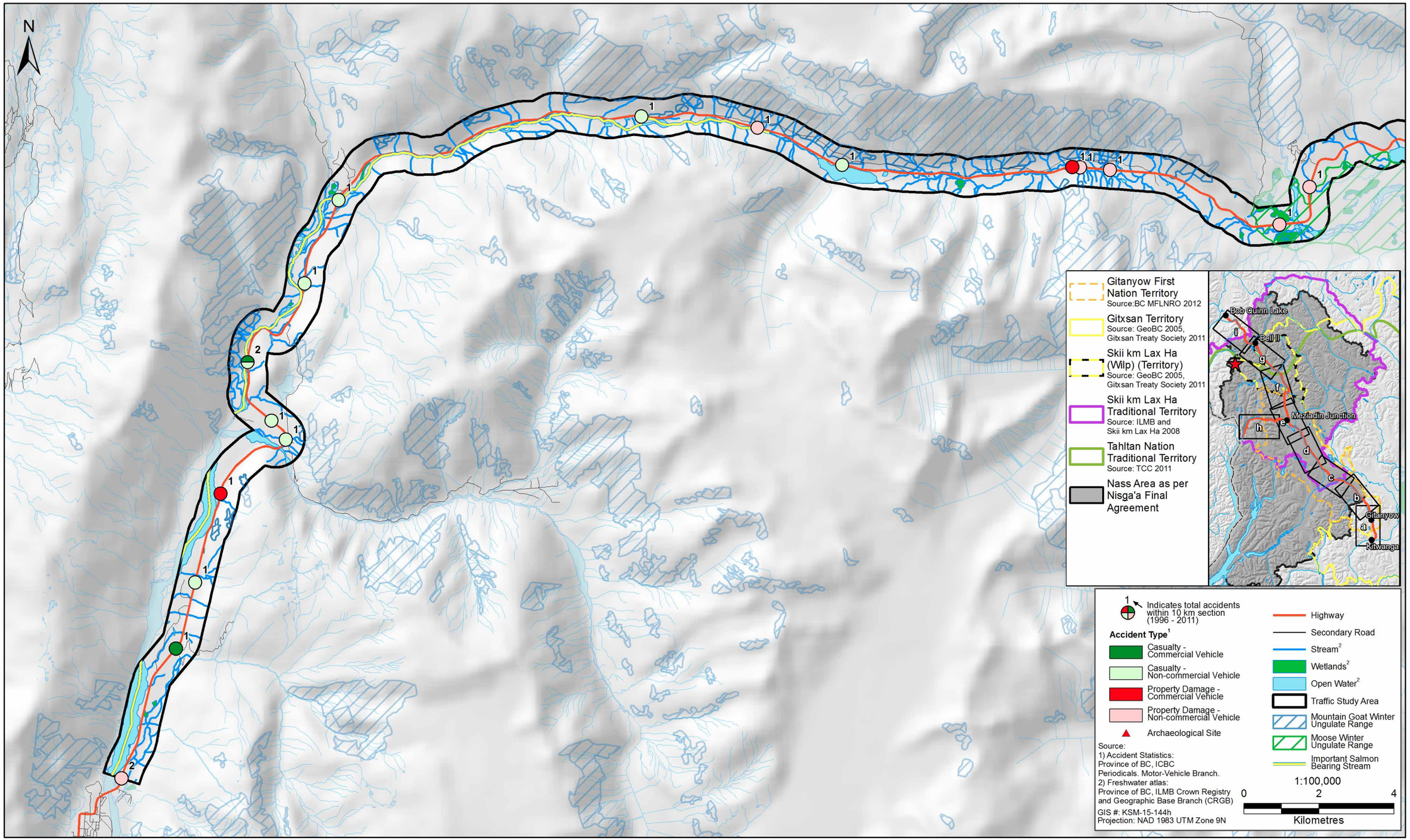

Figure 5.1-1h

SEABRIDGE GOLD
KSM PROJECT

Rescan Engineers & Scientists

Traffic Study Area Baseline Map

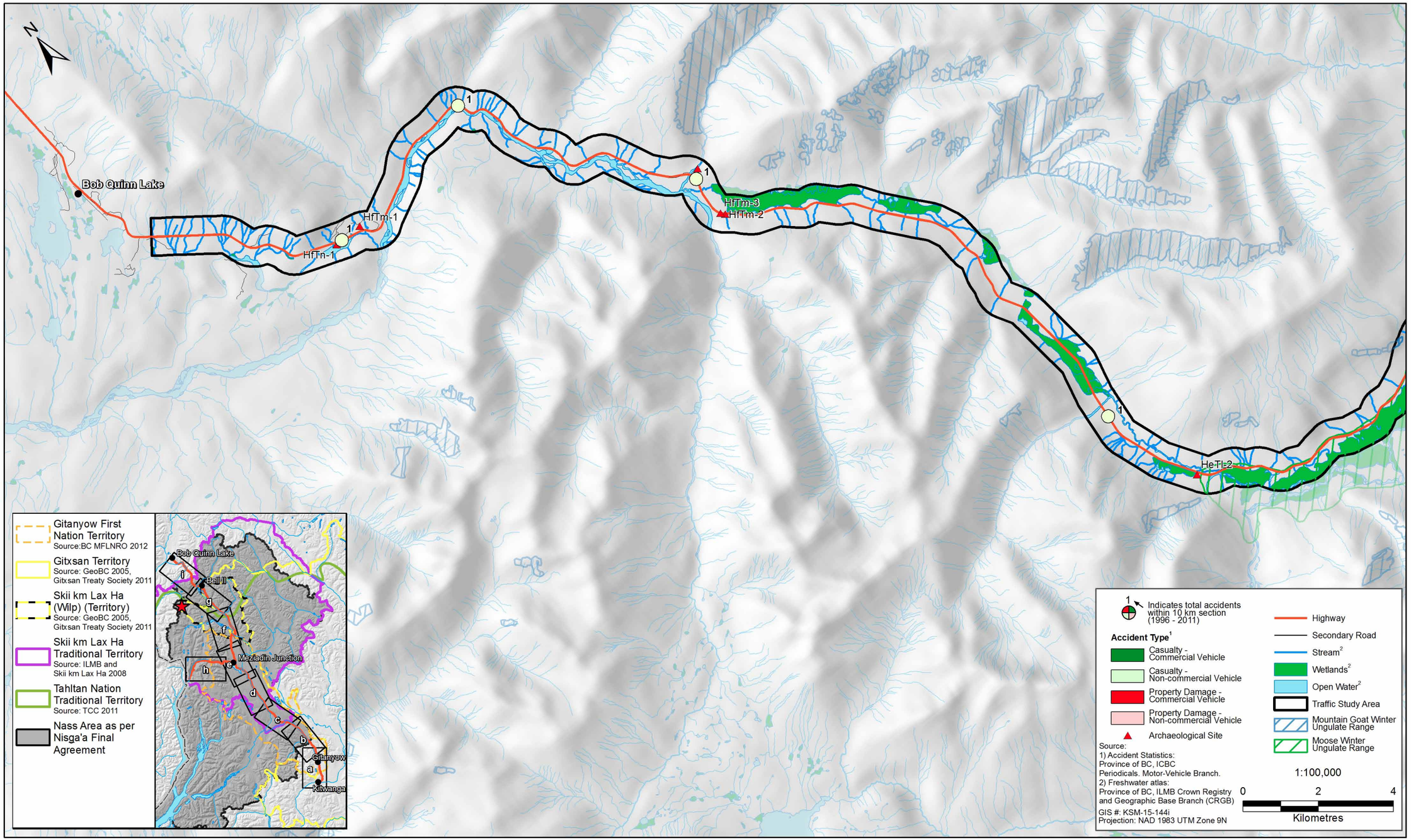

Figure 5.1-1i

SEABRIDGE GOLD
KSM PROJECT

Rescan Engineers & Scientists

Traffic Study Area Baseline Map

Kitwanga's economy relies on primary and secondary industries, including natural resources, and manufacturing (Statistics Canada 2007). Forestry has been the main resource industry; however, the closure of the local sawmill in October 2011 (after its reopening in June 2011) has resulted in fewer forestry opportunities in the area.

Kitwanga's total labour force population was approximately 340 people in 2006. Of these, 33.8% were employed and 25% were unemployed. Labour force participation (being either employed or unemployed and seeking work) in the community was 57.4% in 2006. Median earnings in 2005 were reported at $11,392 (Statistics Canada 2007). The full-time earnings were markedly lower (estimated at $30,592) than the provincial median level ($42,230) in 2005. Government transfers were a major source of income, representing 29% of total income.

Kitwanga relies primarily on Hazelton, and to a lesser extent Terrace, for health care and policing. Fire services are provided by the Gitsegukla Fire Hall in Kitwanga. BC Ambulance provides ambulance from Kitwanga. Residents in need of medical attention are transported to the Wrinch Memorial Hospital in Hazelton. The Community Well-Being (CWB) Index score for Kitwanga was 55 in 2006, lower than both the non-First Nations CWB average of 82 and the First Nations CWB average of 57 (AANDC 2011).

Gitanyow

Gitanyow (Gitanyow Indian Reserve 1) is located on the Kitwanga River, 8 km south of Kitwancool Lake, at the confluence of Kitwancool Creek. The Gitanyow First Nation is politically independent, although culturally affiliated with the Gitxsan. Gitanyow is located approximately 400 m west of Highway 37 and approximately 140 km northeast of Terrace.

The registered population of the Gitanyow First Nation was approximately 802 in 2012 (AANDC 2012a). Just under half of the population (48% or 382 people) live on the Gitanyow reserve.

In 2006, only 20% of the Gitanyow population aged 15 years and over had completed a high school certificate. (Statistics Canada 2007). The Gitanyow high school incompletion rate (54%) was more than twice the provincial rate (20%). A higher proportion of the Gitanyow population obtained trades certificates (14%) compared to 11% province-wide.

The unemployment rate for the community of Gitanyow was 51.7% in 2006, up substantially from 34.8% in 2001 (Statistics Canada 2007). Annual full-time median earnings, representing income received as wage or salary, for Gitanyow was $27,200 in 2005, much lower than the full-time median earnings for BC as a whole ($42,230).

The economy within the Gitanyow community is rooted in primary and secondary industries, including natural resources, construction and manufacturing (Statistics Canada 2007). Forestry has been the main resource industry; however, the closure of the Kitwanga sawmill in October 2011 has affected the Gitanyow community along with other communities in the area (Gitanyow Hereditary Chiefs 2006).

The total labour force population on Gitanyow Indian Reserve 1 was 275 people in 2006 (Statistics Canada 2007). Of these, 25.5% were employed and 51.7% were unemployed. Labour force participation (being either employed or unemployed and seeking work) in the Gitanyow community was 52.7% in 2006 and 46.9% in 2001. Government transfers were a major source of income, representing 29.5% of total income. This proportion is almost three times higher than the amount for British Columbia overall (10.7%- Statistics Canada 2007).

Gitanyow health services are managed by Gitanyow Human Services (GHS), an office that runs a number of health programs within the community. Health services are primarily procured in Terrace or Hazelton. Policing and ambulance services are provided through the Hazeltons. A local fire department

provides emergency fire protection. The 2006 CWB Index for Gitanyow was 54, lower than the average First Nations score of 57 (AANDC 2010, 2011).

Settlements

Bob Quinn Lake, Meziadin Junction, and Bell II are generally considered tourist destinations, and are significantly smaller than the communities previously discussed. Most businesses are seasonal, including businesses related to fishing, hiking, heli-skiing, snowmobiling, and hunting. Bell II and Bob Quinn Lake have helped support local mineral exploration activities, primarily through the provision of accommodations. Facilities at Meziadin Junction have been decommissioned.

5.1.2 Issue Scoping

5.1.2.1 Socio-economic and Land Use Scoping

Project activities are expected to result in additional traffic volumes on highways 37 and 37A, although not exceeding historical peaks. Potential risks related to traffic are presented in Table 5.1-2.

Table 5.1-2. Socio-economic and Land Use Scoping Matrix

Topic	Potential Risk?	Rationale for Selection/Exclusion
Project traffic		
	Yes	Project traffic has the potential to affect community well-being due to increased traffic volume on the highways (e.g., vehicle noise and emissions). Project traffic has the potential to affect availability of resources harvested by land users as a result of wildlife-vehicle interactions.
Traffic accidents		
All traffic	Yes	Traffic accidents have the potential to affect socio-economic VCs due to increased traffic volumes. This could pose a safety risk to local residents and tourists travelling along the highways. Traffic accidents may require local emergency services and first responders in the area.

5.1.2.2 Valued Component Scoping

The selected socio-economic VCs and the rationale for their inclusion or exclusion are presented in Table 5.1-3. The party who identified each potential VC is also referenced in the table: Aboriginal groups (AG); government (G); public/stakeholder (P/S); or other (O) (e.g., legislation, technical expertise).

Table 5.1-3. Identification and Rationale for Socio-economic and Land Use Valued Component Selection/Exclusion

	Identified by[1]				Selected for…[2]		
VC	AG	G	P/S	O	…Project Traffic?	… Traffic Accidents?	Rationale for Selection/Exclusion
Community demographics and infrastructure	-	-	X	X	No	No	A change in traffic volume is not anticipated to affect community demographics or population numbers. No changes to infrastructure are anticipated as Project traffic will be along existing highways.
Education, skills development, and training	X	-	-	X	No	No	No change in education, skills or training is anticipated as a result of Project traffic. Any changes in these areas are anticipated to be directly linked to Project development.

(continued)

Table 5.1-3. Identification and Rationale for Socio-economic and Land Use Valued Component Selection/Exclusion (completed)

VC	Identified by[1]				Selected for…[2]		Rationale for Selection/Exclusion
	AG	G	P/S	O	… Project Traffic?	… Traffic Accidents?	
Community Well-being (CWB)	X	-	-	-	Yes	Yes	Project traffic may result in an increase in vehicle noise and emissions over existing baseline conditions, as well as a decrease in public safety.
Employment and Income	X	-	X	-	No	No	No change in employment and income is anticipated as a result of Project traffic. Any changes in these areas are anticipated to be directly linked to Project development.
Business Opportunities and Economic Development	x		x	x	No	No	No change in business opportunities and economic development is anticipated as a result of Project traffic. Any changes in these areas are anticipated to be directly linked to Project development.
Access	X	X	X	X	No	No	No change in access anticipated as a result of Project traffic. Any changes in these areas are anticipated to be directly linked to Project development.
Hunting and Trapping	X	X	X	X	Yes	No	The proposed Project may affect availability of resources harvested by land users as a result of wildlife/vehicle interactions. Potential subsistence activities carried out by the Nisga'a Nation, Skii km Lax Ha, Tahltan Nation and Gitanyow First Nation could be altered as a result of changes in the availability of resources.

[1] "X" indicates that the corresponding group (AG = Aboriginal Group, G = Government, P/S = Public/Stakeholder, or O = Other) has identified the VC as an issue; "-" indicates that the group did not identify the VC as an issue.
[2] "Yes" indicates that the VC is selected for further analysis; "No" indicates that the VC is excluded from further analysis.

Community well-being is a multi-dimensional concept that refers to individual and collective levels of health, satisfaction, quality of life, and standard of living (Kusel 1996; Costa, Silvana, and Scoble 2006; Sirgy et al. 2009).Community Well-being dimensions include financial independence and access to goods and services; sense of individual and community worth; substance misuse; family stress; the quality of the natural environment; and traffic safety.

Community Well-Being (CWB) is the only socio-economic VC to be potentially affected by Project traffic. Potential impacts include nuisance effects from vehicle noise and emissions in the vicinity of the highways, particularly where the highways pass through communities and settlements. Public safety may also be impacted. There may also be perceived impacts on the quality of the natural environment, both due to Project traffic and the type of Project vehicles using the highways (i.e., haul trucks).

Accidents involving Project vehicles have the potential to affect aspects of CWB as they pose a safety risk to residents and tourists travelling along the highways. Traffic accidents could occur anywhere along the highway corridors and could involve one or multiple vehicles and vehicle types.

The Land Use VC, Hunting and Trapping was identified as having the potential to be indirectly affected by Project-related traffic along highways 37 and 37A. Wildlife/vehicle interactions from Project-traffic such as disruption of movement and direct mortality could potentially affect availability of wildlife resources harvested by land users for recreational, subsistence and traditional purposes. This is true mainly for moose and bears. Other harvest resources of interest to land users, including hoary marmots, American marten, and mountain goats, are also not predicted to be at increased risk from vehicle collisions. Subsistence harvest resources, such as fish and edible plants, are not anticipated to be at increased risk from change in traffic. These resources are not considered further in this assessment.

5.1.2.3 Potential Traffic/Valued Component Interactions

The potential traffic/socio-economic and land use interactions associated with Project traffic along highways 37 and 37A are related to the CWB and hunting and trapping VCs (Table 5.1-4). Vehicles will be transporting either non-hazardous or hazardous cargo and accidents could potentially affect public safety. Four broad categories of traffic accidents were considered in this assessment in order to be inclusive of all types of traffic accidents.

Table 5.1-4. Potential Traffic / Socio-economic and Land Use Valued Component Interaction Matrix

	VCs	
Traffic Type	**Community Well-being**	**Hunting and Trapping**
Project traffic		
All traffic types	X	X
Traffic accidents: on-road		
All non-hazardous cargo	X	-
All hazardous cargo	X	-
Traffic accidents: off-road		
All non-hazardous cargo	X	-
All hazardous cargo	X	-

"X" indicates that a potential interaction has been identified.
"-" indicates that no potential interaction was identified.

5.1.3 Risk Analysis

5.1.3.1 Community Well-being

This section analyzes the risks associated with Project traffic on the CWB VC. There are four potential effects related to the CWB VC: (1) nuisance effects from vehicle emissions (potential air quality impacts), (2) nuisance effects from vehicle noise, (3) perceived impacts on the quality of the natural environment due to the type and number of Project vehicles, and (4) reduced public safety due to Project traffic and related accidents.

The following sections describe each potential effect and how it relates to the CWB VC. Each of these potential effects, including mitigation, predicted likelihood and severity of effects are discussed in the following sections. Table 5.1-5 describes the scale used to qualitatively assess the risks. The potential risks, mitigation, and evaluation of severity are shown in Table 5.1-6 and Table 5.1-7.

Ambient Air Quality Effects

Risk Identification

The potential for effects on CWB from air quality associated with Project traffic along highways 37 and 37A will exist during all Project phases. However, air emission contributions from the Project will vary for each phase due to changes in traffic volumes. Further, it is anticipated that any potential effects to ambient air quality will be highly localised and experienced within 50 m of the highway corridor.

Project traffic activities will contribute to air quality effects along the highways because of engine combustion emissions. Table 5.1-6 shows the potential risk before and after mitigation. Since engine combustion is continuous for vehicles, the contribution to VCs will occur regularly during all phases of the Project.

Table 5.1-5. Social-economic and Land Use Risk Assessment Severity Scale Descriptors

Descriptor	Definition
Negligible	No measurable or detectable change from baseline conditions.
Minor	Safety conditions differ to a small degree (e.g., within the range of natural variation). Air and noise effects limited to a few individuals. Traffic accidents do not involve any injuries. Land use value differs from the average value for baseline conditions, but is within the range of natural variation and well below threshold values.
Moderate	Air, noise and safety effects limited to communities (Gitanyow, Kitwanga, Bob Quinn Lake, Bell 11, Meziadin Junction) adjacent to the highway. Traffic accidents involve minor injuries. Land use value differs from the average value for baseline conditions, and approaches the range of natural variation, but below threshold values.
Major	Air, noise and safety effects extend to the local community. Traffic accidents include significant injury. Land use value differs from baseline conditions and exceed threshold values so that there will be a detectable change beyond the range of natural variation
Catastrophic	Traffic accidents involve human death. Land use value differs from baseline conditions and exceed threshold values so that there will be a structural and functional changes in land use values beyond the range of natural variation

Risk Mitigation

Vehicle emissions will be minimized using the following mitigation measures:

- switching fuel to more efficient blends;
- optimizing vehicle load rates to minimize the number of trips;
- following procedures and schedules provided by vehicle manufacturers to increase fuel efficiency;
- minimizing idling; and
- ensuring diesel vehicles use low sulfur content fuel as required by law.

Risk Characterization

Project traffic is expected to result in ambient air quality concentrations of Criteria Air Contaminants (CACs) below BC air quality objectives and standards. The maximum potential extent of this effect is anticipated to occur during Operation. Project activities are expected to result in additional traffic volumes, not exceeding historical peaks (in most cases less than 30% of historic maximums), on highways 37 and 37A. Therefore, the risk to the CWB VC due to air quality effects is expected to be minimal. The Project's contribution to vehicle emissions is discussed in further detail in Section 5.7.3.

Noise Effects

Risk Identification

Potential noise effects associated with Project traffic along highways 37 and 37A could occur through all phases of the Project. However, noise effects on CWB will differ for each phase due to varying traffic volumes.

Health Canada considers noise a human health concern and requires noise assessment to be undertaken as part of an environmental assessment.

Table 5.1-6. Social Risk Assessment Matrix for Project Traffic

VC	Traffic Type	Description of Potential Risk (pre-mitigation)	Project Phase	Description of Mitigation Measures	Post-mitigation		
					Likelihood	Severity	Description of Consequence of Realized Risk
Community Well-being	All traffic types	Reduced ambient air quality from increased vehicle emissions	All phases	Using well maintained vehicles to optimize combustion, using low sulphur fuel, minimize trips on highway	Possible	Minor	Reduced local ambient air quality with minimal risk to community well-being
	All traffic types	Nuisance from increased vehicle noise	All phases	Using well maintained vehicles, minimize trips on highway	Likely	Minor	Minor increase in noise levels of a very localized nature
	All traffic types	Reduced quality of the natural environment	All phases	Using well maintained vehicles, minimize trips on highway	-	-	Fully mitigated
	All traffic types	Reduced public safety	All phases	Ensure appropriate signage along the highway corridor; Enforce speed limits and other traffic rules; Appropriate driver safety training; Company zero-tolerance policy on alcohol; Adhere to accident first aid, emergency response and other procedures; Highway maintenance	Possible	Major	Increase of vehicle accidents and decreased public safety

Table 5.1-7. Social Risk Assessment Matrix for Traffic Accidents

VC	Traffic Type	Description of Potential Risk (pre-mitigation)	Project Phase	Description of Mitigation Measures	Post-mitigation		
					Likelihood	Severity	Description of Consequence of Realized Risk
Community Well-being	All traffic types	Accidents of varying severity leading to injury or death of drivers, passengers, and other highway users. Hazardous cargo spills from accidents may expose local residents or emergency responders to additional safety risks.	All phases	Ensure appropriate signage along the highway corridor; Enforce speed limits and other traffic rules; Appropriate driver safety training; Company zero-tolerance policy on alcohol; Adhere to accident first aid, emergency response and other procedures; Ensure emergency responders are appropriately equipped and trained; Highway maintenance	Possible	Catastrophic	Accidents are rare, but may affect human health and safety to a large degree, including death

Health Canada has developed a draft guideline for a noise human health assessment; however, there are no applicable guidelines or enforced standards. Health Canada advises proponents to consult with provincial or local government authorities for applicable or relevant standards. This study considers standards developed by the Canada Mortgage and Housing Corporation (CMHC 1986), which are similar to general noise level thresholds accepted by many authorities across Canada and internationally.

Risk Mitigation

Noise reduction is directly related to the operation and type of vehicles used for the Project as noise concerns are mainly attributable to engine type and size. Potential noise effects from the Project will be mitigated by:

- minimizing the number of trips required;
- following maintenance procedures and schedules provided by vehicle manufacturers;
- using vehicle noise suppression technologies where possible;
- avoiding the use of engine brakes near communities; and
- providing noise awareness training for Project transportation personnel.

Risk Characterization

Noise from Project traffic will occur throughout all phases of the Project; however, the level of potential effects will change according to the Project phase and also vary depending on the traffic schedule, vehicle types, ground cover, topography and number of human receptors in proximity to the highways. Moreover, sound intensity decreases in proportion with the square of the distance from the source; a drop-off rate of 4.5 dBA is generally used in traffic analyses for each doubling of distance. Traffic noise is not a serious problem for people who live more than 30 to 60 m from lightly traveled roads (FHWA 1995).

Potential noise effects from Project traffic will have the greatest impact during Operation. However, with the addition of Project traffic, the level of traffic on the highways will be below historical levels (in most cases less than 30% of historic maximums) so the overall impact on noise is not expected to adversely affect Community Well-Being (see Sections 5.6.3 and 5.8.3).

Quality of the Natural Environment

Risk Identification

The Project will occur in a sparsely populated area of northwestern BC. Residents and tourists value the quiet and wilderness aspects of this region of the Province. The increased visual presence of vehicles, as well as potential nuisance effects resulting from vehicle noise and emissions, may be perceived to have a negative effect on the quality of the natural environment. The increase in industrial traffic, in particular, may contribute to this perception.

Risk Mitigation

The perceived negative effects on the quality of the natural environment will be minimized by using the following mitigation measures:

- minimizing the number of trips required;
- following maintenance procedures and schedules provided by vehicle manufacturers;
- using vehicle noise suppression technologies where possible; and
- ensuring Project-related vehicles avoid local roads and remain on the highways.

Risk Characterization

Perceptions with respect to the quality of the natural environment are intangible and vary by individual and community. It is difficult to ascertain objectively the extent to which the northwestern region of the province is valued for its pristine qualities, and to what extent this may be altered as a result of Project industrial traffic. However, the highway was designed to accommodate industrial traffic, including mining and forestry vehicles. With the addition of Project traffic, the level of traffic will be below historical levels (in most cases less than 30% of historic maximums) so the perceived negative effect on the quality of the natural environment (visual, nuisance) is unlikely to occur and anticipated to be fully mitigated.

Reduced Public Safety/Increase in Accidents

Risk Identification

It is anticipated that any increase in vehicle traffic may result in reduced public safety, for both vehicles and pedestrians, due to the increased probability of vehicle accidents. Vehicle collisions may result in immediate safety and human health effects (i.e., injury or fatality), thereby affecting CWB. Traffic accidents in or near communities, particularly involving dangerous cargo, could further affect community safety.

Police accident reports were used to assess the risks of traffic accidents (Chapter 3). Between 1996 and 2011, 118 severe collisions[6] were recorded on Highway 37 between Bob Quinn Camp and Kitwanga (an average of 7.4 severe collisions per year) and 10 severe collisions were recorded for Highway 37A between Stewart and Meziadin (average of 0.63 per year), including commercial and non-commercial vehicles. Severe collisions of commercial vehicle accidents was 34 (average 2.1 per year) on Highway 37 and 4 (average 0.25 per year) on Highway 37A. Collisions and effects to human health are discussed further in Section 5.8.3.

Risk Mitigation

The BC MOTI will be encouraged to post additional signage along appropriate places on the highways. Speed limits and other traffic rules will be enforced and adhered to by Project personnel. All contractors and workers will be required to adhere to BC Occupational Health and Safety Regulation (BC Reg 296/97), as well as a zero-tolerance policy on alcohol and drugs. Procedures for emergency response and occupational first aid will be developed and workers and contractors will undergo required training. Information on weather and highway conditions as well as communication devices, will be made available to all Project drivers before departure.

Risk Characterization

Historically (between 1996 and 2011), an average of 2.1 severe collisions (resulting in injury or casualty) per year on Highway 37 and an average of 0.25 severe collisions per year on Highway 37A involving a commercial vehicle occurred. Accident statistics show a downward trend between 1996 and 2011 in tandem with a reduction in traffic volume; however, increases and decreases in the rate of traffic accidents are not anticipated to be concurrent with any increase or decrease in traffic volume (see Section 3.2). As shown in the CPM (Section 3.2.3), a maximum incremental increase of 0.191 collisions per year is predicted due to an increase in traffic from the KSM Project. Residual effects to safety and direct human health risks from accidents cannot be eliminated. However, while the probability of accidents increases slightly, the severity of injury cannot be predicted.

[6] Severe collisions are those resulting in human injury or fatality.

5.1.3.2 Hunting and Trapping

Risk Identification

Land users may be indirectly affected by changes in traffic volumes along highways 37 and 37A. Indirect effects relate to potential adverse traffic risks to the harvest of wildlife resources, through disruption of movement and direct mortality effects on wildlife. Many land users, particularly hunters and trappers, adapt their activities based on the presence and habits of wildlife resources. Species harvested in the Study Area which could be at risk from a change in traffic along highways 37 and 37A include bear and moose (see Wildlife, Section 5.3).

Disruption of Movement Risk to Quantity of Resources

Increased traffic volumes along highways 37 and 37A may have an indirect effect on the quantity of resources available to hunters and trappers by disrupting or acting as a barrier to wildlife movements. Vehicle traffic may disrupt wildlife movement by decreasing the highway crossings by certain hunted and trapped species, including moose, grizzly bears, and black bears. In turn, risks to these harvest species may indirectly affect hunting and trapping activities within the Study Area.

The Wildlife risk assessment (Section 5.3) identifies that moose and bear movements may be at risk along highways 37 and 37A as a result of traffic volumes.

Direct Mortality Risk to Quantity of Resources

The quantity of resources available to hunters and trappers may also be indirectly affected by vehicle-related wildlife mortalities. As described in Section 5.3, because of the current status of the moose population in the area (i.e., with a history of declining numbers), and the potential habitat along Highway 37, direct mortality from vehicle-moose collisions was identified as a risk and potential effects of vehicle-related direct mortality on moose are evaluated using a population viability assessment, and moose a vehicle collision model (see Section 5.3 and Appendix D). With respect to moose, hunting and trapping interest may be at risk.

Conversely, following the implementation of mitigation measures to minimize vehicle-related wildlife mortality (e.g., enforcing speed limits, yielding to observed wildlife, etc.), no risk was predicted for black or grizzly bears as a result of vehicle-wildlife collisions. Further, there is no risk of vehicles colliding with bears in winter, as bears are in their dens during winter months. With respect to bear, hunting and trapping interest are not anticipated to be at increased risk.

Risk Mitigation

A change in the quantity of moose as resources is dependent on multiple factors affecting both land users and wildlife within the Study Area. In addition to mitigation strategies introduced in Section 5.3 to reduce the disruption to wildlife movement and direct mortality of wildlife (e.g., wildlife right-of-way, speed limits, and adhering to signage in areas of wildlife crossing), along Highway 37 and 37A, the Traffic and Access Management Plan enable land users to plan their activities on the basis of information about Project activities, and will be implemented to mitigate changes in the quantity of resources and to facilitate the continued safe access of land use areas off of Highway 37.

Risk Characterization

Despite mitigation, it is possible that disruption of movement to moose may occur as a result of increased traffic on Highway 37. The population viability assessment and moose vehicle collision model include a sensitivity analysis (see Section 5.3 and Appendix D). The sensitivity analysis performed

considered population predictions, and vehicle traffic under a variety of possible future survival rates and hunting rates.

Model results of the historic reconstruction of the moose population indicate that hunting rates were the likely initial cause of the moose population decline from 1595 to 517 animals during 2001 – 2011 and indicate that the addition of traffic from the KSM project is projected to cause an additional <1% mortality to the moose population at the current population size, a mortality rate that does not predict a substantial decline from the base case scenario. Under a scenario of baseline traffic plus KSM traffic, if the modeled survival rate of moose is increased a small amount (2-3%) such as by altering hunting rates, the model predicts an increase in the Nass moose population by 2030 from current conditions.

While possible, hunting and trapping activities are not predicted to be at risk from a change in traffic volumes as a result of the Project. As such, the severity of the risk for hunting and trapping as a result of change in traffic is expected to be minor.

5.2 FISH AND AQUATIC HABITAT

5.2.1 Baseline Data Overview

Traffic from the Project will travel through three major watersheds: the Nass River, Skeena River, and North Coast rivers (coastal rivers near Stewart, e.g. Bear River) watersheds. All three watersheds support large stocks of commercial and non-commercial fish species. Chinook salmon (*Oncorhynchus tshawytscha*), sockeye salmon (*Oncorhynchus nerka*), coho salmon (*Oncorhynchus kisutch*), pink salmon (*Oncorhynchus gorbuscha*), chum salmon (*Oncorhynchus keta*) and steelhead (*Oncorhynchus mykiss*) are commercially and culturally important species found in watercourses along highways 37 and 37A. Other species, including Dolly Varden (*Salvelinus malma malma*), bull trout (*Salvelinus confluentus*), Pacific lamprey (*Lampetra tridentate*) and mountain whitefish (*Prosopium williamsoni*) are also present throughout watercourses along the Project traffic routes (Figure 5.1-1).

A list of the specific watercourses (i.e., streams, rivers, lakes, and wetlands) were there are sensitive fish and aquatic habitat values along the transportation route are provided in Table 5.2-1. Table 5.2-1 provides the watercourse name, fish species present, and sensitive time period (based upon species presence and life history).

Table 5.2-1. Watercourses with Sensitive Fish and Aquatic Habitat Values along Highways 37 and 37A

Waterbody	Species Present	Sensitive Life History Stage	Timing
Bell-Irving River	Chinook salmon	Spawning - Egg incubation	August - May
	Coho salmon	Spawning - Egg incubation	September - June
Bear River	Chum salmon	Spawning - Egg incubation	August - April
	Coho salmon	Spawning - Egg incubation	September - June
Brown Bear Creek	Steelhead	Spawning - Egg incubation	September - March
	Sockeye/Kokanee Salmon	Spawning - Egg incubation	September - March
	Steelhead	Spawning - Egg incubation	September - March
Cranberry River	Chinook salmon	Spawning - Egg incubation	August - May
	Coho salmon	Spawning - Egg incubation	September - June
	Pink salmon	Spawning - Egg incubation	August - March
	Steelhead	Spawning - Egg incubation	September - March
	Bull trout	All life stages	Year-round

(continued)

Table 5.2-1. Watercourses with Sensitive Fish and Aquatic Habitat Values along Highways 37 and 37A (completed)

Waterbody	Species Present	Sensitive Life History Stage	Timing
Hanna Creek	Chinook salmon	Spawning - Egg incubation	August - May
	Coho salmon	Spawning - Egg incubation	September - June
	Sockeye/Kokanee Salmon	Spawning - Egg incubation	September - March
	Steelhead	Spawning - Egg incubation	September - March
	Bull trout	All life stages	Year-round
Kitwancool Lake	Sockeye/Kokanee Salmon	Rearing	Year-round
Kitwanga River	Chinook salmon	Spawning - Egg incubation	August - May
	Chum salmon	Spawning - Egg incubation	August - April
	Coho salmon	Spawning - Egg incubation	September - June
	Pink salmon	Spawning - Egg incubation	August - March
	Sockeye/Kokanee Salmon	Spawning - Egg incubation	September - March
	Steelhead	Spawning - Egg incubation	September - March
	Bull trout	All life stages	Year-round
Meziadin Lake	Sockeye/Kokanee Salmon	Rearing	Year-round
	Bull trout	All life stages	Year-round
Meziadin River	Coho salmon	Spawning - Egg incubation	September - June
	Pink salmon	Spawning - Egg incubation	August - March
Nass River	Chinook salmon	Migration (to Kwinageese, Damdochax River)	July - August
Tintina Creek	Chinook salmon	Spawning - Egg incubation	August - May
	Coho salmon	Spawning - Egg incubation	September - June
	Sockeye/Kokanee Salmon	Spawning - Egg incubation	September - March
	Steelhead	Spawning - Egg incubation	September - March
	Bull trout	All life stages	Year-round

Note: This table presents the species that were identified as being important by Nisg̲a'a and First Nations. It is not a comprehensive list of the species present in each waterbody.

The Nass River Watershed provides spawning and rearing habitat for salmon and steelhead populations.

Sockeye salmon are a large component of local fisheries and an important ecological keystone species. Between 1994 and 2009, the mean run size estimate of sockeye salmon reaching Gitwinksihlkw and entering the Upper Nass system was 278,000 (Nisg̲a'a Fisheries 2010). Hanna and Tintina creeks in the Nass River system support significant populations of sockeye salmon, along with chinook salmon, coho salmon and steelhead. The largest Skeena River sockeye runs are not along the proposed Project traffic routes. Kitwancool Lake (also referred to as Gitanyow Lake) is within 1 km of the traffic route. The Kitwancool Lake/Kitwanga River sockeye stock has been identified as being at serious risk of extirpation (Gottesfeld, Rabnett, and Hall 2002). Kokanee salmon have also been identified in Kitwancool Lake (Gottesfeld, Rabnett, and Hall 2002).

Coho salmon spawn and rear within 1 km of the proposed travel route. The Bell-Irving, Meziadin, and Cranberry rivers provide many of the coho smolts in the Upper Nass region (Bocking and Peacock 2004). Kitwanga River coho are considered a significant coho stock within the Skeena watershed (M. Cleveland, pers. comm, 2012). Coho salmon are numerous within the Bear River system and spawn in the Bear River adjacent to the Project traffic route.

The Bell-Irving and Cranberry river systems provide spawning grounds for an estimated 45% of chinook salmon in the Upper Nass system (Koski, Link, and English 1996). An additional two of the major chinook spawning grounds in the Nass system, Kwinageese River and Damdochax River, are upstream of the proposed traffic routes. While the spawning and rearing grounds for fish upstream of the route are outside any influence from Project traffic, salmon travelling to and from the spawning grounds migrate by the proposed travel route. In the Skeena Watershed, the Kitwanga River is a major area for chinook spawning and rearing, and recent low escapement numbers have suggested that this stock is particularly vulnerable (Gottesfeld, Rabnett, and Hall 2002).

Pink salmon are found in both the Nass and Skeena watersheds. The Cranberry, Meziadin, and Kitwanga rivers are important spawning and rearing locations for pink salmon (Gottesfeld, Rabnett, and Hall 2002).

Chum are not particularly numerous in the Skeena Watershed. Therefore stocks spawning and rearing in the Kitwanga River and its tributaries are particularly important in this system. Recent population estimates indicate there are low spawner numbers (Gottesfeld, Rabnett, and Hall 2002). Chum salmon are also found in the Bear River (BC MOE 2009; Figure 5.2-1).

Meziadin Lake and its major tributaries, Hanna, Tintina and Surprise creeks, account for up to 80% of the total Nass sockeye assessment (DFO 2004). Meziadin Lake is also the main sportfishing lake in the area. It features a number of popular sport fishing species including salmon, whitefish, Dolly Varden, kokanee, rainbow trout, bull trout and steelhead (Pierce Lefebvre Consulting 2008).

Steelhead are dependent upon a limited number of spawning and rearing areas along the Project travel route. Critical steelhead wintering areas have been located in the Cranberry River alongside Highway 37 (Mitchell 2006). Brown Bear Creek in the Nass system, a midsized waterbody along the proposed travel route, provides much of the spawning grounds for trout in the area, including steelhead, as well as sockeye (BC MOE 2009). The Kitwanga River and its tributaries are particularly important for Skeena steelhead, especially in providing critical overwintering habitat for steelhead stocks in the area (Gottesfeld, Rabnett, and Hall 2002).

Bull trout, a species of provincial concern, are abundant in the Kitwanga River watershed (Gottesfeld, Rabnett, and Hall 2002), as well as in the Cranberry River, and Hanna and Tintina creeks (M. Cleveland,pers. comm., 2012). Dolly Varden, a yellow-listed species, is found all along the transportation corridor (M. Cleveland, pers. comm., 2012).

5.2.2 Issue Scoping

5.2.2.1 Fish and Aquatic Habitat Scoping

Project activities are expected to result in additional traffic volumes, although not exceeding historical peaks, on highways 37 and 37A. The effects assessment considers potential effects on fish and fish habitat and concerns associated with Project traffic; potential alterations or upgrades to highways 37 and 37A are not considered in this document (Table 5.2-2).

Traffic from the Project is expected to have little to no effect on fish and aquatic habitat. The traffic will travel on paved or seal-coated highways and it is not expected to generate dust in amounts sufficient to affect fish or aquatic habitats. The operation of Project traffic is not expected to cause any additional stress or damage to aquatic systems or species beyond the current operation of the highway.

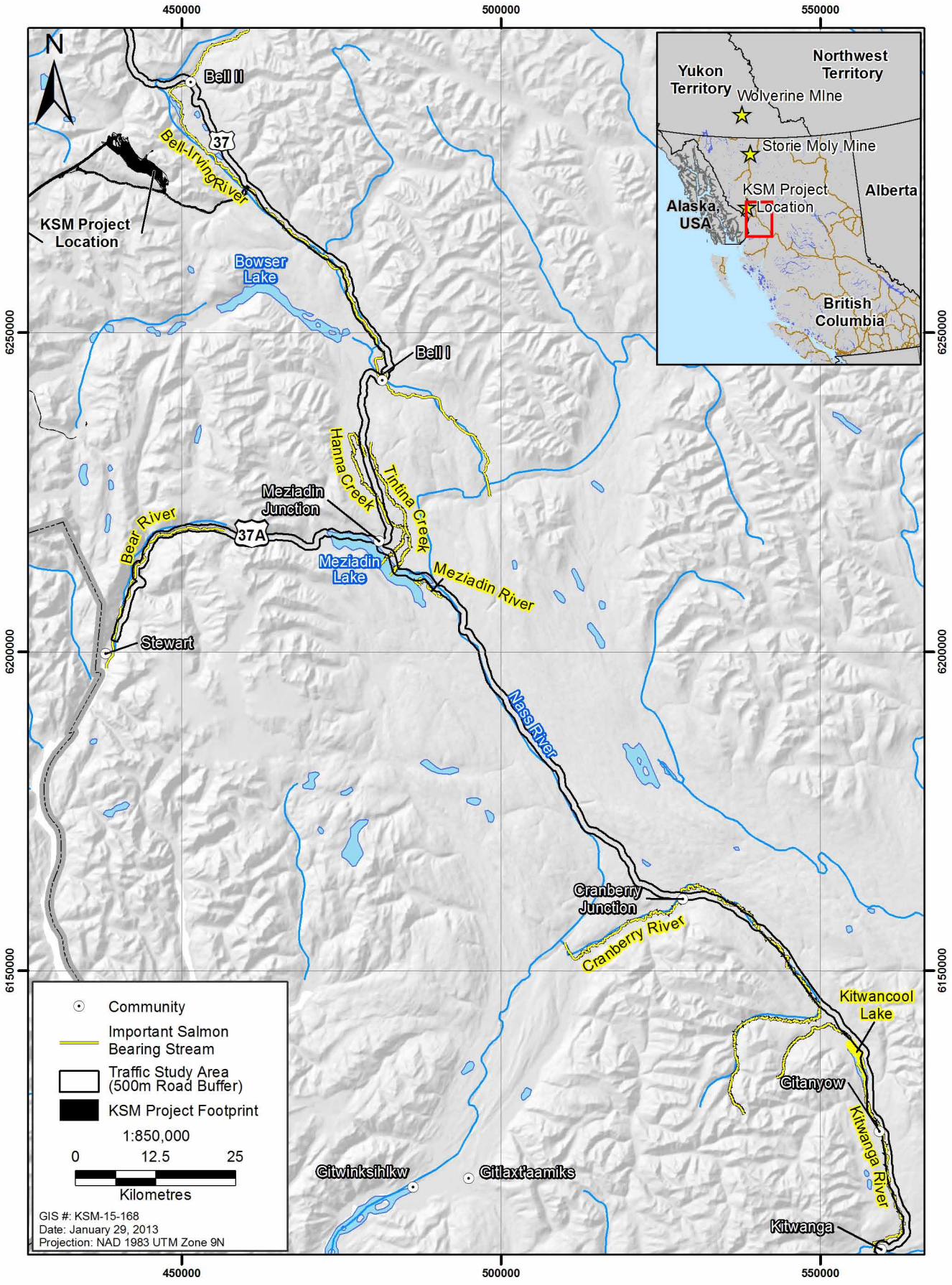

Figure 5.2-1

Important Salmon Bearing Streams

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Table 5.2-2. Fish and Aquatic Habitat Scoping Matrix

Traffic Type	Potential Risk? (Yes/No)	Rationale for Selection/Exclusion
Project traffic		
Personnel and non-hazardous cargo		
All non-hazardous	No	Project traffic will use existing highways; therefore no Project/aquatic habitat interactions are expected as aquatic habitat will not be altered.
Hazardous cargo		
Diesel fuel and lubricants	No	
Concentrates	No	Project traffic will use existing highways; therefore no Project/aquatic habitat interactions are expected as aquatic habitat will not be altered.
Lime and reagents	No	
Explosives	No	
Traffic accidents		
Personnel and non-hazardous cargo		
All non-hazardous	No	Non –hazardous cargo does not pose a risk to fish or aquatic habitats.
Hazardous cargo		
All hazardous	Yes	In the event of an accident, hazardous cargo may spill and enter nearby waterbodies. Hazardous substances could affect water quality, aquatic vegetation, aquatic invertebrates, and fish at any stage of their life cycle.

There are potential risks associated with traffic accidents. For traffic accidents to affect fish or aquatic habitat, the accident must occur at a watercourse crossing or where the highway runs in close proximity to a watercourse (Figure 5.1-1).

5.2.2.2 Valued Component Scoping

The selected fish and aquatic habitat VCs and the rationales for their inclusion or exclusion in the assessment are presented in Table 5.2-3. The party who identified each potential VC is also referenced in the table: Aboriginal groups (AG); government (G); public/stakeholder (P/S); or other (O) (e.g., legislation, technical expertise). The VCs for the Project include Pacific salmon, steelhead/rainbow trout, bull trout, and Dolly Varden. For the purposes of this study, all fish species have been grouped together, as potential effects and mitigation measures will be similar for all fish species.

Table 5.2-3. Identification and Rationale for Fish and Aquatic Habitat Valued Component Selection/Exclusion

	Identified by[1]				Selected for…[2]		
VC	AG	G	P/S	O	… Project Traffic?	…Traffic Accidents?	Rationale for Selection/Exclusion
Fish species	X	X	X		No	Yes	Accidents involving Project traffic may affect fish species during all phases of the Project's life span. All fish species have been grouped together as potential effects and mitigation measures will be the same for all species.
Aquatic habitat	X	X			No	Yes	Traffic accidents involving Project traffic may affect aquatic ecosystems during all phases of the Project.

[1] "X" indicates that the corresponding group (AG = Aboriginal Group, G = Government, P/S = Public/Stakeholder, or O = Other) has identified the VC as an issue; "-" indicates that the group did not identify the VC as an issue.
[2] "Yes" indicates that the VC is selected for further analysis; "No" indicates that the VC is excluded from further analysis.

5.2.2.3 Identification of Potential Traffic/Valued Component Interactions

The potential interactions between Project traffic and the identified VCs are identified in Table 5.2-4. Where there is potential for an interaction between a traffic type and a VC, the potential is identified with an "X". Only traffic types that have been identified to potentially affect one or more VCs are included in the Risk Analysis (Section 5.2.3).

Table 5.2-4. Potential Traffic / Fish and Aquatic Habitat Valued Component Interaction Matrix

	VCs	
Traffic Type	**Fish Species**	**Aquatic Habitat**
Project traffic		
Lime and reagents	-	-
Explosives	-	-
Traffic accidents: on-road		
Diesel fuel and lubricants	X	X
Concentrates	-	-
Lime and reagents	-	X
Explosives	-	-
Traffic accidents: off-road		
Diesel fuel and lubricants	X	X
Concentrates	X	X
Lime and reagents	X	X
Explosives	X	X

"X" indicates that a potential interaction has been identified.
"-" indicates that no potential interaction was identified.

5.2.3 Risk Analysis

This section provides an analysis of the risks associated with Project traffic on fish and aquatic habitat. Interactions identified in Table 5.2-4 are analysed and assigned a risk severity according to the definitions in Table 5.2-5. Traffic types, their potential risks, mitigation measures and severity are shown in Table 5.2-6 and Table 5.2-7.

Table 5.2-5. Fish and Aquatic Habitat Risk Assessment Severity Scale Descriptors

Descriptor	Definition
Negligible	No detectable change to aquatic organism abundance or fish health, and Ministry of Environment water quality guidelines will not be exceeded.
Minor	Effects are localized, short in duration, and low in magnitude. Fish species harvest rates will not be affected.
Moderate	Effects are moderate or high in magnitude but very limited spatially and temporally. Fish species harvest rates will not be affected.
Major	Effects are moderate in magnitude but are spatially or temporally extensive. Fish species harvest rates will not be affected.
Catastrophic	Permanent or semi-permanent high level effects over a large area. Potential for negative effects on fish harvest rates.

5.2.3.1 Fuel or Lubricant Spill

Risk Identification

Project traffic creates a risk of diesel fuel or lubricant entering aquatic habitat. The introduction of these substances to aquatic habitat may occur if a traffic accident occurs at a watercourse crossing or where traffic routes are in close proximity to a watercourse.

The geographic scope of a petroleum product spill may be localized to far-ranging. Most petroleum products are toxic to fish and aquatic organisms. They may cause mortality at high concentrations and reduced health or altered behaviour at sublethal levels. The toxicity of these products occurs through their water-soluble constituents and emulsions, and toxicity increases when dissolved oxygen levels are low. Hydrocarbons in petroleum products can damage gill epithelia, nerves, the liver and result in general organ failure (Fryday et al. 1996; Omoregie and Ufodike 2000).

Fuel spills reduce secondary producers (e.g., phytoplankton and zooplankton) and the effects of major fuel spills on aquatic habitat may extend as far as 12 km downstream of the source of the spill and may persist for longer than a year after the initial spill and clean-up (Poulton, Finger, and Humphry 1997; Lytle and Peckarsky 2001).

Behavioural changes in fish after sublethal exposure to spilled petroleum products typically are responses to the physiological changes caused by the toxins. In the event of a diesel fuel or lubricant spill in a river, these effects may occur farther downstream than direct mortality and persist after initial clean-up. Acute and chronic stress responses, as indicated by disturbances in blood chemistry (Zbanyszek and Smith 1984; Alkindi et al. 1996), can lead to behavioural changes such as decreased feeding activity (Camargo, Alonso, and Salamanca 2005) and changes in swimming behaviour (Struhsaker 1977; Little and DeLonay 1996).

Risk Mitigation

Prevention is the best form of mitigating spills. Petroleum spills will be prevented, and in the event of a spill, mitigated by implementing best management practices (BMPs) with regard to the handling and transportation of petroleum products, spill prevention and response in the event of a spill. BMPs relating to petroleum spills will be described in detail the Spill Prevention and Emergency Response Plan. This plan will provide specifications for preventing and controlling the release of spills during traffic accidents. Prompt containment and clean-up of spills is essential to mitigating risks to aquatic habitat and organisms. The plan will minimize response time and maximize clean-up efficiency, preventing long-term or geographically extensive effects.

Risk Characterization

While moderate effects on fish and aquatic habitat may be expected at the spill site, the Spill Prevention and Emergency Response Plan will limit the temporal and spatial effects of a spill. Outside the spill site, effects should be minor with few residual effects.

5.2.3.2 Concentrate Spills

Risk Identification

There is a risk of copper or molybdenum concentrate entering aquatic habitat. The introduction of these substances to aquatic habitat may occur if a traffic accident occurs at a stream crossing or where traffic routes are in close proximity to a watercourse and the vehicle or its cargo enters the watercourse.

Table 5.2-6. Fish and Aquatic Habitat Risk Assessment Matrix for Project Traffic

VC	Traffic Type	Description of Potential Risk (pre-mitigation)	Project Phase	Description of Mitigation Measures	Post-mitigation		
					Likelihood	Severity	Description of Consequence of Realized Risk
Fish species	All traffic types	-	All phases	-	Possible	-	No effects on fish species
Aquatic Habitat	All traffic types	-	All phases	-	Possible	-	No effects on aquatic habitat

Table 5.2-7. Fish and Aquatic Habitat Risk Assessment Matrix for Traffic Accidents

VC	Traffic Type	Description of Potential Risk (pre-mitigation)	Project Phase	Description of Mitigation Measures	Post-mitigation		
					Likelihood	Severity	Description of Consequence of Realized Risk
Fish species	Diesel fuel and lubricants	Fuel or lubricant spill into waterbody may cause localized or far-reaching effects. Petroleum products are toxic to fish species. Exposure to low concentrations may change fish behaviour	All phases	Use of best management practices to minimize spill entry to water bodies; Enforced speed limits and traffic safety; Adhere to the Spill Prevention and Emergency Response Plan; Prompt containment and cleanup	Unlikely	Moderate	Localized, short-term, moderate effects on fish species
Fish species	Concentrates	Metal concentrate spill into waterbody may be toxic at the point source and exceed water quality guidelines at a distance; smothering of eggs and fish	Operations	Use of best management practices to minimize spill entry to water bodies; Enforced speed limits and traffic safety; Adhere to the Spill Prevention and Emergency Response Plan; Prompt containment and cleanup; Low moisture concentrate	Unlikely	Moderate	Moderate to high effects confined to local area and on a short-term basis, rapid clean-up of concentrates
Fish species	Lime and reagents	Should lime and reagents spill into a waterbody, the resulting change in pH and water chemistry may result in mortality or decreased fish health. Reagent spills into waterbodies range in effect from localized disturbance to significant morality and population changes in fish stocks	All phases	Use of best management practices to minimize spill entry to water bodies; Enforced speed limits and traffic safety; Adhere to the Spill Prevention and Emergency Response Plan; Prompt containment and cleanup	Unlikely	Moderate	Negligible to major effects on local area on a short term basis, dependent on spill type. Negligible to moderate effects outside of immediate area
Fish species	Explosives	Explosives are toxic to aquatic invertebrates and fish eggs and fry. Explosive compounds entering aquatic systems may result in death or serious sublethal effects to invertebrate food sources for fish and to incubating or rearing juvenile fish	Operations	Enforced speed limits and traffic safety; Adhere to the Spill Prevention and Emergency Response Plan	Unlikely	Moderate	Spills minimized and contained due to Spill Prevention and Emergency Response Plan. Moderate effects in immediate area, minor effects outside of immediate area.
Fish species	Explosives	Explosives are toxic to aquatic invertebrates and fish eggs and fry. Explosive compounds entering aquatic systems may result in death or serious sublethal effects to invertebrate food sources for fish and to incubating or rearing juvenile fish	Construction	Enforced speed limits and traffic safety; Adhere to the Spill Prevention and Emergency Response Plan	Unlikely	Moderate	Spills minimized and contained due to Spill Prevention and Emergency Response Plan. Moderate effects in immediate area, minor effects outside of immediate area.
Aquatic Habitat	Diesel fuel and lubricants	Fuel or lubricant spill into waterbody may cause localized or far-reaching effects. Petroleum products are toxic to invertebrates. Exposure to low concentrations may change fish behaviour	All phases	Use of best management practices to minimize spill entry to water bodies; Enforced speed limits and traffic safety; Adhere to the Spill Prevention and Emergency Response Plan; Prompt containment and cleanup	Unlikely	Moderate	Moderate to major effects confined to local area and on a short-term basis, rapid clean-up of concentrates
Aquatic Habitat	Concentrates	Metal concentrate spill into waterbody may be toxic at the point source and exceed water quality guidelines at a distance; smothering of benthic organisms	Operations	Use of best management practices to minimize spill entry to water bodies; Enforced speed limits and traffic safety; Adhere to the Spill Prevention and Emergency Response Plan; Prompt containment and cleanup; Concentrate dewatered to a low moisture content before transport	Unlikely	Moderate	Moderate effects on local area on a short term basis. Negligible effects outside of immediate area
Aquatic Habitat	Lime and reagents	Should lime spill into a waterbody, the resulting change in pH and water chemistry may result in mortality of periphyton, macrophytes, and aquatic invertebrates. Reagent spills into waterbodies range in effect from localized disturbance to significant morality and population changes of periphyton, macrophytes, and aquatic invertebrates	All phases	Use of best management practices to minimize spill entry to water bodies; Enforced speed limits and traffic safety; Adhere to the Spill Prevention and Emergency Response Plan; Prompt containment and cleanup	Unlikely	Moderate	Negligible to major effects on local area on a short term basis, dependent on spill type. Negligible to moderate effects outside of immediate area
Aquatic Habitat	Explosives	Explosives are toxic to aquatic invertebrates and fish eggs and fry. Explosive compounds entering aquatic systems may result in death or serious sublethal effects to invertebrate food sources for fish and to incubating or rearing juvenile fish	Operations	Enforced speed limits and traffic safety; Adhere to the Spill Containment and Emergency Response Plan	Unlikely	Negligible	Spills minimized and contained due to Spill Prevention and Emergency Response Plan. Moderate effects in immediate area, minor effects outside of immediate area.
Aquatic Habitat	Explosives	Explosives are toxic to aquatic invertebrates. Explosive compounds entering aquatic systems may result in death or serious sublethal effects to freshwater invertebrates	Construction	Enforced speed limits and traffic safety; Adhere to the Spill Prevention and Emergency Response Plan	Unlikely	Negligible	Spills minimized and contained due to Spill Prevention and Emergency Response Plan. Moderate effects in immediate area, minor effects outside of immediate area.

The majority of the effects of a concentrate spill would be highly localized. Low-moisture concentrate would not quickly mobilize and could be cleaned up relatively easily. Direct mortality would result if the concentrate enters the watercourse and crushes or smothers fish or aquatic organisms. Mortality may also occur if metal concentrations in the water around the spill increase above toxicity levels. These levels vary by species, water chemistry, and water temperature; however, copper and molybdenum toxicity has been known to occur at concentrations as low as 35 ppm (Eisler 1989, 1998).

Sublethal effects occur when metal accumulation in the gills of fish cause a stress response that can lead to behavioural changes (Wendelaar Bonga 1997).

Physiological effects of metal exposure in fish include acid-base disturbance, changes in gill function, ionic fluxes, and metals toxicity (Evans 1987; Wood 1992). Chronic stress caused by exposure to metals at sublethal levels can lead to decreased growth in fish through an increase in metabolic demands (Todd et al. 2006). The stress response is caused by metal uptake and pH surges that in turn stimulate increased gas exchange (Wood 1992).

Risk Mitigation

Prevention is the best form of mitigating spills. In the event of an accident resulting spilled concentrate, mitigation measures will be similar to those identified for diesel fuel and lubricant spills. Clean-up of concentrate spills will be easier than fuel spills due to the low-moisture levels. Prompt clean-up according to the Spill Prevention and Emergency Response Plan will limit the potential impact to minor effects in the local area.

Risk Characterization

With mitigation measures in place, effects will be limited to crushing or smothering of fish or aquatic organisms at the spill site, plus any additional damage to substrate and benthic communities from removing contaminated soils during clean-up. Metal contamination outside of the spill site will be minimal and should not cause large-scale or long-term effects.

5.2.3.3 Lime and Reagents

Risk Identification

The Project requires the transportation of large amounts of lime and other reagents. An off-road accident near a watercourse could result in the truck and its cargo entering the watercourse.

The introduction of lime into a watercourse could cause severe damage in small or stagnant waterbodies as it would not be quickly diluted. At low concentrations, lime is used to treat acidified waterbodies as it provides a buffering effect against acidification (Hultbert and Andersson 1982). However, at higher concentrations it can be hazardous to aquatic habitat and organisms.

The primary way in which lime affects aquatic habitat is by raising water pH. Certain macrophyte and aquatic invertebrate species are highly sensitive to liming, and will die when exposed to lime (Ye and Randall 1991; Brandrud 2002). In general, a pH of 9 or more will cause mortality in most fish species (Ye and Randall 1991). When exposed to lower levels of alkalinity, fish experience impaired ammonia excretion and sodium influx that may result in changes to blood ammonia levels (Ye and Randall 1991). Behaviour changes resulting from the physical stress, such as impaired swimming performance, may affect fish growth and survival.

Several other reagents expected to be transported along this route, including sodium hydroxide, hydrochloric acid, and sulphuric acid could also affect aquatic habitats due by influencing pH.

Other reagents have additional toxicity concerns. Sodium cyanide is toxic to fish, aquatic invertebrates, vegetation, and amphibians, and cyanide spills have caused serious damage to aquatic ecosystems (Eisler et al. 1999). A cyanide spill in an aquatic habitat would have lethal effects for nearby aquatic life. However, cyanide rapidly oxidizes in aquatic environments and is unlikely to persist at toxic levels for more than 40 days, although population-level effects from associated mortality may affect fish stocks for much longer. Copper sulphate (Cu_2SO_4) and potassium amyl xanthate (PAX) are toxic to aquatic vegetation, invertebrates, and fish and may persist in the environment. Potential effects of chemical hazards on fish and aquatic habitat are described in greater detail in Section 6.4.4 and Table 6.4-5.

Risk Mitigation

Prevention is the primary way of mitigating risks off-road traffic accidents, and in the event of an accident resulting in a spill, ensuring prompt clean-up of lime and reagent spills. Adhering to speed limits and safe traffic practices will prevent off-road accidents. Cyanide transportation will follow guidelines established in the International Cyanide Management Code (ICMI n.d.). Should an accident occur, prompt action according to the Spill Prevention and Emergency Response Plan will limit the potential impact to the local area.

Risk Characterization

Lime spills from Project traffic are likely to cause minimal to negligible effects. Outside the area directly adjacent to the spill, the lime is unlikely to harm aquatic life, especially in larger running watercourses where it will be quickly diluted. The potential effects of reagent spills are highly dependent on the type and quantity of reagent spilled. While some reagent spills (e.g., activated carbon) would have negligible effects, others (e.g., copper sulphate or sodium cyanide) have the potential to cause more severe effects. Persistence of effects is dependent on the type and volume of reagent spilled and may range from very short term to long term.

5.2.3.4 Explosives

Risk Identification

The exact pathways, lethal concentrations, and effects of explosives on aquatic organisms vary by explosive type. Most explosives used at mine sites are nitrogen-based, and nitrogen content creates the greatest risk for aquatic environments in the event of an explosives spill (Levit 2010). The nitrogen in explosives is often in highly water-soluble formats, in particular, nitrate and ammonia (Forsynth, Cameron, and Miller 1995).

Nitrate primarily causes damage to freshwater organisms by damaging the oxygen-carrying pigments in the blood, such as haemoglobin (Camargo, Alonso, and Salamanca 2005). In freshwater invertebrates, nitrates can cause mortality or sublethal effects including muscle fragmentation or shrinkage. Fish are particularly vulnerable to nitrate toxicity in the egg, fry and larval stages. Juvenile fish exposed to nitrates exhibit damage to blood proteins and pigments as well as liver damage (Camargo, Alonso, and Salamanca 2005).

Unlike responses to nitrate, fish are more strongly affected by ammonia exposure than invertebrates (Arthur et al. 1987). Ammonia can harm fish by damaging gill epithelia and the immune system, reducing the oxygen-carrying capacity of blood, disrupting blood vessels and osmoregulation, and preventing adenosine triphosphate production (Camargo and Alonso 2006).

Risk Mitigation

Preventing off-road traffic accidents is the primary way of mitigating risk. Adhering to speed limits and safe traffic practices will prevent off-road accidents. Should an accident occur, prompt action according to the Spill Prevention and Emergency Response Plan, ensuring prompt containment and clean-up of lime, explosives and reagent spills will limit the potential impact to the local area.

Risk Characterization

While potential effects may be expected at the spill site, the Spill Prevention and Emergency Response Plan will limit the temporal and spatial effects of the spill. Outside the spill site, effects are expected to be moderate with few residual effects.

5.3 WILDLIFE

5.3.1 Baseline Data Overview

Baseline conditions along the highways for wildlife VCs selected for this assessment are described below.

5.3.1.1 Moose

Moose are common throughout BC's forested areas, with an estimated population size of 170,000 animals (Blood 2000). However, the moose population in the Nass Wildlife Area (NWA) near Highway 37 has been declining since 2001. Corrected for sightability, the population was estimated to be 1,595 ± 19 % in 2001, and declined to 638 ± 33% in 2007, and to 517 ± 28% in 2011. Despite management actions taken in 2007 to reduce harvest, the population has continued to decline (M. W. Demarchi 2011).

The Nass South Sustainable Resource Management Plan (SRMP) and the Cranberry SRMP area have been identified as providing high value moose habitat, including important calving, rutting and winter habitat. Winter habitat is generally the limiting factor in the carrying capacity for moose in BC because of increased energy demands from moving through snow pack and reduced nutritional forage quality (Armleder, Dawson, and Thomson 1986; Nyberg and Janz 1990). Moose winter range along the highway consists primarily of low elevation wetland-timber complexes, floodplains of main rivers, and large tributary streams adjacent to coniferous stands.

The low elevation and gentle topography of much of the area along Highway 37 represents suitable moose winter habitat, and movement corridors are present along Highway 37. Demarchi (2000) identified core use areas in the NWA where moose are consistently observed during the winter. Moose winter range has also been identified in the area from Meziadin to the Ningunsaw summit (Pollard 2007) and near Cranberry Junction and Cranberry River (BC MFLNRO 2012a). One calving area was identified by the Skii km Lax Ha on the floodplains and associated wetlands on the Bell-Irving River below Bell II (Rescan 2010a).

Movement corridors connect habitats that are exploited during different times of the year. Corridors maintain animal movement between habitat patches, increase population size, increase gene flow, and maintain biodiversity (Haddad et al. 2003). Migratory movements of moose, for example, often follow traditional routes, using the same migration corridor every year (Bowyer, Ballenberghe, and Kie 2003). Moose are known to cross the Nass River when moving between their seasonal ranges, most commonly near Van Dyke Island (Rescan 2010a), near Cottonwood Island west of Cranberry Junction, and at the Bell-Irving/Spruce crossing (Demarchi 2003). The valley between Bell II and Bob Quinn, which contains Highway 37, has also been identified as a wildlife movement corridor for a variety of wildlife species (Rescan 2010a).

Ungulate Winter Ranges (UWRs) ensure environmental sustainability across a landscape through two objectives: (1) identify suitable habitat, and (2) integrate habitats that provide a variety of functions (including considerations for habitat interspersion). There are no approved UWR for moose along the highways 37 and 37A; however, moose winter range has been mapped along the Bell-Irving River and Snowbank Creek near Highway 37, near Cranberry Junction, Van Dyke Island, and Meziadin Junction (Mahon et al. 2005; McElhanney 2007; Rescan 2010b).

5.3.1.2 Bears

Grizzly bears are found throughout the majority of BC across a broad range of elevations, from sea level to high alpine regions; an estimated 13,800 grizzlies live in the province (Gyug, Hamilton, and Austin 2004). Distribution of grizzly bears is often related to food supply, with higher densities in areas with abundant food (Hamilton 1987), such as along streams during salmon runs, and on alpine and subalpine slopes when berries are abundant. A three-year study conducted from 1996 to 1999 (Demarchi 2000; Demarchi and Johnson 2000) estimated a density of 0.04 bears/km^2 in the NWA based on surveys conducted in 1996 (Demarchi and Johnson 2000).

Highly suitable grizzly bear spring habitat has been identified near the Ningunsaw Pass, Bowser River, Dragon Lake, the mouth of the Kitsumkalum River (Rescan 2010a), and throughout the South Nass Timber Supply Area. In addition, Demarchi and Johnson (2000) identified Hanna and Tintina creeks near Meziadin Junction as important areas where grizzly bears feed on salmon. Reaches of potential importance for salmon spawning include the Nass River around Cottonwood Island, the lower Bowser River to its confluence with the Bell-Irving River, and the large floodplain associated with the Bell-Irving River and Teigen Creek drainages near Bell II (Rescan 2010a). A potential movement corridor used by grizzly bear has also been identified leading from the Cedar River into the Kiteen River drainage (Rescan 2010a).

Wildlife Habitat Areas (WHAs) are areas of high quality grizzly bear habitat. Management objectives associated with WHAs are created to maintain habitat necessary to sustain the local grizzly bear population across one or more seasons. The aim of WHAs is to identify areas for future integrated resource management; thus, delineated WHAs consider features such as topography for security and linkages between areas of seasonal habitat use. There are no approved WHAs for grizzly bear along the highways; however, WHA candidates for grizzly bear have been mapped. Candidate WHA polygons for grizzly bear occur in the North Nass Timber Supply Area between Meziadin Lake and Ningunsaw Summit, the South Nass Timber Supply Area between Meziadin Lake and Cranberry Junction, and within the Cranberry SRMP along Highway 37 south of Cranberry Junction (BC MFLNRO 2012a). In many cases, WHAs are blocks of un-harvested forest between cut blocks that were part of the large-scale cedar forestry industry along Highway 37.

5.3.1.3 Western Toads

The western toad (*Anaxyrus boreas*) is a federally listed species of special concern that is protected under Schedule 1 of the *Species at Risk Act* (SARA, City of Terrace 2002; Government of Canada 2010). It is also internationally recognized as a near threatened species by the International Union for the Conservation of Nature (IUCN 2010). In British Columbia, it is considered secure but is afforded protection under the BC *Wildlife Act* (1996).

Western toads occupy predominantly terrestrial habitats, but move seasonally to breeding ponds in the spring. Toad populations can experience relatively high rates of mortality when these migration routes cross roads. Considering the conservation status of western toads and its potential sensitivity to development, a toad study was conducted within the Wildlife Study Area at the Project site to identify toad breeding ponds. No systematic baseline surveys were conducted for western toads along highways 37 or 37A. Therefore, it is assumed for the purposes of this analysis that western toads may occur within the Study Area.

5.3.1.4 Avian Community

Avian species that migrate between countries receive protection under the federal *Migratory Birds Convention Act* (1994). Bird species, especially raptors, are also afforded additional protection under the BC *Wildlife Act* (1996), while avian species at risk are protected under SARA (City of Terrace 2002). No systematic baseline surveys were conducted for birds along highways 37 or 37A; however, for the purposes of this analysis it is assumed that birds occur within the Study Area.

5.3.2 Issue Scoping

5.3.2.1 Wildlife Scoping

Project activities are expected to result in additional traffic volumes on highways 37 and 37A, although not exceeding historical peaks. This assessment addresses potential wildlife issues and concerns associated with Project traffic. The principal issues for wildlife are associated with Project traffic and traffic accidents (Table 5.3-1).

Table 5.3-1. Wildlife Scoping Matrix

Traffic Type	Potential Risk? Yes/No	Rationale for Selection/Exclusion
Project traffic		
All traffic	Yes	All traffic types may affect wildlife due to increased traffic volume on the highways (e.g., increased risk of vehicle/wildlife interactions and disruption of movement).
Traffic accidents		
All traffic	Yes	Traffic accidents have the potential to affect wildlife VCs, as hydrocarbon or other environmental contamination may result. If chemicals spill, they may be hazardous to wildlife (i.e., passed up the food chain into plants, small mammals, etc.).

5.3.2.2 Valued Component Scoping

The selected wildlife VCs and the rationales for their inclusion or exclusion in the assessment are presented in Table 5.3-2. The party who identified each potential VC is also referenced in the table: Aboriginal groups (AG); government (G); public/stakeholder (P/S); or other (O) (e.g., legislation, technical expertise).

5.3.2.3 Identification of Potential Traffic/Valued Component Interactions

The potential traffic/wildlife interactions associated with Project traffic along highways 37 and 37A are primarily associated with moose and bears. The potential traffic/wildlife interactions are shown in Table 5.3-3.

5.3.3 Risk Analysis

The effects assessment addresses potential wildlife issues and risks associated with Project traffic along highways 37 and 37A. It is based on an assessment of VCs focused on selected wildlife species or groups selected in Table 5.3-2.

Table 5.3-2. Identification and Rationale for Wildlife Valued Component Selection/Exclusion

VC	Identified by[1]				Selected for…[2]		Rationale for Selection/Exclusion
	AG	G	P/S	O	Normal Project Traffic?	Traffic Accidents?	
Moose	X	X	X	X	Yes	Yes	Considered because moose are identified as a culturally important and hunted species for the Nisga'a Nation, Skii km Lax Ha, Tahltan, Gitxsan and Gitanyow. Under the Nisga'a Final Agreement, moose is also an initial designated species for which the Nisga'a have a wildlife allocation. Moose are an economically important species to local hunters and guide outfitters. Moose are a species requiring increased management consideration in land management plans including Nass South SRMP (BC MFLNRO 2012b), Cassiar Iskut-Stikine Land and Resource Management Plan (LRMP) (BC ILMB 2000b), Cranberry SRMP (BC MFLNRO 2012a), and the Nisga'a Land Use Plan (NLG 2002). Biologically and ecologically important species. Candidate moose UWRs have been identified along the highway, as well as movement corridors. Moose/vehicle interactions are commonly reported along the highway, with 855 collisions reported between 1983 and 2002 in the Bulkley-Stikine District (Sielecki 2004), and are therefore considered in the assessment.
Bears (grizzly bear and black bear)	X	X	X	X	Yes	Yes	Considered because grizzly bears are provincially blue-listed and federally listed Species of Special Concern. Species of ecological and cultural importance for the Nisga'a Nation, Tahltan, Gitxsan, Gitanyow and Skii km Lax Ha, for hunting subsistence and traditional reasons. Under the Nisga'a Final Agreement, grizzly bear is also an initial designated species for which the Nisga'a have a wildlife allocation. Biologically important as an umbrella species[7]. Economically important to local hunters and guide outfitters. Identified as an important species requiring increased management consideration by land management plans including Nass South SRMP (BC MFLNRO 2012b), Cassiar Iskut-Stikine LRMP (BC ILMB 2000b), Cranberry SRMP (BC MFLNRO 2012a), and the Nisga'a Land Use Plan (NLG 2002). High value grizzly bear foraging habitat and spawning salmon reaches have been identified near the highways. Black bears were identified as a culturally important and hunted species for the Nisga'a Nation, Tahltan, Skii km Lax Ha, Gitxsan, and Gitanyow. Vehicle strike data along highways in the Bulkley-Stikine District collected between 1983 and 2002 documented 181 collisions with bears (grizzly or black) in 19 years (Sielecki 2004), and are therefore considered in the assessment.
American Marten	X	-	X	X	No	No	Considered because American marten are identified as a culturally important and trapped species for the Nisga'a Nation, Skii km Lax Ha, Tahltan, Gitxsan, and Gitanyow. Economically important furbearer to local trappers. Identified as an important species requiring increased management consideration by land management plans including the Nass South SRMP (BC MFLNRO 2012b) and Cassiar Iskut-Stikine LRMP (BC ILMB 2000b). Marten are excluded as a VC as the exposure of American marten to vehicular collisions is anticipated to be relatively low along the road because marten tend to avoid roads and areas that lack overhead cover (Poole et al. 2004).

(continued)

[7] An "umbrella species" is defined as one with large area requirements for which the protection of the species offers protection to other species that share the same habitat.

Table 5.3-2. Identification and Rationale for Wildlife Valued Component Selection/Exclusion (continued)

VC	Identified by[1]				Selected for…[2]		Rationale for Selection/Exclusion
	AG	G	P/S	O	Normal Project Traffic?	Traffic Accidents?	
American Marten *(continued)*							This conclusion is supported by mortality rates of marten along low and high use highways. Vehicle strike data along highways in the Bulkley-Stikine District collected between 1983 and 2002 documented three collisions with American marten in 19 years (Sielecki 2004). Similarly, in Banff National Park, American marten made up 2% of small vertebrate roadkills (Clevenger, Chruszcz, and Gunson 2003). Therefore, marten mortality due to vehicle collisions is expected to be an infrequent event and is excluded.
Hoary Marmot	X	-	-	-	No	No	Considered because marmots are a culturally important and trapped species for the Nisga'a Nation, Skii km Lax Ha, Tahltan, Gitxsan, and Gitanyow. Economically important furbearer to local trappers. Hoary marmots occupy relatively small home ranges (approximately 13.8 ha) (Holmes 1984), and foraging usually takes place within a few hundred metres of a burrow entrance (Banfield 1981). Given the small home range and relatively sedentary nature of marmots, it is unlikely that these animals will cross the highway, thereby reducing the risk of vehicle interactions. In addition, two vehicle collisions with marmots were recorded along highways in the Bulkley-Stikine District (Sielecki 2004) over 19 years. Based on these results additional traffic volumes, albeit not exceeding historical peaks along the highway in association with the Project is not expected to increase vehicle incidents with marmot and is therefore excluded from the assessment.
Birds (waterfowl, forest birds, and raptors)	X	X	-	X	Yes	No	Considered because many birds are protected under the *Migratory Birds Convention Act*. Some bird species (e.g., crossbills, pine siskins) are vulnerable to vehicles strikes and are therefore considered in the assessment.
Amphibians (including Western Toad)	-	X	-	X	Yes	Yes	Considered because western toads are a Species of Special Concern under Schedule 1 of SARA (City of Terrace 2002). Biological importance as indicator species. High traffic roads can cause considerable mortality, particularly during breeding migrations (Lesbarrères, Lodé, and Merilä 2004). There is potential for toads and toadlets to be moving from breeding sites to upland areas and to cross roads, and for a spill to occur in a nearby wetland occupied by toads; therefore, they are considered in the assessment.
Deer (Mule and White-tailed)	X	-	-	X	No	No	Considered because this group is culturally important for the Nisga'a Nation, Gitxsan and Gitanyow. It is also hunted by local residents. Deer are excluded because white-tailed deer and mule deer populations are secure and not at risk in BC and any effects of increased traffic along Highway 37 will be accounted for in the assessment by referring to the moose assessment.

(continued)

Table 5.3-2. Identification and Rationale for Wildlife Valued Component Selection/Exclusion (continued)

VC	Identified by[1]				Selected for…[2]		Rationale for Selection/Exclusion
	AG	G	P/S	O	Normal Project Traffic?	Traffic Accidents?	
Mountain Goat	X	X	X	X	No	No	Considered because mountain goat are identified as a culturally important and hunted species for the Nisga'a Nation, Tahltan, Gitxsan, Skii km Lax Ha and Gitanyow. Under the Nisga'a Final Agreement, mountain goat is also an initial designated species for which the Nisga'a have a wildlife allocation. Identified as an important species requiring increased management consideration by land management plans including Nass South SRMP (BC MFLNRO 2012b), Cassiar Iskut-Stikine LRMP (BC ILMB 2000b), Cranberry SRMP (BC MFLNRO 2012a), and the Nisga'a Land Use Plan (NLG 2002). Mountain goats are excluded because there is a very low likelihood of vehicle-related mortality of mountain goats in association with the Project along Highway 37. The highway is located at elevations below suitable goat habitat, thereby limiting the possibility of goats being present on or near the road. Mountain goat sensitivity to disturbance may also ensure that they remain a safe distance away from transportation infrastructure. This is supported by the complete absence of vehicle incidents involving mountain goats along highways in the Bulkley-Stikine District from 1983 to 2002 (Sielecki 2004).
Wolverine	X	X	X	X	No	No	Considered because wolverine is blue-listed in BC and of Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2003). Culturally important species for the Tahltan, Gitxsan, and Skii km Lax Ha. Also identified in the Nass South SRMP (BC MFLNRO 2012b) and Cranberry SRMP (BC MFLNRO 2012a) as requiring enhanced management consideration. Wolverine are excluded because wolverines are habitat generalists and wolverine's low population density and large home range size mean there would be limited interaction with the proposed Project traffic. There is a very low likelihood of vehicle-related mortality of wolverine in association with the Project along highways 37 and 37A. This is supported by the complete absence of vehicle incidents involving wolverine along highways in the Bulkley-Stikine District from 1983 to 2002 (Sielecki 2004).
Fisher	X	-	X	X	No	No	Considered because fisher are provincially blue-listed. Culturally important and trapped species by the Nisga'a Nation, the Tahltan, Gitxsan, Gitanyow and Skii km Lax Ha. Identified as an important species requiring increased management consideration by land management plans including the Nass South SRMP (BC MFLNRO 2012b), Cranberry SRMP (BC MFLNRO 2012a) and Cassiar Iskut-Stikine LRMP (BC ILMB 2000b). There is a very low likelihood of vehicle-related mortality of fisher in association with the Project along highways 37 and 37A. This is supported by the complete absence of vehicle incidents involving fisher along highways in the Bulkley-Stikine District from 1983 to 2002 (Sielecki 2004); therefore, fisher are excluded from the assessment.

(continued)

Table 5.3-2. Identification and Rationale for Wildlife Valued Component Selection/Exclusion (completed)

VC	Identified by[1]				Selected for…[2]		Rationale for Selection/Exclusion
	AG	G	P/S	O	Normal Project Traffic?	Traffic Accidents?	
Lynx, fox, wolf, coyote, weasel ermine, mink, river otter	X	-	-	-	No	No	These species were considered because they are identified as culturally important for the Nisga'a Nation (weasel, lynx, wolf, mink), the Tahltan (wolf, lynx, mink, river otter), Gitxsan (lynx, fox, wolf, coyote, weasel, mink, river otter), Gitanyow (fox, lynx, coyote, wolf, ermine, mink) and Skii km Lax Ha (wolf). Lynx, fox, coyote and weasels were excluded because their populations are considered stable and not at risk, have low population density, are able to adapt to and tolerate human disturbance and encroachment well. There is a very low likelihood of vehicle-related mortality of these species in association with the Project along highways 37 and 37A. This is supported by the low number of vehicle incidents involving these species along highways in the Bulkley-Stikine District from 1983 to 2002 (Sielecki 2004); therefore, they are excluded from the assessment.
Rodents, rabbits, hares (beaver, squirrels, muskrat, gophers, porcupine, snowshoe hare)	X	-	-	-	No	No	Considered because these species were identified as culturally important for the Nisga'a Nation (beaver, rabbit, porcupine), the Tahltan (snowshoe hare, red squirrel, flying squirrel, ground squirrel, porcupine), Gitxsan (beaver, squirrel), Gitanyow (beaver, muskrat, red squirrel, porcupine) and the Skii km Lax Ha (beaver, muskrat, rabbit, ground squirrel). These species are excluded because populations are considered stable and not at risk.

[1] "X" indicates that the corresponding group (AG = Aboriginal Group, G = Government, P/S = Public/Stakeholder, or O = Other) has identified the VC as an issue; "-" indicates that the group did not identify the VC as an issue.
[2] "Yes" indicates that the VC is selected for further analysis; "No" indicates that the VC is excluded from further analysis.

Table 5.3-3. Potential Traffic / Wildlife Valued Component Interaction Matrix

Traffic Type	VCs			
	Moose	Bears	Western Toad	Birds
Project traffic				
All traffic	X	X	X	X
Traffic accidents: on-road				
Non-hazardous cargo	-	-	-	-
Hazardous cargo	X	X	-	-
Traffic accidents: off-road				
All traffic	X	X	X	-

"X" indicates that a potential interaction has been identified.
"-" indicates that no potential interaction was identified.

Given the hierarchical nature of biological systems, potential wildlife effects are discussed with regard to changes at both the individual animal level (e.g., behaviour, physiological condition, survival) and the population level (population size, distribution, mortality rate, reproductive fitness). A population is defined as "a group of organisms coexisting at the same time and place and capable of interbreeding" or "as a group of non-specific organisms that occupy a loosely defined geographic region and exhibit reproductive continuity from generation to generation" (Futuyma 1979). Because the geographic

population boundaries for the local populations considered in this assessment are both unknown and dynamic, the assessment is generally qualitative. Effects at the population level are considered of greater concern because of their magnitude, compared to those at the individual level; thus, the assessment primarily focuses on potential effects on local populations.

The following sections (5.3.3.1 to 5.3.3.4) assess the risk of Project-related traffic effects on each VC. Each section is subdivided according to the issues deemed to be of concern for that VC. Within each section, the likelihood and severity (Table 5.3-4) of potential effects on wildlife VCs are predicted. A detailed description of the effects assessment methodology is presented in Chapter 4.

Table 5.3-4. Wildlife Risk Assessment Severity Scale Descriptors

Descriptor	Definition
Negligible	No detectable change from baseline conditions. Effect limited to a few individuals.
Minor	Differs from the average value for baseline conditions to a small degree (e.g., within the range of natural variation and well below a guideline or threshold value). Effect mainly limited to a few individuals.
Moderate	Differs substantially from the average value for baseline conditions and approaches the limits of natural variation, but below or equal to a guideline or threshold value. Effect limited to the local population.
Major	Differs substantially from baseline conditions beyond a guideline or threshold value, resulting in a detectable change beyond the range of natural variation. Effect limited to the local population.
Catastrophic	Differs substantially from baseline conditions beyond a guideline or threshold value, resulting in a detectable change beyond the range of natural variation. Effect extends beyond the local population to the regional population.

Three potential effects were identified for this assessment. These included disruption of movement patterns (which includes sensory disturbance), direct mortality, and chemical hazards (Tables 5.3-5 and 5.3-6). Each of these potential effects, including mitigation and predicted severity of effects is discussed in further detail in the following sections.

5.3.3.1 Disruption of Movement

Risk Identification

Wildlife movement corridors are linear landscape features that provide a linkage between daily or seasonal habitats, and facilitate movement. Movement between isolated patches of habitat is important to maintain wildlife populations and biodiversity (Bennett 2003). Disruption of movement patterns is often the result of increased habitat/landscape fragmentation (e.g., increased density of human access corridors such as roads, and increased cleared area) or higher road use levels, which may limit daily or seasonal wildlife travel. This section outlines the potential effects of Project traffic along the highways on moose and bear movement.

Individual wildlife movement patterns are associated with short-range movements (i.e., daily routine) and long-range movements (i.e., migration and dispersal). Short-range movements are day-to-day activities within a particular season. Long-range wildlife movements are typically passages or movement corridors from winter and summer ranges or dispersal of young individuals to new territories. Moving between summer and winter ranges is critical when one habitat cannot support a species in both seasons. Moose, for example, are known to migrate up and down river drainages, moving between their seasonal ranges (Demarchi 2003). Dispersal is critical for the maintenance of many populations (Clobert et al. 2001). Dispersal distances can be many times greater than home range distances. Typically, the greatest risk of disruption, blockage, and impediments to wildlife occurs with seasonal and dispersal movements.

Table 5.3-5. Wildlife Risk Assessment Matrix for Project Traffic

VC	Traffic Type	Description of Potential Risk (pre-mitigation)	Project Phase	Description of Mitigation Measures	Post-mitigation		
					Likelihood	Severity	Description of Consequence of Realized Risk
Moose	All traffic types	Disruption of Movement	All phases	Adhere to speed limits and wildlife warning signs along highways, give wildlife right of way, limit traffic disturbance where possible	Possible	Minor	Roads with traffic may act as a barrier to movement for a few individual moose.
Bear	All traffic types	Disruption of Movement	All phases	Adhere to speed limits and wildlife warning signs along highways, give wildlife right of way, limit traffic disturbance where possible	Possible	Minor	Roads with traffic may act as a barrier to movement for a few individual bears.
Moose	All traffic types	Direct Mortality	All phases	Adhere to and enforce speed limits, yield to wildlife along roads, document vehicle/wildlife interactions, communicate observations of wildlife to other trucks	Possible	Moderate	An average of approximately 20 moose are killed per year due to vehicle collisions along Highway 37 between Kitwanga and Burrage (within the Project study area). Project traffic will increase the traffic volume along the highways and direct mortality to moose is possible. However, even through traffic volumes will be increasing considerably, the number of animal collisions will not increase by an equal percentage.
Bear	All traffic types	Direct Mortality	All phases	Adhere to and enforce speed limits, yield to wildlife along roads, document vehicle/wildlife interactions, communicate observations of wildlife to other trucks	Possible	Minor	Between 0 and 28 bears are killed per year due to vehicle collisions. Project traffic will increase the traffic volume along the highways and direct mortality to bears is possible. However, even through traffic volumes will be increasing considerably, the number of animal collisions will not increase by an equal percentage.
Western Toad	All traffic types	Direct Mortality	All phases	Adhere to and enforce speed limits, document vehicle/wildlife interactions v	Possible	Minor	Western toads may be impacted by increased traffic if migration events occur across the highways.
Birds	All traffic types	Direct Mortality	All phases	Adhere to and enforce speed limits, document vehicle/wildlife interactions v	Possible	Minor	Mortality events involving flocking bird species (e.g., pine siskin or crossbill) and vehicles may occur along the highway, particularly in winter or spring.

Table 5.3-6. Wildlife Risk Assessment Matrix for Traffic Accidents

VC	Traffic Type	Description of Potential Risk (pre-mitigation)	Project Phase	Description of Mitigation Measures	Post-mitigation		
					Likelihood	Severity	Description of Consequence of Realized Risk
Moose	All traffic types	Chemical Hazards	All phases	Spills will be mitigated per the Spill Prevention and Emergency Response Plan. Part of the spill response plan is immediate cleanup, which will minimize if not eliminate effects on wildlife receptors. Wildlife will be excluded from the spill site if cleanup cannot occur immediately.	Unlikely	Minor	In the rare event of a traffic accident, chemical hazards may pose a risk to moose. It is anticipated that the cleanup will occur immediately and moose will be excluded from the spill site, reducing the risk.
Bear	All traffic types	Chemical Hazards	All phases	Spills will be mitigated per the Spill Prevention and Emergency Response Plan. Part of the spill response plan is immediate cleanup, which will minimize if not eliminate effects on wildlife receptors. Bears will be excluded from the spill site if cleanup cannot occur immediately.	Unlikely	Minor	In the rare event of a traffic accident, chemical hazards may pose a risk to bears. It is anticipated that the cleanup will occur immediately and bears will be excluded from the spill site, reducing the risk.
Western Toad	All traffic types	Chemical Hazards	All phases	Spills will be mitigated per the Spill Prevention and Emergency Response Plan. Part of the spill response plan is immediate cleanup, which will minimize the effects on toads.	Unlikely	Moderate	In the rare event of a traffic accident, chemical hazards may pose a risk to western toads if the spill occurs in a wetland occupied by toads.

Wildlife species and individuals within populations are not affected to the same degree by the potential barrier effect of roads and traffic. Roads may act as filters that stop some individuals, or allow others to pass through. However, by filtering out different species or portions of a population, habitat barriers can have important population level effects (Fahrig and Rytwinski 2009). The volume of vehicle traffic along a road will affect species differently. In general, large roads with relatively high traffic volume have the highest effect on wildlife crossing, while roads with lower volumes are crossed or used as travel pathways.

Increased traffic volumes along highways 37 and 37A may decrease moose and bear crossings, affecting movement. For the purpose of this assessment, it is assumed that vehicles will be used during construction, operation, closure, and post-closure for 365 days a year, 24 hours per day. The numbers of vehicles on the road per day, and per hour, are summarized in Tables 5.3-7 through 5.3-9.

Table 5.3-7. Average Annual Daily Traffic along Highway 37 (Eskay Creek Mine Access Road to Meziadin Junction)

Project Phase	Average Number of Vehicles*		Average Number of Vehicles with Hazardous Cargo	
	Vehicles/day	Vehicles/h	Vehicles/day	Vehicles/h
Construction (5-year period)	22	0.92	1	0.04
Operation (51.5-year period)	85	3.54	36	1.50
Closure (3-year period)	16	0.67	3	0.13
Post-closure (250-year period)	6	0.25	3	0.13

** Vehicles represent one-way trips.*

Table 5.3-8. Average Annual Daily Traffic along Highway 37 (Meziadin Junction to Kitwanga)

Project Phase	Average Number of Vehicles*		Average Number of Vehicles with Hazardous Cargo	
	Vehicles/day	Vehicles/h	Vehicles/day	Vehicles/h
Construction (5-year period)	25	1.04	1	0.04
Operation (50 to 55-year period)	49	2.04	18	0.75
Closure (3-year period)	16	0.67	3	0.13
Post-closure (250-year period)	6	0.25	3	0.13

** Vehicles represent one-way trips.*

Table 5.3-9. Average Annual Daily Traffic along Highway 37A

Project Phase	Average Number of Vehicles*		Average Number of Hazardous Vehicles	
	Vehicles/day	Vehicles/h	Vehicles/day	Vehicles/h
Construction	3	0.13	0	0
Operation (50 to 55-year period)	36	1.50	18	0.75

** Vehicles represent one-way trips.*

Disruption of movement will begin during the construction phase of the Project along Highway 37, and continue through operation on both highways 37 and 37A, and closure and post-closure along Highway 37. Wildlife VCs that may be affected by disruption of movement include both moose and bears.

Risk Mitigation

Mitigation strategies that will be introduced to reduce the disruption to wildlife movement include minimizing potential vehicle-related disturbance to wildlife (e.g., wildlife right-of-way, speed limits, and adhering to signage in areas of wildlife crossing).

Risk Characterization

Moose

Disruption of moose movement may occur because of increased traffic volume along highways 37 and 37A. The effects on moose are likely to be related primarily to the physical presence of vehicles. While studies have documented the reactions of moose to vehicle traffic, it is unknown if the reactions result in a disruption of movement. In Denali National Park, for example, 50% of moose showed no reaction to buses, 20% showed a mild reaction, and 29% showed a strong reaction within 20 m of the road (Jalkotzy, Ross, and Nasserden 1997).

High quality moose winter habitat, UWRs, and movement corridors have been identified in the Study Area (Section 5.3.2). Therefore, increased traffic along Highway 37, particularly near movement corridors and high quality habitat, may reduce movement between these areas for moose.

Traffic volumes have decreased along the highways since 2000. Traffic at Meziadin Junction has decreased from approximately 500 annual average daily trips in 2000 (approximately 21 vehicles/hour), to approximately 200 in 2008 (approximately nine vehicles/hour; BC MOTI 2011e). Therefore, traffic volumes have decreased by more than half. Project traffic will add a maximum of four vehicles per hour along Highway 37, remaining below volumes reported in 2000.

Despite mitigation, it is possible that disruption of movement to moose may occur as a result of increased traffic on the highways (particularly Highway 37), but the severity is expected to be minor.

Bear

Grizzly bears maintain large individual home ranges that include separate seasonal habitats, such as wetlands in early spring and alpine areas in the late summer. Travel routes within and between habitats are variable and in most cases not easily identifiable in the landscape. The greatest potential impacts to grizzly bear movements are therefore when one seasonal habitat is completely isolated from another.

Roads may act as barriers to grizzly bear movements, effectively isolating seasonal habitats. Females are particularly sensitive and avoid crossing large roads in some parts of their range (Ross 2002; Waller and Servheen 2005). Roads can also act as an attractant, however, offering high quality vegetation forage along the roadside. Thus, the crucial point for bears is the amount of traffic on roads. When traffic volume rises above a threshold point, bears may avoid a particular road, making it a barrier to movement.

The numbers of vehicles on the road per day, and per hour, are summarized in Tables 5.3-7 through 5.3-9. The maximum number of vehicles will occur during the operation phase. During operation, the maximum traffic volume will increase by approximately four vehicles per hour along Highway 37 and approximately two vehicles per hour along Highway 37A. Bears were reported to cross roads when traffic volumes are less than 10 vehicles per hour (Waller and Servheen 2005). Given the current traffic volume (approximately nine vehicles per hour), the additional four Project-related vehicles per hour along Highway 37 will result in 13 vehicles per hour, which is slightly higher than the threshold of 10 vehicles per hour and may result in a barrier to movement for bears.

During construction and operation, potential vehicle-related disturbance to wildlife will be minimized by identifying wildlife right-of-ways, posting speed limits, and adhering to signage in areas of wildlife crossing. In addition, Project traffic volumes will decrease to six vehicles per day along Highway 37 in the post-closure phase. Despite mitigation, it is possible that disruption of movement to bears will occur as a result of increased traffic on the highways (particularly Highway 37), but the severity is expected to be minor.

5.3.3.2 Direct Mortality

Risk Identification

Direct mortality of wildlife could occur along highways 37 and 37A as a result of vehicle traffic from the Project to Stewart and Kitwanga. Records of mortalities of several wildlife species along the highway are kept by the Province (Sielecki 2004). This information is compiled in the Wildlife Accident Reporting System (WARS) database, which is maintained by BC MOTI. There are several limitations to the WARS data, including under-representation of wildlife mortalities and lack of information regarding locations of accidents. For example, in 2002, of 5,031 reports received, 28% lacked valid segment numbers, and 28% lacked valid kilometer references (Sielecki 2010). Therefore, although WARS data are the best available information, they must be interpreted with caution.

The Project will contribute to traffic volumes on highways 37 and 37A. During construction, a maximum of 25 Project trucks per day will be travelling along Highway 37 (Table 5.3-8), and will increase to a maximum of 85 Project trucks per day during operation (Table 5.3-7); therefore, potential vehicle interactions with moose, bear, western toad, and birds could occur.

Risk Mitigation

Vehicle-related mortality will be mitigated through the following measures:

- adhering to and enforcement of speed limits;
- yielding to wildlife observed along the road;
- communicating locations of observed wildlife to other trucks; and
- documenting cases and locations where collisions between wildlife and vehicles have occurred or have a higher likelihood of occurring and adapting mitigation strategies based on information gathered (Rea et al. 2006; Hesse et al. 2010).

Risk Characterization

Moose

Direct mortality of moose caused by vehicle collisions on highways 37 and 37A could occur during the construction, operation, closure and post-closure phases.

In general, ungulate-vehicle collisions tend to be aggregated in both time and space: temporal patterns include changing food availability, seasonal migrations, and snow cover; while spatial factors include location of preferred foraging habitat, landscape topography, and road and traffic characteristics. Increased collision risk with animals is also associated with linear landscape features that funnel animals alongside or across roads, such as riparian corridors, transmission lines and steep slopes and ridges (Seiler 2005).

The density of moose in particular areas may increase the risk of collisions with vehicles (Seiler 2005). During the growing season, moose may frequent edge habitats, such as road verges, because they

contain succulent and high-quality forage and provide easy movement. Vehicle-related animal strikes also depend on vehicle speed and traffic volume. Moose-vehicle collisions in northern BC appear to be more frequent in winter (December and January), coinciding with times of high snowfall when they are found near highways that are actively kept clear of snow (Sielecki 2004, 2010).

Moose-vehicle collisions occur throughout the species range and are highlighted as a problem from both wildlife management and traffic safety perspectives (Sielecki 2004; Rea et al. 2006). Along highways in the Bulkley-Stikine District (which includes highways 16, 37, and 37A), collisions with moose were the most commonly recorded road accident between 1988 and 2007 (1,022 incidents), representing 38% of all wildlife collisions, and an average of approximately 51 moose/year (Sielecki 2010).

Within the Bulkley-Stikine District, the WARS database is subdivided into highway LKI segments. These data are also an under-representation of the actual number of wildlife collisions, mainly due to reporting error. Despite being the best available data, the numbers must be interpreted with caution. The Project transport route covers a portion of Highway 37 from Kitwanga to the Eskay Creek Mine access road, which is included in LKI segments 3710, 3720, 3730, and 45 km of 3740 (LKI 3740 extends north from Bell II to Burrage, approximately 39 km north of the Eskay Creek Road). LKI segment 3740 is included in this assessment, as the Study Area includes 54% of this segment. The transport route along Highway 37A is LKI segment 3725. Wildlife accidents in the four LKI segments along Highway 37 between 1991 and 2010 consist primarily of moose (N = 111; average 5.8 moose/year; BC MOTI 2011a). The majority (51%) of moose collisions occurred in December (N = 22) and January (N = 35). Along Highway 37A, only three moose accidents were reported (BC MOTI 2011a).

It is estimated that the wildlife collision numbers recorded by the WARS system may only represent 25% to 35% of the actual number of animals killed on roads (Sielecki 2010). The average number of moose-vehicle collisions per year along Highway 37 within the Study Area is 5.8. Based on the estimate that only 25% to 35% of actual kills are reported, the number of vehicle/moose collisions could in fact range from 17 to 23 per year (average 18.5 moose per year).

In order to assess the potential effects of increased direct mortality of moose due to increased traffic, a population viability assessment was conducted of the Nass moose population. A population dynamics model received from the British Columbia Ministry of Environment was used to perform a historical reconstruction of the Nass population under known harvests and demographic rates.

A statistical reconstruction produced a best fitting model to empirical trends of abundance survey data and harvest survey data. A moose vehicle collision model was imbedded into the population dynamics model to emulate the fraction of moose mortality that could be explained by the current level of vehicle collisions. The parameters estimated in the statistical reconstruction were treated as predictors of how the Nass population behaves, and used to perform a sensitivity analysis of population predictions under future assumed conditions of harvest and vehicle traffic (see Appendix D).

The model results indicated that:

- Overall, the modeled population is very sensitive to small changes in survival rate – this result is partly due to the many age classes (20) used in the BC MOE model – yielding a modeled population which is likely more sensitive to changes in mortality than the true Nass moose population. Typical moose models use only 3 age classes and are typically less sensitive to small changes in survival.
- Historic reconstruction of the moose population indicates that hunting rates were the likely initial cause of the moose population decline from 1595 to 517 animals during 2001 - 2011.

- Under a scenario of current traffic and hunting levels, the model predicts that the Nass moose population will not decline substantially, on average, by 2030.
- The addition of traffic from the KSM project is projected to cause an additional <1% mortality to the moose population at the current population size, a mortality rate that does not predict a substantial decline from the base case scenario.
- Under a scenario of baseline traffic plus KSM traffic, if the modeled survival rate of moose is increased a small amount (2-3%) such as by altering hunting rates, the model predicts an increase in the Nass moose population by 2030 from current conditions.

After mitigation, it is possible that vehicle/moose collisions will occur resulting in direct mortality due to increased traffic on the highways (particularly Highway 37).

Because of the current status of the moose population in the area (i.e., with a history of declining), the high value habitat along Highway 37, and the modeled possible future scenarios with the addition of KSM, the severity is expected to be moderate.

Bear

Vehicle collisions will be of concern for both grizzly and black bears. Direct mortality caused by vehicle collisions could occur along highways 37 and 37A. In the spring, bears that have recently emerged from torpor often forage on roadside vegetation and carrion, and are typically less cognizant of potential dangers. Wildlife accidents involving bears increased between 1988 and 2007 in the Bulkley-Stikine District, ranging from 0 to 28 per year, with approximately 67% (of 248) reported from 1999 to 2007 (Sielecki 2004, 2010). However, traffic at Meziadin Junction (i.e., highways 37 and 37A) has decreased from 469 annual average daily trips in 2000, to 224 in 2008 (BC MOTI 2011e). There appears also to be a seasonal trend, with the majority of strikes occurring in the months of August and September (Sielecki 2004, 2010). There is no risk of vehicles colliding with bears in winter, as bears are in their dens during winter months.

Between 1991 and 2010, there were 108 reported vehicle accidents with bears in the four LKI segments along Highway 37 (average 5.7 bears/year; BC MOTI 2011a). The majority (68.5%) of bear collisions occurred in July (N = 21), August (N = 24), and September (N = 29). Along Highway 37A, 26 bear accidents were reported between 1996 and 2010 (BC MOTI 2011a).

It is estimated that the wildlife collision numbers recorded by the WARS system may only represent 25% to 35% of the actual number of animals killed on roads (Sielecki 2010). The average number of bear/vehicle collisions per year along Highway 37 within the Study Area is 5.7, and along Highway 37A is 2.2. Based on the estimate that only 25% to 35% of actual kills are reported, the number of bear/vehicle collisions along Highway 37 could in fact range from 16 to 23 per year (average 20 bears per year), and from six to nine per year along Highway 37A.

Project-related vehicles would add to traffic on highways, thus increasing the probability of bear-vehicle collisions. Along roads, bears will be at risk of vehicle collision along areas where habitat is suitable for grizzly bears and black bears, particularly near salmon spawning habitat in September (e.g., near Meziadin Lake and Cranberry River, the lower Bowser River to its confluence with the Bell-Irving River, Hanna and Tintina creeks near Meziadin Junction, and the large floodplain associated with the Bell-Irving River and Teigen Creek drainages near Bell II), or near proposed grizzly bear WHAs.

Potential project-related vehicle interactions with bears would be mitigated through adherence to road and traffic signs. Despite implementation of mitigation measures, bear collisions with Project vehicles are possible along the highways. The severity will be minor; even though traffic volumes will be

increasing considerably during the operation phase on Highway 37A and the northern sections of Highway 37 (in comparison to current traffic volumes, but not historical peaks) the number of animal collisions may not increase by an equal percentage.

Western Toad

Western toads use terrestrial habitats for most of the year (Bartelt and Peterson 1994) but return to aquatic habitats to breed. Western toads are capable of moving over 5 km between breeding sites; occasional long-distance excursions of up to 7.2 km have been noted for this species (Wind and Dupuis 2002). Young toads (toadlets) spend the first period of their terrestrial life within the riparian area, eventually dispersing upland. Little is known of the mechanisms that determine the direction and magnitude of toadlet dispersal.

The greatest concern for western toad populations near the highways will be direct mortality of adults and newly emerged terrestrial juveniles near roads and close to wetlands during the spring and late summer. High and low-traffic roads can both cause considerable mortality, particularly during breeding migrations (Lesbarrères, Lodé, and Merilä 2004). Western toads will disperse more than 600 m from breeding sites (Rittenhouse and Semlitsch 2007). Therefore, there is potential for toads and toadlets to be moving from breeding sites to upland areas and to cross a road. Toad mortality is possible along the highways, but the severity will be minor, as traffic already exists on the highways.

Birds

Direct mortality of birds, particularly flocking species such as pine siskins and crossbills, may occur as a result of increased traffic along the highways. Most road mortalities to these species occur during winter or early spring (Campbell et al. 1997). Crossbills, grosbeaks, and siskins are particularly vulnerable to vehicle collisions on highways, as they are attracted to road salts, gravel, and sand (Mineau and Brownlee 2005). It has also been noted that high traffic volume roads can have a repelling or avoidance effect on small vertebrates, thus potentially decreasing the risk of mortality to birds (Clevenger, Chruszcz, and Gunson 2003). The Project will be contributing a maximum of four additional vehicles per hour to the existing nine vehicles per hour north of Meziadin Junction. South of Meziadin Junction, the Project will contribute an additional two vehicles per hour, which is approximately 6% of the existing 33 vehicles per hour. Therefore, although bird mortality is possible along the highways, the severity will be minor.

5.3.3.3 Chemical Hazards

Risk Identification

Chemicals transported by truck along the highways could be released into the environment in the event of a motor vehicle accident (see Table 2.4-6 for a list of chemicals intended to be used in Project activities). For the purpose of this assessment, a chemical hazard is defined as “a chemical that has the potential to cause an adverse health effect on wildlife receptors (VCs) due to a chemical spill along the highway.” This potential depends on the concentration of a chemical in the environment and the exposure that a VC receives. However, the chemical concentrations occurring in the environment after an accident cannot be reliably predicted. Potential effects of chemical hazards on moose, bear, and western toad could occur and are described in greater detail in Table 6.4-5 in Section 6.4.4.

Risk Mitigation

Spills will be mitigated as per the Spill Prevention and Emergency Response Plan. Part of this plan is immediate clean-up, which will minimize if not eliminate effects on wildlife receptors. In addition, wildlife would be excluded from the spill site until effective clean-up of the area. However, in the

event of a major spill, soil, water, and vegetation within the spill area will be monitored to ensure that the chemical levels are within the appropriate regulatory guidelines.

Risk Characterization

In the event of a chemical spill, the time that elapses between occurrence and subsequent clean-up represents the potential for acute effects on VCs near the spill. However, these potential effects cannot be evaluated at this time because the volume of the spill and the concentrations that may enter the environmental media are unknown. Other information required in evaluating this risk, such as the location of the spill or the time of year, is also unknown; therefore, in the event of a spill a risk assessment that evaluates acute exposure to VCs will be implemented.

Moose

Habitats along the highway used by moose, particularly the calving area on the Bell Irving River below Bell II, may be vulnerable to effects from traffic accidents, such as chemical spills. It is possible that individuals may ingest chemicals through soil, water, or vegetation, particularly if the contaminant is in the form of a salt. Although effects on individuals are possible, the fact that moose move great distances indicate that no population level effects from exposure to chemicals along the highway in the event of a spill are expected to occur. An event of this nature occurring is unlikely, and severity would be minor, depending on the location and the amount of time that lapses between occurrence and clean-up.

Bear

Habitats along the highways may be used by bears during spring, summer, and fall (near salmon spawning habitat). Although grizzly bears hibernate for six months of the year and their home range sizes are typically large (25 to 200 square kilometres for females and 60 to 700 square kilometres for males; Demarchi and Johnson 2000), it is possible that individuals may ingest chemicals through soil, water, vegetation and prey. Thus, although effects on individuals are possible, the relatively large home ranges of grizzly bears, and the fact that their home ranges do not substantially overlap, indicate that no population level effects from exposure to chemicals along the highway in the event of a spill are expected to occur. An event of this nature occurring is unlikely, and severity would be minor, depending on the location and the amount of time that lapses between occurrence and clean-up.

Western Toad

Western toads have the potential to be exposed to chemicals in the event of a traffic accident involving the spill of chemicals into a wetland occupied by western toads. Toads could be exposed to the chemicals via the ingestion of soil, water, and prey species and via dermal absorption. Although toads hibernate for up to six months of the year, amphibians are particularity sensitive to environmental contaminants. For example, exposure to liquid chlorine (sodium hypochlorite) is severely toxic to amphibians (Section 6.4.4, Table 6.4-5). An event of this nature occurring is unlikely; however, the severity of the event if it occurred could be moderate, depending on the location (i.e., breeding pond) and the amount of time that lapses between occurrence and clean-up.

5.4 TERRESTRIAL ECOSYSTEMS

5.4.1 Baseline Data Overview

Baseline conditions for terrestrial ecosystems VCs selected for this assessment along the highways are described below.

Highway 37 passes primarily through the valley bottoms, lower slopes, and mid-slopes of valley systems running predominantly north-south. It crosses a variety of ecosystem types, including a network of

mature forest, seral forest, wetlands, and non-treed ecosystems such as avalanche tracks. The highway crosses four biogeoclimatic ecosystem classification zones, which are divided into eight subzones and variants, each with unique vegetation, soil, topographical, and climatic characteristics.

According to existing mapping, more than 86% of the Project's transportation route is classified as forest (Rescan 2009). Approximately 51% is classified as mesic (intermediate moisture) forest and is characterized by intermediate soil moisture and nutrient regimes that occur on mid-slope positions, and moderately deep to deep soils with unrestricted drainage (Banner et al. 1993). Mesic forests are the dominant ecosystem type in each of the subzones apart from Interior Cedar Hemlock moist cold Nass Variant (ICHmc1), where the moist forest ecosystem type is more dominant. Overall, the moist forest ecosystem type also accounts for a considerable portion of the highway route, while dry forests and wet forests are less common.

5.4.1.1 Disturbance History

Many areas along highways 37 and 37A have been disturbed by logging and other development, leading to fragmented late seral forests and the prominence of early seral stages. Few areas of valley bottom intact old growth forests remain, while the remaining forests are heavily fragmented and contain a network of active, inactive, and unmaintained forestry roads.

5.4.2 Issue Scoping

5.4.2.1 Terrestrial Ecosystems Scoping

Project activities are expected to result in additional traffic volumes on highways 37 and 37A, although not exceeding historical peaks. The principal issues for terrestrial ecosystems associated with Project traffic and traffic accidents are summarized in Table 5.4-1.

Table 5.4-1. Terrestrial Ecosystems Scoping Matrix

Traffic Type	Potential Risk? (Yes/No)	Rationale for Selection/Exclusion
Project traffic		
All traffic	Yes	An increase in Project traffic may result in the potential for introduction and spread of invasive plants, and increased incidence of wildfire from improper disposal of smoking material.
Traffic accidents		
All traffic	Yes	Traffic accidents may result in increased incidence of wildfire and chemical contamination.

5.4.2.2 Valued Component Scoping

The selected terrestrial ecosystem VCs and the rationales for their inclusion or exclusion in the assessment are presented in Table 5.4-2. The party who identified each potential VC is also referenced in the table: Aboriginal groups (AG); government (G); public/stakeholder (P/S); or other (O) (e.g., legislation, technical expertise).

5.4.2.3 Potential Traffic/Valued Component Interactions

The potential interactions between Project traffic and terrestrial ecosystems VCs along highways 37 and 37A are shown in Table 5.4-3.

Table 5.4-2. Identification and Rationale for Terrestrial Ecosystems Valued Component Selection/Exclusion

VC	Identified by[1]				Selected for…[2]		
	AG	G	P/S	O	Project Traffic?	Traffic Accidents?	Rationale for Selection/Exclusion
Rare and Sensitive Ecosystems	X	X		X	Yes	Yes	Plant communities (ecosystems) listed by the BC Conservation Data Centre (CDC) have particular threats, declining population trends, or restricted distributions which indicate they require special attention. Managing these communities and plants is a goal outlined in each of the applicable LRMPs.
Old Growth Forest and Management Areas	X	X	X		Yes	Yes	Old growth forests were identified by First Nations, LRMPs, and SRMPs as an important issue. Old Growth Forest and Management Areas are set aside to protect current or future old growth forests.
Other Terrestrial Ecosystems	X			X	Yes	Yes	Other terrestrial ecosystems are important for continued diversity of natural ecosystems and seral stages; they provide a range of wildlife habitat, recreation areas, etc.; and include plant species that are traditionally harvested by Aboriginal groups.

[1] *"X" indicates that the corresponding group (AG = Aboriginal Group, G = Government, P/S = Public/Stakeholder, or O = Other) has identified the VC as an issue; "-" indicates that the group did not identify the VC as an issue.*
[2] *"Yes" indicates that the VC is selected for further analysis; "No" indicates that the VC is excluded from further analysis.*

Table 5.4-3. Potential Traffic / Terrestrial Ecosystems Valued Component Interaction Matrix

Traffic Type	VCs		
	Rare and Sensitive Ecosystems	Old Growth Forests	Other Terrestrial Ecosystems
Project traffic			
All traffic	X	X	X
Traffic accidents: on-road			
All traffic	X	X	X
Traffic accidents: off-road			
All traffic	X	X	X

"X" indicates that a potential interaction has been identified.
"-" indicates that no potential interaction was identified.

5.4.3 Risk Analysis

The effects assessment addresses potential issues and risks associated with Project traffic interactions with terrestrial ecosystem VCs along highways 37 and 37A.

The following sections describe each potential effect and how it relates to terrestrial ecosystem VCs. Each of these potential effects, including mitigation and predicted likelihood and severity of effects (Table 5.4-4) is discussed in further detail in the following sections.

Three potential effects relevant to terrestrial VCs are identified in relation to Project traffic. These are: (1) introduction and spread of invasive plants, (2) incidence of wildfire, and (3) chemical contamination (Tables 5.4-5 and 5.4-6).

Table 5.4-4. Terrestrial Ecosystems Risk Assessment Severity Scale Descriptors

Descriptor	Definition
Negligible	No detectable change from baseline conditions. Effect limited to a few individuals.
Minor	Differs from the average value for baseline conditions to a small degree (e.g., within the range of natural variation and well below a guideline or threshold value). Effect mainly limited to a few individuals.
Moderate	Differs substantially from the average value for baseline conditions and approaches the limits of natural variation, but below or equal to a guideline or threshold value. Effect limited to the local population.
Major	Differs substantially from baseline conditions beyond a guideline or threshold value, resulting in a detectable change beyond the range of natural variation. Effect limited to the local population.
Catastrophic	Differs substantially from baseline conditions beyond a guideline or threshold value, resulting in a detectable change beyond the range of natural variation. Effect extends beyond the local population to the regional population.

5.4.3.1 Introduction and Spread of Invasive Species

Risk Identification

Invasive plants are a considerable threat to natural habitats (Canadian Food Inspection Agency 2008) as they can aggressively establish in disturbed areas, thereby reducing biodiversity (Polster 2005). Their establishment can have a negative effect on ecosystem function, particularly in areas that are maintained in an early seral state, such as road rights-of-way. Roads and other linear corridors provide a continuous zone of such habitat. An increase in vehicular traffic travelling along such corridors provides additional exposure and dispersal mechanisms. Vehicles of any size (e.g., heavy machinery to all-terrain vehicles) can carry plant propagules in tires, the undercarriage, or in mud on the vehicle, and inadvertently transport them to previously unaffected areas.

Invasive plant species can influence ecosystem diversity, structure, and function through invasion, establishment and hybridization. Invasive plants can alter the structure of a natural ecosystem and ultimately change the way in which the site is used by wildlife, insects and microorganisms. Changes to nutrient cycling, hydrology, erosion and fire regimes may also occur (Canadian Food Inspection Agency 2008).

Risk Mitigation

Preventing the initial establishment of invasive plants is the most effective method of control (Clark 2003; Polster 2005; BC MOFR 2010a). Introduction and spread of invasive plants into terrestrial VCs will be avoided through inspections by provincial government staff on Project sites. Where risk of invasive plant introduction and establishment is identified, appropriate action will be taken. Identification of target plants will be based on the management plans outlined by the Northwest Invasive Plant Council (2011).

Risk Characterization

Efforts will be made to avoid invasive plant introduction and establishment. After mitigation, however, if invasive plants are unintentionally introduced, these plants will be managed by the BC MOTI, who controls noxious weeds on rights-of-way within BC. Many invasive plants are not shade-tolerant and do not thrive in the low light conditions found in many riparian and floodplain forests or old growth forests. Thus, the likelihood of invasive plant introduction and spread in rare and sensitive ecosystems is unlikely. Subsequently, the severity is negligible. Nevertheless, the likelihood of invasive plant introduction into other terrestrial ecosystems is likely. Invasive plants can spread from highway rights-of-way to forest edges, which are susceptible to the introduction of invasive species propagules from adjacent clearings (Murphy and Lovett-Doust 2004). The severity is expected to be minor, depending on the invasive plant species involved and the density and distribution of the population.

Table 5.4-5. Terrestrial Ecosystems Risk Assessment Matrix for Project Traffic

VC	Traffic Type	Description of Potential Risk (pre-mitigation)	Project Phase	Description of Mitigation Measures	Post-mitigation		
					Likelihood	Severity	Description of Consequence of Realized Risk
Rare and Sensitive Ecosystems	All traffic types	increase in invasive plant in riparian area and floodplains adjacent to highway	All phases	Ensure vehicles are washed during appropriate time of year prior to leaving areas with known invasive weeds	Unlikely	Minor	Increase in invasive weeds along cleared road right of ways. Some of these cleared right of ways may intersect with riparian areas and floodplains
Old Growth Forests	All traffic types	increase in invasive weeds in old growth forests	All phases	Ensure vehicles are washed during appropriate time of year prior to leaving areas with known invasive weeds	Unlikely	Minor	Old growth forests do not usually have a light regime that promotes invasive plant establishment, as many are not shade tolerant. Old growth forest tend to be located away from the highway
Other Terrestrial Ecosystems	All traffic types	increase in invasive weeds in terrestrial ecosystems	All phases	Ensure vehicles are washed during appropriate time of year prior to leaving areas with known invasive weeds	Likely	Minor	Increase in invasive weeds along cleared road right of ways, which can lead to migration of invasive plants into the adjacent terrestrial ecosystems. Since many invasives are not shade tolerant, compromise of ecosystem function is not expected
Rare and Sensitive Ecosystems	All traffic types	increased wildfire incidence	All phases	No smoking in vehicle policies, proper disposal of smoking materials, proper vehicle maintenance	Rare	Moderate	Wildfire is not common in the ecosystems associated with Highway 37. Risk going forward will depend greatly on larger climate trends. Many rare ecosystems are associated with riparian areas, which are at limited risk for fire. Depends on duration and severity of the wildfire. Ranges from beneficial to detrimental to the ecosystem depending on the extent of removal of the forested ecosystems from the landscape.
Old Growth Forests	All traffic types	increased wildfire incidence	All phases	No smoking in vehicle policies, proper disposal of smoking materials, proper vehicle maintenance	Rare	Moderate	Wildfire is not common in the ecosystems associated with Highway 37. Risk going forward will depend greatly on larger climate trends. Depends on duration and severity of the wildfire. Ranges from beneficial to detrimental to the ecosystem depending on the extent of removal of the forested ecosystems from the landscape.
Other Terrestrial Ecosystems	All traffic types	increased wildfire incidence	All phases	No smoking in vehicle policies, proper disposal of smoking materials, proper vehicle maintenance	Rare	Minor	Wildfire is not common in the ecosystems associated with Highway 37. Risk going forward will depend greatly on larger climate trends. depends on duration and severity of the wildfire. Ranges from beneficial to detrimental to the ecosystem depending on the extent of removal of the forested ecosystems from the landscape.

Table 5.4-6. Terrestrial Ecosystems Risk Assessment Matrix for Traffic Accidents

VC	Traffic Type	Description of Potential Risk (pre-mitigation)	Project Phase	Description of Mitigation Measures	Post-mitigation		
					Likelihood	Severity	Description of Consequence of Realized Risk
Rare and Sensitive Ecosystems	All traffic types	Increase in vehicle traffic may result in increased accidents involving spilling of deleterious substances, which can result in damage to ecosystem structure and function.	All phases	none	Rare	Negligible to Moderate*	Tissue damage to vegetation and contamination of soil. Circumstances of spill will determine extent and severity of damage.
		Increased incidence and severity of wildfires due to flammable material spills	All phases	none	Rare	Moderate	Depends on duration and severity of the wildfire. Ranges from beneficial to detrimental to the ecosystem depending on the extent of removal of the forested ecosystems from the landscape.
Old Growth Forests	All traffic types	Increase in vehicle traffic may result in increased accidents involving spilling of deleterious substances, which can result in damage to ecosystem structure and function.	All phases	none	Rare	Negligible to Moderate*	Tissue damage to vegetation and contamination of soil. Circumstances of spill will determine extent and severity of damage.
		Increased incidence and severity of wildfires due to flammable material spills	All phases	none	Rare	Moderate	Depends on duration and severity of the wildfire. Ranges from beneficial to detrimental to the ecosystem depending on the extent of removal of the forested ecosystems from the landscape.
Other Terrestrial Ecosystems	All traffic types	Increase in vehicle traffic may result in increased accidents involving spilling of deleterious substances, which can result in damage to ecosystem structure and function.	All phases	none	Rare	Negligible to Moderate*	Tissue damage to vegetation and contamination of soil. Circumstances of spill will determine extent and severity of damage.
		Increased incidence and severity of wildfires due to flammable material spills	All phases	none	Rare	Moderate	Depends on duration and severity of the wildfire. Ranges from beneficial to detrimental to the ecosystem depending on the extent of removal of the forested ecosystems from the landscape.

**See Section 5.4.3.2 for justification of this rating.*

5.4.3.2 Incidence of Wildfire

Risk Identification

A wildfire is an unplanned natural or anthropogenic fire that may require suppression. On average, about 2,000 wildfires occur in BC every year, half of which are caused by human activity and half by lightning ignition (BC Forest Service Protection Branch 2008). An increase in vehicle traffic along highways 37 and 37A may result in an increased risk of wildfire in comparison to current conditions, but not in comparison to historical peaks in traffic. Such an increase would be related to traffic accidents and improper disposal of smoking materials as ignition sources.

Wildfires have the potential to alter terrestrial ecosystems in terms of plant community species composition, structure and ecosystem function. The potential to alter terrestrial ecosystems is dependent on the severity of a fire, which is determined by both the areal extent and intensity. For example, fires that are of low intensity can be spatially extensive, but still benefit ecosystem function, as they can promote wildlife habitat through increased berry production. Severe fires (or stand replacement events) are spatially extensive and intensive. These result in the wholesale removal of vegetation from the landscape, along with the ecological functions provided by the forest.

Risk Mitigation

Preventing an increase in wildfire incidence will involve reducing the risk of vehicle accidents and enacting strong policies requiring the proper disposal of smoking materials. Reduction of vehicle accidents will be accomplished with policies that address vehicle maintenance, speed limits, driver attention, drug and alcohol prohibition and driving under poor weather conditions.

Risk Characterization

Highway 37 runs through the Kalum Forest District (Northwest Fire Centre) of northwestern BC, which has seen few major (>4 ha burned area) and several minor (<4 ha burned area) wildfires during the past decade (BC MOFR 2008). This low incidence of wildfire is due to the regional climate characteristics (long winters and short, wet summers), and limited access to backcountry areas.

After mitigation, the likelihood of an increase in wildfire incidence due to an increase in traffic is rare. This rating is due mainly to the low background level of fire incidence in this area of BC. Mitigation will be most important during summer months, when weather conditions can result in higher risk of wildfire. The severity of wildfire occurrence is highly variable, and depends on local climate conditions, the time of wildfire ignition, the resources available to respond, and the speed at which it is suppressed.

5.4.3.3 Chemical Contamination

Risk Identification

Traffic accidents and malfunctions have the potential to damage terrestrial ecosystems and vegetation through introduction of deleterious substances into the environment. For the purpose of this assessment, a chemical hazard is defined as “a chemical that has the potential to cause an adverse health effect on terrestrial ecosystems (VCs) due to a chemical spill along the highway.” Chemicals transported by trucks along the highway could be released into the environment in the event of a vehicle accident (see Section 2.4.5 for a list of hazardous cargo intended to be used by the Project). These substances could cause loss of vegetation through tissue damage (in the case of lime and reagent spills), or through increased fire incidence and intensity (in the case of fuel and lubricant spills).This potential depends on the concentration of a chemical in the environment and the exposure that a VC receives. Potential effects of chemical hazards on terrestrial ecosystems are described in greater detail in Table 6.4-5 in Section 6.4.4.

Risk Mitigation

Preventing the introduction of deleterious substances into the environment is the most effective way to avoid effects to terrestrial VCs. Specific preventative measures that will be implemented include conducting a vehicle assessment (for oil leaks, secure cargo, etc.), checking road conditions prior to departure, maintaining an appropriate distance between vehicles, adhering to speed limits, and adjusting driving styles to suit road conditions.

In the event of a spill, the guidelines and procedures outlined in the Spill Prevention and Emergency Response Plan will be followed in order to avoid contamination and degradation of terrestrial VCs. However, in the event of a major spill, soil, water, and vegetation within the spill area will be monitored and managed to ensure that the chemical levels are within the appropriate regulatory guidelines.

Risk Characterization

In the event of a chemical spill, the more time that elapses between occurrence and clean-up, the higher the potential for effects on VCs near the spill. However, the full nature of potential effects cannot be evaluated at this time because the volume of the spill and the concentrations that may enter the environmental media are unknown. Other information required in evaluating this risk, such as the location of the spill or the time of year, is also unknown; therefore, in the event of a spill, a risk assessment that evaluates exposure to VCs will be conducted.

After mitigation, the likelihood of chemical contamination to terrestrial VCs is rare. The severity ranges from negligible to moderate depending on the type, frequency and size of the spill as well as the elapsed time between the occurrence and the removal of contaminants.

5.5 WETLANDS

5.5.1 Baseline Data Overview

Although there is limited wetland baseline information for the Highway 37 corridor, data from the publicly available Terrain Resource Information Management (TRIM) Program identifies two types of TRIM wetlands and covers the entire Study Area (Figure 5.1-1):

1. **marsh**: a water-saturated, poorly drained, treeless area, intermittently or permanently water-covered, having cattail, rushes, or grass-like vegetation; and
2. **swamp**: a water-saturated area, intermittently or permanently water-covered, having shrubs.

TRIM data are summarized in Table 5.5-1, which presents areas of TRIM swamp and TRIM marsh within 500 m, 100 m, and less than 10 m of highways 37 and 37A within the Study Area.

Table 5.5-1. Areas of TRIM Wetlands along Highways 37 and 37A within the Study Area

	TRIM Wetlands within 500 m of Highways 37 and 37A		TRIM Wetlands within 100 m of Highways 37 and 37A		TRIM Wetlands within 10 m of Highways 37 and 37A	
	Number	Surface Area	Number	Surface Area	Number	Surface Area
TRIM Marsh	122	7,16.4 ha	32	482.8 ha	15	425.8 ha
TRIM Swamp	122	1,917.6 ha	43	1,069.1 ha	18	427.0 ha
TOTAL	244	2,634.0 ha	75	1551.9 ha	33	852.8 ha

Note: The area of wetlands presented is for the entire polygon even though only a portion of the wetland may be within the area of interest (500 m, 100 m, or 10 m)

5.5.2 Issue Scoping

5.5.2.1 Wetlands Scoping

Project activities are expected to result in additional traffic volumes on highways 37 and 37A, although not exceeding historical peaks. The primary way wetlands may be affected by development is through direct interactions or changes to local hydrology. Direct interactions include constructing infrastructure on wetlands. This activity generally involves in-filling, whereby non-wetland material is deposited in a wetland. Additionally, direct interactions can also result in changes to wetland hydrology. As wetlands are an interface between terrestrial and aquatic systems, subtle changes can result in a significant change in an ecological community. For example, if a road is constructed adjacent to a seepage slope, the impermeable road bed may prevent natural draining, causing a small pond to form, and potentially altering the functions provided by wetlands in that area.

This assessment of potential risks is for the use of existing roads (highways 37 and 37A) and does not consider road alterations, upgrades, or maintenance. Thus, no potential risks to wetlands from Project traffic are anticipated except for potential risks to wetlands associated with traffic accidents (Table 5.5-2).

Table 5.5-2. Wetlands Scoping Matrix

Traffic Type	Potential Risk? (Yes/No)	Rationale for Selection/Exclusion
Project traffic		
All traffic	No	This assessment is for the use of existing roads; alterations, upgrades, or maintenance to the road are not considered. Thus no, Project traffic/wetland interactions are expected given that wetlands will not be altered.
Traffic accidents		
All traffic	Yes	Traffic accidents have the potential to affect wetlands if accidents occur in or near wetlands, as hydrocarbon contamination may result.

A total of 2,634.0 ha of wetlands were identified within 500 m of the centreline of the highways. However, only wetlands immediately adjacent to the highway (less than 10 m) may be at risk due to traffic accidents. Potential risks for traffic accidents are rationalized in Table 5.5-2.

5.5.2.2 Valued Component Scoping

The VCs usually considered when considering environmental effects on wetlands are extent and function. Wetland extent includes the area of wetlands, the size of individual wetlands, and the type of wetlands present in a given area. Wetland function includes the process that wetlands carry out: principally hydrological, biochemical, ecological, and habitat processes.

This assessment focuses on an activity (the use of existing highways) rather than Project infrastructure. Thus, no affects to wetland extent are expected; the wetland extent as a VC was scoped out of this assessment. The use of the existing highways will also not affect wetland function as the assessment is not considering alterations, upgrades, or maintenance. The use of the highways may affect components of wetland function such as vegetation structure or wildlife, but these effects are addressed elsewhere within this document.

Traffic accidents have the potential to affect one or more wetland functions. For example, a vehicle accident involving a transport truck driven into a wetland may contribute environmental contaminants

to the wetland, which will in turn affect the wetland's ability to maintain good water quality or provide habitat to the area's wildlife. Traffic accidents and their effect on wetland function are considered in this document (Table 5.5-3). The party who identified each potential VC is also referenced in the table: Aboriginal groups (AG); government (G); public/stakeholder (P/S); or other (O) (e.g., legislation, technical expertise).

Table 5.5-3. Identification and Rationale for Wetlands Valued Component Selection/Exclusion

VC	Identified by[1]				Selected for…[2]		Rationale for Selection/Exclusion
	AG	G	P/S	O	…Project Traffic?	…Traffic Accidents?	
Wetland Extent	X	X		X	No	No	Extent is affected by direct footprint interactions. As this assessment is based on use of existing highways potential effects to extent are not expected.
Wetland Function	X	X		X	No	Yes	The use of existing highways will not affect wetlands ability to continue to perform the functions they currently provide; this VC was therefore scoped out. Traffic accidents have the potential to affect wetland function if vehicle crashes or spills occur in wetlands.

[1] *"X" indicates that the corresponding group (AG = Aboriginal Group, G = Government, P/S = Public/Stakeholder, or O = Other) has identified the VC as an issue; "-" indicates that the group did not identify the VC as an issue.*
[2] *"Yes" indicates that the VC is selected for further analysis; "No" indicates that the VC is excluded from further analysis.*

5.5.2.3 Potential Traffic/Valued Component Interactions

A potential interaction with a VC and the potential consequences to wetland function were only identified for a traffic accident scenario (Table 5.5-3). Traffic accidents are defined as involving one or more vehicles. The accidents can happen in one of two locations: (1) on the road, or (2) off the road. The vehicles will be transporting either non-hazardous or hazardous cargo. Thus four potential traffic accident scenarios were considered with respect to wetland function (Table 5.5-4).

Table 5.5-4. Potential Traffic / Wetlands Valued Component Interaction Matrix

Traffic Type	VCs
	Wetland Function
Project traffic	
All traffic types	-
Traffic accidents: on-road	
All non-hazardous cargo	-
All hazardous cargo	X
Traffic accidents: off-road	
All non-hazardous cargo	X
All hazardous cargo	X

"X" indicates that a potential interaction has been identified.
"-" indicates that no potential interaction was identified.

On-road traffic accidents involving non-hazardous cargo were determined to pose little to no risk to wetland function. An on-road, non-hazardous traffic accident may include a malfunction where one or more vehicles remain on the road and no hazardous substances are involved. A hazardous substance is

defined as any substance that, in the concentrations present, may adversely affect a functioning ecological system.

On-road traffic accidents involving hazardous cargo were determined to pose a risk to wetland function. An on-road, hazardous traffic accident may include any malfunction where one or more vehicles transporting hazardous substances remain on the road. To be included in this traffic accident category, there must be a risk of a hazardous substance being released into the environment. The risk to wetland function arises if the hazardous substance was to migrate from the road surface into a wetland or watercourse.

Off-road traffic accidents involving non-hazardous cargo were determined to pose a risk to wetland function. An off-road, non-hazardous traffic accident may include a malfunction where one or more vehicles leave the road and end up in a wetland. The risk to wetland function arises because every vehicle contains hazardous substances (principally gasoline or diesel) and there is potential that these substances could be released into the wetland.

Off-road traffic accidents involving hazardous cargo were determined to pose a risk to wetland function. An off-road, hazardous traffic accident may include any malfunction where one or more vehicles transporting hazardous substances leave the road and end up in or adjacent to a wetland. The risk to wetland function arises if the hazardous substance were to be deposited in a wetland or watercourse.

5.5.3 Risk Analysis

A risk analysis was completed on the three traffic accident scenarios identified in Table 5.5-4 as having an effect on wetland function. The risk analysis involved assigning a descriptor to the traffic accidents. Wetland risk descriptors are defined in Table 5.5-5.

Table 5.5-5. Wetlands Risk Assessment Severity Scale Descriptors

Descriptor	Definition
Negligible	No measurable effect results.
Minor	A measurable effect results but the effect does not affect a wetland's ability to carry out its functions. For example, a kitchen supply truck crash deposits baked goods into a wetland.
Moderate	A measurable effect results and the ability of a wetland to perform a given function is affected. For example, a kitchen supply truck crash deposits baked goods into a wetland drainage temporarily retarding water release.
Major	A measurable effect results and the wetland can no longer provide a given function. For example, a kitchen supply truck crash deposits cleaning products and chemicals which make the wetland hazardous to animals.
Catastrophic	A measurable effect results and the wetland can no longer provide two or more functions at multiple wetlands. For example, a kitchen supply truck crash deposits cleaning products and chemicals which make the wetland hazardous to animals and the accident severely alters the wetland drainage pattern. This in turn has numerous downstream effects resulting in changes to multiple wetlands.

The risk assessment was generalized for all traffic types because all traffic types are susceptible to accidents. The potential risks were identified as:

- on-road traffic accidents involving hazardous cargo;
- off-road traffic accidents involving non-hazardous cargo; and
- off-road traffic accidents involving hazardous cargo.

The wetland risk assessment matrix for these traffic accident scenarios is presented in Table 5.5-6.

Table 5.5-6. Wetlands Risk Assessment Matrix for Traffic Accidents

VC	Traffic Type	Description of Potential Risk (pre-mitigation)	Project Phase	Description of Mitigation Measures	Post-mitigation		
					Likelihood	Severity	Description of Consequence of Realized Risk
Wetland Function	All traffic types	depositon of deleterious substances in wetlands from: • on road, toxic, unintended events • off road, non-toxic, unintended events • off road, toxic, unintended events	All phases	Limit the extent of contamination; Limit the time a contaminant may be in contact with a wetland, and follow Spill Prevention and Emergency Response plans	Unlikely	Major	A loss of wetland function at a wetland

5.5.3.1 Vehicle Accident in Wetland

Risk Identification

These potential risks were identified as possible in all Project phases because highway use is expected in some capacity during each Project phase and wetlands are distributed along the travel corridor.

Risk Mitigation

Mitigation measures for potential effects on wetland function include:

- limiting the time any vehicle or deleterious substance remains in a wetland after a traffic accident (Spill Prevention and Emergency Response Plan); and
- limiting the extent to which a deleterious substance can migrate through a wetland; and following standard spill prevention and emergency response planning.

Risk Characterization

The likelihood of any one Project-related traffic accident releasing deleterious substances into a wetland was identified as unlikely. The severity of one of these traffic accidents was assessed as major; however, depending on the specific location and type of vehicle, the severity could range from minor to catastrophic for a specific wetland. Potential effects of chemical hazards on wetlands are described in greater detail in Section 6.4.4, Table 6.4-5.

5.6 NOISE

5.6.1 Baseline Data Overview

Baseline noise data was calculated by BKL using traffic data counts at two locations in the Study Area (Appendix E). Noise baseline information is required to quantify the potential increase in noise levels near the Project traffic corridor (northern segment) and near the town of Kitwanga (southern segment). The *northern segment* noise level was calculated based on the traffic count on Highway 37 at Meziadin Lake Junction Station (47-016-NS; located 1 km north of the Highway 37/37A intersection on Highway 37); the *southern segment* noise level was calculated based on the traffic count data at the intersection of Highway 37 and Highway 16 by Kitwanga.

The predicted A-weighted baseline noise levels, averaged over 24 hours, are summarized in Table 5.6-1. The receiver distance of 50 m and 25 m for northern and southern segments, respectively, is the distance from the Highway to the closest house[8] based on Google Earth imagery, close to the locations of the traffic counts.

5.6.2 Issue Scoping

5.6.2.1 Noise Scoping

Project activities are expected to result in additional traffic volumes on highways 37 and 37A, although not exceeding historical peaks. Project traffic over all phases of the Project may lead to an increase in noise levels in the Study Area. The magnitude of the increase will depend on the traffic volume as it is more or less continuous for the duration of the Project.

[8] NAD83 UTM Zone 9: North segment receiver is at an easting of 480966.78 m, and a northing of 6217255.63 m; South segment receiver is at an easting of 559072.81 m, and northing of 6106353.34 m.

Table 5.6-1. Estimated Baseline Traffic Noise Levels Averaged Over 24 Hours

Count Station	Case	Existing Noise Level (dBA)	Receiver Distance (m)
North Segment (47-016-NS)	AADT	47	50
	SADT	49	
South Segment (P47-9-NS)	AADT	58	25
	SADT	59	

Source: BKL 2013, Appendix E

Traffic accidents may also contribute to increases in noise levels depending on the type and severity of the accident. However, these events are short-term and temporary, and not considered to be a risk. For the purposes of this study, noise resulting from traffic accidents is not considered further. Table 5.6-2 identifies the potential noise issues related to traffic.

Table 5.6-2. Noise Scoping Matrix

Traffic Type	Potential Risk? (Yes/No)	Rationale for Selection/Exclusion
Project traffic		
All traffic	Yes	Increasing noise levels in the vicinity of the traffic
Traffic accidents		
All traffic	No	May cause short-term noise events, but these are not considered to be a risk

5.6.2.2 Valued Component Scoping

The selected noise VCs and the rationales for their inclusion or exclusion in the assessment are presented in Table 5.6-3. The party who identified each potential VC is also referenced in the table, including Aboriginal groups (AG); government (G); public/stakeholder (P/S); or other (O) (e.g., legislation, technical expertise).

Table 5.6-3. Identification and Rationale for Noise Valued Component Selection/Exclusion

	Identified by[1]				Selected for…[2]		
VC	AG	G	P/S	O	…Project Traffic?	…Traffic Accidents?	Rationale for Selection/Exclusion
Human Health	-	X	X	X	Yes	No	Noise from increased vehicle traffic increases the noise levels in the Study Area, which may contribute to effects on human health.
Wildlife	X	X	X	X	Yes	No	Noise from increased vehicle traffic increases the noise levels in the Study Area, and may contribute to effects on wildlife.

[1] *"X" indicates that the corresponding group (AG = Aboriginal Group, G = Government, P/S = Public/Stakeholder, or O = Other) has identified the VC as an issue; "-" indicates that the group did not identify the VC as an issue.*
[2] *"Yes" indicates that the VC is selected for further analysis; "No" indicates that the VC is excluded from further analysis.*

Since vehicle transportation generates noise and therefore increased noise levels, all Project traffic will contribute to effects on VCs during the Project's life span on a regular basis.

5.6.2.3 Potential Traffic/Valued Component Interactions

Environmental noise is comprised of ambient sound levels as well as natural events such as thunder and rain, and human activities such as traffic and industry. Human health and wildlife have been selected as the relevant noise VCs (Table 5.6-4) for the Project. Excess noise can lead to direct or indirect human health effects such as stress, annoyance, and lower sleeping quality and quantity. Disturbance to wildlife from noise from highway traffic can also be important depending on the species affected and length and type of noise disturbance.

Table 5.6-4. Potential Traffic / Valued Component Interaction Matrix — Noise

	VCs	
Traffic Type	**Human Health**	**Wildlife**
Project traffic		
All traffic	X	X

"X" indicates that a potential interaction has been identified.
"-" indicates that no potential interaction was identified.

5.6.3 Risk Analysis

Baseline noise levels and predictions for the Project's operation phase are summarized in Table 5.6-5. Also see Section 5.8.3.2 for further analysis in regards to human health.

Table 5.6-5. Estimated Traffic Noise Levels Averaged Over 24 Hours — Baseline and Predicted during Operation Phase

Count Station	Case	Existing Level (dBA)	Project Operation Phase (dBA)	Receiver Distance (m)
Northern Segment (47-016-NS)	AADT	47	50	50
	SADT	49	52	
Southern Segment (P47-9-NS)	AADT	58	59	25
	SADT	59	60	

Note: Estimated by BKL using the existing traffic and predicted operation (i.e., maximum) phase traffic estimations (Appendix E).

In Section 5.6.2, two noise VCs were identified: human health and wildlife. Risk assessments of increased noise levels on community well-being and human health are presented in Section 5.1, and Section 5.8. Effects on wildlife of increased noise are considered in the assessment of the risk of barrier to movement, presented in Section 5.3.

5.7 CLIMATE AND AIR QUALITY

5.7.1 Baseline Data Overview

The best available estimates of background concentrations for sulphur dioxide (SO_2) are from ambient background concentrations monitored by Environment Canada's Canadian Air and Precipitation Monitoring Network (CAPMoN). CAPMoN is a non-urban air quality monitoring network with siting criteria designed to ensure that measurement locations are regionally representative (i.e., not affected by local sources of air pollution). The closest CAPMoN measurement site to the Project is the Saturna Station, off the southern tip of Vancouver Island in the middle of the Strait of Georgia (also known as the Salish Sea). Although the station is almost 1,000 km southeast of the Study Area, it provides the best available estimate of background concentrations available for non-urban BC (Environment Canada 2010).

Daily measurements of SO_2 concentration are available from the Saturna Station from 1996 to 2002 (except 1997, from which data are missing). The average annual SO_2 concentration for this period was 2.3 micrograms per cubic metre (µg/m³), with an average standard deviation of 2 µg/m³ (Environment Canada 2010).

Background concentrations for SO_2, nitrogen dioxide (NO_2), and carbon monoxide (CO) from the Diavik Diamond Mine in the Northwest Territories were also estimated in a study done by Cirrus (1998; see Table 5.7-1).

Table 5.7-1. Background Air Contaminant Measurements — Diavik Diamond Mine

Contaminant	Averaging Time Period	Background Concentration (µg/m³)
SO_2	1-hour and 24-hour	4.0
	Annual	2.0
NO_2	1-hour and 24-hour	21.0
	Annual	5.0
CO	All averaging times	100

Source: Cirrus (1998)

The annual average SO_2 background concentration of 2.0 µg/m³ for the Diavik Mine is generally in agreement with the average concentration observed at the Saturna Station. Accordingly, for the purposes of this study, NO_2 and CO background concentrations from the Diavik Mine were assumed to be representative of the conditions of a northern, undisturbed remote area such as the Study Area.

Concentrations of $PM_{2.5}$ are available from McKendry (2006); however, this data does not contain PM_{10} concentrations, reportedly due to a general lack of PM_{10} data in pristine environments in BC. However, data from the Galore Creek Project measured 98th percentile background concentrates of PM_{10} and $PM_{2.5}$ as defined by the province's air dispersion modelling guidelines (BC MOE 2008; see Table 5.7-2).

Table 5.7-2. Background Air Contaminant Measurements — Galore Creek Project

Contaminant	Averaging Time Period	Background Concentration (µg/m³)
PM_{10}	24-hour	3.4
$PM_{2.5}$	24-hour	1.3

Source: RTEC (2006)

The Galore Creek project's background concentration for $PM_{2.5}$ is in general agreement with those measured in the McKendry study. The latter estimated the mean annual $PM_{2.5}$ background as 2.5 µg/m³, with a seasonal range of 1 to 4 µg/m³, and short term peaks of up to 250 µg/m³ from local forest fires. These background levels are well below the BC Air Quality Objectives and Standards level of 8 µg/m³ and the Canadian guide 24-hour level of 25 µg/m³ (Government of BC 2009a).

5.7.2 Issue Scoping

5.7.2.1 Climate and Air Quality Scoping

There are potential climate and air quality issues and risks associated with Project traffic as well as accident scenarios (Table 5.7-3). The main source of air emissions is from vehicle tail-pipe exhaust which will contribute to changes in air quality and climate change.

Table 5.7-3. Climate and Air Quality Scoping Matrix

Traffic Type	Potential Risk? (Yes/No)	Rationale for Selection/Exclusion
Project traffic		
All traffic	Yes	Air emissions* from vehicle exhaust.
Traffic accidents		
Personnel and non-hazardous cargo		
Personnel vehicle	Yes	Air emissions in case of fire.
Non-hazardous cargo	Yes	Air emissions in case of fire and/or spills.
Hazardous cargo		
All hazardous cargo	Yes	Air emissions in case of fire or spills.

** "Air emissions" are not limited to CACs and GHGs, but refer to air emissions in general.*

CACs are the primary pollutants from combustion engines. CACs include oxides of nitrogen (NO_X), SO_2, CO, and particulates, which include both visible (smoke) and non-visible emissions. Air emissions due to Project traffic will lead to an increase in ambient concentrations of CACs during the life of the Project.

Climate change resulting from anthropogenic greenhouse gases (GHGs) is an issue that has been demonstrated by international authorities (IPCC 2007) and recognized by federal and provincial governments (CEA Agency 2003). In general, GHG inventories can be quantified (and reported depending on the size of the Project) for activities such as traffic, and steps can also be taken to mitigate GHG emissions, as will be discussed further in Section 5.7.3.

5.7.2.2 Valued Component Scoping

Project traffic will emit GHGs and CACs during all phases of the Project, affecting both air quality and climate. Traffic accidents may also contribute to effects on air quality and climate if the accidents cause fires or large spills (e.g., chemical reagent spills, burned fuel containers). For these reasons, both climate and air quality were selected as VCs for this risk assessment.

The climate and air quality VCs, and the rationales for their inclusion or exclusion in the assessment are presented in Table 5.7-4. The party who identified each potential VC is also referenced in the table: Aboriginal groups (AG); government (G); public/stakeholder (P/S); or other (O) (e.g., legislation, technical expertise).

Table 5.7-4. Identification and Rationale for Climate and Air Quality Valued Component Selection/Exclusion

	Identified by[1]				Selected for…[2]		
VC	AG	G	P/S	O	… Project Traffic?	…Traffic Accidents?	Rationale for Selection/Exclusion
Climate	-	X	X	X	Yes	Yes	GHGs from vehicle exhaust contribute to total atmospheric GHGs during operation; therefore, effects may contribute to climate change.
Air Quality	X	X	X	X	Yes	Yes	Air emissions from vehicle exhaust will increase air pollutant concentrations in ambient air during operation. Air contaminants may be emitted in the event of a traffic accident resulting in fire and/or spills from traffic accidents.

[1] "X" indicates that the corresponding group (AG = Aboriginal Group, G = Government, P/S = Public/Stakeholder, or O = Other) has identified the VC as an issue; "-" indicates that the group did not identify the VC as an issue.
[2] "Yes" indicates that the VC is selected for further analysis; "No" indicates that the VC is excluded from further analysis.

5.7.2.3 Potential Traffic/Valued Component Interactions

Potential interactions between traffic types identified in Table 5.7-3 and VCs identified in Table 5.7-4 are identified in Table 5.7-5. All traffic types are expected to interact with both climate and air quality.

Table 5.7-5. Potential Traffic / Climate and Air Quality Valued Component Interaction Matrix

	VCs	
Traffic Type	**Climate**	**Air Quality**
Project traffic		
All traffic	X	X
Traffic accidents: on-road		
All traffic	X	X
Traffic accidents: off-road		
All traffic	X	X

"X" indicates that a potential interaction has been identified.
"-" indicates that no potential interaction was identified.

5.7.3 Risk Analysis

This assessment evaluates climate and air quality concerns and risks associated with Project traffic-related air emissions resulting from Project operation, as well as traffic accidents.

5.7.3.1 Climate and Air Quality

Risk Identification

Potential effects on climate and air quality VCs will exist during all Project phases. However, the magnitude of climate and air quality effects will be different for each phase because Project traffic volumes will change over time.

Traffic accidents may contribute to climate and air quality effects if flammable cargo or fuel tanks are ignited. For example, an accident involving a fuel truck could cause a fire which results in concentrated, short-term air emissions.

Table 5.7-6 describes the definitions in risk assessment matrices related to climate and air quality.

Table 5.7-6. Climate and Air Quality Risk Assessment Severity Scale Descriptors

Descriptor	Definition
Negligible	No detectable change in ambient concentrations from the baseline conditions.
Minor	Ambient concentrations differ from the baseline conditions to a small degree, but are within the range of natural variation and well below a guideline or threshold value.
Moderate	Ambient concentrations differ from the baseline conditions and approach the limits of natural variation, but are below or equal to a guideline or threshold value.
Major	Ambient concentrations differ from baseline conditions beyond the range of natural variation, resulting in a measurable change beyond a guideline or threshold value..
Catastrophic	Ambient concentrations differ substantially from the baseline conditions beyond the range of natural variation, resulting in a measurable change that goes well beyond a guideline or threshold value.

Air Quality

CACs are the primary pollutants from combustion engines. They include NO_X, SO_2, CO, and particulates, which include both visible (smoke) and non-visible emissions. NO_X formation relates directly to high pressures and temperatures during the combustion process, while sulphur compound formation—mainly in the form of SO_2—relates to the sulphur content of fuel.

Other pollutants, such as CO and smoke, are primarily the result of incomplete combustion in engines. Regarding particulate matter, PM_{10} and $PM_{2.5}$ are considered, in particular $PM_{2.5}$, which has been identified as a potential health risk in BC due to its small size, potential lung penetration ability and association with cancer and respiratory health issues (potential effects on human health are discussed in Section 5.8).

Potential risks to air quality associated with traffic accidents are the same, whether the accident results in the vehicle remaining on the road or travels off-road. Small traffic accidents, which do not involve fires or spills, do not have any potential risks to air quality. On the other hand, larger accidents that result in fires or spills may contribute to effects on air quality, with the effects varying with the severity of an accident. The type, likelihood, and severity of effects are defined in Table 5.7-8.

It is assumed that the potential risk of accidents involving vehicles with non-hazardous cargo (i.e., personnel and supplies) is limited to regular vehicle fuel tanks, and is therefore considered a negligible risk to air quality. Traffic accidents will contribute to effects on air quality only if the accident is large and/or vehicles are carrying hazardous cargo which may be lead to a major chemical spill or fire.

Climate

During operation, any kind of vehicle that emits GHGs has potential to interact with the Climate VC. GHGs from engine fossil fuel combustion include primarily CO_2, as well as N_2O and methane (CH_4). GHGs are measured and reported in carbon dioxide equivalents, CO_2e. These GHGs contribute to the greenhouse gas effect; as their atmospheric concentration levels increase, climate changes. Therefore, GHG emissions from Project vehicles have the potential to contribute to climate change (see Table 5.7-7). Estimated Project-related GHGs will be characterized qualitatively and compared to annual industrial and provincial totals in the Project's Application/EIS.

The contribution of GHG emissions as a result of traffic accidents depends on the accident type; therefore, traffic accidents have also been identified as a potential risk for climate. As described above for air quality, there is no difference between "on-road" and "off-road" accidents, and it is assumed that the potential risks of accidents involving vehicles with non-hazardous cargo are considered negligible. Table 5.7-8 describes the potential risks to climate associated traffic accidents.

Risk Mitigation

Since the risks of the Project's contribution to climate change, and potential contribution to a reduction in ambient air quality, arise from the air emissions associated with fuel combustion, mitigation measures will focus on vehicle fuel efficiency, fuel type and fuel consumption.

Air emissions cannot be eliminated from Project traffic activities, since most vehicles will likely have to use fossil-fuel-based engines. However, in addition to the expected emission reductions from technology improvements over the Project lifespan, emissions will be minimized using the following mitigation measures:

- switching fuel to more efficient blends to reduce GHGs;
- optimizing the vehicle load rates to minimize the number of trips;

- following procedures and schedules provided by the vehicle manufacturers to increase fuel efficiency;
- having fleets with newer engines;
- minimizing idling; and
- ensuring diesel vehicles use low sulphur content fuel as required by law.

Many of the above emission reducing measures will lead to fuel conservation and a reduction in GHGs, and ultimately result in cost savings for the Project. Fuel standards, regulations and best practices to mitigate tail pipe emissions from the transport sector are likely to evolve during the Project lifetime. For instance, the BC Climate Action Plan seeks to achieve targets such as overall provincial GHG reductions of 33% by 2020 compared to 2007 levels (BC Government 2008), and there are new national GHG emission regulations for the transport sector under the provisions of the *Canadian Environmental Protection Act* (1999) that are slated to come into effect in 2014. Aside from promoting the voluntary mitigation measures such as the ones listed above, the Project proponent will ensure that traffic emissions will comply with new legislation and codes of practice as they are introduced.

Risk Characterization

Air Quality

Even after mitigation, Project traffic will contribute to emissions of CACs regularly during the Project. The maximum contribution of emissions is expected to occur during the operation phase and along the northern segment of Highway 37, where the maximum traffic volume increase is expected.

A detailed quantification of potential Project effects on air quality requires computer modelling that considers vehicle and engine types, fuel types and consumption, etc. This type of assessment will be included in the Application/EIS. However, vehicle emissions along roads can be roughly correlated to traffic volumes. Given baseline levels of CACs and the level of expected traffic increase, CACs contribution to ambient air quality is expected to remain well below BC air quality objectives and standards. Background concentrations of CACs were approximately ten times below the maximum desirable concentrations for all CACs. The annual average background concentration of SO_2 was estimated at 2.0 $\mu g/m^3$, while the 2009 Air Quality Objectives and Standards for British Columbia and Canada state the desirable maximum annual arithmetic mean for sulphur dioxide is 30 $\mu g/m^3$ (Government of BC 2009b). Background annual average concentration of NO_2 was estimated at 5.0 $\mu g/m^3$, while BC air quality objectives state that 60.0 $\mu g/m^3$ the desirable maximum annual arithmetic mean. While the likelihood of emissions from Project operation is certain, the severity of the effect is considered to be minor. For Project-related vehicle accidents, the likelihood is considered rare and the severity is negligible to minor depending on the type of cargo (Table 5.7-7). Traffic accidents that do not involve fires or large spills will not contribute to effects on air quality. Predicted increases in total traffic accidents as a result of the Project are expected to be very low, as outlined in Section 2.5, and the probability of an accident resulting in a spill or fire is even lower. Accordingly, the likelihood of traffic accidents resulting in a situation that affects ambient air quality is rare and severity is negligible to minor depending on the cargo being transported (Table 5.7-8).

Climate

Project traffic emissions from combustion engines will contribute to GHG emissions. Levels of GHGs resulting from the Project will vary from phase to phase as traffic volumes change. When comparing historical traffic volumes in the Study Area and the estimated Project traffic, the contribution of the Project will be minor in terms of climate (see Section 2.3).

Table 5.7-7. Climate and Air Quality Risk Assessment Matrix for Traffic Accidents

VC	Traffic Type	Description of Potential Risk (pre-mitigation)	Project Phase	Description of Mitigation Measures	Post-mitigation		
					Likelihood	Severity	Description of Consequence of Realized Risk
Climate	Personnel	Increase in GHG emissions from fuel combustion	All phases	Take preventive measures to reduce risk of fire. In the event of an accident, follow emergency response procedures to mitigate fires and other sources of GHG emissions	Rare	Negligible	Contribution to climate change risk
	Materials, equipment, and supplies	Increase in GHG emissions from fuel combustion	All phases	Take preventive measures to reduce risk of fire. In the event of an accident, follow emergency response procedures to mitigate fires and other sources of GHG emissions	Rare	Negligible	Contribution to climate change risk
	Diesel fuel and lubricants	Increase in GHG emissions from fuel combustion	All phases	Take preventive measures to reduce risk of fire. In the event of an accident, follow emergency response procedures to mitigate fires and other sources of GHG emissions	Rare	Minor	Contribution to climate change risk
	Concentrates	Increase in GHG emissions from fuel combustion	All phases	Take preventive measures to reduce risk of fire. In the event of an accident, follow emergency response procedures to mitigate fires and other sources of GHG emissions	Rare	Negligible	Contribution to climate change risk
	Lime and reagents	Increase in GHG emissions from fuel combustion	All phases	Take preventive measures to reduce risk of fire. In the event of an accident, follow emergency response procedures to mitigate fires and other sources of GHG emissions	Rare	Minor	Contribution to climate change risk
	Explosives	Increase in GHG emissions from fuel combustion	All phases	Take preventive measures to reduce risk of fire. In the event of an accident, follow emergency response procedures to mitigate fires and other sources of GHG emissions	Rare	Minor	Contribution to climate change risk
Air Quality	Personnel	Increase in air contaminant emissions from fuel combustion	All phases	Take preventive measures to reduce risk of fire. In the event of an accident, follow emergency response procedures to mitigate fires and other potential vapourization from spills	Rare	Negligible	Contribution to air contaminant emissions and reduction of ambient air quality
	Materials, equipment, and supplies	Increase in air contaminant emissions from fuel combustion	All phases	Take preventive measures to reduce risk of fire. In the event of an accident, follow emergency response procedures to mitigate fires and other potential vapourization from spills	Rare	Negligible	Contribution to air contaminant emissions and reduction of ambient air quality
	Diesel fuel and lubricants	Increase in air contaminant emissions from fuel combustion	All phases	Take preventive measures to reduce risk of fire. In the event of an accident, follow emergency response procedures to mitigate fires and other potential vapourization from spills	Rare	Minor	Contribution to air contaminant emissions and reduction of ambient air quality
	Concentrates	Increase in air contaminant emissions from fuel combustion	All phases	Take preventive measures to reduce risk of fire. In the event of an accident, follow emergency response procedures to mitigate fires and other potential vapourization from spills	Rare	Negligible	Contribution to air contaminant emissions and reduction of ambient air quality
	Lime and reagents	Increase in air contaminant emissions from fuel combustion	All phases	Take preventive measures to reduce risk of fire. In the event of an accident, follow emergency response procedures to mitigate fires and other potential vapourization from spills	Rare	Minor	Contribution to air contaminant emissions and reduction of ambient air quality
	Explosives	Increase in air contaminant emissions from fuel combustion	All phases	Stay up to date for all regulatory acts used to transport explosives. Vehicles outlined in the act must have explosives vehicle certificate	Rare	Minor	Contribution to air contaminant emissions and reduction of ambient air quality

Table 5.7-8. Climate and Air Quality Risk Assessment Matrix for Project Traffic

VC	Traffic Type	Description of Potential Risk (pre-mitigation)	Project Phase	Description of Mitigation Measures	Post-mitigation		
					Likelihood	Severity	Description of Consequence of Realized Risk
Climate	All traffic types	Increase in GHG emissions from fuel combustion	All phases	Use well maintained vehicles to optimize combustion; use hybrid or electric vehicles.	Certain	Minor	Contribution to climate change risk
Air Quality	All traffic types	Increase in air contaminant emissions from fuel combustion	All phases	Use well maintained vehicles to optimize combustion; use low sulphur content fuel for diesel vehicles or use biodiesel; use hybrid or electric vehicles.	Certain	Minor	Contribution to air contaminant emissions and reduction of ambient air quality

Similar to air quality, traffic accidents that do not involve fire or large spills will not contribute to effects on climate, as these will not involve combustion related emissions to the atmosphere. In the event of large accidents, such as fuel truck fires, air emissions will be released immediately. Since the duration of such incidents would be short and the frequency rare, the possibility of incremental effects to identified VCs is low.

Mitigation measures previously described will reduce the risks to climate from Project traffic, but the risks cannot be eliminated fully as Project vehicles will likely be dependent on fossil fuel combustion. Nevertheless, overall effects to climate are classified as minor for Project activities and minor or negligible for traffic accidents (Tables 5.7-7 and 5.7-8).

5.8 HUMAN HEALTH

5.8.1 Baseline Data Overview

This section assesses the human health risks due to Project traffic and traffic accidents. Potential risks to country foods, drinking water, air quality, and human safety are considered.

The human health traffic effects assessment considers the communities and settlements in the traffic Study Area (Figure 5.1-1). The settlements include Bob Quinn Lake (just north of the Eskay Creek Mine access road junction), Bell II, Meziadin Junction, and the villages of Gitanyow and Kitwanga. A 500 m buffer on either side of the highways was included to encompass any land use activities, such as trap lines and other economic activities that could potentially be affected by Project traffic on the transport routes.

Aboriginal people are the predominant residents of most of the smaller communities near the Study Area, including the Tahltan Nation communities of Iskut and Telegraph Creek. Other Aboriginal groups include the Nisga'a Nation, Skii km Lax Ha, Gitanyow First Nation, and Gitxsan Nation. Aboriginal groups in the region practice subsistence activities such as fishing, hunting, trapping, and gathering, which are important to maintaining culture. A more detailed description of subsistence activities can be found in the *KSM Project: 2012 Economic Baseline Report* (Rescan 2012a).

Bob Quinn Lake and Bell II are generally classified as tourist destinations and facilities, and are significantly smaller than the other communities in the region. Most businesses are based on seasonal outdoor activities including fishing, hunting, hiking, backcountry skiing, heli-skiing and snowmobiling. Tourism activities focus on wilderness opportunities and draw tourists from around the world.

Project traffic will travel through three major watersheds: the Nass River, Skeena River, and North Coast rivers watersheds. The Nass South SRMP Socio-economic Assessment (Pierce Lefebvre Consulting 2008) provides a detailed assessment of country foods harvests by native and non-native residents and tourists in the SRMP area. The Nass South SRMP overlaps the Study Area and therefore provides a reasonable estimate of land use and especially country food use for this study.

Section 5.2 describes the details of the fish and water resources within the Study Area. Commercial fishing is very important to communities surrounding the Nass South SRMP area, especially to Aboriginal groups. The Skeena Native Development Society reports that in 2006, the commercial fishing sector generated employment for 65 people residing in the Nisga'a villages and eight people residing in the Gitanyow/Gitxsan villages (SNDS 2006). The Nass Watershed supports the provincially significant Nass salmon fishery. Meziadin Lake and its major tributaries- Hanna, Tintina and Surprise creeks- account for up to 80% of the total Nass sockeye assessment (DFO 2004). Meziadin Lake is also the main sport-fishing lake in the Nass South SRMP area. It features a number of popular sport fishing species including salmon, whitefish, Dolly Varden, kokanee, rainbow trout, bull trout and steelhead (Pierce Lefebvre Consulting 2008).

The Study Area traverses valuable moose and bear habitat, and Highway 37A's location at elevations below suitable mountain goat habitat provides access to hunters (Section 5.3; Pierce Lefebvre Consulting 2008). Guided hunting by tourists and hunting by Aboriginal groups and BC residents are important components of the local economy.

Non-timber forest products, especially the harvest of wild pine mushrooms is common in the area (Pierce Lefebvre Consulting 2008). The largest northwestern BC pine mushroom harvesting sites are in the Nass River Valley (Kalum District), which includes mushroom harvesting on Nisga'a Lands as well as in the Nass South SRMP area, and the Hazeltons-Kispiox Valley (Kispiox District). Since the NFA was implemented, pine mushroom harvesting on Nisga'a Lands has been monitored through the sale of permits to Nisga'a and non-Nisga'a pine mushroom harvesters. In 2008, the Nisga'a harvested 11,656 kg of mushrooms, which generated over $43,000 in revenue (NLG 2009).

Based on the land uses described above, this report focuses on human health risks to Aboriginal groups, local residents, guide outfitters, anglers, trappers, and recreational land users (e.g., campers, fishers, hunters) as these are the people likely living and travelling along highways 37 and 37A.

5.8.2 Issue Scoping

5.8.2.1 Human Health Scoping

Potential risks to human health are associated with Project traffic and Project-related traffic accidents (Table 5.8-1)

Table 5.8-1. Human Health Scoping Matrix

Traffic Type	Potential Risk? (Yes/No)	Rationale for Selection/Exclusion
Project traffic		
All traffic	Yes	Project traffic may decrease air quality and increase noise potentially causing human health effects.
Traffic accidents		
Personnel and non-hazardous cargo		
All non-hazardous	Yes	Traffic accidents involving vehicles carrying non-hazardous cargo could result in a spill from the vehicle's fuel tank into aquatic and terrestrial environments.
Hazardous cargo		
Diesel fuel and lubricants	Yes	Traffic accidents resulting in diesel spills pose a risk to human health from inhalation of volatiles and ignition/explosion. Combustion particulates are probably carcinogenic to humans (IARC 1998) if exceeding certain limits. Hydrocarbons may bioaccumulate in fish that people consume. Diesel spills could contaminate drinking water.
Concentrates	Yes	Concentrate spills pose risk to human health if not handled properly. Direct human health risks develop when fires from accidents produce dangerous sulphur dioxide fumes; indirect risks develop when metals leach from concentrate and accumulate in aquatic habitat and fish consumed by people. Metals may bioaccumulate in plants if concentrate remains in the terrestrial environment.

(continued)

Table 5.8-1. Human Health Scoping Matrix (completed)

Traffic Type	Potential Risk? (Yes/No)	Rationale for Selection/Exclusion
Lime and reagents	Yes	Spills of lime and reagents are hazardous to human health if not handled properly and can cause problems if in contact with eyes, skin, or inhaled. Spills in aquatic habitat could affect fish.
Explosives	Yes	Spills of ammonium nitrate pose risks to human health if not handled properly. These spills are hazardous in the case of skin or eye contact, ingestion, or inhalation, and slightly hazardous in the case of skin contact as a permeator. Thermal decomposition produces toxic fumes of nitrogen oxides such as: NO, NO_2, N_2O, N_2O_3, etc. This material may explode, and is toxic to aquatic life.

Project traffic may decrease air quality and increase noise potentially causing human health effects. Project traffic is not expected to generate dust because highways 37 and 37A are paved and concentrate will be trucked in covered containers. Human health effects are therefore unlikely to occur as a result of ingestion of berries, mushrooms and medicinal plants from the Study Area or from the ingestion of animals foraging on plants in the Study Area. This risk is not considered further.

On-road and off-road traffic accidents resulting in the discharge of hazardous materials into the receiving environment could potentially affect human health. Traffic accidents involving spillage and/or ignition of hazardous materials could affect human health if not handled properly by trained professionals according to emergency response protocols. People may be exposed to hazardous materials or combustion fumes through accidental skin contact, inhalation or ingestion. If not contained and remediated, diesel spills could enter surface water or groundwater used as drinking water sources by communities For traffic accidents to affect human health via consumption of fish, the accident must occur at a stream crossing or where the highway runs in close proximity to a fish-bearing watercourse used for recreational or subsistence fishing. Off-road spills of hazardous materials into the terrestrial environment may affect human health via the ingestion of berries, mushrooms, and medicinal plants, or via the consumption of the animals that forage on these plants and may bioaccumulate contaminants of concern.

5.8.2.2 Valued Component Scoping

The selected human health VCs and the rationales for their inclusion or exclusion in the assessment are presented in Table 5.8-2. The party who identified each potential VC is also referenced in the table: Aboriginal groups (AG); government (G); public/stakeholder (P/S); or other (O) (e.g., legislation, technical expertise). The VCs include country foods (plants such as berries, medicinal plants, mushrooms; fish; birds such as grouse; and mammals such as hare, moose, deer and bear), noise, air quality, drinking water quality, and human safety. The VCs are relevant to the health of workers (personnel and truck drivers, emergency response teams), and members of the communities of Bell II, Meziadin Junction, Cranberry Junction, Gitanyow and Kitwanga. Country foods are consumed by community members as well as sports fishermen and hunters from outside the local communities. The quality of animal foods (such as moose and fish) can be indirectly affected through bioaccumulation of contaminants in the food chain.

5.8.2.3 Potential Traffic/Valued Component Interactions

The potential interactions between Project traffic along proposed haul routes and the identified VCs are identified in Table 5.8-3. Where there is potential for an interaction between a traffic type and a VC, the potential is identified with an "X". Only traffic types that have been identified to potentially affect one or more VCs will be included in the Risk Analysis (Section 5.8.3).

Table 5.8-2. Identification and Rationale for Human Health Valued Component Selection/Exclusion

VC	Identified by[1]				Selected for…[2]		Rationale for Selection/Exclusion
	AG	G	P/S	O	Project Traffic?	Traffic Accidents?	
Country foods	X	X	X	X	No	Yes	Project traffic will not affect country foods. Traffic accidents may affect plants, fish, birds, and mammals in the Study Area during all Project phases of the Project's life span. Moose, bear, deer and small mammals are identified as culturally important and hunted species for the Nisga'a Nation, Skii km Lax Ha, Tahltan, Gitxsan and Gitanyow. Moose, bear, deer, and small mammals are economically important species to local hunters and guide outfitters.
Noise	X	X	X	X	Yes	No	An increase in truck traffic may result in an increase in noise from engines and friction affecting health of local residents.
Air quality	X	X	X	X	Yes	Yes	An increase in truck traffic may lead to an increase in ambient air quality concentrations of CACs such as carbon monoxide (CO), sulphur dioxide (SO_2), nitrogen dioxides (NO_2), and particulate matter, harmful to human health of local residents. Traffic accidents resulting in vehicle fires may release toxic fumes from diesel, reagents, and concentrate harmful to human health.
Drinking water quality	X	X	X	X	No	Yes	In the event of an accident, large diesel spills could enter surface water or ground water used as drinking water resource by downstream communities if not contained and remediated.
Human safety	X	X	X	X	No	Yes	Traffic accidents may physically impact the driver, personnel, or other highway users.

[1] "X" indicates that the corresponding group (AG = Aboriginal Group, G = Government, P/S = Public/Stakeholder, or O = Other) has identified the VC as an issue; "-" indicates that the group did not identify the VC as an issue.
[2] "Yes" indicates that the VC is selected for further analysis; "No" indicates that the VC is excluded from further analysis.

Table 5.8-3. Potential Traffic / Valued Component Interaction Matrix – Human Health

Traffic Type	VCs						
	Country Foods (plants)	Country Foods (fish)	Country Foods (birds, large and small mammals)	Noise	Air Quality	Drinking Water	Human Safety
Project traffic							
All traffic	-	-	-	X	X	-	-
Traffic accidents: on-road							
All traffic	-	-	-	-	X	-	X
Traffic accidents: off-road							
All non-hazardous cargo	X	X	-	-	X	-	X
Hazardous cargo							
Diesel fuel and lubricants	X	X	X	-	X	X	X
Concentrates	X	X	X	-	X	X	X
Lime and reagents	X	X	X	-	X	X	X
Explosives	-	X	-	-	X	X	X

"X" indicates that a potential interaction has been identified.
"-" indicates that no potential interaction was identified.

5.8.3 Risk Analysis

The effects assessment addresses potential human health issues and risks associated with Project traffic along highways 37 and 37A. It is based on an assessment of VCs identified in Table 5.8-2, and focused on selected plant and wildlife species. Interactions identified in Table 5.8-3 are analysed and assigned a risk severity according to the definitions in Table 5.8-4. The traffic types, their potential risks, mitigation measures and severity are shown in Table 5.8-5 and Table 5.8-6. A more detailed description of the risks and mitigation measures can be found in the sections following.

Table 5.8-4. Human Health Risk Assessment Severity Scale Descriptors

	Definitions			
Descriptor	**Country Foods and Drinking Water**	**Noise**	**Air Quality**	**Safety**
Negligible	No human health effect from consumption of country foods/water	Noise not perceived as elevated above background	No detectable change from baseline conditions. Effect limited to a few individuals.	No harm
Minor	Minor risk of acute toxic effects due to low probability that food/water is contaminated and low consumption rates of food	Noise level elevated, but not disruptive to normal sleep patterns and not interfering with normal conversation	Differs from the average value for baseline conditions to a small degree (e.g., within the range of natural variation and well below a guideline or threshold value. Effect limited to a few individuals up to the local population.	Minor injuries not requiring hospitalization
Moderate	Moderate risk of acute toxic effects due to low probability that food/water is contaminated but higher consumption rates of food	Noise level elevated, but not disruptive to normal sleep patterns during night-time, but interfering with normal conversation during day time	Differs substantially from the average value for baseline conditions and approaches the limits of natural variation, but below or equal to a guideline or threshold value. Effect limited to the local population.	Moderate injuries requiring hospitalization
Major	Major risk of acute toxic effects due to high probability that food/water is contaminated and frequent consumption	Noise level elevated and at frequency that disrupts normal sleep patterns and interferes with normal conversation	Differs substantially from baseline conditions beyond a guideline or threshold value, resulting in a detectable change beyond the range of natural variation. Effect limited to the local population.	Critical injuries requiring hospitalization
Catastrophic	Severe acute and chronic toxic effects from consumption of country foods and water	Temporary and permanent loss of hearing	Differs substantially from baseline conditions beyond a guideline or threshold value, resulting in a detectable change beyond the range of natural variation. Effect extends beyond the local population.	Mortality

5.8.3.1 Country Foods

Risk Identification

Country foods are animals, plants, and fungi used by humans for nutritional and medicinal purposes that are harvested in the wild. The quality of country foods is directly related to the quality of the surrounding environmental media (e.g., soil, water and vegetation).

Hunting and fishing are important components of the local subsistence and tourism economies. The traditional subsistence economy is still strongly evident, and traditional hunting camps are also

widely pursued (Rescan 2012a). Bell II Lodge serves as a base for sports fishing on the Bell-Irving and Upper Nass Rivers (Bell 2 Lodge 2012), while the Tatogga Lake Resort advertises fly-in hunting and fishing (Tatogga Lake Resort 2012).

Contamination of country foods is not predicted to occur during normal Project traffic, but may result from traffic accidents in the event that hazardous materials are spilled into the terrestrial or aquatic environment. Although country foods harvesting data are largely unavailable for the Study Area, it is assumed that the highway is used to access and collect plant foods (berries, mushrooms, medicinal plants) by Nisga'a Nation, First Nations and local residents. Animals such as moose, deer, bear, and some bird species, which are consumed as country foods, will forage at least part of the time in the Study Area and may thus be affected if contaminants are released into the environment. Fish may be affected if contaminants are allowed to enter the aquatic environment.

Petroleum hydrocarbons from diesel and lubricants are very complex mixtures and may enter the aquatic and terrestrial environments during an off-road accident. Most petroleum hydrocarbon constituents present adverse effects through human and environmental toxicity. Lighter hydrocarbons are mobile and migrate considerable distances from their point of release and may enter groundwater resources. Larger and branched-chain hydrocarbons are persistent in the environment. Petroleum hydrocarbons may create problems such as offensive odour, taste or appearance of water and fish. Some fractions of petroleum hydrocarbons may bioaccumulate in aquatic organisms.

Concentrate may spill off-road into the terrestrial and aquatic environment during traffic accidents involving concentrate haul trucks. The toxicological properties of concentrates have not been fully investigated (see Table 2.4-5 in Section 2.4.5 for an analysis of KSM copper concentrate toxicity). The Toxicity Characterization Leaching Procedure –EPA 1311 test was performed by ALS Environmental assess whether metals can leach in the longer term from the copper concentrate after off-road spillage into the aquatic environment under worst case scenario conditions (acidic, aerobic). This test is used in screening level risk assessments for BC contaminated sites. The metal concentrations in the resulting extract were compared to Canadian (CCME) and BC water quality guidelines for the protection of aquatic life to detect exceedances. Leachable antimony, arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, selenium, silver, thallium, vanadium, and zinc concentrations exceeded either the CCME or the BC water quality guidelines, or both. However, environmental conditions of receiving waters are far less acidic than the leach test conditions and the concentrate itself is alkaline. As a result, in the event of a concentrate spill metals will leach into receiving waters at much lower rates and concentrations and will be diluted (the EPA1311 test does not take dilution into account). Direct comparison to CCME Sediment and Soil Quality Guidelines is not possible, since the mass of sediment and/or soil that would be affected by metal-rich leachate from a concentrate spill has not been determined. Spillage into the terrestrial environment is expected to have minimal effects due to implementation of risk mitigation measures and negligible exposure of plants and animals to metals in the concentrate.

Lime and reagents may spill off-road into the terrestrial and aquatic environment during traffic accidents. The effect of reagents on human health through the consumption of country foods depends on the nature of the reagents. Lime will increase the pH in the environment, damage plant tissues and may thereby be harmful to ecological health. Cyanide is acutely toxic to fish and wildlife, but degrades quickly in the environment and does not bioaccumulate or biomagnify in the food chain. Plants and berries may be affected, and collection of plants from an area affected by a spill would have to be avoided in the short term. There is no toxicological health effect to humans through consumption of country foods that have bioaccumulated lime or cyanide, but the amount of fish and plants harvested may be affected negatively. Potential effects of chemical hazards are described in greater detail in Section 6.4.4, Table 6.4-5.

Table 5.8-5. Human Health Risk Assessment Matrix for Project Traffic

VCs	Traffic Type	Description of Potential Risk (pre-mitigation)	Project Phase	Description of Mitigation Measures	Post-mitigation		
					Likelihood	Severity	Description of Consequence of Realized Risk
Traffic Noise	All traffic types	Increase in noise levels due to an increase in project-related traffic, especially from heavy trucks.	All phases	Source mitigation: Enforced speed limits; avoid use of engine brakes and reversing; vehicle maintenance; Receptor mitigation: barriers (e.g., vegetation, berms)	Certain	Minor	Small increase in percentage of highly annoyed receptors
Air Quality	All traffic types	Low ambient air quality because of air emissons to the atmosphere with minor risks to human health	All phases	Enforce speed limits; use well maintained vehicles to optimize combustion, using low sulphur fuel	Certain	Minor	Increase in local ambient air quality concentrations with minor health risks.

Table 5.8-6. Human Health Risk Assessment Matrix for Traffic Accidents

VC	Traffic Type	Description of Potential Risk (pre-mitigation)	Project Phase	Description of Mitigation Measures	Post-mitigation		
					Likelihood	Severity	Description of Consequence of Realized Risk
Country foods - Plants	Diesel fuel and lubricants	Fuel or lubricant spill into terrestrial environment may result in inhibition of plant germination and growth. Plants may take up hydrocarbons and bioaccumulate, metabolize or volatilize HCs thus introducing them into the food chain.	All phases	Use of best management practices to minimize spill entry to the terrestrial environment; Enforced speed limits and traffic safety; Adhere to the Spill Prevention and Emergency Response Plan; Prompt containment and cleanup	Unlikely	Moderate	Localized, moderate effects on consumption of plant species. Refrain from collection of plants from spill area and test plants before resuming collection.
Country foods - Plants	Concentrates	Metals from spilled concentrate may be taken up by plants and subsequently ingested by human harvesters.	Operations	Use of best management practices to minimize spill entry to the terrestrial environment; Enforced speed limits and traffic safety; Adhere to the Spill Prevention and Emergency Response Plan; Prompt containment and cleanup	Unlikely	Minor	Localized, short-term, minor effects on consumption of plant species. Refrain from collection of plants from spill area and test plants before resuming collection.
Country foods - Plants	Lime and reagents	Lime and reagent spills into terrestrial environments result in changes in pH and may result in inhibition of plant germination and growth.	All phases	Use of best management practices to minimize spill entry to the terrestrial environment; Enforced speed limits and traffic safety; Adhere to the Spill Prevention and Emergency Response Plan; Prompt containment and cleanup	Unlikely	Negligible	Localized, short-term, minor effects on consumption of plant species. Refrain from collection of plants from spill area and mitigate recovery.
Country foods - Fish	Diesel fuel and lubricants	Fuel or lubricant spill into waterbody may cause localized or far-reaching effects. Petroleum products are toxic to fish species. Hydrocarbons may bioaccumulate in the food chain.	All phases	Use of best management practices to minimize spill entry to water bodies; Enforced speed limits and traffic safety; Adhere to the Spill Prevention and Emergency Response Plan; Prompt containment and cleanup	Unlikely	Moderate	Localized, short-term, moderate effects on consumption of fish species. Tainting of fish at small concentrations of hydrocarbons possible. Fish should be tested for potential contamination.
Country foods - Fish	Concentrates	Metal concentrate spill into waterbody may be toxic at the point source and exceed water quality guidelines at a distance; smothering of eggs and fish. Some metals may bioaccumulate in the food chain.	Operations	Use of best management practices to minimize spill entry to water bodies; Enforced speed limits and traffic safety; Adhere to the Spill Prevention and Emergency Response Plan; Prompt containment and cleanup; Low moisture concentrate.	Unlikely	Moderate	Moderate effects confined to local area and on a short-term basis, rapid clean-up of concentrates required. Fish should be tested for potential metal contamination.
Country foods - birds, small and large mammals	Diesel fuel and lubricants	Exposure of animals may result from direct contact with spill or from ingesting contaminated plant material via the food chain. Meat for human consumption may become tainted.	All phases	Use of best management practices to minimize spill entry to the terrestrial environment; Enforced speed limits and traffic safety; Adhere to the Spill Prevention and Emergency Response Plan; Prompt containment and cleanup will minimize if not eliminate effects on wildlife and hence human consumption. Large mammals (moose, deer, bear) will be excluded from the spill site if cleanup cannot occur immediately.	Rare	Minor	Minor effect on human consumption of wildlife.
Country foods - birds, small and large mammals	Concentrates	Metals from spilled concentrate may be taken up by plants and subsequently ingested by wildlife. Metals may bioaccumulate in wildlife meat used for human consumption.	Operations	Use of best management practices to minimize spill entry to the terrestrial environment; Enforced speed limits and traffic safety; Adhere to the Spill Prevention and Emergency Response Plan; Prompt containment and cleanup will minimize if not eliminate effects on wildlife. Large mammals (moose, deer, bear) will be excluded from the spill site if cleanup cannot occur immediately.	Rare	Minor	Minor effect on human consumption of wildlife.

(continued)

Table 5.8-6. Human Health Risk Assessment Matrix for Traffic Accidents (completed)

VC	Traffic Type	Description of Potential Risk (pre-mitigation)	Project Phase	Description of Mitigation Measures	Post-mitigation		
					Likelihood	Severity	Description of Consequence of Realized Risk
Country foods - birds, small and large mammals	Lime and reagents	Chemical hazard to wildlife from changes in pH. No bioaccumulation potential.	All phases	Use of best management practices to minimize spill entry to the terrestrial environment; Enforced speed limits and traffic safety; Adhere to the Spill Prevention and Emergency Response Plan; Prompt containment and cleanup will minimize if not eliminate effects on wildlife. Large mammals (moose, bear) will be excluded from the spill site if cleanup cannot occur immediately.	Rare	Negligible	Negligible effect on human consumption of wildlife
Air Quality	All non-hazardous cargo	Poor ambient air quality because of air emissons to the atmosphere, harmful fuel fires emissions	All phases	Initiate emergency response procedure to minimize fire duration (if exists) and spill response procedure to contain the spill therefore minimize vaporization	Rare	Negligible	Increasing local ambient air quality concentrations with negligable risk to human health
Air Quality	All hazardous cargo	Poor ambient air quality because of air emissons to the atmosphere, harmful fuel fire emissions	All phases	Initiate emergency response procedure to minimize fire duration (if exists) and spill response procedure to contain the spill therefore minimize vaporization	Rare	Minor	Increasing local ambient air quality concentrations with overall minor risk to human health
Air Quality	Diesel fuel and lubricants	Poor ambient air quality because of air emissons to the atmosphere, large and harmful diesel fuel fire emissions	All phases	Initiate emergency response procedure to minimize fire duration (if exists) and spill response procedure to contain the spill therefore minimize vaporization	Rare	Moderate	Increasing local ambient air quality concentrations with minor risk to human health. Moderate human health risks realized by emergency reponse teams during diesel spill clean-up and fire response.
Drinking Water Quality	Diesel fuel and lubricants	Fuel or lubricant spill into surface water used for drinking or into the terrestrial environment located above an aquifer used for drinking water may cause localized or far-reaching effects of hydrocarbon contamination of drinking water resources.	All phases	Use of best management practices to minimize spill entry to the terrestrial environment and water bodies; Enforced speed limits and traffic safety; Adhere to the Spill Prevention and Emergency Response Plan; Prompt containment and cleanup.	Unlikely	Moderate	Localized, short-term, moderate effects on drinking water. Water should be tested for potential contamination.
Drinking Water Quality	Concentrates	Metal concentrate spill into waterbody may be toxic at the point source and exceed water quality guidelines at a distance. Spills may interfere with the beneficial use of surface water as drinking water.	Operations	Use of best management practices to minimize spill entry to water bodies; Enforced speed limits and traffic safety; Adhere to the Spill Prevention and Emergency Response Plan; Prompt containment and cleanup; Low moisture concentrate.	Unlikely	Unknown*	Moderate effects confined to local area and on a short-term basis, rapid clean-up of concentrates required. Water should be tested for potential metal contamination before consumption.
Drinking Water Quality	Lime and reagents	Should lime and reagents spill into surface water, the resulting change in pH and water chemistry may affect drinking water quality.	All phases	Use of best management practices to minimize spill entry to water bodies; Enforced speed limits and traffic safety; Adhere to the Spill Prevention and Emergency Response Plan; Prompt containment, neutralization and cleanup.	Unlikely	Minor	Minor, short-term and localized effects on drinking water quality. Rapid clean-up required. Water should be tested before consumption.
Drinking Water Quality	Explosives	Ammonium nitrate spills into waterbodies or onto terrestrial environments may lead to nitrate contamination of surface water or ground water resources used for drinking. Small babies are susceptible to poisoning.	Operations	Use of best management practices to minimize spill entry to water bodies and terrestrial environments; Enforced speed limits and traffic safety; Adhere to the Spill Prevention and Emergency Response Plan; Prompt containment and cleanup.	Unlikely	Moderate	Minor, short-term and localized effects on drinking water quality. Rapid clean-up required. Water should be tested before consumption.
Traffic Victims	All traffic types	Accidents of varying severity leading to injury and death of drivers, personnel, and other highway users	All phases	Enforce speed limits and other traffic rules; Company zero-tolerance policy on alcohol; Adhere to accident first aid, emergency response and other procedures; Highway maintenance	Possible	Catastrophic	Accidents are rare, but may affect human health to a large degree, including death

**See Section 5.8.3.4 for rationale for this rating.*

Explosives are transported as ammonium nitrate and may spill off-road into the terrestrial and aquatic environment during traffic accidents. There are no direct toxicological effects on human health through the consumption of country foods expected from the spillage of ammonium nitrate into the terrestrial or aquatic environment, but the amount of fish harvested may be affected negatively, due to the toxicity of ammonium nitrate to aquatic life.

Risk Mitigation

Prevention of traffic accidents resulting in spills is the best way to reduce the risk of hazardous materials entering the environment. Correct transport procedures for dangerous goods and hazardous materials, following the Dangerous Goods and Hazadardous Materials Management Plan, will assist in ensuring that spills do not occur. Drivers will be TDG, WHMIS (Workplace Hazardous Materials Information System) and CPPI (Canadian Petroleum Products Institute) certified as required.

Enforcement of speed limits and traffic safety rules, regular vehicle inspections, a scheduled maintenance program, and operation of vehicles that meet or exceed Transport Canada's minimum requirements (Transport Canada n.d.) will also prevent traffic accidents resulting in spills.

In the event of an accident, communication devices (VHF radio, satellite phone) and emergency contacts will be readily accessible to drivers. As part of the Emergency Response Plan, procedures for emergency response and occupational first aid will be developed, and workers and contractors will undergo required training. In the unlikely event of a fire, emergency response procedures to minimize fire duration and extent will be initiated promptly.

The Spill Prevention and Emergency Response Plan will be developed and implemented to limit effects on country foods and human health. The Spill Prevention and Emergency Response Plan, for example, will limit the infiltration of leachate from spilled concentrate into the soil environment. In the event of a spill into the aquatic environment, metal concentrations would be monitored in the sediment and water. Exceedance of guidelines will be included in human health and ecological risk assessments, if required

Risk Characterization

The characterization of risk of off-road spillage is based on traffic accident data from 1996 to 2011 (ICBC 2011a, 2011b), as described in Chapter 2.

The risk to water quality or fish is lower than the risk to plants or animals foraging on affected plants. The severity of the risk of spills into the terrestrial environment is mitigated by the assumption that spills can be contained and cleaned up quickly and effectively and that long-term contamination of plants is therefore unlikely. Spillage into the aquatic environment is unlikely, but the severity of residual risks will depend on effective containment and clean-up.

5.8.3.2 Noise

Risk Identification

Noise has the potential to induce adverse human health effects. There is a potential for frequent night-time traffic to produce sleep disturbance, and the increase in daytime traffic noise may be perceived as an annoyance.

Highway traffic due to Project activities will occur 24 hours a day, although some suppliers may prefer daytime deliveries. It is assumed for the assessment of human health effects from traffic noise that

traffic predominantly occurs during the day (7 a.m. to 10 p.m.), but that 25-30% of traffic will occur between 10 p.m. and 7 a.m.

The percent highly annoyed (% HA) endpoint is recommended by Health Canada to assess potential human health effects from an increase in noise. High annoyance (HA), which can be measured in community surveys or modelled, is an indicator of CWB. An increase in % HA of 6.5% is deemed acceptable (Health Canada 2011). Table 5.8-7 provides a summary of sound levels and calculated impact from Project traffic following Health Canada guidance on calculating the change in % HA.

Table 5.8-7. Predicted and Adjusted Sound Levels for Baseline and Project Traffic Noise and Calculated Impact from Project Traffic on Percentage Change in High Annoyance

	Adjusted Baseline L_{eq}[1] (dBA)[2] for 24 Hour Average	Adjusted Baseline L_{dn}[3] (dBA)	% HA Baseline	Adjusted Project L_{eq}[1] (dBA)[2] for 24 Hour Average	Adjusted Project L_{dn}[3] (dBA)	% HA Operation	% HA Project - % HA Baseline	Exceeds 6.5% Increase in % HA (Y/N)
Northern Section								
AADT	47	59.7	7.4	50	60.5	8.2	0.8	N
SADT	49	61.7	9.5	52	62.5	10.5	1.0	N
Southern Section								
AADT	58	70.7	25.6	59	70.9	26.2	0.6	N
SADT	59	71.7	28.2	60	72	28.8	0.6	N

[1] L_{eq} *Equivalent continuous sounds level*
[2] *dBA A-weighted decibels, A-weighting refers to weighting of the frequencies in a sound that approximates the response of the human ear to frequencies in moderately loud sounds (sound pressure levels in the range of 45 to 65 dBA).*
[3] L_{dn} *Day-night sound level*

Baseline daytime noise levels are assumed to be equivalent to night-time noise levels. It was further assumed that the night-time Project noise level would be similar to the night-time baseline noise level, because Project traffic is expected during night-time hours. Because noise predictions were made based on traffic during the operation phase, the predicted changes in % HA is a conservative, worst case estimate. The resulting change in % HA was less than or equal to 1% for AADT and SADT for both the northern and southern sections. The lower number for SADT accounts for the fact that the SADT baseline noise levels are generally higher than the estimated AADT baseline noise level. The predicted change in % HA is below the recommended maximum of 6.5% for AADT and SADT.

For individual noise events during the night, the WHO guideline (1999)recommends that indoor sound pressure levels should not exceed 45 dBA more than 10 to 15 times per night. Health Canada (2011) draft guidance states that an increase in the percentage of awakenings is not expected to occur at indoor sound exposure levels of 55 to 60 dBA with house windows either partially or fully closed during the night.

Risk Mitigation

Risk mitigation for traffic noise can include measures at the source as well as measures at the receptor. Source risk mitigation will include: reducing speeds to 50 km/h in residential areas; avoiding the use of engine brakes in residential areas; adhering to a truck maintenance program; and avoiding reversing (use of reverse-alarm) in residential areas. Mitigation on the part of the receptor is beyond the scope of Seabridge to address.

Risk Characterization

Human health risks due to the minor predicted increase in traffic noise are expected to be negligible in the context of daytime activities and normal sleep patterns.

5.8.3.3 Air Quality

Risk Identification

Air contaminants are an important factor to consider for human health in this study. Air emissions due to normal Project traffic during all phases of the proposed Project's operating life may lead to an increase in ambient air quality concentrations of CACs such as CO, SO_2, NO_2, and suspended particulate matters (Section 5.7). In addition, traffic accidents leading to fires of hydrocarbon fuel and other materials may release gases and particulates harmful to human health in the short-term.

Concentrates are unlikely to be released during normal traffic as vehicles will be covered. Accidental releases of dust during traffic accidents may have a small effect on human health. The toxicological properties of leachable components of Project copper concentrates have been investigated, but this data does not inform on the specifics on the effects of concentrate dust; however, the Highland Valley Copper project has a Materials Safety Datasheet (MSDS) for concentrate issued by Teck Metals Ltd. The information contained in the MSDS is based on information in the technical and scientific literature about the material's constituent components (Teck 2010). It concludes that concentrate dust is an irritant through inhalation and ingestion, but is not readily absorbed within the body. Also, if set fire in as a result of an accident, concentrate can burn and release copper oxide fumes, as well as toxic SO_2 gas.

Diesel and lubricants will not be released to the air; however, combustion products and particulate matter from diesel combustion will increase. During traffic accidents, small or large volumes of diesel may be released from truck fuel tanks or diesel fuel trucks, respectively. The light-weight molecules of diesel and lubricants are highly volatile and the inhalation of vapours can be harmful to human health. Excessive exposure can cause irritation to the nose, throat, lungs, and respiratory tract and effects to the central nervous system. Vapours can also ignite rapidly and release dangerous fumes containing CO and particulate matter (PM). PM can be inhaled at sizes smaller than 10 µm, and $PM_{2.5}$ is recognized as having the largest health risks due to deeper lung penetration (Liu 2004). $PM_{2.5}$ has been identified by the BC Lung Association as the air emission of the most concern from a human health perspective (BC MOE 2007), and linked to health problems such as respiratory diseases and lung cancer (BC Air Smart 2010). A health threat can also occur from aspiration (breathing into the lungs) of liquid droplets of diesel. Aspiration may result in chemical pneumonia (fluid in the lungs), severe lung damage, respiratory failure, and even death. Diesel has been characterized as a possible carcinogen after prolonged exposure. A short occasional exposure to diesel will not normally cause any long-term health effects.

Risk Mitigation

Risks to human health from increases in air emissions from normal traffic will be minimized by enforcing speed limits and operating well maintained vehicles powered by low sulphur fuel to optimize combustion. Further mitigation measures can be found in Section 5.7. In the event of traffic accidents, emergency response procedures to prevent fires or minimize fire duration and extent will be initiated promptly. Responsible personnel will be trained in spill response procedures to contain the spill, thereby minimizing vaporization or evolution of concentrate dust. Personnel will also be trained in safety and personal protection procedures to avoid contact with spilled material. Potentially affected residents will be informed of a spill, and access to the spill site will be restricted in consultation with regulators. These actions will largely eliminate health risks from inhaling dust, vapours or combustion fumes.

Risk Characterization

The contribution of Project traffic to air quality is unavoidable because all vehicles will require fuel combustion engines. However as described in Section 5.7, given baseline levels of CACs and the level of expected traffic increase, CAC contribution to ambient air quality is expected to remain well bell below BC air quality objectives and standards. This conclusion will be quantified by the detailed dispersion study that will be presented in the Application/EIS, where the modelling domain will be extended to include a sufficient part of Highway 37 (i.e., the section between Bowser Lake and the Highway 37/Eskay Creek access road intersection) for the assessment of Project air emissions.

Traffic accidents that do not involve fires or large spills will not contribute to the effects on air quality and human health because they will not involve combustion-related emissions or dust releases to the atmosphere. In the event of large accidents, such as fuel truck fires or concentrate spills, air emissions will be released immediately. Since the duration of such incidents would be short and localized, and since spill response procedures would be implemented, the probability of adverse effects is rare.

5.8.3.4 Drinking Water Quality

Risk Identification

Local communities mostly rely on well water for their drinking water needs (BC MOE 2012). For any health effects to occur from the consumption of drinking water, contaminants need to infiltrate a groundwater aquifer used as a source for drinking water. Highly soluble (e.g., ammonium nitrate) and mobile (e.g., ammonium nitrate and light diesel/lubricant fractions) substances could come in contact with groundwater aquifers used for drinking water in the event of an accident. Metals leached from spilled concentrates, hydrocarbons, and nitrates can be harmful to human health if not mitigated and if ingested at sufficiently high concentrations.

The aforementioned EPA 1311 test for copper concentrate toxicity (see Section 2.4.5) provided data on metal concentrations in the resulting leachate that were compared to Canadian Drinking Water Guidelines to detect exceedances. Acid-leachable antimony, arsenic, barium, cadmium, chromium, iron, lead, and selenium exceeded the Canadian Drinking Water Guidelines (BC MOE 2006)(Table 2.4-5). However, environmental conditions are unlikely to be as acidic as tested with the EPA 1311 test, and the pH of the copper concentrate itself is alkaline. As a result, lower concentrations of metals will leach into receiving waters should a spill occur. In addition, the EPA 1311 test does not take dilution into account.

Lime spills may result in an increase of local pH above the Drinking Water Guideline of 6.5 to 8.5 (Health Canada 2011) but has no long-term toxic effects. Potential effects of chemical hazards are described in greater detail in Table 6.4-5, Section 6.4.4.

Risk Mitigation

BMPs will be used to minimize spill contact with waterbodies or the terrestrial environment. This will include regular truck inspections, a scheduled maintenance program, and operation of trucks that meet or exceed Transport Canada's minimum requirements (Transport Canada n.d.). Drivers and personnel will receive training and industry-related education and conduct monthly safety meetings in order to handle challenges effectively. Drivers will be TDG, WHMIS and CPPI-certified as required. Speed limits and traffic safety rules will be enforced. Communication devices (VHF radio, satellite phone) and emergency contacts will be readily accessible to drivers. The Spill Prevention and Emergency Response Plan will be developed and implemented to limit effects on drinking water and human health. Water quality will be monitored in the event that a spill enters the aquatic environment.

Risk Characterization

Human health effects from the ingestion of contaminated drinking water are unlikely. This assessment is based on the low number of historic and predicted traffic accidents (as described in Chapter 2) and the commitment to BMPs in spill management planning. Immediate clean-up of spills will prevent hazardous materials from entering local drinking water sources. However, to determine the severity of risks from a concentrate spill into surface water, metal concentrations in a test leachate will be incorporated into the risk assessment for Human Health in the EA document.

5.8.3.5 Human Safety

Risk Identification

Vehicle collisions may result in immediate human health effects (i.e., injury or fatality). Historical police accident reports for highways 37 and 37A (Chapter 3) distinguish between accidents resulting in injury or fatality, and accidents resulting in PDO; however, accidents causing either injuries or fatalities are not further distinguished. Thus, the severity of health risks to a person is difficult to assess. Between 1996 and 2011, 119 severe accidents were recorded on Highway 37 between Bob Quinn Camp and Kitwanga (an average of 7.4 severe accidents per year) and 12 severe accidents for Highway 37A between Stewart and Meziadin (an average of 0.75 accidents per year). Of the total number of severe accidents, there were 23 involving commercial vehicles (average 1.4 per year) on Highway 37, and 3 involving commercial vehicles (average 0.2 per year) on Highway 37A. Police data do not indicate whether injuries or fatalities were incurred among pedestrians or cyclists. ICBC data, which are incomplete and can therefore not be cross-referenced with police data, indicate no injuries or fatalities among cyclists or pedestrians for the accidents they recorded on highways 37 and 37A.

Risk Mitigation

Speed limits and other traffic rules will be strictly enforced. All contractors and workers are required to adhere to the BC Occupational Health and Safety Regulation (BC Reg 296/97), as well as a zero-tolerance policy on alcohol and drugs. Procedures for emergency response and occupational first aid will be developed, and workers and contractors will undergo required training. Information on weather and highway conditions as well as communication devices (VHF radio, satellite telephone) will be made available to all drivers before departure.

Risk Characterization

Historically, an annual average of 1.4 and 0.2 severe collisions (resulting in injury or fatality) per year occurred on highways 37 and 37A, respectively. Accident statistics show a downward trend between 1996 and 2011. A minor increase in the *predicted* number of severe collisions per year is expected during operation on the northern segment of Highway 37, and a negligible increase in severe collisions is predicted for the south segment of Highway 37 and on Highway 37A. Construction, closure and post-closure phases of the Project will not negatively affect human health due to severe collisions. Human health risks from accidents cannot be eliminated, but while the number of accidents may increase slightly during the operation phase, the severity of injury cannot be determined from the available data.

5.9 HERITAGE

5.9.1 Baseline Data Overview

The heritage effects assessment focuses on the first 200 m area on either side of the highways in the Study Area (Figure 5.1-1). A search of the BC Archaeology Branch's Remote Access to Archaeological Data (RAAD) application, and a review of pertinent maps and reports, were conducted to identify protected

archaeological sites within this range in the Study Area. The results of this search are presented in Table 5.9-1. According to RAAD, no archaeological sites have been recorded within 200m of Highway 37A.

Table 5.9-1. Archaeological Sites within 200 Metres of Highway 37

Borden Number	Distance to Highway 37 (m)	Site Type	Site Location
GhTa-1	200	Village site	Near Gitanyow
GhTa-3	143	Historic mill	Near Gitanyow
GhTa-5	176	Culturally Modified Trees (CMTs)	Near Gitanyow
GiTa-4	216	Cultural depressions, CMTs	Near Gitanyow
GiTa-5	182	Historic camp, CMTs	Near Gitanyow
GiTa-6	137	Cultural depressions, CMTs	Near Gitanyow
GiTa-7	78	Subsurface lithics	Near Gitanyow
GiTa-8	78	Subsurface lithics	Near Gitanyow
GjTb-1	14	Grave site	Near Cranberry River
GjTd-1	113	Cabin, trail	Near Cranberry Junction
GkTf-1	200	Village site	Near Van Dyke Camp
GkTf-2	126	Grave site, CMTs, arbourglyph	Near Van Dyke Camp
GkTf-3	185	Historic cache	Near Van Dyke Camp
GlTg-1	120	Cultural depressions	Near Meziadin Lake
HbTh-1	27	Grave site, CMTs	Near Bell I bridge
HeTk-1	200	Surface and subsurface lithics	Near Bell II
HeTk-3	95	Bell Irving Telegraph Cabin	Near Bell II
HeTl-2	42	Snowbank Creek Telegraph Cabin	Near Bell II
HfTm-1	198	Subsurface lithics	Near Bob Quinn
HfTm-2	14	Subsurface lithics	Near Bob Quinn
HfTm-3	5	Subsurface lithics	Near Bob Quinn
HfTm-4	155	Trail, CMT	Near Bob Quinn
HfTn-1	58	Echo Lake Telegraph Cabin	Near Bob Quinn

The 23 archaeological sites described in Table 5.9-1 are all those sites that are presently recorded in the assessment area. There may be additional sites that have not yet been recorded. In addition to the 23 archaeological sites, three Aboriginal and/or historically documented trails may run within 200 m of portions of highways 37 and 37A. The routes of the Kitwancool Grease Trail, the Stikine Trail and the Yukon Telegraph Trail paralleled some of the segments of Highway 37 under consideration in this study. However, in general, the trails themselves have not been recently ground-truthed, and their current condition is not well documented.

5.9.2 Issue Scoping

5.9.2.1 Heritage Scoping

Normal Project traffic is rated as posing no risk to archaeological sites, as it would not be expected to result in substantial off-highway disturbance to ground and vegetation. Even if an off-road forest fire or a serious accident or spill (involving hazardous materials resulting in emergency remediation) were to occur, the likelihood of such an event affecting one of the 23 known sites in the assessment area is

assessed to be low to nil, as the majority of those sites are small, and 18 of them are greater than 50 m from the highway (Table 5.9-2).

Table 5.9-2. Heritage Scoping Matrix

Traffic Type	Potential Risk? (Yes/No)	Rationale for Selection/Exclusion
Project traffic		
All traffic	No	Project activity confined to highway.
Traffic accidents		
All traffic	Yes	Potential risk for off-road disturbance to ground and vegetation.

5.9.2.2 Valued Component Scoping

This assessment considers archaeological sites protected by the BC *Heritage Conservation Act* as a VC (Table 5.9-3). The party who identified each potential VC is also referenced in the table: Aboriginal groups (AG); government (G); public/stakeholder (P/S); or other (O) (e.g., legislation, technical expertise).

Table 5.9-3. Identification and Rationale for Heritage Valued Component Selection/Exclusion

VC	Identified by[1]				Selected for…[2]		Rationale for Selection/Exclusion
	AG	G	P/S	O	Normal Project Traffic?	Traffic Accidents?	
Archaeological sites		X			No	Yes	Sites are legally protected. Potential effects from an off-road vehicle accident.

[1] *"X" indicates that the corresponding group (AG = Aboriginal Group, G = Government, P/S = Public/Stakeholder, or = Other) has identified the VC as an issue; "-" indicates that the group did not identify the VC as an issue.*
[2] *"Yes" indicates that the VC is selected for further analysis; "No" indicates that the VC is excluded from further analysis.*

5.9.2.3 Potential Traffic/Valued Component Interactions

Potential interactions between traffic accidents along proposed routes and archaeological sites are summarized in Table 5.9-4. Scenarios that could pose a potential risk to archaeological sites are off-highway incidents such as a hazardous materials accident or a spill that results in emergency remediation of contaminated soils or a forest fire along the highway.

Table 5.9-4. Potential Traffic/Heritage Valued Component Interaction Matrix

Traffic Type	VCs
	Archaeological Site Condition
Project traffic	
All traffic	-
Traffic accidents: on-road	
All traffic	-
Traffic accidents: off-road	
All traffic	X

"X" indicates that a potential interaction has been identified.
"-" indicates that no potential interaction was identified.

5.9.3 Risk Analysis

This section analyses the risks associated with Project traffic on archaeological sites. Interactions identified in Table 5.9-3 are analysed and assigned a risk severity according to the definitions in Table 5.9-5. The traffic types, their potential risks, mitigation measures and severity are shown in Table 5.9-6.

Table 5.9-5. Heritage Risk Assessment Severity Scale Descriptors

Descriptor	Definition
Negligible	No disturbance to the integrity of the site.
Minor	Small-scale disturbance to the site (<5% disturbance of site area).
Moderate	Moderate-scale disturbance to the site (6-20% disturbance of site area).
Major	Large-scale disturbance to the site (20-50% disturbance of site area).
Catastrophic	Total or near total disturbance of the site (>50% disturbance of site area).

Risk Identification

Scenarios that could pose a potential risk to archaeological and heritage sites are off-road incidents that result in disturbance to ground or vegetation. Examples of such events could include a hazardous materials accident or a spill that results in emergency remediation of contaminated soils. The likelihood of such an event affecting one of the 23 known sites and three trails in the assessment area is low, as these sites represent very small portions of the assessment area and the majority of the sites are greater than 50 m from the highway.

5.9.3.1 Chemical Contamination

Risk Mitigation

Preventing the introduction of hazardous substances into the environment is the most effective way to avoid effects to heritage VCs. Specific preventative measures that may be implemented include conducting a vehicle assessment (for oil leaks, secure cargo, etc.) and checking road conditions prior to departure, maintaining an appropriate driving distance between vehicles, adhering to speed limits, and adjusting driving styles to suit road conditions.

In the event of a spill, the guidelines and procedures outlined in the Spill Prevention and Emergency Response Plan will be followed in order to avoid contamination and degradation of archaeological sites.

Risk Characterization

The potential impact to archaeological soils would depend on the type of chemical and proximity to archaeological and heritage sites to the spill. The full nature of potential effects cannot be evaluated at this time because the volume of the spill and the concentrations that may enter the environment are unknown; therefore, in the event of a spill, a risk assessment that evaluates exposure to VCs will be conducted.

After mitigation, the likelihood of chemical contamination to heritage VCs is rare. The severity ranges from negligible to moderate depending on the type, frequency and size of the spill as well as the elapsed time between the occurrence and the removal of contaminants.

Table 5.9-6. Heritage Risk Assessment Matrix for Traffic Accidents

VC	Traffic Type	Description of Potential Risk (pre-mitigation)	Project Phase	Description of Mitigation Measures	Post-mitigation		
					Likelihood	Severity	Description of Consequence of Realized Risk
Archaeological and Heritage Sites	All traffic types	Increase in vehicle traffic may result in increased accidents involving spilling of deleterious substances, which can result in damage to archaeological and heritage sites	All phases	Conducting a vehicle assessment; checking road conditions prior to departure; maintaining appropriate distance between vehicles; adhering to speed limits; adjusting driving styles to suit road conditions; and adhering to the Spill Prevention and Emergency response Plan	Rare	Negligible	The circumstances of the spill will determine the extent of potential contamination of subsurface components of the site.
Archaeological and Heritage Sites	All traffic types	Increased incidence and severity of wildfires due to flammable material spills	All phases	Policy requiring the proper disposal of smoking materials; and fire watch and reporting program	Rare	Moderate	Depends on duration and severity of the wildfire. Can range from minor disturbance to the site to removal of surficial features if present and contamination of subsurface components

5.9.3.2 Incidence of Wildfire

Risk Identification

An increase in vehicle traffic along Highway 37 may result in an increased risk of wildfire. Such an increase would be related to traffic accidents as ignition sources and improper disposal of smoking materials.

Wildfires have the potential to alter archaeological and heritage sites by destroying surface features (if present), and to introduce contamination of subsurface components of sites when roots are burned.

The potential to alter archaeological and heritage sites is dependent on the severity of the fire, which is determined by both the areal extent and intensity.

Risk Mitigation

Preventing an increase in wildfire incidence involves reducing the risk of vehicle accidents and enacting policies requiring the proper disposal of smoking materials. Reduction of vehicle accidents can be accomplished with policies that address vehicle maintenance, driving under poor conditions (snow-covered or icy roads, night driving), and driver fatigue. Accidental ignition due to improper disposal of smoking materials can be addressed by strong policies requiring their proper disposal. Risk will further be reduced by instituting a fire watch and reporting program by drivers who will be on the road 24 hours a day, and an Emergency Response Plan (which will be included in the Project's Application/EIS).

Risk Characterization

Highway 37 runs through the Kalum Forest District (Northwest Fire Centre) of northwestern BC, which has seen few major (>4 ha burned area) and several minor (<4 ha burned area) wildfires during the past decade (BC Forest Service Protection Branch 2008). This low incidence of wildfire is due to the regional climate characteristics (long winters and short, wet summers), and limited access to backcountry areas.

After mitigation, the likelihood of increase in wildfire due to an increase in traffic is rare. This rating is due mainly to the low background level of fire incidence in this area of BC. Mitigation will be most important during the summer months, when drier weather can result in higher risk of wildfire.

The severity of wildfire occurrence is highly variable, and depends on local climate conditions, the time of wildfire ignition, and the resources available for response.

6. Summary of the Potential Risks of Project Traffic Accidents

6.1 INTRODUCTION

This chapter assesses the potential for Project-related traffic accidents on highways 37 and 37A. Using a risk assessment approach, the probability and severity of various potential accidents and malfunctions was assessed for effects to: social and economic environments; fish and aquatic habitat; wildlife; terrestrial ecosystems; wetlands; noise; climate and air quality; human health; and heritage (Sections 5.1 through 5.9, respectively).This chapter also summarizes the potential risks of traffic accidents particular to each of these detailed assessments.

Traffic accidents exclude any risks associated with traffic from the Project. Traffic accidents are categorized as "on-road" or "off-road," and involving either hazardous or non-hazardous cargo. Utilizing available data on traffic accidents along the segments of highway scoped into this study, collision prediction modelling (Section 3.2) was used to make determinations about the probability and potential severity of traffic accidents on each VC. Each topic-specific traffic assessment (Sections 5.1 through 5.9) used the prediction analysis to classify the likelihood and severity of a traffic accident.

Examples of potential results of traffic accidents related to Project traffic are spills of hazardous materials (including hydrocarbon leakage from fuel tanks), detonation of explosives, fires, and human injury or mortality as a result of Project-related traffic on highways 37 and 37A. Traffic accidents may occur due to malfunctioning equipment, driver error or fatigue, poor weather, unexpected road conditions, or unforeseen circumstances. The Mitigation and Management chapter (Chapter 7) discusses the precautions that will be taken to minimize the likelihood and severity of traffic accidents.

6.2 SCOPE AND OBJECTIVE

The objective of this section is to determine the potential risk and severity of traffic accidents which could occur in spite of mitigation measures implemented for Project-related-traffic. VCs discussed relate specifically to biophysical and human environment components included in Chapter 5. The section also includes a summary discussion on mitigating and managing the potential risks arising as a result of the accidents themselves.

6.3 POTENTIAL TRAFFIC ACCIDENT SCENARIOS

Project-related vehicles will transport non-hazardous cargo, such as tools and building materials, as well as personnel along Highway 37. For non-hazardous cargo, the risk of a traffic accident resulting in hydrocarbon leakage and/or human effects is considered in the risk assessment. Additionally, Project related vehicles will carry hazardous cargo. The following section includes a description of potential accident scenarios that were considered in the risk assessment in each topic-specific study (Chapter 5).

6.3.1 Discharge of Hazardous Materials into the Environment

Risks include:

- Discharge of hazardous cargo into the receiving environment for both on-road (with potential seepage) and off-road vehicle accidents.
- Hydrocarbon leakage from vehicles, both on-road (with potential seepage) and off-road, into the receiving environment.

- Particulate dispersion from cargo containing solid or powdered hazardous material, including cyanide, due to high winds, failure of containment or storage measures or other unforeseen circumstances, into the receiving environment.

6.3.2 Detonation of Explosives

A proportion of Project-related traffic will be carrying explosive materials. Potential risks from the accidental detonation of explosives were considered. Detonation could occur in the event of ignition of the engine and/or vehicle fuel as a result of an accident. Detonation could occur if the fire were to reach the explosive materials, potentially leading to further property damage and impacts on human health.

6.3.3 Fires

Fires could occur following traffic accidents, particularly when collisions involve more than one vehicle, as a result of hydrocarbon leakage or overheating engines. Fires could lead to additional property damage (vehicles or buildings), environmental effects, as well as negatively affect human health.

6.3.4 Injury or Mortality

Accidental collisions involving two or more vehicles pose potential risks of injury or mortality to humans.

6.4 RISKS BY ACCIDENT SCENARIO

Traffic accidents are a rare occurrence that may take place in spite of the mitigation and management measures that are put into place for Project-related traffic. The biophysical and human risks associated with these events for both on-road and off-road accidents, involving non-hazardous or hazardous cargo, are detailed in the following section. Additional mitigation and management measures to minimize risks arising from traffic accidents are also discussed.

6.4.1 On-road, Non-hazardous Cargo

Risks associated with on-road traffic accidents involving non-hazardous cargo are detailed in Table 6.4-1.

The likelihood of such events is predominantly characterized as unlikely or rare. The severity of potential, unintended consequences is predominantly characterized as minor or moderate. The level of consequence of effects on the biophysical environment depends on the location and time lapse between occurrence and clean-up. In case of an on-road accident with non-hazardous cargo, the following measures will be implemented to minimize potential risks detailed in Table 6.4-1:

- Project-related drivers and personnel will be certified in First Aid.
- All Project-related vehicles will be equipped with fire extinguishers.
- BMPs will be employed to minimize spill entry into waterbodies.
- Discussions and training will be carried out with community first responders and local emergency service providers to ensure they are appropriately trained and equipped to implement emergency response procedures.
- A prompt spill response procedure will be implemented to contain any potential hydrocarbon spill and minimize both vaporization and/or biophysical environmental contamination (including any effects on wildlife). The procedure will limit the time and extent a contaminant may be in contact with the biophysical environment.
- An emergency response procedure in the event of fire will be carried out to minimize fire duration and extent.

Table 6.4-1. Potential Risks and Severity of On-road Traffic Accidents (Non-hazardous Cargo)

Assessment Topic	Risk
Socio-economic	Reduction in safety for other vehicle traffic along the highway. Potential human injury or death.
Fish and Aquatic Habitat	Fuel or lubricant spill(s) from the vehicle(s) fuel tanks could extend beyond the road surface resulting in the deposition of deleterious substances into aquatic habitat.
Wildlife	Toads, moose and bears could be exposed to hydrocarbons from spilled fuel tanks via the ingestion of soil, water and prey species and via dermal absorption. Habitats along the highway used by moose and bears may be vulnerable to traffic accidents, such as gasoline spills.
Terrestrial Ecosystems	Tissue damage to vegetation and contamination of soil.
Wetlands	Wetland function could be compromised if fuel or lubricant spill(s) from the vehicle(s) extend beyond the road surface resulting in the deposition of deleterious substances into a wetland.
Noise	None.
Climate and Air Quality	A localised reduction in air quality from potentially harmful emissions due to fuel fires. Potential contribution of GHG emissions.
Human Health	Potential human injury or death. Potential for fuel or lubricant spill(s) into drinking water.
Heritage	Fuel or lubricant spill(s) from the vehicle(s) could extend beyond the road surface. Deleterious substances could damage archaeological and heritage sites.

6.4.2 On-road, Hazardous Cargo

Risks associated with on-road traffic accidents involving hazardous cargo are detailed in Table 6.4-2, while a more detailed description of the risks and mitigation associated with the transport of Process Plant reagents are detailed in Table 6.4-5.

Table 6.4-2. Potential Risks and Severity of On-road Traffic Accidents (Hazardous Cargo)

Assessment Topic	Risk
Socio-economic	Reduction in safety for other vehicle traffic along the highway. Potential human injury or death.
Fish and Aquatic Habitat	Hazardous cargo spill(s) could extend beyond the road surface resulting in the deposition of deleterious substances into the aquatic habitat.
Wildlife	Toads, moose and bears could be exposed to the chemicals via the ingestion of soil, water and prey species and via dermal absorption. Habitats along the highway used by moose and bears may be vulnerable to traffic accidents, such as chemical spills, including gasoline.
Terrestrial Ecosystems	Tissue damage to vegetation and contamination of soil.
Wetlands	Wetland function could be compromised if hazardous cargo spill(s) extend beyond the road surface resulting in the deposition of deleterious substances into a wetland.
Noise	None.
Climate and Air Quality	A localised short term reduction in air quality from potentially harmful emissions due to fuel fires. Potential contribution of GHG emissions.
Human Health	Potential human injury or death. Potential for hazardous cargo spill(s) into drinking water.
Heritage	Hazardous cargo spill(s) could extend beyond the road surface. Deleterious substances could damage archaeological and heritage sites.

The likelihood of such events is predominantly characterized as unlikely or rare. The severity of potential, unintended consequences is predominantly characterized as minor or moderate. The severity could be minor to moderate for the biophysical environment, depending on the location and time lapse between occurrence and clean-up. In case of an on-road accident with hazardous cargo, the following measures, in addition to the aforementioned measures in Section 6.4.1, will be implemented to minimize any potential risk detailed in Table 6.4-2:

- Use of best technologies and practices, including the International Cyanide Management Code (ICMI n.d.), for containing chemicals and explosives.
- Shipment of low moisture concentrate where and when possible.
- Neutralization of active materials, including lime.

6.4.3 Off-road, Non-hazardous Cargo

Risks associated with off-road traffic accidents involving non-hazardous cargo are detailed in Table 6.4-3.

Table 6.4-3. Potential Risks and Severity of Off-road Traffic Accidents (Non-hazardous Cargo)

Assessment Topic	Risk
Socio-economic	Reduction in safety for other vehicle traffic along the highway. Potential human injury or death.
Fish and Aquatic Habitat	Fuel or lubricant spill(s) from the vehicle(s) could result in the deposition of deleterious substances into the aquatic habitat.
Wildlife	Toads, moose and bears could be exposed to the chemicals via the ingestion of soil, water and prey species and via dermal absorption. Habitats along the highway used by moose and bears may be vulnerable to traffic accidents, such as gasoline spills.
Terrestrial Ecosystems	Tissue damage to vegetation and contamination of soil.
Wetlands	Wetland function could be compromised by any vehicle presence within a wetland system. Wetland function could be affected if fuel or lubricant spill(s) from the vehicle(s) result in the deposition of deleterious substances into the wetland.
Noise	None.
Climate and Air Quality	A localised short term reduction in air quality from potentially harmful emissions due to fuel fires. Potential contribution of GHG emissions.
Human Health	Potential human injury or death. Potential fuel or lubricant spill(s) into drinking water.
Heritage	Fuel or lubricant spill(s) from the vehicle(s) could extend beyond the road surface. Deleterious substances and potential fires could damage archaeological and heritage sites.

The likelihood of such events is predominantly characterized as unlikely or rare. The severity of potential, unintended consequences is predominantly characterized as minor to moderate. The severity could be minor to moderate for the biophysical environment, depending on the location and time lapse between occurrence and clean-up. In case of an off-road accident with non-hazardous cargo, the following measures will be implemented to minimize any potential risk detailed in Table 6.4-3:

- Project-related drivers and personnel will be certified in First Aid.
- All Project-related vehicles will be equipped with fire extinguishers.
- BMPs will be employed to minimize spill entry into waterbodies.
- Discussions and training will be carried out with community first responders and local emergency service providers to ensure they are appropriately trained and equipped to implement emergency response procedures.

- A prompt spill response procedure will be implemented to contain any potential hydrocarbon spill and minimize both vaporization and/or environmental contamination (including any effects on wildlife). The procedure will limit the time and extent a contaminant may be in contact with the biophysical environment.
- An emergency response procedure in the event of fire will be carried out to minimize fire duration and extent.

6.4.4 Off-road, Hazardous Cargo

General risks associated with off-road traffic accidents involving hazardous cargo are detailed in Table 6.4-4. Table 6.6-5 provides a more detail on the risks associated with an off-road accident involving a vehicle carrying Process Plant reagents. The severity associated with reagent spills is categorized as acute (the effect would be immediate and potentially severe), chronic (the effect would be of long duration), and/or bioaccumulating.

The likelihood of such an event is rare, and severity could be minor to catastrophic for the biophysical environment, depending on the location, the substance spilled, and time lapse between occurrence and clean-up. In case of an off-road accident with hazardous cargo, the following measures, in addition to the aforementioned measures in Section 6.4.1, will be implemented to minimize any potential risk detailed in Tables 6.4-4 and 6.4-5:

- Use of best technologies and practices, including International Cyanide Management Code (ICMI n.d.), for containing chemical and explosives.
- Shipment of low moisture concentrate where and when possible.
- Neutralization of active materials, including lime.

Table 6.4-4. Potential Risks and Severity of Off-road Traffic Accidents (Hazardous Cargo)

Assessment Topic	Risk
Socio-economic	Reduction in safety for other vehicle traffic along the highway. Potential human injury or death.
Fish and Aquatic Habitat	Hazardous cargo spill(s) would result in the deposition of deleterious substances into the aquatic habitat.
Wildlife	Toads, moose and bears could be exposed to the chemicals via the ingestion of soil, water and prey species and via dermal absorption. Habitats along the highway used by moose and bears may be vulnerable to traffic accidents, such as chemical spills, including gasoline.
Terrestrial Ecosystems	Tissue damage to vegetation and contamination of soil.
Wetlands	Wetland function could be compromised by any vehicle presence within a wetland system. Wetland function could be compromised if hazardous cargo spills result in the deposition of deleterious substances into a wetland.
Noise	None.
Climate and Air Quality	A localised short term reduction in air quality from potentially harmful emissions due to fuel fires. Potential contribution of GHG emissions.
Human Health	Potential human injury or death. Potential for hazardous cargo spill(s) into the terrestrial and aquatic environments and affecting country foods and drinking water.
Heritage	Deleterious substances and fire could damage archaeological and heritage sites.

Table 6.4-5. Potential Risks and Severity of Traffic Accidents involving Process Plant Reagent Spills

Reagent	Description and Potential Risk Considering Mitigation			
	Acute	Chronic	Bioaccumulating	Description
Sodium Hydrosulphide (NaHS)	Y	N	N	**Fish and Wildlife:** Acute toxic effects. LC50 (96 hr) ranges from 46 – 6,080 mg/L depending on species. **Wetlands and Terrestrial Ecosystems:** If dissolved in water, exposure to plants is acutely toxic and will damage contacted plant tissues. **Human Health:** Acute toxic effects. Causes burns by all exposure routes. Develops highly toxic hydrogen sulfide gas if exposed to acid or heat source (fire). Substance may have chronic effects but they are unlikely to occur given spill clean-up protocol.
Sodium Cyanide (NaCN)	Y	Y	N	**Fish and Wildlife:** Acute toxic effects causing death. LD50 range from 2.7 - 28 mg/kg body weight depending on species. Chronic effects in nature are rare as cyanide is short-lived, but prolonged exposure can cause damage to skin, eyes and nervous system. **Wetlands and Terrestrial Ecosystems:** If dissolved in water, exposure to plants is acutely toxic and will damage contacted plant tissues. **Human Health:** Maximum allowable cyanide concentration in drinking water is 0.2 mg/L (US EPA 1994) , or 200 µg/L for free cyanide(Health Canada 1991) , and higher concentrations are considered extremely harmful to life (Lordi et al. 1980). Chronic effects include adverse reproductive effects (maternal and paternal fertility) based on animal data. Acute effects include irritation to skin, eyes, respiratory tract, and may be fatal if inhaled or swallowed.
Sodium Silicate (Na_2SiO_3) (Sodium Metasilicate)	Y	Y	N	**Fish and Wildlife:** Oral toxicological effects include ulceration or bleeding in the stomach, duodenum, and small intestine. LD50s range from 200 mg/kg to 2400 mg/kg depending on the species. If dissolved in water, alkaline pH is harmful to aquatic life. As a dust, causes mild eye and skin irritation. **Wetlands and Terrestrial Ecosystems:** If dissolved in water, alkaline pH may harm plant tissues. **Human Health:** Dust may cause mild skin and eye irritation. Inhalation is irritating to the respiratory tract. Chronic exposure to the lunges is a cancer hazard, but this risk is highly unlikely given the spill clean-up protocol.
Activated Carbon	Y	N	N	**Fish and Wildlife**: Not toxic, in its original state. LD50 (oral, rat) > 10,000 mg/kg. May become toxic as used activated carbon may exhibit characteristics of the absorbed material. **Wetlands and Terrestrial Ecosystems:** No adverse effect in original state. **Human Health:** Minor skin and eye irritant with prolonged exposure.
Hydrochloric Acid (HCl)	Y	Y	N	**Fish and Wildlife:** Exposure can lead to burns and damage of target organs. Acutely toxic to fish and may cause death LC50 = 10 -100 ppm in most sensitive species. pH shifts outside of the range of 5-10 standard units may be toxic to aquatic organisms. **Wetlands and Terrestrial Ecosystems**: Exposure of plants is acutely toxic and will damage contacted plant tissues; effects will not persist following neutralization. Chronic plant toxicity at 100 ppm. **Human Health:** Adverse effects if in contact with skin or eyes, if ingested, or inhaled. Substance may have chronic toxic effects to kidneys, liver, mucous membranes, upper respiratory tract, skin, eyes, circulatory system, teeth. This is highly unlikely given spill cleanup protocol.
Sodium Hydroxide (NaOH) (Caustic soda)	Y	Y	N	**Fish and Wildlife:** Exposure can lead to burns and damage of target organs and death LC50 = 35-100 mg/L in freshwater. **Wetlands and Terrestrial Ecosystems:** Exposure to plants is acutely toxic and will damage contacted plant tissues; effects will not persist following neutralization. **Human Health:** Adverse effects if in contact with skin or eyes, if ingested, or inhaled. Substance may have chronic toxic effects to lungs. This is highly unlikely given spill clean-up protocol.
Sodium Metabisulfite (MBS)	Y	Y	N	**Fish and Wildlife:** Acute oral toxicity LD50 ~ 1,000 mg/kg (Guinea pig, Rat). Lung irritant. **Wetlands and Terrestrial Ecosystems**: No toxic or adverse effect is predicted. **Human Health:** Skin irritant and hazardous in case of ingestion or inhalation. May be mutagenic or cause adverse reproductive effects. Potential chronic effects to upper respiratory tract if repeated or prolonged exposure. Prolonged exposure is unlikely.
Copper Sulphate Pentahydrate ($CuSO_4.5H_2O$)	Y	Y	Y	**Fish and Wildlife:** Practically nontoxic to birds, but highly toxic to fish and other aquatic life especially in soft or acidic waters. May cause effects such as behavioral changes at low concentration to death at concentration of 0.39 mg/L over 96-hours. May be poisonous to mammals if ingested. **Wetlands and Terrestrial Ecosystems:** This material has serious potential for phytotoxicity and kills plants by disrupting phtosynthesis. When released into the soil or water, this material is not expected to biodegrade. **Human Health:** Acute effects include hazards in case of skin contact (irritant), of eye contact (irritant), of ingestion and inhalation. Chronic effects include mutagenesis and toxicity to kidneys, and liver. Repeated or prolonged exposure to the substance can produce target organs damage.
Sulphuric Acid (H_2SO_4)	Y	Y	N	**Fish and Wildlife:** Sulphuric acid is toxic to aquatic life in very low concentrations. It may be dangerous if it enters water intakes and may cause death. **Wetlands and Terrestrial Ecosystems:** Endangers drinking water supply if allowed to enter soil and/or waters in large quantities. Exposure to plants is accutely toxic and will damage/kill plants with contact. Effects will not persist after a spill is cleaned up. **Human Health:** When inhaled, results in damage of mucous membranes of mouth, nose, throat and lungs. Causes severe pain, nausea, vomiting and diarrhea if ingested. Causes severe burns with skin contact. Leads to cornea damage and risk of blindness with eye contact. Chronic toxicity includes bronchitis, emphysema erosion of the teeth, chronic runny nose, tearing of the eyes, nose bleeds, and stomach upset. Has potential to cause lung cancer. Chronic exposure is highly unlikely given spill clean-up protocol.

(continued)

Table 6.4-5. Potential Risks and Severity of Traffic Accidents involving Process Plant Reagent Spills (completed)

Reagent	Description and Potential Risk Considering Mitigation			
	Acute	Chronic	Bioaccumulation	Description
PAX (potassium amyl xanthate)	Y	Y	N	**Fish and Wildlife**: Skin or eye contact may be irritating. Harmful if absorbed through skin. May be toxic to aquatic biota at concentrations of less than 1 mg/L. **Wetlands and Terrestrial Ecosystems:** No adverse effect is predicted. **Human Health:** Minor skin and eye irritant. Prolonged exposure may cause adverse reproductive effects. Prolonged exposure is unlikely.
A208 (Diethyl Dithiophosphate)	Y	N	N	**Fish and Wildlife**: Low toxicity to aquatic organisms due to limited bioavailability. May be lethally toxic (LD50 = 7,900 mg/kg (oral, rat). May cause skin or eye irritation. **Wetlands and Terrestrial Ecosystems:** No adverse effect is predicted. **Human Health:** Minor skin and eye irritant.
3418A (Dialkyl Dithiophosphinate)	Y	N	N	**Fish and Wildlife**: Low toxicity to fish and wildlife. **Wetlands and Terrestrial Ecosystems:** No adverse effect is predicted. **Human Health:** Minor skin and eye irritant.
MIBC (Methyl Isobutyl Carbinol)	Y	Y	N	**Fish and Wildlife:** This material is practically non-toxic to fish and wildlife. Unlikely to persist in the environment. **Wetlands and Terrestrial Ecosystems:** This material is slightly adsorptive in soils and sediments and has an evaporation half-life of 23-hrs (rivers) to 10.6 days (pond). No effects on plants reported. **Human Health:** Harmful if swallowed, inhaled or absorbed through skin. Causes irritation to skin, eyes and respiratory tract. High concentrations cause central nervous system effects, such as dullness, dizziness, anesthesia.
Floculant (Magnafloc 336)	Y	Y	N	**Fish and Wildlife:** May contain cationic polymers that may be toxic to aquatic organisms; toxicity reduced by natural particles in the water. **Wetlands and Terrestrial Ecosystems:** No adverse effect is predicted. **Human Health:** This material has a low order of oral toxicity.
Anti-scalant	Y	N	N	**Fish and Wildlife**: No toxic effects predicted. Mild skin irritant. **Wetland and Terrestrial Ecosystems:** No adverse effects predicted. **Human Health:** Mild irritation to eyes and skin upon contact.
Fuel Oil	Y	Y	N	**Fish and Wildlife**: Cause harm to wildlife through physical contact, ingestion, inhalation and absorption. Light oils (gasoline, diesel aviation fuel) generally affect aquatic life and may be toxic to fish and invertebrates including reproductive impairment, and toxicity impacts to eggs and larvae. **Wetland and Terrestrial Ecosystems:** High mobility in soils may cause soil and/or groundwater contamination. **Human Health**: Irritation to eyes and skin upon contact. Inhalation may cause irritation, anesthetic effects, and respiratory system effects. Long-term exposure may cause target organ damage. Benzene is a known carcinogen.
Lime	Y	N	N	**Fish and Wildlife:** Exposure will lead to tissue damage due to direct contact or increase in water pH. Expected to be toxic to aquatic life. **Wetland and Terrestrial Ecosystems**: Exposure of plants will damage tissues; effects will not persist following clean up. **Human Health:** Severe damage to eyes and skin upon contact. Gastrointestinal tract burns, severe pain, nausea, vomiting when ingested. May cause circulatory system failure if in direct contact with large amounts.
Ferric Chloride ($FeCl_3$)	Y	N	N	**Fish and Wildlife:** Corrosive if mixed with water due to acidic pH. Very hazardous in case of skin or eye contact or if ingested. No chronic effects. **Wetland and Terrestrial Ecosystems:** Corrosive if mixed with water due to acidic pH. Damaging to plant tissue. **Human Health:** Very hazardous in case of skin or eye contact or if ingested. No chronic effects.
Calcium Chloride ($CaCl_2$)	Y	Y	N	**Fish and Wildlife:** Toxic to fish (LC50 (fish) 100 mg/L). Hazardous to wildlife upon contact or ingestion. **Wetland and Terrestrial Ecosystems:** Will burn plants. **Human Health:** Acute: Irritant to skin and eyes. Hazardous if ingested or inhaled. Chronic: May affect genetic material (mutagenic, carcinogenic) based on animal data. May affect taste of drinking water.
Copper Chloride ($CuCl_2.2H_2O$)	Y	Y	N	**Fish and Wildlife:** Acute and long-term toxicity to aquatic organisms in freshwater and marine environments. LC50 range from 0.08 - 0.9 mg/L in fish. Very hazardous in case of skin- and eye contact or ingestion. **Wetland and Terrestrial Ecosystems:** Acute and long-term toxicity to aquatic organisms in wetlands. Long-term toxic effect in plants. **Human Health:** Very hazardous in case of skin contact (irritant, blistering, permeator), of eye contact (irritant, blindness), of ingestion, of inhalation. Chronic effects: May affect genetic material (mutagenic).
Antifoam	Y	Y	N	**Fish and Wildlife:** No toxic effects predicted. Mild skin irritant. **Wetland and Terrestrial Ecosystems**: No adverse effects predicted. **Human Health:** Mild irritation to eyes and skin upon contact. May cause adverse reproductive effects if repeatedly inhaled, which is unlikely. Chronic exposure by inhalation may affect blood, respiration, behavior and liver.
Liquid Chlorine (Sodium Hypochlorite)	Y	N	N	**Fish and Wildlife:** Severely toxic to fish, amphibians and other aquatic life. Severe irritant to skin, eye, lungs or when ingested by wildlife. No chronic effects. **Wetland and Terrestrial Ecosystems:** Severely toxic to aquatic plants. Immediate damage to plants. **Human Health:** Severe irritant to skin, eye, lungs or when ingested. No chronic effects.

7. Summary of Mitigation and Environmental Management

7.1 INTRODUCTION

The Application/EIS will identify proposed mitigation and monitoring plans, including a Traffic and Access Management Plan, Dangerous Goods and Hazardous Materials Management Plan, Emergency Response Plan, and Spill Prevention and Emergency Response Plan. These plans will include mitigation and monitoring plans for the Project site, access roads and highway transportation routes in greater detail than provided for in this report. For this study, mitigation is focussed on the Project traffic along highways 37 and 37A.

Measures to avoid or mitigate potential effects associated with highway traffic are described in Section 7.3. These measures will be included in the Application/EIS as part of the Traffic and Road Management Plan and the Dangerous Goods and Hazardous Materials Management Plan.

Measures to avoid or mitigate potential effects associated with traffic accidents are described in Section 7.4. These measures will be included in the Application/EIS in the Emergency Response Plan (for emergencies other than spills), and the Spill Prevention and Emergency Response Plan. Additionally, the Accidents and Malfunctions chapter in the Application/EIS will address accidents and malfunctions on the Project site and along access roads.

Risk mitigations in this chapter are described relative to the social and environmental topics included in the individual traffic risk assessments (see Chapter 5).

7.2 MITIGATION AND MANAGEMENT OBJECTIVES

The objective of mitigation and management is to minimize potential environmental effects and effects on humans from Project-related traffic. The mitigation measures detailed here are intended to provide guidance for conducting Project activities along highways 37 and 37A in accordance with this objective. They are to ensure, for example, that Project activities are conducted in a manner that maximizes road safety, reduces potential for vehicle accidents, and avoids vehicle/wildlife interactions.

All components of the environmental management plans will be in compliance with regulatory requirements and will utilize BMPs as an additional guiding principle. Objectives and targets for the management plans related to traffic will continue to be refined as the Application/EIS is developed.

7.3 HIGHWAY TRAFFIC MANAGEMENT

7.3.1 Action to Avoid or Mitigate

This section identifies the measures that will help minimize and mitigate potential risks of Project-related traffic activities.

7.3.1.1 Traffic and Access Management Plan Risk Mitigation Measures

The following actions will be included in the Traffic and Road Management Plan in the Application/EIS:

- Posted speed limits will be enforced.

- All heavy vehicles travelling to and from the Project area will follow dedicated heavy vehicle routes.
- Vehicle load rates will be optimized to minimize the number of trips.
- Noise suppression technologies will be used where possible.
- Speeds will be reduced to 50 km/h in designated residential areas or as otherwise directed. Along the travelled portion of Highway 37, the only residential area is within Kitwanga Village near the gas station, speed limits are posted accordingly.
- Use of engine brakes, and reversing (use of reverse-alarm) will be avoided in residential areas.
- Vehicle idling will be minimized.

Vehicle specification and maintenance activities will also be identified in the Traffic and Road Management Plan:

- Project trucks will meet or exceed Transport Canada's minimum requirements (e.g., maximum allowable noise levels from heavy duty trucks).
- Vehicle manufacturers' procedures and maintenance schedules will be followed.
- Vehicles will undergo regular, scheduled maintenance to ensure that engines, brakes and other mechanical parts are in an acceptable working condition.
- Regular vehicle inspections (for leaks, secure cargo, etc.) will be conducted.
- Excess dust and dirt will be removed from vehicles before leaving site, if necessary.

Traffic-related mitigation measures related to general safety procedures will also be provided in the Plan:

- Contractors and workers will be required to adhere the BC Occupational Health and Safety Regulation (BC Reg 296/97), as well as a zero-tolerance policy on alcohol and drugs while transporting goods and materials to and from the site.
- Policies regarding proper disposal of smoking materials will be implemented to prevent forest fires.
- A driver fire watch and reporting program by drivers and a response plan will be implemented.
- Workers and contractors will follow a specified journey management procedure, including departure and arrival check-ins.
- Information on weather and highway conditions will be made available to all drivers before departure. Drivers will be required to check road conditions prior to departure, and will adjust driving styles to conditions.
- Drivers and personnel will receive appropriate training (e.g., safe driving practices such as maintaining appropriate distances between vehicles, adjusting driving styles to suit road conditions, noise awareness training).

Other measures to be implemented relate to communication with community and governments:

- If required, traffic control and/or road shutdowns will be used on Highway 37 near the entry to Project access roads during peak construction periods.
- Project traffic plans will be communicated to the provincial and local governments to ensure adequate signage is posted beside public roads.

- Local communities will be advised of driving routes, peak transportation periods and potential road shutdowns when transporting heavy/wide loads.

7.3.1.2 Wildlife and Terrestrial Ecosystems Specific Risk Mitigation Measures

The following measures will be undertaken to minimize interactions between wildlife and vehicles, reduce disruption to wildlife movement, and mitigate potential effects on terrestrial ecosystems:

- Project drivers will yield to wildlife observed along the highways.
- Project drivers will adhere to signage in areas of wildlife crossing.
- Project personnel (including drivers) will communicate locations of observed wildlife to drivers.
- Locations of collisions between wildlife and vehicles will be documented.
- Vehicle inspection stations will be established on site for vehicles entering and exiting the Project access roads, and appropriate action will be taken where risk of invasive plant introduction is identified.

7.3.1.3 Climate and Air Quality Specific Risk Mitigation Measures

The following measures will be taken to minimize potential traffic effects on climate and air quality:

- Diesel vehicles will use low sulphur content fuel, as required by law.
- Use of more efficient fuel blends will be considered.

7.3.1.4 Dangerous Goods and Hazardous Materials Management Plan Risk Mitigation Measures

Project activities involving dangerous goods or hazardous materials will be guided by the Dangerous Goods and Hazardous Materials Management Plan, which will be included in the Application/EIS. In relation to highway traffic, adherence to this plan is intended to prevent the introduction of hazardous and/or deleterious substances into the environment during their transportation.

Correct transport procedures for dangerous goods and hazardous materials will assist in ensuring that chemicals and dangerous goods do not cause environmental or human harm. In the Application/EIS, transport procedures will be developed that adhere to all applicable municipal, provincial and federal regulations and legislation such as the *Transportation of Dangerous Goods Act*(1992), WHMIS, Canadian Environmental Code of Practice for Metal Mines (Environment Canada n.d.), the BC Occupational Health and Safety Regulation (BC Reg 296/97), and the Health, Safety and Reclamation Code for Mines in BC (BC MEMPR 2008). Additionally, industry best practice standards will be adhered to, such as the International Cyanide Management Code (ICMI n.d.).

The following measures will be included in the Dangerous Goods and Hazardous Materials Management Plan:

- Drivers transporting dangerous goods or hazardous materials will be required to have appropriate safety training (e.g., TDG, WHMIS, and CPPI certification).
- All Project employees and contractors will be required to follow correct, cargo-specific transport procedures.
- Transportation of explosives will be in enclosed trailers/closed containers.
- Regular vehicle inspections (for oil leaks, secure cargo, etc.) will be conducted.
- Concentrate will be dewatered to a low moisture content before transport.

- Concentrate will be trucked in covered transport vehicles.
- Procedures will outline specific measures to be adhered to when transporting materials over or near any aquatic systems (wetlands and water bodies), including designated route selection.
- Requirements of the International Cyanide Management Code will be followed, and contractors delivering cyanide will be verified under the International Cyanide Management Code (ICMI n.d.) for transportation.

7.4 TRAFFIC ACCIDENTS MANAGEMENT

7.4.1 Action to Avoid or Mitigate

This section identifies the procedures that will be followed in the unlikely event of a traffic accident. Actions to prevent cargo (hazardous and non-hazardous) release into the environment as a result of a traffic accident are also identified. The items discussed below will provide the frameworks for the Emergency Response Plan, and the Spill Prevention and Emergency Response Plan, which will be included in the Application/EIS.

7.4.1.1 Emergency Response Plan Risk Mitigation Measures

The Emergency Response Plan that will be developed as part of the Application/EIS is intended to ensure that in the event of an emergency (other than a spill), all available resources are used appropriately to minimize the extent and severity of the effect on the safety of personnel, the public, and the environment.

Examples of actions taken in the event of an emergency include:

- The plan will include a description of communication and warning systems.
- Emergency contacts will be readily accessible to drivers.
- Procedures for emergency response and occupational first aid will be developed and workers and contractors will undergo required training.
- In the unlikely event of a fire, emergency response procedures to minimize fire duration and extent will be promptly initiated.

7.4.1.2 Spill Prevention and Emergency Response Plan Risk Mitigation Measures

Potential spills of hazardous and non-hazardous cargo will be mitigated as per the Spill Prevention and Emergency Response Plan, which will be developed in accordance with standards and Best Management Practices and included in the Application/EIS.

The Spill Prevention and Emergency Response Plan will include actions that are intended to prevent hazardous and non-hazardous spills into the environment as a result of traffic accidents, and to ensure that if accidental spills occur, all available resources are used appropriately to minimize the extent and severity of the effect on the safety of personnel, the public, and the environment. The plan will include the following:

- Specifications for preventing and controlling the release of materials during traffic accidents.
- Provisions for spill availability on vehicles transporting dangerous goods or hazardous materials, and set up at select locations along the Project haul route.

- Provisions for isolating, containing and managing all transported fuels, solvents, and other chemicals.
- Specifications for conducting vehicle assessments for oil leaks, secure cargo, etc.

The plan will include the following responses measures:

- Provide details on the location and nature of spill response equipment.
- Identify the steps to be taken to properly contain, recover, and clean up any spills that may take place.
- Outline procedures to minimize response time and ensure prompt clean-up.
- Train personnel (including drivers) in spill response procedures relevant to the materials present being transported.
- Train personnel (including drivers) in personal protection procedures to avoid contact with spilled material.
- Perform spill simulation drills to assess the effectiveness of the Spill Prevention and Emergency Response Plan and the adequacy of personnel training.
- Provide notification and reporting procedures in the event of a spill; for example, project staff and contractors will be required to report incidents of spills, seepages, leaks, or similar occurrences to the environmental staff.
- Use BMPs to minimize spill entry to waterbodies or into the terrestrial environment.
- Inform residents of the spill and restrict access to the spill site.
- Exclude wildlife (e.g. bears, moose) from the spill site until effective clean-up of the area.
- Monitor, soil, water, and vegetation within the spill area in the event of a major spill to ensure that the chemical levels are within the appropriate regulatory guidelines.
- Avoid directing spilled substances into closed storm drains or sewage line systems in the event of a volatile chemical spill (to prevent fires).
- Prepare a detailed cyanide management plan during the detailed design phase which will be consistent with the International Cyanide Management Code (ICMI n.d.). The plan will include provisions related to cyanide transportation, spill prevention and spill containment measures.
- Develop a procedure to respond to an unplanned release of process concentrate which will include: recovery of the material; re-processing or disposal; and confirmatory sampling to confirm no residual contamination is present above industrial standards.

Table 7.4-1 outlines spill response measures for specific reagents contained in Transport Canada's TDG Emergency Response Guidebook (2008).

7.5 MONITORING AND REPORTING

Monitoring and enforcement is fundamental to ensuring that the management plans are functioning to their full extent over the life span of the Project. Monitoring of selected environmental performance indicators in relation to developed targets assists in determining whether management plans require updating to improve the level of environmental protection.

A framework for monitoring risk mitigations described in the Traffic and Access Management Plan, the Hazardous Materials Management Plan, the Emergency Response Plan, and the Spill Prevention and Emergency Response Plan, will be included in the Application/EIS.

Additionally, details on the frequency and type of reporting, and to whom reports are to be submitted, will be included in the Application/EIS, as well as identification of the person responsible (e.g. Mine Manager, environmental officer, construction engineer, etc.).

Table 7.4-1. Spill Response Measures for Specific Reagents

Process Plant Reagent	Description	Description of Spill Response Measures
Sodium Hydrosulphide (NaHS)	Corrosive; spontaneously combustible	In the event of a spill, dust generation will be avoided, all ignition sources removed, and measures to prevent NaHS from entering the environment will be taken.
Sodium Cyanide (NaCN)	Poisonous (toxic) and infectious substance; Toxic and/or corrosive (non-combustible/water sensitive)	In the event of a spill, ICMI 2012 Guidelines for spill containment measures will be followed. Personnel will not get water inside containers, all ignition sources will be removed, small spills will be covered with dry earth or sand and plastic sheeting to minimize spreading or contact with rain, and other measures to prevent runoff from contacting spilled material.
Sodium Silicate (Na_2SiO_3) (Sodium Metasilicate	High pH, noncombustible	In the event of a spill, material will be carefully shoveled into suitable container(s); dust generation will be avoided, and in case of contact with water, runoff will be prevented from entering into storm sewers and ditches which lead to natural waterways.
Activated Carbon	Flammable and combustible; on contact with water emits flammable gases	In event of a spill, all ignition sources will be removed, small spill would be placed into clean dry container, cleared and removed; large spill would be wetted with water, diked for later disposal, entry into waterways, sewers, or confined areas will be prevented.
Hydrochloric Acid (HCl)	Toxic and/or Corrosive (non-combustible/water sensitive)	Personnel will not get water inside containers, all ignition sources will be removed; water spray may be used to reduce vapors or divert vapor cloud drift; spill residue will be neutralized with dilute solution of sodium carbonate; spill with be absorbed with dry earth or sand and contact with runoff will be prevented.
Sodium Hydroxide (NaOH) (Caustic soda)	Toxic and/or Corrosive (non-combustible)	Personnel will not get water inside containers, all sources of ignition will be removed; spill residue will be neutralized with a dilute solution of acetic acid; Contact with water, and contact with runoff will be prevented.
Sodium Metabisulfite (MBS)	Low pH (Acidic); moisture and air sensitive; non-flammable; non-corrosive in the presence of glass	A shovel will be used to put material into a waste disposal container, and cleaning will be finished by spreading water on the contaminated surface.
Copper Sulphate Pentahydrate ($CuSO_4.5H_2O$)	Air sensitive; corrosive to finely powdered metals; non-flammable	In case of a large spill, appropriate tools will be used to place material in a suitable container for reclamation or disposal, using a method that does not generate dust.
Sulphuric Acid (H_2SO_4)	Corrosive; water-reactive; not combustible	Spills will be cleaned up immediately; emergency personnel will wear self-contained breathing apparatus, rubber boots and heavy rubber gloves; spilled material will be covered with sand, dry lime or soda ash, and place in a closed container and marked for disposal.

(continued)

Table 7.4-1. Spill Response Measures for Specific Reagents (continued)

Process Plant Reagent	Description	Description of Reagent-specific Spill Response Measures
PAX (potassium amyl xanthate)	Corrosive; spontaneously combustible	In event of a spill, dust generation will be avoided, all sources of ignition removed, material will be collected for proper disposal, and measures to prevent chemical from entering the environment will be taken. In case of fire, flooding amounts of water will be used to stop the reaction as smothering will not work for these materials.
A208 (Diethyl Dithiophosphate)	Proprietary reagent	Spill response measures specific for this reagent will be developed and outlined in the MSDS.
3418A (Dialkyl Dithiophosphinate)	Proprietary reagent	Spill response measures specific for this reagent will be developed and outlined in the MSDS.
Sodium Hydrosulphide (NaHS)	Corrosive; spontaneously combustible	In the event of a spill, dust generation will be avoided, all ignition sources removed, and measures to prevent NaHS from entering the environment will be taken.
Sodium Cyanide (NaCN)	Poisonous (toxic) and infectious substance; Toxic and/or corrosive (non-combustible/water sensitive)	In the event of a spill, ICMI Guidelines for spill containment measures will be followed. Personnel will not get water inside containers, all ignition sources will be removed, small spills will be covered with dry earth or sand and plastic sheeting to minimize spreading or contact with rain, and other measures to prevent runoff from contacting spilled material.
Sodium Silicate (Na_2SiO_3) (Sodium Metasilicate	High pH; non-combustible	In the event of a spill, material will be carefully shoveled into suitable container(s); dust generation will be avoided, and in case of contact with water, runoff will be prevented from entering into storm sewers and ditches which lead to natural waterways.
Activated Carbon	Flammable and combustible; on contact with water emits flammable gases	In event of a spill, all ignition sources will be removed, small spill would be placed into clean dry container, cleared and removed; large spill would be wetted with water, diked for later disposal, entry into waterways, sewers, or confined areas will be prevented.
Hydrochloric Acid (HCl)	Toxic and/or Corrosive (non-combustible/water sensitive)	Personnel will not get water inside containers, all ignition sources will be removed; water spray may be used to reduce vapors or divert vapor cloud drift; spill residue will be neutralized with dilute solution of sodium carbonate; spill with be absorbed with dry earth or sand and contact with runoff will be prevented.
Sodium Hydroxide (NaOH) (Caustic soda)	Toxic and/or Corrosive (non-combustible)	Personnel will not get water inside containers, all sources of ignition will be removed; spill residue will be neutralized with a dilute solution of acetic acid; Contact with water, and contact with runoff will be prevented.
Sodium Metabisulfite (MBS)	Low pH (Acidic); moisture and air sensitive; non-flammable; non-corrosive in the presence of glass	A shovel will be used to put material into a waste disposal container, and cleaning will be finished by spreading water on the contaminated surface.

(continued)

Table 7.4-1. Spill Response Measures for Specific Reagents (continued)

Process Plant Reagent	Description	Description of Reagent-specific Spill Response Measures
Copper Sulphate Pentahydrate ($CuSO_4.5H_2O$)	Air sensitive; corrosive to finely powdered metals; non-flammable	In case of a large spill, appropriate tools will be used to place material in a suitable container for reclamation or disposal, using a method that does not generate dust.
Sulphuric Acid (H_2SO_4)	Corrosive; water-reactive; not combustible	Spills will be cleaned up immediately; emergency personnel will wear self-contained breathing apparatus, rubber boots and heavy rubber gloves; spilled material will be covered with sand, dry lime or soda ash, and place in a closed container and marked for disposal.
PAX (potassium amyl xanthate)	Corrosive; spontaneously combustible	In event of a spill, dust generation will be avoided, all sources of ignition removed, material will be collected for proper disposal, and measures to prevent chemical from entering the environment will be taken. In case of fire, flooding amounts of water will be used to stop the reaction as smothering will not work for these materials.
A208 (Diethyl Dithiophosphate)	Proprietary reagent	Spill response measures specific for this reagent will be developed and outlined in the MSDS.
3418A (Dialkyl Dithiophosphinate)	Proprietary reagent	Spill response measures specific for this reagent will be developed and outlined in the MSDS.
MIBC (Methyl Isobutyl Carbinol)	Flammable and combustible liquids (polar/water-miscible/noxious)	In event of spill, MIBC will be absorbed using an inert material (e.g., vermiculite, dry sand, earth) and placed in a chemical waste container. All ignition sources will be removed; personnel will wear personal protection equipment including a full face-piece respirator, protective clothing, boots, and gloves.
Flocculant (Magnafloc 336)	Proprietary reagent; Slippery; low corrosivity	Spills would be cleaned up immediately. Dry spills would be left dry and swept up. Avoid dust formation. If the polymer becomes wet, an absorbent material should be applied to the spill, then swept up and discarded; aluminum and galvanized equipment will be avoided.
Anti-scalant	Proprietary reagent; interferes with precipitation reactions	Spill response measures specific for this reagent will be developed and outlined in the MSDS.
Fuel Oil	Flammable and combustible liquids (non-polar/water-immiscible)	All ignition sources will be eliminated; spilled material will be absorbed or cover with dry earth, sand or other non-combustible material and transfer to containers. Large spills will be diked far ahead of liquid spill for later disposal. Measures will be taken to prevent entry into waterways, sewers, basements or confined areas. Water spray may be used to reduce vapor.
Lime (Calcium Oxide)	Toxic and/or corrosive (noncombustible/water sensitive)	Personnel will not get water inside containers, all ignition sources will be removed; water spray may be used to reduce vapors or divert vapor cloud drift. Material will be shoveled into waste disposal container. Dilute acid will be used to neutralize residuals.

(continued)

Table 7.4-1. Spill Response Measures for Specific Reagents (completed)

Process Plant Reagent	Description	Description of Reagent-specific Spill Response Measures
Ferric Chloride ($FeCl_3$)	Toxic and/or corrosive (non-combustible)	In case of spill, material will be put into an appropriate waste disposal container or absorb with an inert material (e.g., vermiculite, dry sand, earth); contact with water, and contact with runoff will be prevented.
Calcium Chloride ($CaCl_2$)	Normally stable; very soluble in water; not combustible; not corrosive	In case of spill, dust generation will be avoided, spilled material will be shoveled into containers, and the area will be flushed with water. Measures will be taken so that drainages or waterways are not contaminated.
Copper Chloride ($CuCl_2.2H_2O$)	Toxic and/or corrosive (non-combustible)	In case of spill, material will be put into an appropriate waste disposal container or absorb with an inert material (e.g., vermiculite, dry sand, earth). Contact with water, and contact with runoff will be prevented.
Antifoam	Proprietary reagent	Spill response measures specific for this reagent will be developed and outlined in the MSDS.
Liquid Chlorine (Sodium Hypochlorite)	Toxic and/or corrosive (non-combustible)	Wear self-contained breathing apparatus and protective clothing. Spills may be absorbed and neutralized into solutions of caustic soda or lime and placed in containers of suitable material.

Source: Reagent (MSDS; Transport Canada 2008)

8. Cumulative Risk Assessment

A traffic cumulative risk assessment (CRA) was conducted in response to concerns raise by the Working Group during the July 9, 2012 Traffic meeting. This section includes cumulative risk assessments of traffic effects on socio-economics and land use, fish and aquatic habitat, wildlife, terrestrial ecosystems, wetlands, climate and air quality, human health and heritage. The chapter is organized into the following sections:

- **Traffic Considered –** A description of traffic considered in the cumulative effects assessment including KSM and other projects related traffic.
- **Potential Cumulative Increases in Traffic –** A description of expected overall increase in the volume of development-related traffic.
- **Vehicle Collision Prediction Modelling –** Results of the analysis predicting the potential for cumulative traffic-related accidents, considering traffic from KSM and other projects.
- **Risk Assessment Methods –** A step-by step explanation of the cumulative risk assessment methods used to assess potential effects of traffic on environmental and socio-economic valued components (VCs).
- **Assessment of the Potential Risks of Cumulative Traffic –** An assessment of potential risks related to cumulative traffic, grouped by assessment topic (i.e., socio-economics, fish and aquatic habitat, wildlife, terrestrial ecosystems, wetlands, noise, climate and air quality, human health, and heritage).

8.1 TRAFFIC CONSIDERED

Current and reasonably foreseeable future traffic along highways 37 and 37A is considered in the cumulative risk assessment. Traffic estimates are based on publicly available information. Traffic from past projects is included in Section 2.1.3, Historical Traffic. Section 2.1.3 also explains the contributions of traffic from the Eskay Creek and Huckleberry mines, forestry, and other industry to historic traffic levels.

The cumulative risk assessment uses publicly available traffic estimates. An approximation is used, where possible, when information is not publicly available. For other mine projects, estimates of product-related haul traffic are calculated based on available concentrate production amounts or production rates, ore grades, and/or concentrate grades and on the assumption that 50-t trucks are used. Estimates of other mine traffic are calculated based on the KSM ratio between trips per day and production rate. Forestry has contributed to higher traffic volumes in the past and forestry traffic could increase again in the future, but publicly available information on planned activities (e.g., quantities of timber to be harvested) is not available. Information to base estimates of the potential cumulative increases in non-commercial vehicles on highways 37 and 37A are also not available.

The CRA aims on taking a conservative approach, as it:

- **considers operation phase traffic estimates –** the majority of proposed projects are mines, for which, the highest levels of traffic are expected to occur during the operation phase when product is being transported from site;

- **assumes all reasonably foreseeable mine and hydro projects will become operational –** most "foreseeable future projects" do not have approved EA certificates, and/or have not yet entered the EA process; any number of these projects, for one reason or another, may or may not become operational; and
- **assumes all projects will occur at the same time** – some projects may or may not operate at the same time as KSM or other projects considered (e.g., Wolverine Mine production may cease before KSM is operational; Snowfield Project is assumed to begin in 2027 once the Kutcho Mine Project has finished). It is unlikely that all projects considered will be operating at the same time.

Spatial overlap was evaluated by considering the Project-related traffic routes along highways 37 and 37A, and other proposed project traffic routes. Other present and future projects identified as sharing or potentially sharing highways 37 and 37A traffic routes with the KSM Project are shown in Figure 8.1-1. These projects include:

Present Projects:

- Forrest Kerr Hydroelectric;
- Red Chris Mine; and
- Wolverine Mine.

Reasonably Foreseeable Future Projects:

- Bronson Slope Mine;
- Brucejack Mine;
- Galore Creek Mine;
- Kitsault Mine;
- Kutcho Mine;
- McLymont Creek Hydroelectric;
- Schaft Creek Mine;
- Snowfield Project;
- Storie Moly Mine; and
- Turnagain Mine.

The location of each project and the overlapping transportation routes are illustrated in Figure 8.1-1. Further details regarding each project will be included in Chapter 5 of the Application/EIS.

8.2 POTENTIAL CUMULATIVE INCREASES IN TRAFFIC

Due to the number of proposed projects in the region (including the KSM Project), an overall increase in the volume of development-related traffic is expected. Estimated traffic volumes are presented in Table 8.2-1. Figures 8.2-1 and 8.2-2 further illustrate how KSM Project and cumulative traffic volumes are divided along transportation routes.

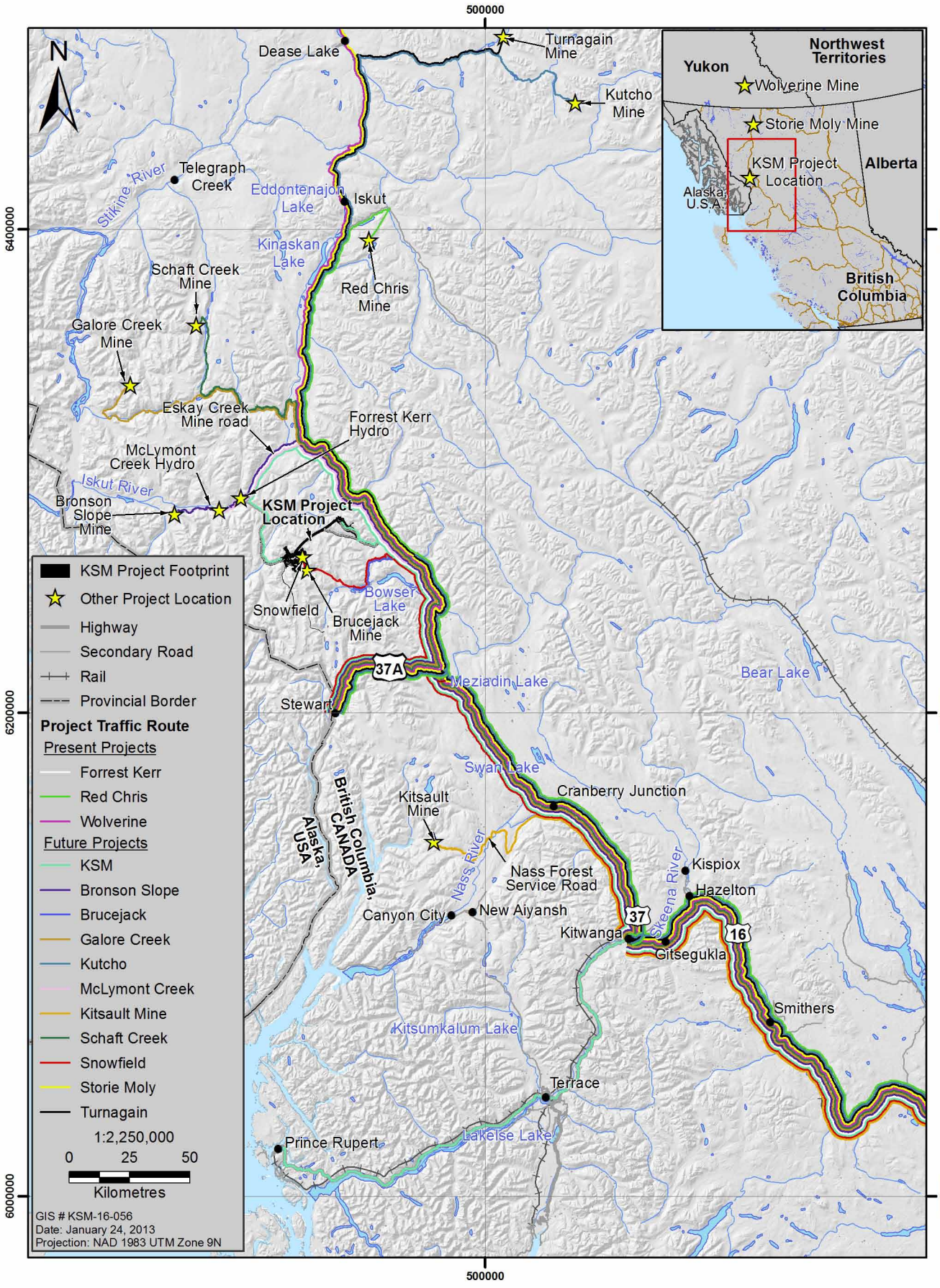

Figure 8.1-1

Present and Future Project Routes

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Table 8.2-1. Potential Cumulative One-way Trips per Day as a Result of KSM and Other Projects during Operation

Project		Estimated Timing of Operation	Average Annual Trips per Day for All Project Traffic per Highway Segment					
			Highway 37 North Segment			Highway 37 South Segment		
			Eskay Creek Mine Road to Treaty Creek Access Road	Treaty Creek Access Road to Newhawk Access Road	Newhawk Access Road to Meziadin Junction	Meziadin Junction to Cranberry Junction	Craberry Junction to Kitwanga	Highway 37A
Present	Forrest Kerr Hydroelectric**	2014-2074	1	1	1	1	1	0
	Red Chris Mine	2014-2042	39	39	39	11	11	28
	Wolverine Mine	2010-2019	19	19	19	1	0	18
Reasonably Forseeable Future	Bronson Slope Mine*	2022-2042	9	9	9	6	6	3
	Brucejack Mine*	2016-2032	0	0	12	1	1	11
	Galore Creek Mine*	2023-2033	70	70	70	36	36	34
	Kitsault Mine*	2016-2030	0	0	0	0	73	0
	Kutcho Mine*	2015-2027	13	13	13	1	1	12
	McLymont Creek Hydroelectric**	2016-2056	1	1	1	1	1	0
	Schaft Creek Mine*	2017-2032	111	111	111	57	57	54
	Snowfield Project*	2027-2054	0	0	83	45	45	38
	Storie Moly Mine*	2020-2040	9	9	9	8	8	1
	Turnagain Mine*	2017-2045	46	46	46	33	33	13
Total Non-KSM Project Traffic			318	318	413	201	273	212
KSM Project		2019-2071	3	85	85	49	49	36
Total Cumulative Traffic by Route			321	403	498	250	322	248
Estimated Baseline Traffic			224	224	224	799	799	244
Total Cumulative Traffic			545	627	722	1049	1121	492
Historical Peak Volume			1014	1014	1014	917	917	917
% Above Current Baseline			143%	180%	222%	31%	40%	102%
% of Historical Peak Volume			54%	62%	71%	114%	122%	54%
% of Highway 37 Capacity1			9%	10%	12%	17%	19%	n/a

Sources: BC EAO (2005); Tobin (2009); Wardrop (2010); Avanti Mining Inc. (2012).
** = unless otherwise referenced, estimates of product-related haul traffic were calculated based on available concentrate production amounts or production rates, ore grades, and/or concentrate grades and on the assumption that 50 tonne trucks are used. Estimates of cargo traffic were calculated based on ratios of trips per day to production rate for KSM and assumed to travel along highway 37 south to Highway 16 rather than through Stewart.*
*** = estimates were calculated based on the assumption that employees would stay in camp.*
Note: NTL is not included as only a limited amount (e.g., 0.05 trips per day) is expected.
[1]Based on Highway 37 modified capacity of 252 commercial vehicles per hour one-way (equivalent to 252 one-way trips per hour) or 6,048 one-way trips per day.

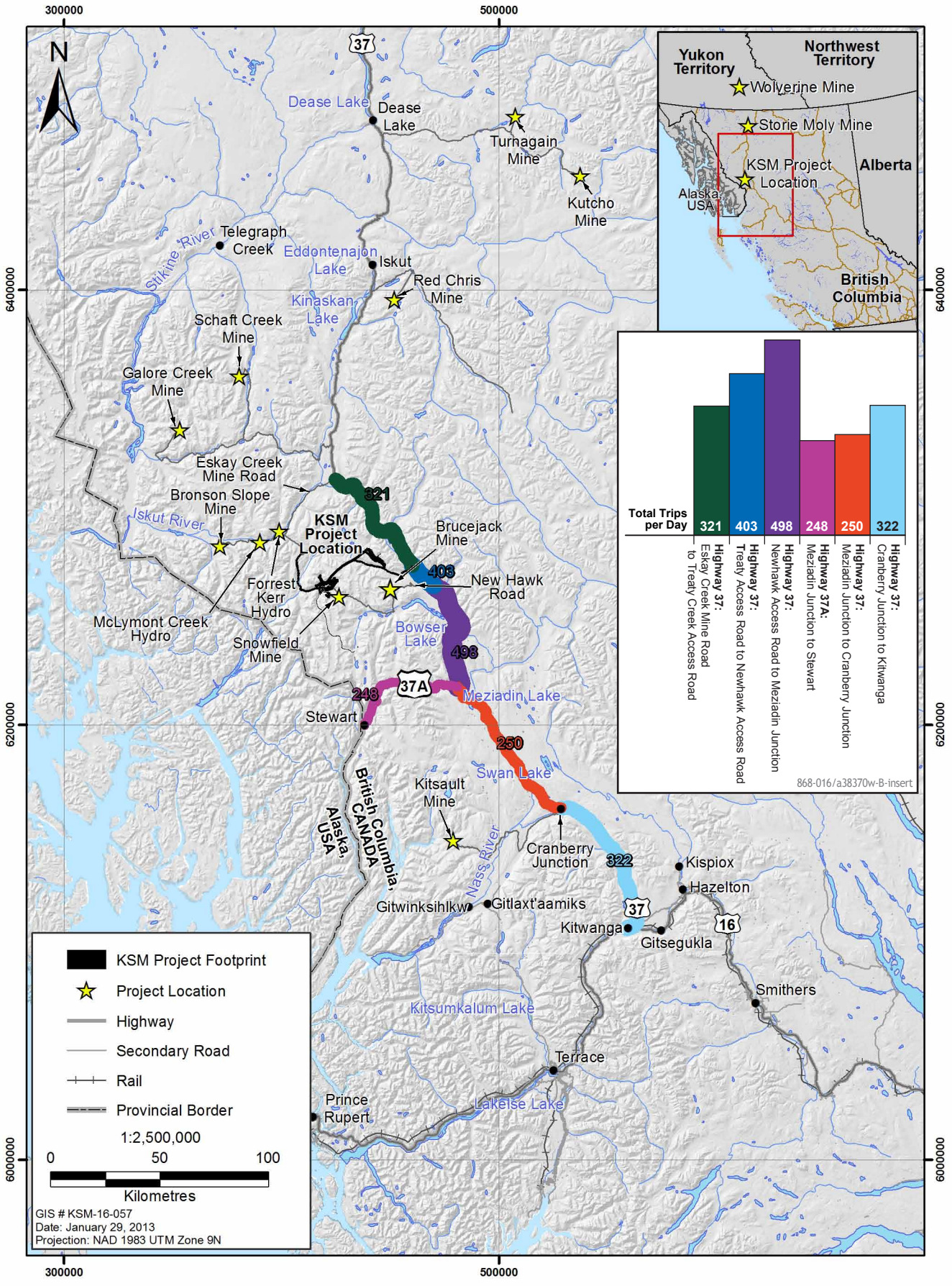

Figure 8.2-1

Potential Cumulative One-Way Trips per Day as a Result of KSM and Other Projects

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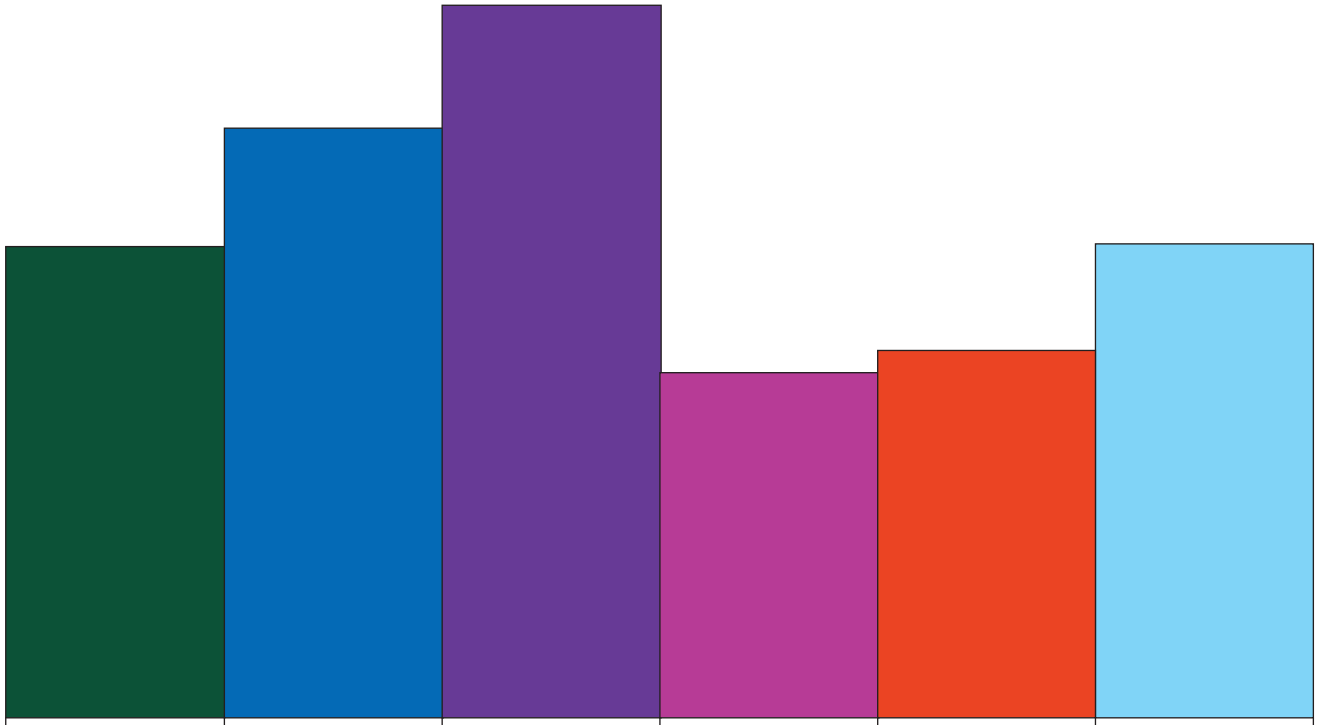

Total Trips per Day	321	403	498	248	250	322
Projects Included	Forrest Kerr Hydro Red Chris Mine Wolverine Mine Bronson Slope Mine Galore Creek Mine Kutcho Mine McLymont Creek Hydro Arctos Anthracite Mine Schaft Creek Mine Storie Moly Mine Turnagain Mine **KSM** *(Some cargo traffic)*	Forrest Kerr Hydro Red Chris Mine Wolverine Mine Bronson Slope Mine Galore Creek Mine Kutcho Mine McLymont Creek Hydro Schaft Creek Mine Storie Moly Mine Turnagain Mine **KSM**	Forrest Kerr Hydro Red Chris Mine Wolverine Mine Bronson Slope Mine Brucejack Mine Galore Creek Mine Kutcho Mine McLymont Creek Hydro Schaft Creek Mine Snowfield Project Storie Moly Mine Turnagain Mine **KSM**	Red Chris Mine Wolverine Mine Bronson Slope Mine Brucejack Mine Galore Creek Mine Kutcho Mine Schaft Creek Mine Snowfield Project Storie Moly Mine Turnagain Mine **KSM** *(Copper Concentrate traffic)*	Red Chris Mine* Wolverine Mine* Bronson Slope Mine* Brucejack Mine* Galore Creek Mine* Kutcho Mine* Schaft Creek Mine* Snowfield Project* Storie Moly Mine* Turnagain Mine* **KSM** *(Cargo and Molybdenum traffic)*	Red Chris Mine* Wolverine Mine* Bronson Slope Mine* Brucejack Mine* Galore Creek Mine* Kitsault Mine Kutcho Mine* Schaft Creek Mine* Snowfield Project* Storie Moly Mine* Turnagain Mine* **KSM** *(Cargo & Molybdenum traffic)*
Section of Road	**Highway 37:** Eskay Creek Mine Road to Treaty Creek Access Road	**Highway 37:** Treaty Access Road to Newhawk Access Road	**Highway 37:** Newhawk Access Road to Meziadin Junction	**Highway 37A:** Meziadin Junction to Stewart	**Highway 37:** Meziadin Junction to Cranberry Junction	**Highway 37:** Cranberry Junction to Kitwanga
					* Cargo traffic only	

Figure 8.2-2

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Potential Cumulative One-way Trips per Day

Figure 8.2-2

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8.3 CUMULATIVE VEHICLE COLLISION PREDICTION MODELLING

The CPMs used in Section 3.2 were also applied to the estimated cumulative traffic increases on highways 37 and 37A described in Table 8.2-1. used because the relationship between collision frequency and exposure is frequently non-linear (Sayed and de Leur 2008). Although it is unlikely that all projects listed in Table 8.2-1 will occur at the same time, all other projects were assumed to occur during the KSM operation phase (the period of highest Project-related traffic volumes). The results of the cumulative CPM analysis are presented in Figures 8.3-1 to 8.3-3 and summarized in Table 8.3-1.

Table 8.3-1. Predicted Number of Collisions per Year – Baseline vs. Cumulative Traffic

Collision Type	Highway 37 North Segment			Highway 37 South Segment			Highway 37 A		
	Baseline	Cumulative Traffic	Change	Baseline	Cumulative Traffic	Change	Baseline	Cumulative Traffic	Change
PDO	1.036	1.536	+0.500	3.693	3.829	+0.136	0.973	1.219	+0.246
Severe	1.525	2.006	+0.481	5.889	6.051	+0.162	1.016	1.300	+0.284
Total	**2.561**	**3.542**	**+0.981**	**9.582**	**9.880**	**+0.298**	**1.989**	**2.519**	**+0.530**

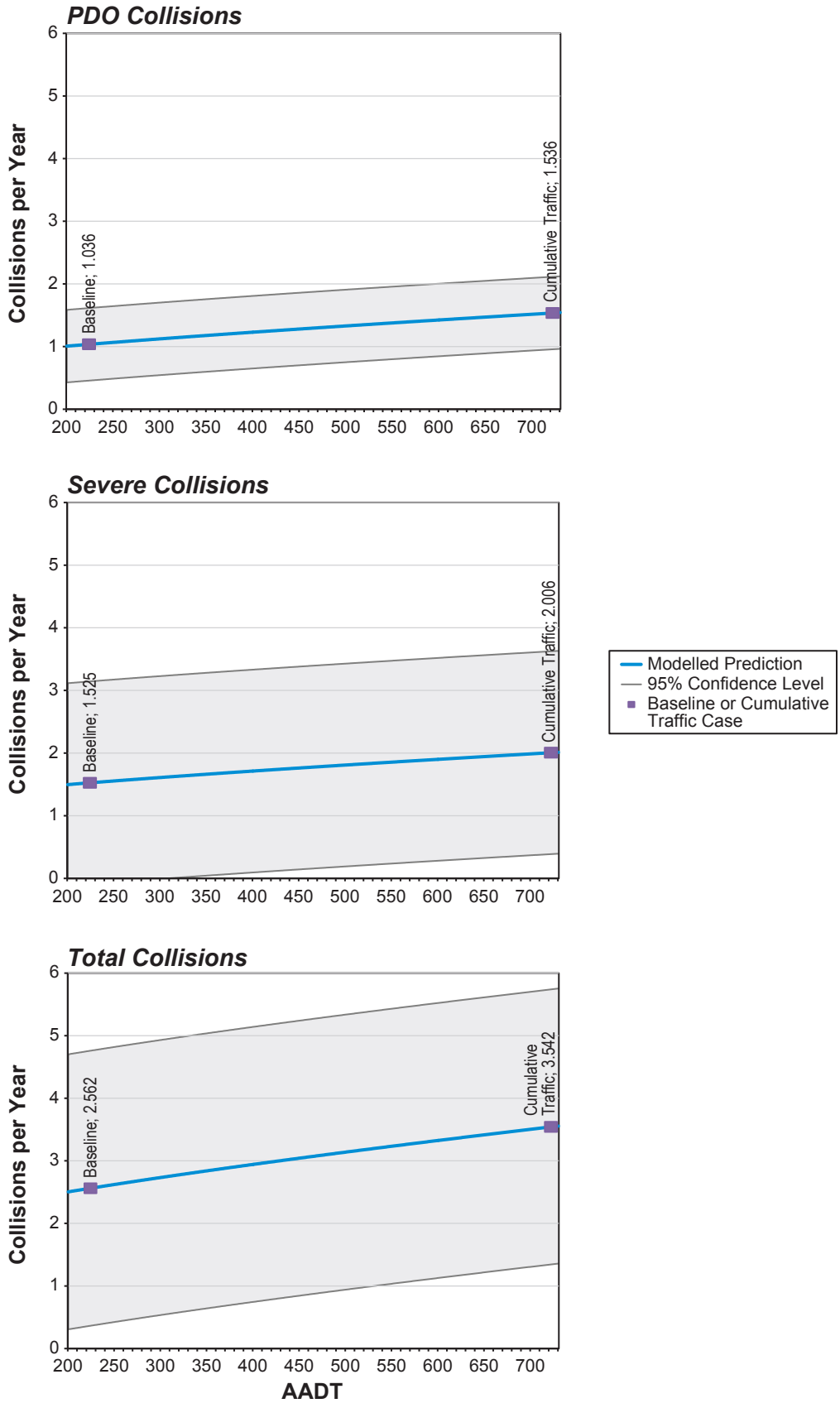
As in the Project-specific results (Section 3.2.3), the largest increase in collisions predicted by the model occurs on the northern segment of Highway 37: a total increase of 0.981 collisions (0.500 PDO collisions and 0.481 severe collisions). The southern segment of Highway 37 is predicted to have the smallest collision increase: 0.298 collisions per year (0.136 PDO collisions and 0.162 severe collisions). Highway 37A is predicted to experience a total increase of 0.530 collisions per year (0.246 PDO collisions and 0.284 severe collisions).

8.4 CUMULATIVE RISK ASSESSMENT METHODOLOGY

The CRA methodology follows a similar method to the one used to assess potential risks associated with Project traffic and traffic accidents along highways 37 and 37A. The CRA for each topic follows three steps:

1. **Review of traffic and potential for traffic accidents from other project's –** Traffic from other projects that has the potential to spatially and temporally overlap with KSM Project traffic along highways 37 and 37A was identified in Sections 8.1 and 8.2 (Step 1). Additionally, cumulative collision prediction modelling was completed in Section 8.3 to gain an understanding of potential increases in traffic accidents as a result of both KSM Project and other traffic;
2. **Cumulative issue scoping –** The Project-specific traffic risk assessment identified interactions between traffic-related risks and selected VCs for each environmental topic. Potential interactions between traffic-related risks and VCs were identified, are carried forward and considered in the CRA.
3. **Cumulative risk analysis –** Potential cumulative traffic-related risks to the VCs that were identified during issue scoping are characterized, as follows:
    a) **cumulative risk identification –** for each VC, potential risks associated with other project and activity traffic are identified and described;
    b) **cumulative risk mitigation** – for each potential cumulative risk, any additional measures proposed by the proponent to mitigate cumulative traffic risks are described; and
    c) **cumulative risk characterization –** taking additional mitigation measures into consideration, the likelihood and severity of any realized cumulative risks are characterized according to the definitions provided for each topic in Chapter 5.

Steps two and three are described in more detail in Sections 8.4-1 to 8.4-3, depicted in Figure 8.4-1.



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Predicted Number of Collisions per Year on Highway 37 North - Baseline Average Annual Daily Trips vs. Cumulative Traffic

Figure 8.3-1

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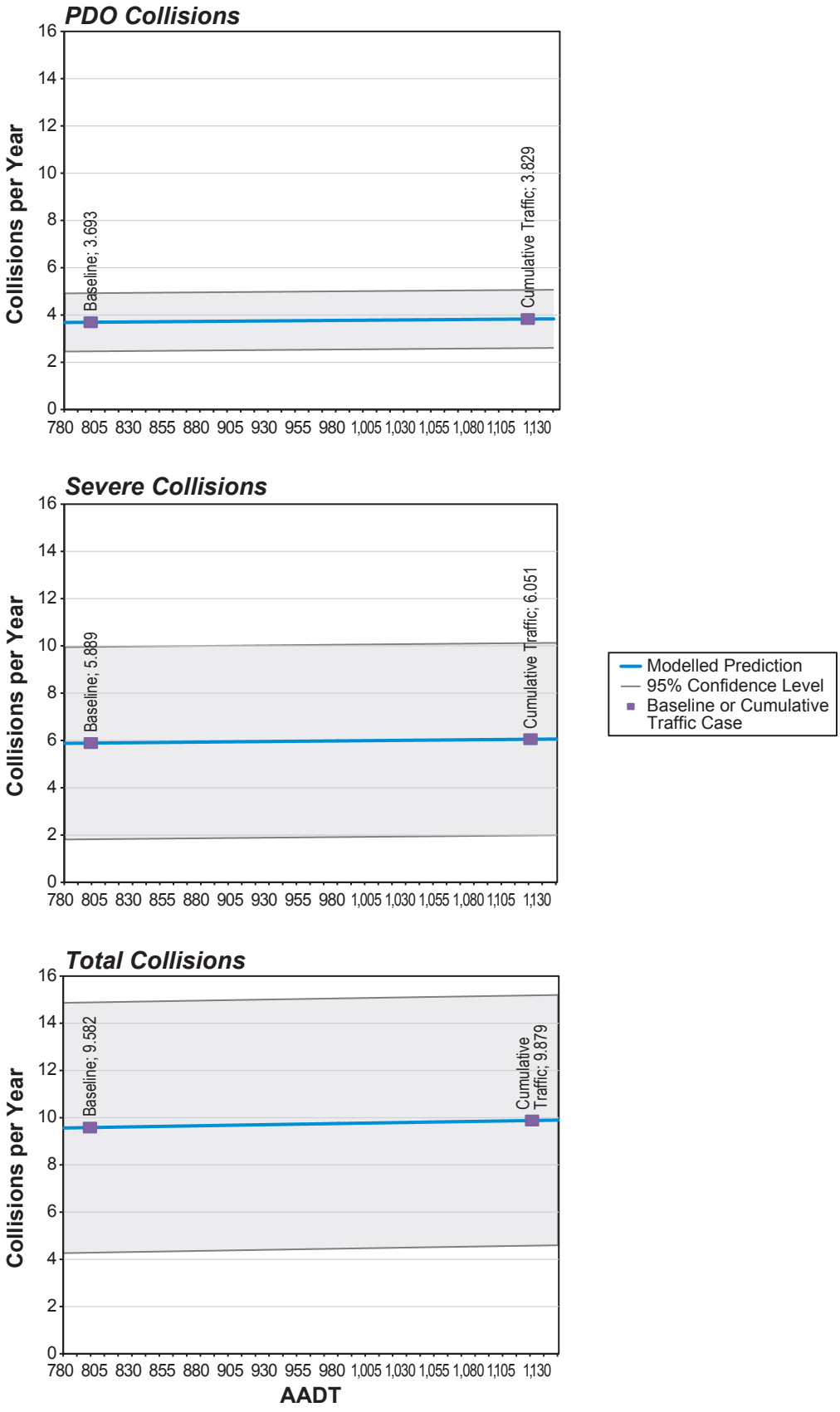

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Predicted Number of Collisions per Year on Highway 37 South - Baseline Average Annual Daily Trips vs. Cumulative Traffic

Figure 8.3-2

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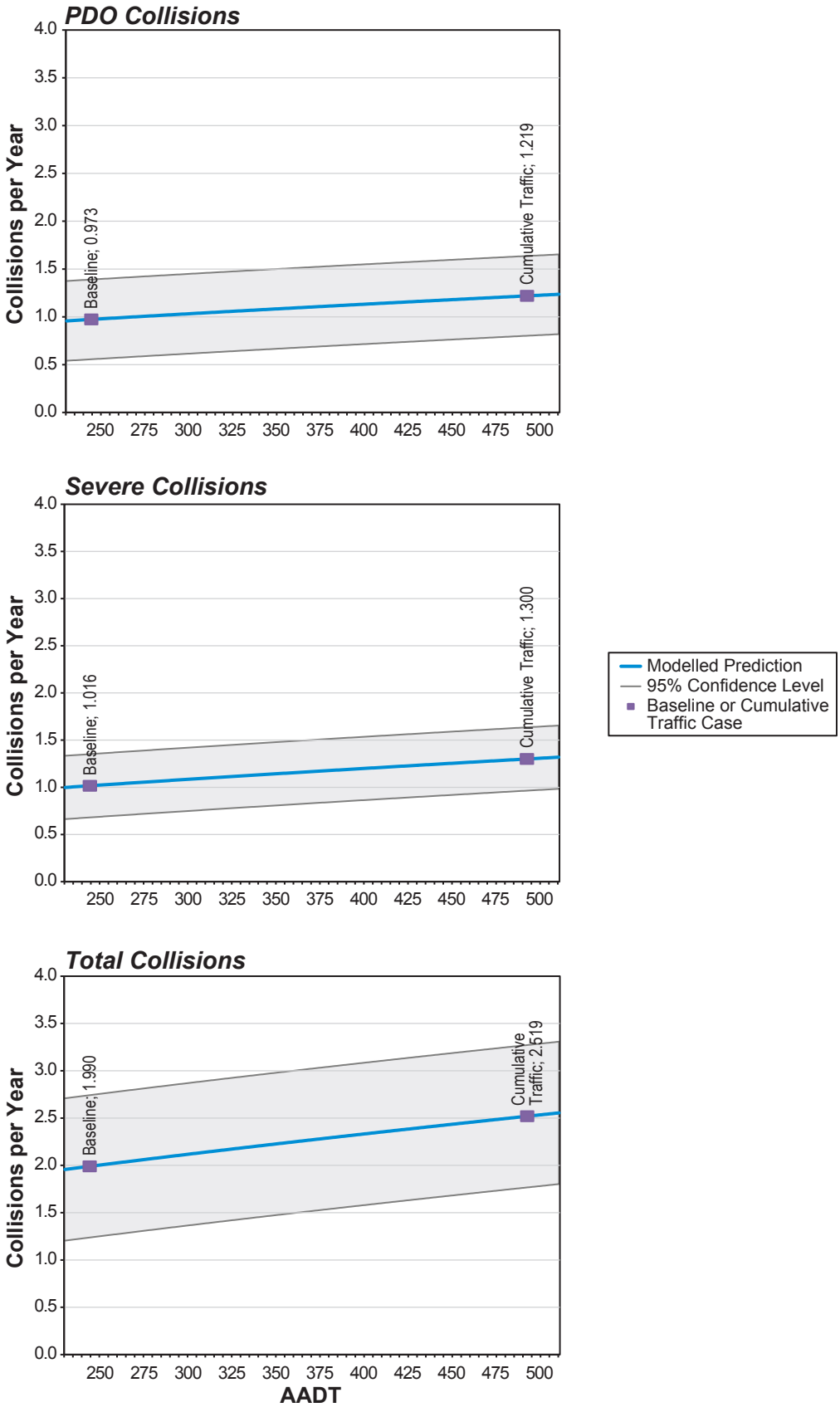

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Predicted Number of Collisions per Year on Highway 37A- Baseline Average Annual Daily Trips vs Cumulative Traffic

Figure 8.3-3

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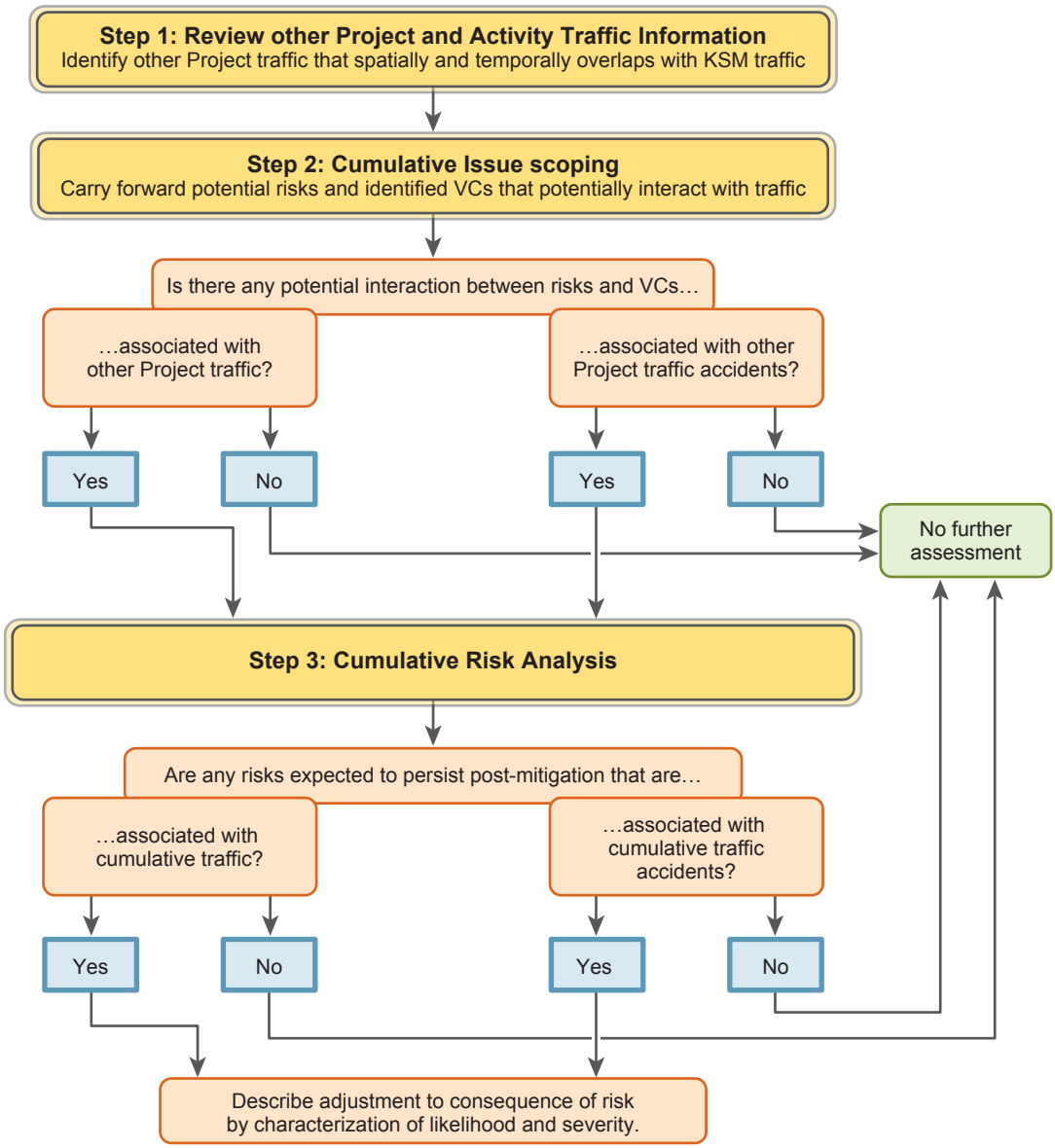

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Cumulative Risk Assessment Flow Chart

Figure 8.4-1

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8.4.1 Cumulative Issue Scoping (Step 2)

Using an interaction matrix, each potential Project-related traffic risk that was identified as interacting with identified VCs in Sections 5.1 through 5.9, is carried forward to the CRA. Each Project-traffic related risk is described in a table (see Example Table 8.4-1, where the example of wetlands is used). Details such as the project phase, the types of traffic or traffic accidents that the risk may be associated with are recorded.

Table 8.4-1. Potential Cumulative Interaction Matrix (Example)

Description of KSM Project-related Risk	Potential for Cumulative Interaction with Traffic from Other Projects
e.g., Deposition of deleterious substances into wetlands through vehicle crashes or hazardous cargo spills	*X*

"X" indicates that a potential interaction has been identified.
"-" indicates that no potential interaction was identified.

Project-specific risks are then considered in the context of the risks associated with other projects and activity traffic. If a Project-related risk has been fully mitigated or does not have the potential to interact cumulatively with traffic from other projects, then the cell in the matrix is left empty, a rationale as to why it is not likely to combine cumulatively with traffic from other projects is provided in the text, and no further consideration is given to that potential cumulative risk.

If there is a potential for interaction between a Project-related risk and that of traffic from other projects, that cell is marked with an "X" and the interaction is examined in detail. A marked cell does not indicate that there will be a cumulative risk, only that there is a potential for cumulative interaction.

Traffic from other projects considered is limited to those identified during Step 1, described in Sections 8.1.1 and 8.2.2.

8.4.2 Cumulative Risk Analysis (Step 3)

In the cumulative risk analysis: (a) interactions with traffic from other projects are examined; (b) any additional measures to mitigate cumulative traffic risks are described; and (c) the realized cumulative risk (a cumulative risk that cannot be fully mitigated) is characterized. Similar to the process for the characterization of Project-specific risks described in Section 4.4.3, cumulative risks are characterized in terms of their likelihood and severity.

8.4.2.1 Cumulative Risk Identification

Table 8.4-1 identified the potential interactions between Project-specific risks and risks associated with traffic from other projects. In the cumulative risk identification sections, the interaction is examined in detail. The potential synergistic and additive risks of overlapping cumulative traffic are described for each assessment topic.

8.4.2.2 Cumulative Risk Mitigation

The determination of likely mitigation by parties responsible for traffic from other projects is considered in the CRA. If applicable, these expected mitigation measures are described, as well as any additional mitigation commitments made by the Proponent to address potential cumulative risks.

8.4.2.3 Cumulative Risk Characterization

The resulting realized cumulative risks, post-cumulative mitigation, are briefly described in a final table. An example using wetlands is shown in Example Table 8.4-2.

Table 8.4-2. Assessment Matrix for Cumulative Risks (Example)

			Post-mitigation				
Valued Component	**Description of Potential Risk (pre-mitigation)**	**Description of Mitigation Measures**	**Likelihood**	**Severity**	**Likelihood Adjusted for CRA**	**Severity Adjusted for CRA**	**Description of Consequence of Realized Cumulative Risk**
e.g., Wetland Function	*e.g., Deposition of deleterious substances into wetlands through vehicle crashes or hazardous cargo spills*	*e.g., Limit the extent of contamination; limit the time a contaminant may be in contact with a wetland, and follow Spill Prevention and Emergency Response Plan*	*e.g., Unlikely*	*e.g., Major*	*e.g., Unlikely*	*e.g., Major*	*e.g., A loss of wetland function within a specific wetland or wetland complex*

Two aspects of cumulative risks, (1) the likelihood and (2) the severity of any risks that are expected to persist post-mitigation, are characterized in the table, using the same method described in Section 4.4.3. Cumulative risks are defined by demonstrating the expected adjustment, if any, to the Project-specific likelihood and severity.

If a particular risk was judged to be fully mitigated, this is indicated in the final column and the likelihood and severity adjusted for CRA columns are marked with "NA."

8.5 CUMULATIVE RISK OF TRAFFIC ON SOCIO-ECONOMICS AND LAND USE

All traffic from other projects identified in Sections 8.1 and 8.2, if approved and into operation, are expected to contribute to increased traffic volumes along highways 37 and 37A. If all combined projects proceed, historic traffic peaks may be exceeded on the southern segment of Highway 37. Most of the people who are resident in the Study Area (approximately 784 combined for Gitwangak and Gitanyow) live along this segment.

8.5.1 Cumulative Issue Scoping for Socio-economics and Land Use

As described in Section 5.1, CWB is a multi-dimensional concept that refers to individual and collective levels of health, satisfaction, quality of life, and standard of living (Kusel 1996; Costa, Silvana, and Scoble 2006; Sirgy et al. 2009).

Apart from CWB, no other socio-economic VC is anticipated to be at risk from Project-related traffic (see Section 5.1.2). Table 8.5-1 highlights each risk to CWB that was identified in Chapter 5. All identified risks to CWB (including reduced ambient air quality, nuisance from increased vehicle noise, and reduced public safety from both increased traffic and traffic accidents) have the potential to interact cumulatively with other traffic since traffic from all projects will be using Highway 37 and/or 37A to varying degrees.

Table 8.5-1. Potential Cumulative Interaction Matrix: Socio-economics and Land Use

Description of KSM Project-related Risk	Potential for Cumulative Interaction with Traffic from Other Projects
Reduced ambient air quality from increased vehicle emissions affecting CWB	X
Nuisance from increased vehicle noise affecting CWB	X
Perceived reduced quality of the natural environment affecting CWB	-
Reduced public safety resulting from an increase in traffic accidents affecting CWB	X
Reduced public safety resulting from traffic accidents, and potential spills of hazardous cargo affecting CWB.	X
Change in availability of wildlife resources affecting hunting and trapping.	X

"X" indicates that a potential interaction has been identified.
"-" indicates that no potential interaction was identified.

The effects of Project-specific traffic on perceived reduced quality of the natural environment is expected to be fully mitigated, by measures such as minimizing the number of trips required, following maintenance procedures and schedules provided by vehicle manufacturers, and using vehicle noise suppression technologies where possible. Therefore, does not have the potential to interact with the same effect from other traffic and is not considered further in this assessment.

Hunting and trapping was identified as a land use VC anticipated to be at risk as a result of changes in availability of moose and bear as resources. Additional traffic from both KSM and other projects have the potential to interact cumulatively with this effect (Table 8.5-1).

8.5.2 Cumulative Risk to Community Well-being

8.5.2.1 Cumulative Risk Identification

Ambient Air Quality Effects

Although any potential effects to ambient air quality are anticipated to be highly localized and experienced within 50 m of the highway corridor, Project traffic is expected to contribute to ambient air quality concentrations of CACs. Traffic from other projects' activities also has the potential to result in increased ambient air quality concentrations of CACs.

Noise Effects

With regards to nuisance impacts from KSM Project traffic-related noise, the risk from noise on CWB is expected to be negligible in the context of daytime activities and normal sleep patterns (see Sections 5.1.3 and 5.8.3.2). Cumulative increases in traffic volume has the potential to increase these risks to those living within 30 m of the highways.

While the noise level along highways 37 and 37A may be more consistently elevated from baseline conditions over a 24-hour period due to cumulative traffic increases, sound levels cannot be added in an arithmetic way. The sound pressure level from two equal sources has been shown to be only 3 dB higher than the sound pressure level of one source. For example, two trucks producing 90 dB each will combine to produce 93 dB, not 180 dB. In other words, a doubling of the noise source produces only a 3 dB increase in the sound pressure level (FHWA 1995). See Section 8.10 for a discussion of results from the cumulative noise model.

Reduced Public Safety/Increase in Accidents

A minor increase in traffic accidents (maximum 0.191 collisions per year along the north segment of Highway 37 during operation) is anticipated as a result of KSM Project activities. As shown in Section 8.3, even with cumulative project traffic, a maximum increase of only 0.959 collisions per year (along the north segment of Highway 37) is predicted. Traffic accident predictions were lower for other highway segments were lower.

8.5.2.2 Cumulative Risk Mitigation

Cumulative effects' mitigations for CWB are the same as those proposed in Section 5.1.3. No additional measures are considered necessary to address cumulative effects. Vehicle emissions and noise will be minimized using the following mitigation measures:

- switching fuel to more efficient blends;
- optimizing vehicle load rates to minimize the number of trips;
- following procedures and schedules provided by vehicle manufacturers to increase fuel efficiency and decrease noise;
- minimizing idling;
- ensuring diesel vehicles use low sulphur content fuel, as required by law;
- ensuring Project-related vehicles avoid local roads and remain on the highways;
- using vehicle noise suppression technologies where possible;
- avoiding the use of engine brakes near communities; and
- providing noise awareness training for Project transportation personnel.

Speed limits and other traffic rules will be enforced and adhered to by Project personnel. All contractors and workers will be required to adhere to the BC Occupational Health and Safety Regulation (BC Reg 296/97), as well as a zero-tolerance policy on alcohol and drugs. Procedures for emergency response and occupational first aid will be developed and workers and contractors will undergo required training. Information on weather and highway conditions will be made available to all Project drivers before departure. Finally, information regarding increases in traffic volume and type will be made available to local communities so that residents are aware of and/or can plan their activities along the highway accordingly (e.g., during large load transfers).

It is anticipated that other projects will adopt similar mitigation strategies as those proposed for the KSM Project.

8.5.2.3 Cumulative Risk Characterization

Ambient Air Quality Effects

Even with cumulative traffic, ambient air quality concentrations of CACs are well below BC air quality objectives and standards (Government of BC 2009b). Risk to ambient air quality as a result of cumulative traffic will not alter the highly localized nature of this risk. As the same kind of mitigation is expected to be used by all projects, the cumulative risk to CWB from changes in air quality remains minor in severity (see Table 8.5-2).

Table 8.5-2. Assessment Matrix for Cumulative Risks: Socio-economics and Land Use

Valued Component	Description of Potential Risk (pre-mitigation)	Description of Mitigation Measures	Post-mitigation				
			Likelihood	Severity	Likelihood Adjusted for CRA	Severity Adjusted for CRA	Description of Consequence of Realized Cumulative Risk
Community Well-being	Reduced ambient air quality from increased vehicle emissions	Using well-maintained vehicles to optimize combustion, using low sulphur fuel, minimize trips on highway	Possible	Minor	Possible	Minor	Reduced local ambient air quality with minimal risk to community well-being
Community Well-being	Nuisance from increased vehicle noise	Using well-maintained vehicles, minimize trips on highway	Likely	Minor	Likely	Moderate	Minor increase in noise levels on the southern segment of Highway 37, and a moderate increase in noise levels on the northern segment of Highway 37. Changes in noise levels are of a very localized nature
Community Well-being	Reduced public safety	Using well-maintained vehicles, minimize trips on highway, increase awareness/communicate traffic volumes and types to local communities	Possible	Minor	Possible	Minor	Increase of vehicle accidents and decreased public safety
Community Well-being	Accidents of varying severity leading to injury or death of drivers, passengers, and other highway users. Hazardous cargo spills from accidents may expose local residents or emergency responders to additional safety risks	Ensure appropriate signage along the highway corridor; enforce speed limits and other traffic rules; appropriate driver safety training; company zero-tolerance policy on alcohol; adhere to accident first aid, emergency response and other procedures; ensure emergency responders are appropriately equipped and maintained; highway maintenance, Increase awareness/communicate traffic volumes and types to local communities	Possible	Catastrophic	Possible	Catastrophic	Additional traffic from other projects may potentially increase the risk for accidents affecting human health and safety to a large degree, including death.
Hunting and Trapping	Change in availability of wildlife resources affecting hunting and trapping	Traffic Management Plan; Noise Management Plan; Fish and Aquatic Habitat Management Plan; Terrestrial Ecosystems Management and Monitoring Plans; Wildlife Management Plan	Possible	Minor	Possible	Moderate	Additional traffic from other projects may potentially increase the risk for wildlife-vehicle interactions and disruption of movement.

Noise Effects

For the assessment of KSM Project traffic on the north and south segments of Highway 37, the appropriate criteria for expected noise levels at the nearest receiver are met. Noise predictions considering cumulative increases in traffic, indicate that noise levels will approach the "absolute" criteria of 55 dBA set by the CMHC (1986) for Outdoor Recreation Areas on the north segment of Highway 37 and may have potential for disturbance. Cumulative noise levels on the south segment of Highway 37 are expected to remain below the maximum allowable increase in noise for that segment (BKL 2013, Appendix E). As a result the cumulative risk to CWB from changes in noise levels remains likely, but severity is adjusted to moderate (see Table 8.5-2).

Reduced Public Safety and Increase in Accidents

Considering mitigation, the effects to safety and direct human health risks from accidents resulting in spilled hazardous material cannot be eliminated; however, the increase in the predicted number of accidents is small (less than one additional accident per year). The cumulative risk to CWB from reduced public safety due to accidents remains possible, and ranging from minor to catastrophic depending on the severity of the accident (see Table 8.5-2).

8.5.3 Cumulative Risk to Hunting and Trapping

8.5.3.1 Cumulative Risk Identification

Cumulative Effect of Quantity of Resources

The proposed Project will be developed in an area that is characterized by remote and largely undeveloped wilderness. Land users in the Study Area, including subsistence users as well as commercial recreationalists, hunters and trappers, rely on wildlife in order to carry out their activities. Project traffic may contribute to a change in the quantity of these harvest resources due to disruption of wildlife movement. Increased pressure on wildlife as a result of wildlife collisions with vehicles in the Study Area could also contribute to a change in the quantity of resources.

Other present and foreseeable future traffic in the Study Area has the potential to act cumulatively by contributing to the potential increase in the disruption of movement and direct mortality of wildlife.

8.5.3.2 Cumulative Risk Mitigation

Potential risks of Project traffic to wildlife will be mitigated through actions such as giving the right-of-way to wildlife on the highways; adhering to posted speed limits; adhering to wildlife warning signs posted along the highways; documenting wildlife/vehicle interactions; and communicating the observance of wildlife to other trucks.

Changes in the availability of wildlife as a resource will be mitigated through the implementation of the Traffic and Access Management Plan, and it is expected that other large resource development projects would adopt mitigation and management measures similar to those of the KSM Project and comply with relevant government legislation with respect to wildlife.

To effectively address cumulative effects to moose caused by increased traffic along highways 37 and 37A, an integrated management strategy is required that includes all stakeholders that have regulatory oversight both with respect to transportation activities on provincial highways and for managing wildlife populations. Other stakeholders including road users, particularly heavy industrial traffic users, and Aboriginal groups that depend on the regional moose population for subsistence purposes (i.e., hunting) must also participate in the establishment of a management plan that addresses all proximal causes contributing to the predicted decline in the moose population. The Proponent is willing to participate in a regional initiative, approved and led by government agencies, with other stakeholders as described.

8.5.3.3 Cumulative Risk Characterization

With the additional effects of traffic from other projects, the severity of the effect on the quantity of resources is predicted to increase due to increased direct mortality, and is rated as moderate.

8.6 CUMULATIVE RISK OF TRAFFIC ON FISH AND AQUATIC HABITAT

All of the projects identified in the cumulative issue scoping exercise (Sections 8.1 and 8.2), if approved, are expected to contribute to increased traffic volumes along highways 37 and 37A.

8.6.1 Cumulative Issue Scoping for Fish and Aquatic Habitat

As described in Section 5.2, potential Project-specific traffic risks to both fish species and aquatic habitat are expected in the event of an accident resulting from spilled hazardous cargo. Spills as a result of Project traffic-related accidents was the only risk identified (see Table 5.2-1) and since this risk cannot be fully mitigated and traffic from other projects is using highway 37 and/or 37A to varying degrees, the risk to fish and aquatic habitat from hazardous cargo spills has the potential for cumulative interaction (Table 8.6-1).

Table 8.6-1. Potential Cumulative Interaction Matrix: Fish and Aquatic Habitat

Description of KSM Project-related Risk	Potential for Cumulative Interaction with Traffic from Other Projects
Accident-related spills of diesel fuel/lubricants, concentrates, lime/reagents, and/or explosives	X

"X" indicates that a potential interaction has been identified.
"-" indicates that no potential interaction was identified.

8.6.2 Cumulative Risk to Fish and Aquatic Habitat

8.6.2.1 Cumulative Risk Identification

Risks identified and analyzed in Section 5.2.3 are assumed to be the same for other Project traffic, especially considering other project traffic is mainly from mining projects that will also be carrying dangerous goods and hazardous materials to and from the respective project site. All risks from spills of fuel/lubricants, concentrate, lime/reagents, and explosives were characterized as being unlikely, as the risk of accidents along highways 37 and 37A are minimal even with the cumulative increase in traffic. Moreover, as long as a spill is limited to the immediate vicinity of the spill site, with effective mitigation measures, the temporal and spatial effects of a spill should be limited, particularly (as in the case of concentrates) when the spilled substance has low solubility in water.

8.6.2.2 Cumulative Risk Mitigation

Cumulative effects mitigations for spills are the same as those proposed in Section 5.2.3. Spills will be mitigated by implementing BMPs which are described in detail in the Spill Prevention and Emergency Response Plan. This plan provides specifications for preventing and controlling the release of spills during traffic accidents. Prompt containment and clean-up of spills is essential to mitigating risks to aquatic habitat and organisms. The plan will minimize response time and maximize clean-up efficiency, preventing long-term or geographically extensive effects.

Adhering to speed limits and safe traffic practices will prevent off-road accidents. Cyanide transportation will follow guidelines established in the International Cyanide Management Code (ICMI n.d.).

It is anticipated that other projects will adopt similar mitigation strategies as the KSM Project. Mitigation measures proposed for the KSM Project are standards stated in federal and provincial

guidelines, such as DFO's *Land Development Guidelines for the Protection of Aquatic Habitat* (DFO 1993), the DFO Pacific Region *Operational Statements* (DFO 2010), and a spill containment and emergency response plan , to which all projects are subject.

8.6.2.3 Cumulative Risk Characterization

Potential spills were assessed as unlikely to occur and negligible to moderate in severity (Table 8.6-2) due to their small size and since the implemented mitigation plan and BMPs will reduce the magnitude of any potential spill. Furthermore, the duration of any spill will be short, and fish and aquatic habitat will be able to recover and recolonize. As the same kind of mitigation is expected to be used by all projects, the cumulative risk to fish and aquatic habitat from accident-related spills will remain unlikely and negligible to moderate in severity.

8.7 CUMULATIVE RISK OF TRAFFIC ON WILDLIFE

All of the projects identified in the cumulative issue scoping exercise (Section 8.1 and 8.2) are expected to contribute to increased traffic volumes along highways 37 and 37A.

8.7.1 Cumulative Issue Scoping for Wildlife

Wildlife VCs identified in Section 5.3 include moose, bears, western toads, and birds. The potential effects to wildlife VCs from disruption of movement, direct mortality, and chemical hazards were identified in Section 5.3.3. Since these risks were not considered to be fully mitigated (see Tables 5.3-5 and 5.3-6), they have the potential for cumulative interaction (see Table 8.7-1), since all traffic from other projects will be using highways 37 and/or 37A to varying degrees.

8.7.2 Cumulative Risk Analysis for Moose

8.7.2.1 Cumulative Risk Identification

Disruption of Movement

The Project-specific traffic risk assessment predicted a minor risk of disruption of movement for moose (Section 5.3.3.1). Cumulative traffic from other potential traffic along highways 37 and 37A was evaluated for its cumulative potential to act as a barrier to movement for moose.

Moose may avoid crossing roads that have high traffic volumes. Thresholds above which moose in BC will not cross roads are unavailable. Müller and Berthoud (1997) used data from a variety of locations to distinguish three stepped levels of barrier effects based on road traffic: (1) Roads with less than 1,000 vehicles per day (42 vehicles per hour [VPH]) are permeable to most wildlife species (see grizzly bear for exception) — many individuals successfully cross roads at these traffic rates and casualties are limited; (2) Roads with traffic between 4,000 and 10,000 vehicles per day (166 to 416 VPH) impose a strong barrier to movement — noise and movements from the traffic will repel many individuals, and many that cross will get hit; and (3) Highways with traffic levels above 10,000 vehicles per day (more than 416 VPH) are impermeable to most species. These traffic rates were used as thresholds to evaluate effects of cumulative vehicle traffic along highways 37 and 37A on moose.

All of highways 37 and 37A within the Study Area were estimated to have hourly vehicular traffic rates below the traffic value threshold of 42 VPH (see Table 8.7-2), and hence roads are expected to be permeable to moose. The section of road with the highest estimated traffic rate (39.5 VPH) is projected to be along Highway 37 between Meziadin and the Newhawk access road. This rate was close to the threshold value of 42 VPH, and if traffic increases from sources not anticipated or accounted for in this analysis, the threshold could be exceeded in the future.

Table 8.6-2. Assessment Matrix for Cumulative Risks: Fish and Aquatic Habitat

Valued Component	Description of Potential Risk (pre-mitigation)	Description of Mitigation Measures	Post-mitigation				
			Likelihood	Severity	Likelihood Adjusted for CRA	Severity Adjusted for CRA	Description of Consequence of Realized Cumulative Risk
Fish and Aquatic Habitat	Accident-related spills of diesel fuel/lubricants, concentrates, lime/reagents, and/or explosives	Use of best management practices to minimize spill entry into waterbodies; enforced speed limits and traffic safety; adhere to Spill Containment and Emergency Response Plan; prompt containment and clean-up; concentrate dewatered to a low moisture content before transport	Unlikely	Negligible to Moderate	Unlikely	Negligible to moderate	Localized, short-term effects on fish and aquatic habitat. Negligible to major severity on a short term basis dependent on the type and volume of spill. Negligible to moderate effects outside of the immediate area of the spill.

Table 8.7-1. Potential Cumulative Interaction Matrix: Wildlife

Description of KSM Project-related Risk	Potential for Cumulative Interaction with Traffic from Other Projects
Disruption of movement	X
Direct mortality	X
Increase in chemical Hazards from accidental spills	X

"X" indicates that a potential interaction has been identified.
"-" indicates that no potential interaction was identified.

Table 8.7-2. Estimated Traffic Rates (Vehicles per Hour) of all Cumulative Risk Assessment Projects Based on Projected Traffic Estimates (all Projects) and Existing Background Traffic Levels

Road Segment	Traffic Rate (VPH) as Projected Traffic and Existing Background Traffic	Total Traffic (VPH) from all Projects Considered for the Cumulative Risk Assessment (including KSM)	# of Vehicles from KSM per Day (VPH and % of Total)
*Highway 37 (Eskay Creek Mine road to TCAR)	13.4 Projected Traffic 18.7 Background Traffic	*32.1	3 (0.1 VPH; 0.4%)
*Highway 37 (TCAR to Newhawk access road)	16.8 Projected Traffic 18.7 Background Traffic	*35.5	85 (3.5 VPH; 10%)
*Highway 37 (Newhawk access road to Meziadin Junction)	20.8 Projected Traffic 18.7 Background Traffic	*39.5	85 (3.5 VPH; 9.0%)
*Highway 37A (Meziadin Junction to Stewart)	10.3 Projected Traffic 18.7 Background Traffic	*29.0	36 (1.5 VPH; 5.2%)
*Highway 37 (Meziadin Junction to Cranberry Junction)	10.2 Projected Traffic 18.7 Background Traffic	*28.9	49 (2.0 VPH; 7.1%)

**indicates above threshold value for grizzly bears of 10 VPH at existing background traffic levels.*
TCAR = Treaty Creek access road.

Direct Mortality

The Project traffic risk assessment predicted a moderate risk of direct mortality for moose (Section 5.3.3.2). Cumulative traffic from all potential projects along highways 37 and 37A were evaluated for the cumulative potential to result in direct mortality of moose.

Increased traffic in the Study Area was evaluated for the potential to increase moose-vehicle collisions and thereby direct moose mortality. Due to the social, cultural, and economic importance of moose in the region, their sensitivity to moose-vehicle collisions, and concerns raised at KSM Working Group meetings, the potential cumulative effects of increased traffic were examined quantitatively, where possible. Data on moose populations were not available for all areas that may experience increased traffic. Hence, the analysis was conducted using data from the area south of the Study Area boundary and applied to the entire Study Area, as moose population data were only available for the Nass Wildlife Area (NWA).

Surveys of moose populations within the NWA, combined with hunting returns and estimates of existing moose mortality, provided sufficient data to conduct a quantitative Population Viability Analysis (PVA) for the highways 37 and 37A road corridor (Appendix D). The moose population in the NWA is declining, potentially due to overharvesting (Appendix D), as there were an estimated 1,595 animals in 2001,

638 animals in 2004, and 517 animals in 2011(Demarchi 2011). Although the majority of this area is south of the Study Area boundary for the traffic effects assessment, the PVA is used for this cumulative risk assessment to represent the cumulative effects of traffic on moose.

The PVA predicted that the increased traffic from the KSM Project would not cause a decline in the NWA moose population (Appendix D). However, results suggested that an additional increase in mortality, above what is expected due to KSM Project traffic, could cause the population to decline. Hence, assuming conditions remain constant (much-reduced moose population, current hunting rates, etc.), if all projects in the Study Area were to operate simultaneously, the PVA predicted that moose-vehicle collisions from these projects may be sufficient to have an effect on the moose population in the NWA.

Chemical Hazards

Habitats along the highway used by moose, particularly the calving area on the Bell-Irving River below Bell II, may be vulnerable to effects from traffic accidents, such as chemical spills. Considering the cumulative traffic from all projects, the risk of vehicle accidents remains (Section 8.3), and it is possible that individuals may ingest chemicals through soil, water, or vegetation, particularly if the contaminant is in the form of a salt. Although effects on individuals are possible, the fact that moose move great distances indicate that no population level effects from exposure to chemicals along the highway in the event of a spill are expected to occur. An event of this nature occurring is unlikely.

8.7.2.2 Cumulative Risk Mitigation

With respect to direct mortality, it is expected that all other projects will include similar mitigation measures as adopted by the KSM Project and will follow all relevant legislation, regulations, and BMPs for the activities that they carry out. To effectively address cumulative effects to moose caused by increased traffic along highways 37 and 37A, an integrated management strategy is required that includes all stakeholders that have regulatory oversight both with respect to transportation activities on provincial highways and for managing wildlife populations. Other stakeholders including road users, particularly heavy industrial traffic users, and Aboriginal groups that depend on the regional moose population for subsistence purposes (i.e., hunting) must also participate in the establishment of a management plan that addresses all proximal causes contributing to the predicted decline in the moose population. The Proponent is willing to participate in a regional initiative, approved and led by government agencies, with other stakeholders as described.

It is expected that spills will be mitigated by following a spill prevention and emergency response plan. Part of this plan would be immediate clean-up, which will minimize if not eliminate effects on wildlife receptors. In addition, wildlife would be excluded from the spill site until effective clean-up of the area. However, in the event of a major spill, soil, water, and vegetation within the spill area will be monitored to ensure that the chemical levels are within the appropriate regulatory guidelines.

8.7.2.3 Cumulative Risk Characterization

Disruption of Movement

Assuming other projects will be adopting similar mitigation measures, it is still possible that disruption of movement to moose may occur as a result of increased traffic on the highways (particularly Highway 37), but the severity is expected to be minor (see Table 8.7-3).

Table 8.7-3. Assessment Matrix for Cumulative Risks: Wildlife

Valued Component	Description of Potential Risk (pre-mitigation)	Description of Mitigation Measures	Post-mitigation				
			Likelihood	Severity	Likelihood Adjusted for CRA	Severity Adjusted for CRA	Description of Consequence of Realized Cumulative Risk
Moose	Disruption of Movement	Adhere to speed limits and wildlife warning signs along highways, give wildlife right of way, limit traffic disturbance where possible	Possible	Minor	Possible	Minor	Roads with traffic may act as a barrier to movement for a few individual moose.
	Direct Mortality	Adhere to and enforce speed limits, yield to wildlife along roads, document vehicle-wildlife interactions, communicate observations of wildlife to other trucks	Possible	Moderate	Unlikely	Major	An average of approximately 20 moose are killed per year due to vehicle collisions along Highway 37 between Kitwanga and Burrage (within the Study Area). Cumulative project traffic will increase the traffic volume along the highways and direct mortality to moose is possible.
	Chemical Hazards (Traffic Accidents)	Spills will be mitigated as per the Emergency Response and Spill Management Plan. Part of the spill response plan is immediate cleanup, which will minimize if not eliminate effects on wildlife receptors. Wildlife will be excluded from the spill site if cleanup cannot occur immediately.	Unlikely	Minor	Unlikely	Minor	In the rare event of a traffic accident, chemical hazards may pose a risk to moose. It is anticipated that the cleanup will occur immediately and moose will be excluded from the spill site, reducing the risk.
Grizzly and Black Bears	Disruption of Movement	Adhere to speed limits and wildlife warning signs along highways, give wildlife right of way, limit traffic disturbance where possible	Possible	Minor	Possible	Minor	Roads with traffic may act as a barrier to movement for a few individual bears.

(continued)

Table 8.7-3. Assessment Matrix for Cumulative Risks: Wildlife (completed)

Valued Component	Description of Potential Risk (pre-mitigation)	Description of Mitigation Measures	Post-mitigation				
			Likelihood	Severity	Likelihood Adjusted for CRA	Severity Adjusted for CRA	Description of Consequence of Realized Cumulative Risk
Grizzly and Black Bears *(cont'd)*	Direct Mortality	Adhere to and enforce speed limits, yield to wildlife along roads, document vehicle-wildlife interactions, communicate observations of wildlife to other trucks	Possible	Minor	Possible	Minor	Between 1991 and 2010, there were 29 reported vehicle accidents (average 1.5 bears/year) with bears along Highway 37 near the KSM Project. Cumulative project traffic will increase the traffic volume along the highways and direct mortality to bears is possible.
	Chemical Hazards (Traffic Accidents)	Spills will be mitigated per the Emergency Response and Spill Management Plan. Part of the spill response plan is immediate cleanup, which will minimize if not eliminate effects on wildlife receptors. Bears will be excluded from the spill site if cleanup cannot occur immediately.	Unlikely	Minor	Unlikely	Minor	In the rare event of a traffic accident, chemical hazards may pose a risk to bears. It is anticipated that the cleanup will occur immediately and bears will be excluded from the spill site, reducing the risk.
Western Toads	Direct Mortality	Adhere to and enforce speed limits, document vehicle-wildlife interactions where possible	Possible	Minor	Possible	Minor	Western toads may be impacted by increased traffic if migration events occur across the highways.
	Chemical Hazards (Traffic Accidents)	Spills will be mitigated per the Emergency Response and Spill Management Plan. Part of the spill response plan is immediate cleanup, which will minimize the effects on toads.	Unlikely	Moderate	Unlikely	Moderate	In the rare event of a traffic accident, chemical hazards may pose a risk to western toads if the spill occurs in a wetland occupied by toads.
Birds	Direct Mortality	Adhere to and enforce speed limits, document vehicle/wildlife interactions where possible.	Possible	Minor	Possible	Minor	Mortality events involving flocking bird species (e.g., pine siskin or crossbill) and vehicles may occur along the highway, particularly in winter or spring.

Direct Mortality

Assuming other projects will be adopting similar mitigation measures, it is still possible that disruption of movement to moose may occur as a result of increased traffic on the highways (particularly Highway 37). Moose have already been pushed below their natural population level in the Nass Wildlife Area by hunting and/or other factors, and the moose vehicle collision modelling indicates that the cumulative effect of all project traffic (regardless of KSM) will depress survival below the 2.5% surplus mortality that the population currently has (although KSM alone would not cause the moose population to decline). For these reasons, severity is adjusted moderate to major.

However, because the model structure is posited to cause it to be overly sensitive to small reductions in survival, the level of future industrial development along the highway 37 corridor is uncertain, and it is unlikely that all currently proposed mine projects will be developed at the same time, the likelihood of this effects is adjusted from possible to unlikely.

Chemical Hazards

Assuming other projects will be adopting similar mitigation measures, the likelihood of vehicle crashes or hazardous cargo spills into moose habitat will still be unlikely and the severity will be minor, depending on the location and the amount of time that lapses between occurrence and clean-up (see Table 8.7-3).

8.7.3 Cumulative Risk Analysis for Bears

8.7.3.1 Cumulative Risk Identification

Disruption of Movement

The Project-specific traffic risk assessment predicted a minor risk of disruption of movement for grizzly and black bears (Section 5.3.3.1). Cumulative traffic from all potential projects along highways 37 and 37A was evaluated for the cumulative potential to act as a barrier to movement for bears.

Traffic along the highway may disrupt movements of grizzly bears. Waller and Servheen (2005) reported that bears will cross roads when traffic volumes are less than 10 VPH, but natural crossing rates can be disrupted when traffic rates exceed this value. Traffic volumes from all present and future projects were converted to hourly rates based on an assumed 24-hour driving day along the highways in the Study Area, because industrial driving occurs throughout a 24-hour period. Background traffic data were estimated from periodic traffic counts taken in 2005 and 2008 on Highway 37, north of Meziadin Junction and in 2006 north of Dease Lake (BC MOTI 2011d).

The average background traffic of 224 vehicles per day was converted to an hourly rate based on an assumed 12-hour driving day, because most driving occurs between 7 a.m. and 7 p.m. Therefore a background traffic rate of 18.7 VPH was added to all sections of Highway 37 and 37A (Table 8.7-2).

The background traffic levels on highways 37 and 37A are approximately twice the 10 VPH threshold, potentially causing a detectable barrier to grizzly bear movement across the highway (Waller and Servheen 2005). The addition of all projects to the baseline brings the total traffic to approximately three times over the threshold on highways 37 and 37A (Table 8.7-2). Traffic due to the KSM Project alone is not enough to cause a disruption of movement for grizzly bears (maximum addition of 3.5 VPH).

The prediction that highways 37 and 37A are currently acting as a barrier to grizzly bear movement may affect the bear populations by fragmenting the population, which increases the chance of local population fluctuations (Lande 1988; Woodroffe and Ginsberg 1998) and reduced gene flow across the

barrier (Frankham, Ballou, and Briscoe 2002). The highway may also cause changes to energy budgets of bears that have to travel farther to reach seasonal habitats or that may be excluded from good quality habitat. However, these effects are potentially already occurring at baseline conditions, prior to addition of projected traffic.

Direct Mortality

The Project-specific traffic risk assessment predicted a minor risk of direct mortality for grizzly and black bears (Section 5.3.3.2). Cumulative traffic from all potential projects along highways 37 and 37A were evaluated for the cumulative potential to result in direct mortality of bears.

Vehicle strikes could increase in some parts of the Study Area due to increased traffic from multiple projects. The number of mortalities due to vehicles strikes may increase with traffic levels (as was predicted for moose) or may remain constant. Grizzly bears are known to avoid highways at even low traffic levels (Section 8.7.2.1), which may act to curb any increases in traffic mortality.

Chemical Hazards

Habitats along the highways may be used by bears during spring, summer, and fall (near salmon spawning habitat). Considering the cumulative traffic from all projects, the risk of vehicle accidents remains (Section 8.3), and it is possible that individuals may ingest chemicals through soil, water, vegetation, and prey in the event of a traffic accident and accidental spill. Although effects on individuals are possible, the relatively large home ranges of grizzly bears, and the fact that their home ranges do not substantially overlap, indicate that no population level effects from exposure to chemicals along the highway in the event of a spill are expected to occur.

8.7.3.2 Cumulative Risk Mitigation

The Proponent will consider participating in government-led monitoring programs by contributing to regionally based monitoring initiatives where those monitoring initiatives replace proposed KSM Project-specific monitoring and are approved by relevant provincial authorities and stakeholders.

It is expected that all other projects will follow relevant acts, regulations, and BMPs for the activities that they carry out. Projects may also be required to participate in any regional, provincially led, joint venture monitoring and mitigation programs that would allow for adaptive management to be triggered when cumulative traffic rates are causing a disruption to grizzly bear movements that threaten the population.

It is expected that for other projects, spills will be mitigated by following a spill prevention and emergency response plan. Part of this plan would be immediate clean-up, which will minimize if not eliminate effects on wildlife receptors. In addition, wildlife would be excluded from the spill site until effective clean-up of the area. However, in the event of a major spill, soil, water, and vegetation within the spill area will be monitored to ensure that the chemical levels are within the appropriate regulatory guidelines.

8.7.3.3 Cumulative Risk Characterization

Disruption of Movement

Assuming other projects will be adopting similar mitigation measures, it is still possible that disruption of movement to bears may occur as a result of increased traffic on the highways, but the severity is expected to be minor (see Table 8.7-3).

Direct Mortality

Assuming other projects will be adopting similar mitigation measures, it is still possible that vehicle-bear collisions may occur resulting in direct mortality due to cumulative traffic from all projects on the highways. The severity will be minor; even though traffic volumes will be increasing, the number of animal collisions may not increase by an equal percentage (see Table 8.7-3).

Chemical Hazards

Assuming other projects will be adopting similar mitigation measures, the likelihood of vehicle crashes or hazardous cargo spills into bear habitat will still be unlikely and the severity will be minor, depending on the location and the amount of time that lapses between occurrence and clean-up (see Table 8.7-3).

8.7.4 Cumulative Risk Analysis for Western Toads

8.7.4.1 Cumulative Risk Identification

Direct Mortality

The project-specific traffic risk assessment predicted a minor risk of direct mortality for western toads (Section 5.3.3.2). Cumulative traffic from all potential projects along highways 37 and 37A were evaluated for the cumulative potential to result in direct mortality of western toads.

Direct mortality of adults and newly emerged terrestrial juveniles may occur near roads and close to wetlands during the spring and late summer. The risk of direct mortality may increase as cumulative traffic is added to the area. Increases in traffic rates due to additional projects within the Study Area could increase the risk of vehicle collisions for western toads.

Chemical Hazards

Western toads have the potential to be exposed to chemicals in the event of a traffic accident involving the spill of chemicals into a wetland occupied by western toads. Considering cumulative traffic from all projects the risk of vehicle accidents remains (Section 8.3) and toads could be exposed to the chemicals via the ingestion of soil, water, and prey species and via dermal absorption. When considering the cumulative traffic from all projects, an event of this nature occurring is possible, but unlikely (Section 8.3).

8.7.4.2 Cumulative Risk Mitigation

It is expected that all other projects will include similar mitigation measures as adopted by the KSM Project and will follow all relevant acts, regulations, and BMPs for the activities that they carry out.

Additionally, it is expected that other projects' spills will be mitigated by following a spill prevention and emergency response plan that is developed specific to each project. Part of such plans should be immediate clean-up, which should minimize if not eliminate effects on wildlife receptors. In addition, wildlife would be excluded from the spill site until effective clean-up of the area. However, in the event of a major spill, soil, water, and vegetation within the spill area will be monitored to ensure that the chemical levels are within the appropriate regulatory guidelines.

8.7.4.3 Cumulative Risk Characterization

Direct Mortality

Assuming other projects will be adopting similar mitigation measures, western toad mortality is still possible along the highways, but the severity will be minor, as traffic already exists on the highways (see Table 8.7-3).

Chemical Hazards

Assuming other projects will be adopting similar mitigation measures, the likelihood of vehicle crashes or hazardous cargo spills into western toad breeding habitat will still be unlikely; however, the severity of the event if it occurred could be moderate, depending on the location (i.e., breeding pond) and the amount of time that lapses between occurrence and clean-up (see Table 8.7-3).

8.7.5 Cumulative Risk Analysis for Birds

8.7.5.1 Cumulative Risk Identification

The Project-specific traffic risk assessment predicted a minor risk of direct mortality for birds (Section 5.3.3.2). Cumulative traffic from all potential projects along highways 37 and 37A were evaluated for the cumulative potential to result in direct mortality of birds.

Direct mortality of birds, particularly flocking species such as pine siskins and crossbills, may occur as a result of increased traffic along the highways. Most road mortalities to these species occur during winter or early spring (Campbell et al. 1997). Crossbills, grosbeaks, and siskins are particularly vulnerable to vehicle collisions on highways, as they are attracted to road salts, gravel, and sand (Mineau and Brownlee 2005). It has also been noted that high traffic volume roads can have a repelling or avoidance effect on small vertebrates, thus potentially decreasing the risk of mortality to birds (Clevenger, Chruszcz, and Gunson 2003). When the cumulative traffic from all projects combined is considered, it is likely that the road would have an avoidance effect, rather than increase mortality to birds.

8.7.5.2 Cumulative Risk Mitigation

It is expected that all other projects will include similar mitigation measures as adopted by the KSM Project and will follow all relevant acts, regulations, and BMPs for the activities that they carry out.

8.7.5.3 Cumulative Risk Characterization

Assuming other projects will be adopting similar mitigation measures, it is still possible that bird mortality may occur along the highways; however, the severity will be minor (see Table 8.7-3).

8.8 CUMULATIVE RISK OF TRAFFIC ON TERRESTRIAL ECOSYSTEMS

All of the projects identified in the cumulative issue scoping exercise (Section 8.1 and 8.2) are expected to contribute to increased traffic volumes along highways 37 and 37A.

8.8.1 Cumulative Issues Scoping for Terrestrial Ecosystems

The potential impact to terrestrial ecosystems (including rare and sensitive ecosystems, old growth forests, and other terrestrial ecosystems) from invasive plants, wildfires and chemical contamination were identified in Section 5.4.3. Since these risks were not considered to be fully mitigated (see Tables 5.4-5 and 5.4-6), they have the potential for cumulative interaction (see Table 8.8-1), since all project traffic will be using Highway 37 and/or 37A to varying degrees.

Table 8.8-1. Potential Cumulative Interaction Matrix: Terrestrial Ecosystems

Description of KSM Project-related Risk	Potential for Cumulative Interaction with Traffic from Other Projects
Increase in invasive plants	X
Increase in wildfire incidence	X
Increase in chemical contamination from spills	X

"X" indicates that a potential interaction has been identified.
"-" indicates that no potential interaction was identified.

8.8.2 Cumulative Risk Analysis for Terrestrial Ecosystems

8.8.2.1 Cumulative Risk Identification

Invasive Plant Species

As discussed in Section 5.4.3, risks to old growth forests or rare and sensitive ecosystems from invasive plant species is unlikely, with a negligible severity rating, since invasive plants do not thrive in the low light conditions of these ecosystems. It is likely, however, that invasive plants could propagate in other terrestrial ecosystems, along the forest edge near the highway. Cumulative increases in traffic, then, could only have a potential effect on invasive plants along the forest edge.

Wildfires

As discussed in Section 5.4.3, the low baseline level of fire incidence in this area of BC makes the probability of a wildfire due to increased traffic to be rare. Cumulative increases in traffic would only increase the risk of wildfires if other projects did not have their own mitigation measures in place.

Chemical Contamination

As discussed in Section 5.4.3, after mitigation, the likelihood of chemical contamination to Terrestrial Ecosystem VCs is rare. Cumulative increases in traffic would only increase the risk of chemical contamination if other projects did not have their own mitigation measures in place, which they are required to have by law.

8.8.2.2 Cumulative Risk Mitigation

Cumulative effects mitigations for invasive plants are the same as those proposed in Section 5.4.3. Preventing the initial establishment of invasive plants is the most effective method of control (Clark 2003; Polster 2005; BC MOFR 2010a). Where risk of invasive plant introduction and establishment is identified, appropriate action will be taken. Identification of target plants will be based on the management plans outlined by the Northwest Invasive Plant Council (NIPC 2011).

Cumulative effects mitigations for wildfires are the same as those proposed in Section 5.4.3. Preventing an increase in wildfire incidence will involve reducing the risk of vehicle accidents and enacting strong policies requiring the proper disposal of smoking materials. Reduction of vehicle accidents will be accomplished with policies that address vehicle maintenance, speed limits, driver attention, drug and alcohol prohibition, and driving under poor weather conditions.

Cumulative effects mitigations for spills are the same as those proposed in Section 5.4.3. Preventing the introduction of deleterious substances into the environment is the most effective way to avoid effects to terrestrial VCs. Specific preventative measures that will be implemented include conducting a vehicle assessment (for oil leaks, secure cargo, etc.), checking road conditions prior to departure,

maintaining an appropriate driving distance between vehicles, adhering to speed limits, and adjusting driving styles to suit road conditions.

In the event of a spill, the guidelines and procedures outlined in the Proponent's Spill Prevention and Emergency Response Plan will be followed in order to avoid contamination and degradation of terrestrial VCs. However, in the event of a major spill, soil, water, and vegetation within the spill area will be monitored and managed to ensure that the chemical levels are within the appropriate regulatory guidelines.

It is anticipated that other projects will adopt similar mitigation strategies as the KSM Project.

8.8.2.3 Cumulative Risk Characterization

Invasive Plant Species

As the same kind of mitigation is expected to be used by all projects, the cumulative effect of invasive plants will remain likely but negligible in severity (see Table 8.8-2).

Wildfires

As the same kind of mitigation is expected to be used by all projects, the cumulative effect of wildfires should remain rare and highly variable in severity, depending on local climate conditions, time of wildfire ignition, and resources available to respond (see Table 8.8-2).

Chemical Contamination

Assuming other projects will be adopting the same or similar mitigation measures to those proposed by the Proponent, the likelihood of chemical contamination to terrestrial VCs will remain rare and ranging from negligible to moderate due to the type, frequency and size of spill, as well as the elapsed time between the occurrence and the removal of contaminants (see Table 8.8-2).

8.9 CUMULATIVE RISK OF TRAFFIC ON WETLANDS

All of the projects identified in the cumulative issue scoping exercise (Section 8.1.1) are expected to contribute to increased traffic volumes along highways 37 and 37A.

8.9.1 Cumulative Issues Scoping for Wetlands

The potential for effects to wetland function from vehicle accidents associated with hazardous cargo spills as a result of Project traffic-related accidents was the only risk identified (see Table 5.5-3). This risk could not be fully mitigated (see Table 5.5-6); thus, the risk to wetland function from vehicle accidents involving hazardous cargo spills have the potential for cumulative interaction (Table 8.9-1), since traffic from all projects will be using highways 37 and/or 37A to varying degrees.

8.9.2 Cumulative Risk Analysis for Wetland Function

8.9.2.1 Cumulative Risk Identification

The use of existing highways will not affect wetlands ability to continue to perform the functions they currently provide, nor will increased use affect wetland extent. Wetlands within 10 m of either side of highways 37 and 37A were considered at risk due to traffic accidents and hazardous cargo spills (Section 5.5.3). The probability of a Project-related traffic accident that involves vehicles crashing into a wetland or releasing deleterious substances into a wetland is very unlikely. Cumulative increases in traffic from other projects would only increase the risk of vehicle crashes or chemical contamination if these projects did not have their own mitigation measures in place, which they are required to have by law.

Table 8.8-2. Assessment Matrix for Cumulative Risks: Terrestrial Ecosystems

			Post-mitigation				
Valued Component	Description of Potential Risk (pre-mitigation)	Description of Mitigation Measures	Likelihood	Severity	Likelihood Adjusted for CRA	Severity Adjusted for CRA	Description of Consequence of Realized Cumulative Risk
Rare and Sensitive Ecosystems	Increase in invasive plants	Ensure vehicles are washed during appropriate time of year prior to leaving areas with known invasive weeds.	Unlikely	Minor	Unlikely	Minor	Increase in invasive weeds along cleared road rights of way. Some of these cleared rights of way may intersect with riparian areas and floodplains
Rare and Sensitive Ecosystems	Increase in wildfire incidence	No smoking in vehicle policies, proper disposal of smoking materials, proper vehicle maintenance	Rare	Moderate	Rare	Moderate	Wildfire is not common in the ecosystems associated with Highway 37. Risk going forward will depend greatly on larger climate trends. Many rare ecosystems are associated with riparian areas, which are at limited risk for fire. Depends on duration and severity of the wildfire. Ranges from beneficial to detrimental to the ecosystem depending on the extent of removal of the forested ecosystems from the landscape.
Rare and Sensitive Ecosystems	Increase in chemical contamination from spills	None	Rare	Negligible to Moderate	Rare	Negligible to Moderate	Tissue damage to vegetation and contamination of soil. Circumstances of spill will determine extent and severity of damage.
Old Growth Forests	Increase in invasive plants	Ensure vehicles are washed during appropriate time of year prior to leaving areas with known invasive weeds.	Unlikely	Minor	Unlikely	Minor	Old growth forests do not usually have a light regime that promotes invasive plant establishment, as many are not shade tolerant. Old growth forest tend to be located away from the highway
Old Growth Forests	Increase in wildfire incidence	No smoking in vehicle policies, proper disposal of smoking materials, proper vehicle maintenance	Rare	Moderate	Rare	Moderate	Wildfire is not common in the ecosystems associated with Highway 37. Risk going forward will depend greatly on larger climate trends. Depends on duration and severity of the wildfire. Ranges from beneficial to detrimental to the ecosystem depending on the extent of removal of the forested ecosystems from the landscape.

(continued)

Table 8.8-2. Assessment Matrix for Cumulative Risks: Terrestrial Ecosystems (completed)

			Post-mitigation				
Valued Component	**Description of Potential Risk (pre-mitigation)**	**Description of Mitigation Measures**	**Likelihood**	**Severity**	**Likelihood Adjusted for CRA**	**Severity Adjusted for CRA**	**Description of Consequence of Realized Cumulative Risk**
Old Growth Forests	Increase in chemical contamination from spills	None	Rare	Negligible to Moderate	Rare	Negligible to Moderate	Tissue damage to vegetation and contamination of soil. Circumstances of spill will determine extent and severity of damage.
Other Terrestrial Ecosystems	Increase in invasive plants	Ensure vehicles are washed during appropriate time of year prior to leaving areas with known invasive weeds.	Likely	Minor	Likely	Minor	Increase in invasive weeds along cleared road rights of way, which can lead to migration of invasive plants into the adjacent terrestrial ecosystems. Since many invasive plants are not shade tolerant, compromise of ecosystem function is not expected
Other Terrestrial Ecosystems	Increase in wildfire incidence	No smoking in vehicle policies, proper disposal of smoking materials, proper vehicle maintenance	Rare	Minor	Rare	Minor	Wildfire is not common in the ecosystems associated with Highway 37. Risk going forward will depend greatly on larger climate trends. Depends on duration and severity of the wildfire. Ranges from beneficial to detrimental to the ecosystem depending on the extent of removal of the forested ecosystems from the landscape.
Other Terrestrial Ecosystems	Increase in chemical contamination from spills	None	Rare	Negligible to Moderate	Rare	Negligible to Moderate	Tissue damage to vegetation and contamination of soil. Circumstances of spill will determine extent and severity of damage.

Table 8.9-1. Potential Cumulative Interaction Matrix: Wetlands

Description of KSM Project-related Risk	Potential for Cumulative Interaction with Traffic from Other Projects
Deposition of deleterious substances into wetlands through vehicle crashes or hazardous cargo spills.	X

"X" indicates that a potential interaction has been identified.
"-" indicates that no potential interaction was identified.

8.9.2.2 Cumulative Risk Mitigation

Cumulative effects mitigations for wetland function are the same as those proposed for Project-related effects (Section 5.5.3). Mitigation measures include:

- limiting the time any vehicle or deleterious substance remains in a wetland after a traffic accident (Spill Prevention and Emergency Response Plan); and
- limiting the extent to which a deleterious substance can migrate through a wetland; and following standard spill prevention and emergency response planning.

It is anticipated that other projects will adopt similar mitigation strategies as the KSM Project.

8.9.2.3 Cumulative Risk Characterization

Assuming other projects will be adopting similar mitigation measures, the likelihood of vehicle accidents resulting in hazardous cargo spills into wetlands will still be unlikely and highly variable in severity, depending on the location of the accident and type of vehicle, but is generally rated as major (see Table 8.9-2).

Table 8.9-2. Assessment Matrix for Cumulative Risks: Wetland Function

			Post-mitigation				
Valued Component	Description of Potential Risk (pre-mitigation)	Description of Mitigation Measures	Likelihood	Severity	Likelihood Adjusted for CRA	Severity Adjusted for CRA	Description of Consequence of Realized Cumulative Risk
Wetland Function	Deposition of deleterious substances into wetlands through vehicle crashes or hazardous cargo spills	Limit the extent of contamination; limit the time a contaminant may be in contact with a wetland, and follow Spill Prevention and Emergency Response Plan	Unlikely	Major	Unlikely	Major	A loss of wetland function within a specific wetland or wetland complex

8.10 CUMULATIVE RISK OF TRAFFIC ON NOISE

All of the projects identified in the cumulative issue scoping exercise (Section 8.1 and 8.2) are expected to contribute to increased traffic along highways 37 and 37A.

8.10.1 Cumulative Issues Scoping for Noise

The potential effects on noise levels from increased traffic cannot be fully mitigated (see Table 5.6-5), thus the risk to human and wildlife receptors from increases in noise has the potential for cumulative interaction (Table 8.10-1), since all project traffic will be using highways 37 and/or 37A to varying degrees.

Table 8.10-1. Potential Cumulative Interaction Matrix: Noise

Description of KSM Project-related Risk	Potential for Cumulative Interaction with Traffic from Other Projects
Increased noise levels	X

"X" indicates that a potential interaction has been identified.
"-" indicates that no potential interaction was identified.

8.10.2 Cumulative Risk Analysis for Noise

8.10.2.1 Cumulative Noise Modelling

As reported by BKL (BKL 2013, Appendix E), and using the same parameters and methodology used in Section 5.6, KSM-related traffic is estimated to increase noise levels in the northern segment by 2 to 3 dB based on a road traffic speed of 90 km/h. This is a noticeable increase, but will still be well below the limit of 55 dBA for an Outdoor Recreation Area or where "indoor conditions are unacceptable unless adequate sound insulation is provided" as recommended in the CMHC guideline (CMHC 1986).

The cumulative effect of nearby project-related traffic (including KSM traffic) at this location is estimated to increase noise levels in the northern segment above the current condition by approximately 6 to 8 dB (to 55 dB) as shown in Table 8.10-2. This is equal to the guideline limit set forth by the CMHC.

Table 8.10-2. Cumulative Traffic Estimates for Noise at the Closest Receiver

Count Station	Case	Present Noise Level (dBA)	Future Noise Level with KSM Project (dBA)	Future Cumulative Noise Level (dBA)	Receiver Distance (m)
47-016-NS	AADT	47	50	55	50
	SADT	49	51	55	
P 47-9-NS	AADT	58	59	61	25
	SADT	59	60	63	

AADT – average annual daily traffic
SADT – summer average daily traffic
Source: BKL (BKL 2013, Appendix E)

With regard to the southern segment, the additional KSM Project related traffic is estimated to increase noise levels at this location by 1 dBA based on a road traffic speed of 90 km/h. This is well below the 4.2 dBA allowance. The cumulative project related traffic is estimated to increase noise levels at this location by 3 to 4 dBA above the current condition based on a road traffic speed of 90 km/h. This is within the 4.2 dBA allowance.

The assessment of additional traffic at both locations meets the appropriate criteria for noise levels at the nearest receiver when viewing KSM Project-related noise contributions only. When assessing cumulative noise levels from all nearby projects, the noise levels are very close to guideline limits, and may have potential for disturbance (BKL 2013, Appendix E). These disturbances are characterized in the

CRA of community well-being and human health in Sections 8.5, and 8.12, as well as being considered in the wildlife cumulative risk assessment as a barrier to wildlife movement (Section 8.7).

8.11 CUMULATIVE RISK OF TRAFFIC ON CLIMATE AND AIR QUALITY

All of the projects identified in the cumulative issue scoping exercise (Section 8.1.1) are expected to contribute to increased traffic volumes along highways 37 and 37A.

8.11.1 Cumulative Issues Scoping for Climate and Air Quality

Potential risks to climate and air quality from GHG and CAC emissions as a result of KSM Project traffic and accidents were identified as risks (see Table 5.7-3). Since these risks were not considered to be fully mitigated (see Tables 5.7-7 and 5.7-8), they have the potential for cumulative interaction (Table 8.11-1), since traffic from all projects will be using highways 37 and/or 37A to varying degrees.

Table 8.11-1. Potential Cumulative Interaction Matrix: Climate and Air Quality

Description of KSM Project-related Risk	Potential for Cumulative Interaction with Traffic from Other Projects
Increase in GHG emissions from fuel combustion	X
Increase in air contaminant emissions from fuel combustion and hence increase in ambient concentrations	X

"X" indicates that a potential interaction has been identified.
"-" indicates that no potential interaction was identified.

Risks to the atmosphere are not anticipated as a result of incremental increases in GHG emissions from Project traffic. Project traffic GHG emissions will be cumulative to the global atmospheric pool, along with provincial, national and international GHG emissions; however, a cumulative risk assessment is not conducted due to the negligible value of Project traffic GHG emissions compared to aggregate world emissions and the impossibility of determining the contribution of the emissions from this individual Project traffic to climate change at the global scale.

8.11.2 Cumulative Risks Analysis for Air Quality

8.11.2.1 Cumulative Risk Identification

Given the low baseline levels of CACs and the level of expected increase in traffic, CACs contribution to ambient air quality due to increased traffic on highways 37 and 37A is expected to remain well below BC air quality objectives and standards. Background concentrations of CACs were approximately 10 times below the maximum desirable concentrations for all CACs. The annual average background concentration of SO_2 was estimated at 2.0 µg/m^3, while the *2009 Air Quality Objectives and Standards for British Columbia* state the desirable maximum annual arithmetic mean for SO_2 is 30 µg/m^3 (Government of BC 2009b). Background annual average concentration of NO_2 was estimated at 5.0 µg/m^3, while BC air quality objectives state that 60.0 µg/m^3 is the desirable maximum annual arithmetic mean. While the likelihood of emissions from Project operation is certain, the severity of the effect is considered to be minor.

Even with cumulative increases in traffic (222% higher than baseline estimates on the northern segment of Highway 37; 102% higher than baseline estimates along Highway 37A; and 40.4% higher than baseline estimates along the southern segment of Highway 37), the contribution of additional CACs is still far below BC air quality objectives and standards (Government of BC 2009b).

8.11.2.2 Cumulative Risk Mitigation

Cumulative effects mitigations for climate and air quality are the same as those proposed in Section 5.7.3. Air emissions cannot be eliminated from Project traffic activities, since most vehicles will likely have to use fossil-fuel-based engines. However, in addition to the expected emission reductions from technology improvements over the Project lifespan, emissions will be minimized using the following mitigation measures:

- switching fuel to more efficient blends to reduce GHGs;
- optimizing the vehicle load rates to minimize the number of trips;
- following maintenance procedures and schedules provided by the vehicle manufacturers to increase fuel efficiency;
- having fleets with newer engines;
- minimizing idling; and
- ensuring diesel vehicles use low sulphur content fuel as required by law (or lower) to reduce SO_2 emissions.

It is anticipated that other projects will adopt similar mitigation strategies as the KSM Project.

8.11.2.3 Cumulative Risk Characterization

As the same kind of mitigation is expected to be used by all projects, the cumulative risk to air quality from increases in CAC emissions will remain certain but minor in severity (see Table 8.11-2).

8.12 CUMULATIVE RISK OF TRAFFIC ON HUMAN HEALTH

All of the projects identified in the cumulative issue scoping exercise (Section 8.1.1) are expected to contribute to increased traffic volumes along highways 37 and 37A; if all projects scoped into the assessment are approved and become operational, historic traffic peaks may be exceeded on the southern segment of Highway 37. Most of the people who are resident in the Study Area (approximately 784 combined for Gitwangak and Gitanyow) live along this segment.

8.12.1 Cumulative Issues Scoping for Human Health

Potential risks to human health from adverse effects to country foods, noise, air quality, drinking water quality, and increased traffic accidents as a result of KSM Project traffic and/or traffic accidents were identified as risks (see Table 5.8-2). Since these risks were not considered to be fully mitigated (see Tables 5.8-5 and 5.8-6), they have the potential for cumulative interaction (Table 8.12-1), since all traffic from other projects will be using Highway 37 and/or 37A to varying degrees.

8.12.2 Cumulative Risk Analysis for Country Foods

8.12.2.1 Cumulative Risk Identification

As stated in Section 5.8.3, contamination of country foods is not expected to occur during normal Project traffic, but may result from a traffic accident that causes a spill. The probability of spills occurring are unlikely and their severity ranges from negligible to moderate depending on the type and extent of the spill. Cumulative increases in traffic would only increase this risk if other projects did not have similar mitigation measures in place to prevent and control spills.

Table 8.11-2. Assessment Matrix for Cumulative Risks: Climate and Air Quality

Valued Component	Description of Potentia Risk (pre-mitigation)	Description of Mitigation Measures	Post-mitigation				
			Likelihood	Severity	Likelihood Adjusted for CRA	Severity Adjusted for CRA	Description of Consequence of Realized Cumulative Risk
Climate	Increase in GHG emissions from fuel combustion	Use well-maintained vehicles to optimize combustion; use hybrid or electric vehicles	Certain	Minor	-	-	No effect at a local or regional level, rather contribution to a global GHG pool
Air Quality	Increase in air contaminant emissions from fuel combustion and hence increase in ambient concentrations	Use well-maintained vehicles to optimize combustion; use low sulphur fuel for diesel vehicles or use biodiesel; use hybrid or electric vehicles	Certain	Minor	Certain	Minor	Contribution to air contaminant emissions and reduction of ambient air quality

Table 8.12-1. Potential Cumulative Interaction Matrix: Human Health

Description of KSM Project-related Risk	Potential for Cumulative Interaction with Traffic from Other Projects
Effects to country foods from spills of diesel fuel/lubricants, concentrates, lime/reagents, and/or explosives.	X
Effects to air quality from increased vehicle emissions or fuel fires.	X
Effects to drinking water quality from spills.	X
Effects from increases in noise	X
Effects to human safety from increases in traffic accidents	X

"X" indicates that a potential interaction has been identified.
"-" indicates that no potential interaction was identified.

8.12.2.2 Cumulative Risk Mitigation

Cumulative effects mitigations for country foods are the same as those proposed in Section 5.8.3. BMPs will be used to minimize spill entry into bodies of water or the terrestrial environment. This will include regular vehicle inspections, a scheduled maintenance program, and operation of vehicles that meet or exceed Transport Canada's minimum requirements (Transport Canada n.d.). The Proponent's Spill Prevention and Emergency Response Plan will be implemented to limit effects on country foods and human health. As part of the Proponent's Emergency Response Plan, procedures for emergency response and occupational first aid will be developed, and workers and contractors will undergo required training. In the unlikely event of a fire, emergency response procedures to minimize fire duration and extent will be initiated promptly.

Drivers will be TDG, WHMIS and CPPI certified as required. Speed limits and traffic safety rules will be enforced. Communication devices (VHF radio, satellite phone) and emergency contacts will be readily accessible to drivers.

The Spill Prevention and Emergency Response Plan will limit the infiltration of leachate from spilled concentrate into the soil environment. In the event of a spill into the aquatic environment, metal concentrations would be monitored in the sediment and water. Exceedance of guidelines will be included in human health and ecological risk assessments, if required.

It is anticipated that other projects will adopt similar mitigation strategies to the KSM Project.

8.12.2.3 Cumulative Risk Characterization

Assuming other projects will be adopting similar mitigation measures, the likelihood of chemical contamination of country foods from hazardous cargo spills will still be unlikely and variable in severity (Table 8.12-2).

8.12.3 Cumulative Risk Analysis for Noise

8.12.3.1 Cumulative Risk Identification

With regards to human health impacts from traffic-related noise, the risk is expected to be negligible in the context of daytime activities and normal sleep patterns (see Sections 5.1.3 and 5.8.3.2). Cumulative increases in traffic volume may increase these risks but only to those living within 30 m of the highways (FHWA 1995). Also, while the noise level along highways 37 and 37A may be more consistently elevated from baseline conditions over a 24-hour period due to cumulative traffic increases, sound levels cannot be added in an arithmetic way. The sound pressure level from two equal sources has been shown to be only 3 dB higher than the sound pressure level of one source. Therefore, two trucks producing 90 dB each will combine to produce 93 dB, not 180 dB. In other words, a doubling of the noise source produces only a 3 dB increase in the sound pressure level (FHWA 1995).

See Section 8.10 for a discussion of results of the cumulative noise model.

8.12.3.2 Cumulative Risk Mitigation

Cumulative effects mitigations for noise are the same as those proposed in Section 5.8.3. Risk mitigation for traffic noise can include measures at the source as well as measures at the receptor. Source risk mitigation will include: reducing speeds to 50 km/h in residential areas; avoiding the use of engine brakes in residential areas; adhering to a truck maintenance program; and avoiding reversing (use of reverse-alarm) in residential areas.

It is anticipated that other projects will adopt similar mitigation strategies as the KSM Project.

Table 8.12-2. Assessment Matrix for Cumulative Risks: Human Health

Valued Component	Description of Potential Risk (pre-mitigation)	Description of Mitigation Measures	Post-mitigation				
			Likelihood	Severity	Likelihood Adjusted for CRA	Severity Adjusted for CRA	Description of Consequence of Realized Cumulative Risk
Country Foods	Effects to country foods from spills of diesel fuel/lubricants, concentrates, lime/reagents, and/or explosives	Use of best management practices to minimize spill entry to the environment; enforced speed limits and traffic safety; adhere to Spill Prevention and Emergency Response Plan; Prompt containment and clean-up	Unlikely	Negligible to Moderate	Unlikely	Negligible to moderate	Localized, short-term effects on consumption of country foods.
Air Quality	Effects to air quality from increased vehicle emissions or fuel fires	Enforce speed limits; use well-maintained vehicles to optimize combustion; use low sulphur fuel	Certain	Minor	Certain	Minor	Increase in local ambient air quality concentrations with minor health risks
Drinking Water Quality	Effects to drinking water quality from spills	Use of best management practices to minimize spill entry to the environment; enforced speed limits and traffic safety; adhere to Spill Prevention and Emergency Response Plan; Prompt containment and clean-up	Unlikely	Minor to Moderate	Unlikely	Minor to Moderate	Localized, short-term effects on drinking water; water should be tested before consumption
Noise	Effects from increases in noise	Source mitigation: Enforce speed limits; avoid use of engine brakes and reversing in residential areas; vehicle maintenance	Certain	Minor	Certain	Moderate	Localized increase in percentage of highly annoyed receptors, particularly on the northern segment of Highway 37
Human Safety	Effects to human safety from increases in traffic accidents	Enforce speed limits and other traffic rules; company zero-tolerance policy on alcohol; adhere to accident first aid, emergency response and other procedures; vehicle maintenance	Possible	Minor to Catastrophic	Possible	Minor to Catastrophic	Accidents are rare, but may affect human health to a large degree, including death

8.12.3.3 Cumulative Risk Characterization

Even though other projects are assumed to be adopting similar noise mitigation measures to the KSM Project, predicted noise levels considering cumulative traffic increases approach the guideline limit of 55 dB along the north segment of Highway 37, and may have increased potential for disturbance (BKL 2013, Appendix E). As a result the cumulative risk to human health effects from increased noise remains certain, and severity is adjusted to moderate (Table 8.12-2).

8.12.4 Cumulative Risk Analysis for Air Quality

8.12.4.1 Cumulative Risk Identification

Given baseline levels of CACs and the level of expected traffic increase, CACs' contribution to ambient air quality is expected to remain well below BC air quality objectives and standards. Background concentrations of CACs were approximately ten times below the maximum desirable concentrations for all CACs. The annual average background concentration of SO_2 was estimated at 2.0 µg/m^3, while the *2009 Air Quality Objectives and Standards for British Columbia* state the desirable maximum annual arithmetic mean for SO_2 is 30 µg/m^3 (Government of BC 2009b). Background annual average concentration of NO_2 was estimated at 5.0 µg/m^3, while BC air quality objectives state that 60.0 µg/m^3 is the desirable maximum annual arithmetic mean. While the likelihood of emissions from traffic during Project operation is certain, the severity of the effect is considered to be minor.

Even with cumulative increases in traffic from other projects (222% higher than baseline estimates on the northern segment of Highway 37; 102% higher than baseline estimates along Highway 37A; and 40.4% higher than baseline estimates along the southern segment of Highway 37), the contribution of additional CACs is still far below BC air quality objectives and standards (Government of BC 2009b, see Section 5.7.3).

8.12.4.2 Cumulative Risk Mitigation

Cumulative effects mitigations for air quality are the same as those proposed in Section 5.8.3. Risks to human health from increases in air emissions from normal traffic will be minimized by enforcing speed limits and operating well-maintained vehicles powered by low sulphur fuel to optimize combustion. Further mitigation measures can be found in Section 5.7.

In the event of traffic accidents, emergency response procedures to prevent fires or minimize fire duration and extent will be initiated promptly. Responsible personnel will be trained in spill response procedures to contain the spill, thereby minimizing vaporization or evolution of concentrate dust. Personnel will also be trained in safety and personal protection procedures to avoid contact with spilled material. Potentially affected residents will be informed of a spill, and access to the spill site will be restricted in consultation with regulators. These actions will largely eliminate health risks from inhaling dust, vapours or combustion fumes.

It is anticipated that other projects will adopt similar mitigation strategies as the KSM Project.

8.12.4.3 Cumulative Risk Characterization

Assuming other projects will be adopting similar mitigation measures, the likelihood of human health impacts due to changes in air quality will still be certain but minor in severity (Table 8.12-2).

8.12.5 Cumulative Risk Analysis for Drinking Water Quality

8.12.5.1 Cumulative Risk Identification

As stated in Section 5.8.3, human health effects from the ingestion of contaminated drinking water are unlikely. This assessment is based on the low number of historic and predicted traffic accidents (as described in Chapter 2) and the commitment to BMPs in spill management planning. Cumulative increases in traffic would only increase the risk if other projects did not have similar mitigation measures in place.

8.12.5.2 Cumulative Risk Mitigation

Cumulative effects mitigations for drinking water quality are the same as those proposed in Section 5.8.3. BMPs will be used to minimize spill contact with waterbodies or the terrestrial environment. This will include regular truck inspections, a scheduled maintenance program, and operation of trucks that meet or exceed Transport Canada's minimum requirements (Transport Canada n.d.). Drivers and personnel will receive training and industry-related education and conduct monthly safety meetings in order to handle challenges effectively. Drivers will be TDG, WHMIS and CPPI-certified as required. Speed limits and traffic safety rules will be enforced. Communication devices (VHF radio, satellite phone) and emergency contacts will be readily accessible to drivers. The Spill Prevention and Emergency Response Plan will be developed and implemented to limit effects on drinking water and human health. Water quality will be monitored in the event that a spill enters the aquatic environment.

It is anticipated that other projects will adopt similar mitigation strategies as the KSM Project.

8.12.5.3 Cumulative Risk Characterization

Assuming other projects will be adopting similar mitigation measures, the likelihood of human health impacts due to changes in drinking water quality will still be unlikely and minor to moderate in severity depending on the type and extent of the spill (Table 8.12-2).

8.12.6 Cumulative Risk Analysis for Human Safety

8.12.6.1 Cumulative Risk Identification

A minor increase in traffic accidents (maximum 0.191 collisions per year along the north segment of Highway 37 during operation) is anticipated as a result of KSM Project activities. As shown in Section 8.3, even with cumulative project traffic, a maximum increase of only 0.959 collisions per year (along the north segment of Highway 37) is predicted.

8.12.6.2 Cumulative Risk Mitigation

Cumulative effects mitigations for human safety are the same as those proposed in Section 5.8.3. Speed limits and other traffic rules will be strictly enforced. All contractors and workers are required to adhere to the BC Occupational Health and Safety Regulation (BC Reg 296/97), as well as a zero-tolerance policy on alcohol and drugs. Procedures for emergency response and occupational first aid will be developed, and workers and contractors will undergo required training. Information on weather and highway conditions as well as communication devices (VHF radio, satellite telephone) will be made available to all drivers before departure.

It is anticipated that other projects will adopt similar mitigation strategies as the KSM Project.

8.12.6.3 Cumulative Risk Characterization

Assuming other projects will be adopting similar mitigation measures, the likelihood of human health risks due to an increase in traffic accidents will still be possible and, depending on the type and conditions of the accident, highly variable in severity (Table 8.12-2).

8.13 CUMULATIVE RISK OF TRAFFIC ON HERITAGE

All of the projects identified in the cumulative issue scoping exercise (Section 8.1 and 8.2) are expected to contribute to increased traffic volumes along highways 37 and 37A; if all projects scoped in the assessment are approved and become operational, historic traffic peaks may be exceeded on the southern segment of Highway 37. Therefore, the potential for cumulative interaction with effects from project traffic and accidents on heritage has been identified (Table 8.13-1).

Table 8.13-1. Potential Cumulative Interaction Matrix: Heritage

Description of KSM Project-related Risk	Potential for Cumulative Interaction with Traffic from Other Projects
Damage to archaeological or heritage sites due to spills of hazardous cargo	X
Damage to archaeological or heritage sites due to increased incidence of wildfires	X

"X" indicates that a potential interaction has been identified.
"-" indicates that no potential interaction was identified.

8.13.1 Cumulative Issues Scoping for Heritage

The potential risks to archaeological or heritage sites from hazardous cargo spills or wildfires as a result of KSM Project-related traffic accidents were risks identified (see Table 5.9-2). Since these risks were not considered to be fully mitigated (see Table 5.9-6), the risk to archaeological or heritage sites from hazardous cargo spills or wildfires has the potential for cumulative interaction, since all traffic from other projects will be using highways 37 and/or 37A to varying degrees.

8.13.2 Cumulative Risks Analysis for Archaeological and Heritage Sites

8.13.2.1 Cumulative Risk Identification

Risk of Hazardous Cargo Spills

As stated in Section 5.9.3, the incremental risk of chemical contamination of soils at archaeological or heritage sites as a result of an accident is characterized as rare with mitigation measures in place. Cumulative increases in traffic would only increase the risk of chemical contamination of heritage VCs if these projects did not have similar mitigation measures in place.

Risk of Wildfires

As discussed in Section 5.9.3, the low baseline level of fire incidence in this area of BC makes the probability of a wildfire due to increased traffic rare.

8.13.2.2 Cumulative Risk Mitigation

Risk of Hazardous Cargo Spills

Cumulative effects mitigations for hazardous cargo spills are the same as those proposed in Section 5.9.3. Preventing the introduction of hazardous substances into the environment is the most

effective way to avoid effects to heritage VCs. Specific preventative measures that may be implemented include conducting a vehicle assessment (for oil leaks, secure cargo, etc.) and checking road conditions prior to departure, maintaining an appropriate driving distance between vehicles, adhering to speed limits, and adjusting driving styles to suit road conditions.

In the event of a spill, the guidelines and procedures outlined in the Spill Prevention and Emergency Response Plan will be followed in order to avoid contamination and degradation of archaeological sites.

Risk of Wildfires

Cumulative effects mitigations for wildfires are the same as those proposed in Section 5.9.3. Preventing an increase in wildfire incidence will involve reducing the risk of vehicle accidents and enacting strong policies requiring the proper disposal of smoking materials. Reduction of vehicle accidents will be accomplished with policies that address vehicle maintenance, speed limits, driver attention, drug and alcohol prohibition and driving under poor weather conditions.

It is anticipated that other projects will adopt similar mitigation strategies as the KSM Project.

8.13.2.3 Cumulative Risk Characterization

Risk of Hazardous Cargo Spills

Assuming other projects will be adopting similar mitigation measures, the likelihood of chemical contamination of heritage VCs from hazardous cargo spills will still be rare and negligible in severity, considering that most archaeological or heritage sites are more than 50 m from the highway (see Table 8.13-2).

Risk of Wildfires

As the same kind of mitigation is expected to be used by all projects, the cumulative effect of wildfires should remain rare and highly variable in severity, depending on local climate conditions, time of wildfire ignition, and resources available to respond (see Table 8.13-2).

Table 8.13-2. Assessment Matrix for Cumulative Risks: Heritage

Valued Component	Description of Potential Risk (pre-mitigation)	Description of Mitigation Measures	Post-mitigation				
			Likelihood	Severity	Likelihood Adjusted for CRA	Severity Adjusted for CRA	Description of Consequence of Realized Cumulative Risk
Archaeological and Heritage Sites	Chemical contamination of sites due to hazardous cargo spills	Conducting a vehicle assessment; checking road conditions prior to departure; maintain appropriate driving distance between vehicles; adhering to speed limits; adjusting driving styles to suit road conditions; and adhering to the Spill Prevention and Emergency Response Plan	Rare	Negligible	Rare	Negligible	The circumstances of the spill will determine the extent of potential contamination of subsurface components of the site
	Increased incidence and severity of wildfires due to flammable material spills	Policy requiring the proper disposal of smoking materials; and fire watch and reporting program	Rare	Moderate	Rare	Moderate	Depends on the duration and severity of the wildfire; can range from minor disturbance of the site to removal of surficial features if present and contamination of subsurface components

9. Summary

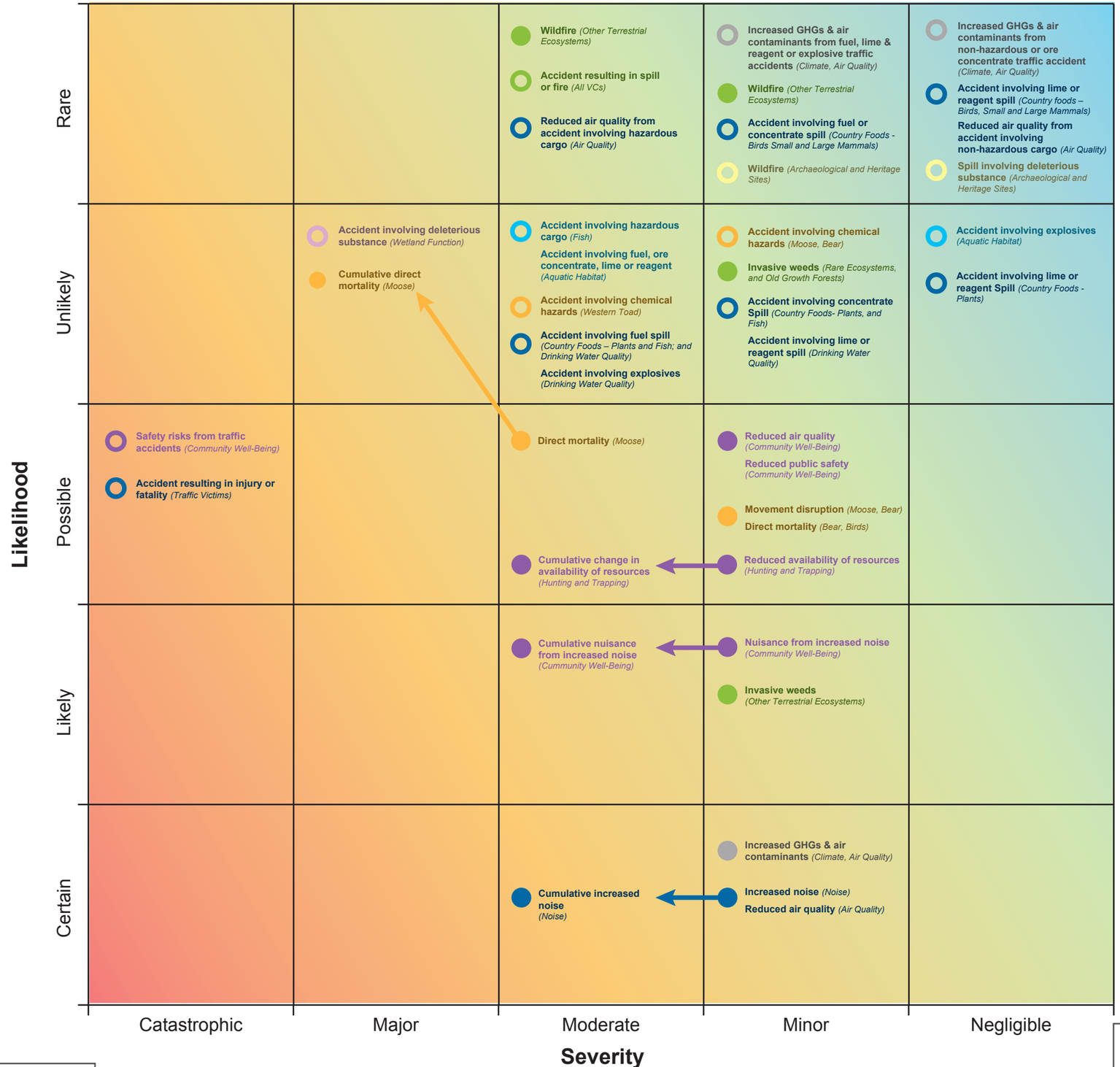
As described in Chapter 5, the potential effects of KSM Project-related traffic on highways 37 and 37A were assessed by considering normal Project traffic and traffic accidents. The potential risk of traffic accidents was also assessed, as described in Section 6. A summary of proposed mitigation and environmental management measures to avoid or mitigate effects from KSM Project traffic is provided in Section 7.

In general, most potential effects identified in this assessment are characterized as being of minor or negligible severity (see Figure 9-1).

The KSM Project-specific traffic assessment concludes there will primarily be minor to negligible effects on wildlife, terrestrial ecosystems, and climate VCs. Some minor effects to human health and socio-economic VCs may also occur. There are two moderately severe effects to Terrestrial Ecosystem VCs (the risk of increased wildfire incidence on rare and sensitive ecosystems and old growth forests), which are characterized as rare; and one moderately severe effect to Wildlife (the risk of moose mortality), which has a likelihood of possible.

In the event of traffic accidents, most potential risks to VCs are characterized as unlikely or rare occurrences. The two potential risks characterized as possible and catastrophic (represented by the two hollow circles on the left side of Figure 9-1) both refer to the potential for a collision resulting in severe human injury or fatality. While the collision model described in Chapter 3 does not predict any significant increase to collisions as a result of Project traffic on the highways, the serious consequence of such a collision is reflected in this risk rating. The Proponent's proposed Traffic and Access Management and Emergency Response plans described in Sections 7.3 and 7.4 are designed to prevent KSM Project-related traffic accidents from occurring, and to promptly take appropriate measures in the unlikely event that an accident occurs.

The cumulative traffic assessment conducted concludes that effects will remain primarily minor to negligible for traffic effects on wildlife, terrestrial ecosystems, and climate VCs. Effects of increases noise on human health and social VCs that were rated as minor in the KSM Project-specific analysis were adjusted to moderate as a result of other predicted traffic from other projects. Additionally, effects relating to moose mortality were adjusted to major, but unlikely, and the reduced availability of resources for hunting and trapping was adjusted to moderate severity as a result of the potential increased pressure on moose populations along highways 37 and 37A from moose-vehicle collisions involving both KSM and other project traffic (see Figure 9-1).



Project Traffic	Traffic Accidents	Topic
●	○	Socio-economics and Land Use
	○	Fish and Aquatic Habitat
●	○	Wildlife
●	○	Terrestrial Ecosystems
	○	Wetlands
●	○	Climate and Air Quality
●	○	Human Health
	○	Heritage
←		Adjusted Risk Rating for Cumulative Effects

Risk Rating

High Risk	Low Risk
(detailed management plan required)	(manage with best practices)

Figure 9-1

Assessment of Potential Risks Associated with Traffic from KSM and Other Projects (by Topic)

SEABRIDGE GOLD
KSM PROJECT

Rescan Engineers & Scientists

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Appendix A
KSM Project Section 13 Order

Rescan™
Engineers and Scientists

BRITISH COLUMBIA

Telephone: 250-387-1032
Facsimile: 250-387-2208
File: 30200-20/KSMP-04-01

Ref: 100826

October 4, 2011

Brent Murphy
Vice President, Environmental Affairs
Seabridge Gold Inc.
400, 106 Front St E
Toronto ON M5A 1E1

Dear Mr. Murphy:

Please find enclosed an Order issued under section 13 of the *Environmental Assessment Act* regarding the proposed (KSM) Kerr Suphurets Mitchell Mine Project (proposed Project). This Order amends the section 11 Order dated November 6, 2009 by changing the scope of the assessment to include potential transportation impacts from the proposed Project along Hwy 37 to the junction of Hwy 16 at Kitwanga as well as clarifying consultation opportunities for Gitanyow *wilp* Malii, *wilp* Gamlaxyeltxw, *wilp* Gwaas Hlaam and *wilp* Gwinuu.

This section 13 Order will be posted on the Environmental Assessment Office's electronic Project Information Centre website at www.eao.gov.bc.ca. If you have any questions or require further information, please contact me by telephone at 250-387-1032, or by email at Chris.Hamilton@gov.bc.ca, or contact Karie Hardie, Project Assessment Officer, by telephone at 250-356-5327 or by email at Karie.Hardie@gov.bc.ca.

Yours truly,

Chris Hamilton
Project Assessment Director

.../2

Environmental Assessment Office

Mailing Address:
PO Box 9426 Stn Prov Govt
Victoria BC V8W 9V1

Location:
1st & 2nd Fl – 836 Yates Street
Victoria BC V8W 1L8

Enclosure: Section 13 Order

pc: Garett Cooper, Project Manager
Canadian Environmental Assessment Agency

Elizabeth Miller, Manager, Environmental Affairs
Seabridge Gold Inc.

Karie Hardie
Environmental Assessment Office

IN THE MATTER OF THE ENVIRONMENTAL ASSESSMENT ACT S.B.C. 2002, c.43
(Act)
AND
AN ENVIRONMENTAL ASSESSMENT OF THE
KSM (Kerr-Sulpherets-Mitchell) Project (proposed Project)

ORDER UNDER SECTION 13 AMENDING SECTION 11 ORDER

WHEREAS:

A. Seabridge Gold Inc. (Proponent) proposes to develop an open pit gold, copper and silver mine located approximately 65 km northwest of Stewart and 20 km southeast of the Eskay Creek mine.

B. The proposed Project constitutes a reviewable project pursuant to Part 3 of the *Reviewable Projects Regulation* (B.C. Reg. 370/02), because the proposed Project is a new mine facility that, during operations, will have a production capacity of equal to or greater than 75,000 tonnes per year of mineral ore.

C. On April 25, 2008, a Project Assessment Director issued an Order under section 10(1)(c) of the Act, stating that the proposed Project requires an environmental assessment (EA) certificate, and that the Proponent may not proceed with the Project without an EA.

D. On November 6, 2009, a Project Assessment Manager issued an Order under Section 11 of the Act outlining the scope, procedures and methods for conducting the EA.

E. On March 7, 2011, the Gitanyow Hereditary Chiefs' Office, on behalf of Gitanyow *huwilp,* wrote to the Environmental Assessment Office (EAO), asking that the Gitanyow Hereditary Chiefs' Office, and Gitanyow *huwilp*, be consulted about the proposed Project.

F. On April 28, 2011, the undersigned Project Assessment Director wrote to the Gitanyow Hereditary Chiefs' Office to confirm that EAO would consult with the potentially affected Gitanyow *wilps* and identifed ways in which consultation would take place.

G. In view of the recent decision of the British Columbia Court of Appeal in *NNTC v. Griffin*, the undersigned Project Assessment Director considers it appropriate to amend the Order made under section 11 of the Act so as to incorporate therein the consultation referred to in Recitals F and G above.

NOW THEREFORE:

Pursuant to section 13 of the Act I order that the Order made under section 11 of the Act, dated November 6, 2009, be amended as follows:

i. By replacing the last bullet under 3.1 that reads "transportation of ore processing reagents and other hazardous chemicals to the plant site, and of explosives to the mine, along the access roads" with the following new bullet:

   "Use of the access roads to the proposed Project site, and Highway 37 between the proposed Project site and its junction with Highway 16 at Kitwanga (as shown in Figure 2), including those potential effects arising from the transport of people, goods and materials, including, but not limited to, fuel, hazardous chemicals and explosives."

ii. By adding a new section 4.2 as follows:

"4.2 For purposes of section 4.1.2, the term "First Nations" includes Gitanyow *wilp* Malii, *wilp* Gamlaxyeltxw, *wilp* Gwaas Hlaam and *wilp* Gwinuu."

iii. By adding a new section 20.8 as follows:

"20.8 The Environmental Assessment Office will, in relation to the environmental assessment of the proposed Project, consult with Gitanyow *wilp* Malii, *wilp* Gamlaxyeltxw, *wilp* Gwaas Hlaam and *wilp* Gwinuu (either directly or, if requested, through the Gitanyow Hereditary Chief's Office) in the following manner:

20.8.1 The Environmental Assessment Office will form a technical working group to discuss road use and potential effects on the aboriginal interests of the Gitanyow *wilp* Malii, *wilp* Gamlaxyeltxw, *wilp* Gwaas Hlaam, *wilp* Gwinuu and other potentially affected First Nations and the Nisga'a Nation arising from the use of Highway 37 by Project-related traffic. The Environmental Assessment Office will inform the Proponent that they are required to participate in these technical working group meetings.

20.8.2 The Environmental Assessment Office will inform Gitanyow *wilp* Malii, *wilp* Gamlaxyeltxw, *wilp* Gwaas Hlaam and *wilp* Gwinuu of all major milestones with respect to the environmental assessment of the Project."

iv. In sections 23.1, 24.1, 25.1 and 27.1.1 by adding "Gitanyow *wilp* Malii, *wilp* Gamlaxyeltxw, *wilp* Gwaas Hlaam and *wilp* Gwinuu after "First Nations".

v. By adding a new section 25.2 as follows:

"25.2 The Nisga'a Nation, First Nations, *wilp* Malii, *wilp* Gamlaxyeltxw, *wilp* Gwaas Hlaam and *wilp* Gwinuu will have the opportunity to provide to the Environmental Assessment Office their respective written submissions about the Assessment Report, which written submissions will be included in the package of materials sent to ministers when the Project is referred to ministers for decision."

vi. By adding Figure 2 attached hereto.

vii. By deleting sections 27.1.2

Chris Hamilton
Project Assessment Director
Proposed KSM (Kerr-Sulphurets-Mitchel) Project

Dated September 29, 2011

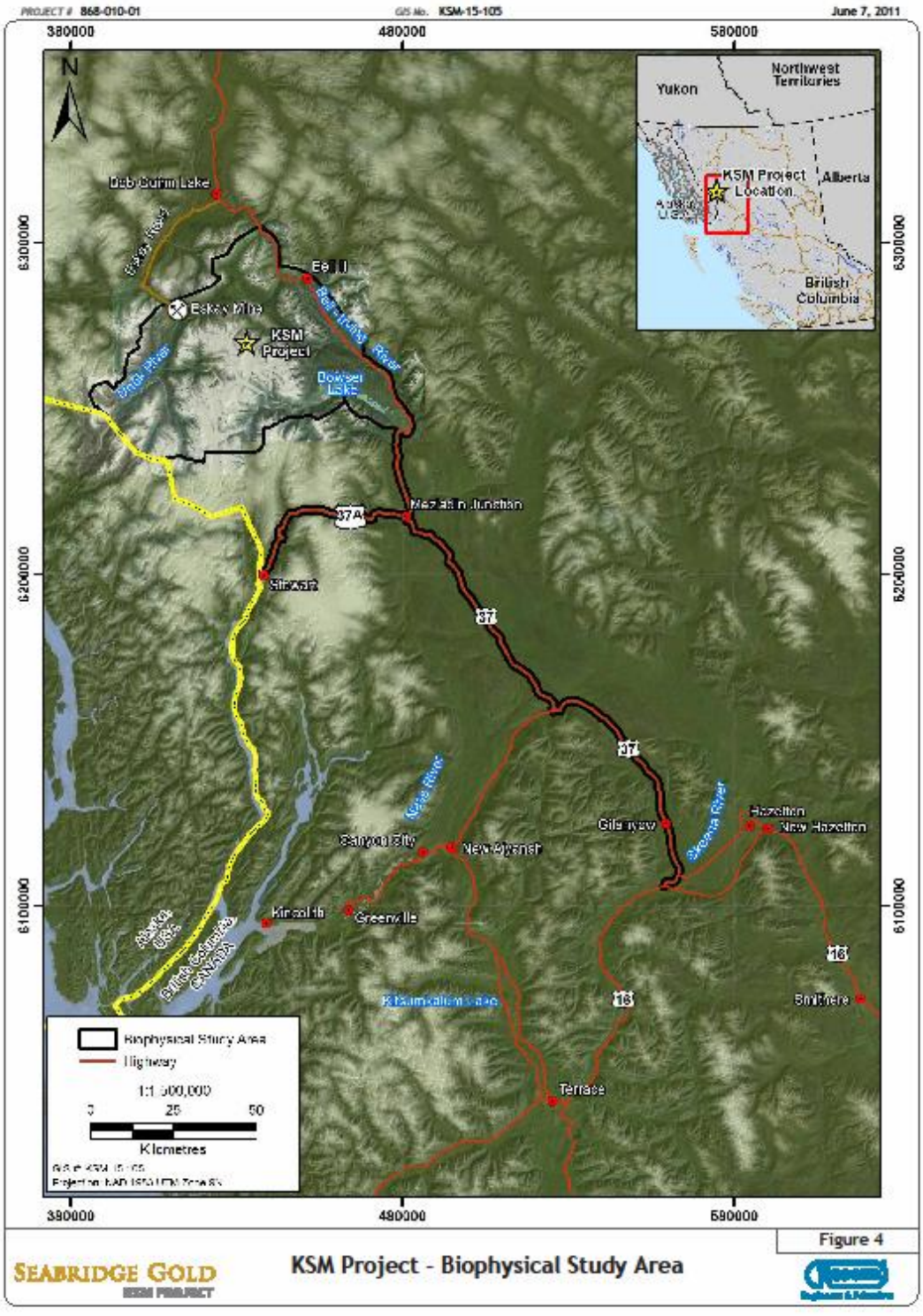


Figure 4

SEABRIDGE GOLD
KSM PROJECT

KSM Project - Biophysical Study Area

Appendix B

Review of Historical Traffic Patterns and Capacity on Highway 37 in Proximity to the Proposed KSM Project

Rescan™
Engineers and Scientists

McElhanney

May 2, 2011
Our File: 2341-01506-0

Brent Murphy
Seabridge Gold Inc.
400 – 106 Front Street. East
Toronto, ON M5A 1E1

REVIEW OF HISTORICAL TRAFFIC PATTERNS AND CAPACITY ON HIGHWAY 37 IN PROXIMITY TO THE PROPOSED KSM PROJECT

McElhanney Consulting Services Ltd. has been retained by Seabridge Gold to review historical traffic volumes and estimate the capacity of Highway 37 in proximity to the proposed KSM Project.

Available Data

Traffic count data on Highway 37 is available at five locations between Dease Lake and Kitwanga. These sites are: Kitwanga sta: 47-9NS, Cranberry Connector sta: 47-024NS, Meziadin Lake Junction Sta: 47-016NS, Stikine River Bridge Sta: 47-026NS, and Dease Lake Sta: 47-019NS. For the purposes of this analysis station 47-016NS was used as there was data available since 1980 and it is situated at a midpoint between Kitwanga and Dease Lake. Traffic volumes from 2008 were used in this analysis. Traffic count data has been included in Appendix A

Historical Traffic Volumes

Upon review of the historical Ministry of Transportation (MoT) traffic count data published in the historical "Traffic Volumes in BC[1]" publication it was determined that count station 017-016NS located approximately 1km North of Meziadin Lake Junction has been in place since 1980. Traffic counting at this station was not performed annually until 1989 except in the years, 1985 and 1987. Between 1980 and 1993 only the Summer Average Daily Traffic (SADT) values were calculated. This value represents the average peak daily traffic volume for the months of July and August in the particular year. Using the SADT data is a conservative approach as traffic volumes are averaged between the two peak traffic months opposed to an average between all 12 months. Based on the SADT volumes shown in Figure 1, traffic on Highway 37 has been decreasing steadily from 1100 vehicles per day (vpd) in 1992 to less than 400 vpd in 2008.

The decrease in total traffic volumes may be attributable to a reduction in both industrial, commercial (forestry), and private vehicle traffic (including tourism). Data pre-2005 does not include a breakdown in the distribution of traffic; therefore it is not possible to determine the distribution of each vehicle type.

Using methodologies outlined in Part 20 of the 2000 Highway Capacity Manual, the service flow rates were calculated for 2008 and 1992 assuming the following:

1 "Traffic Volumes in BC 1979-1994, BC Ministry of Transportation, Multiple Documents

Table 1 Analysis Criteria

Percentage Trucks & Buses	40% of Total Volume[a]
Percent No Passing	40%[b]
Access Points per km	0.1
Peak Hour Factor (PHF)	0.88[c]
Road Grade	<3%[d]

[a] Data from MoT count station 47-016NS located 1km north of Meziadin Lake Junction.

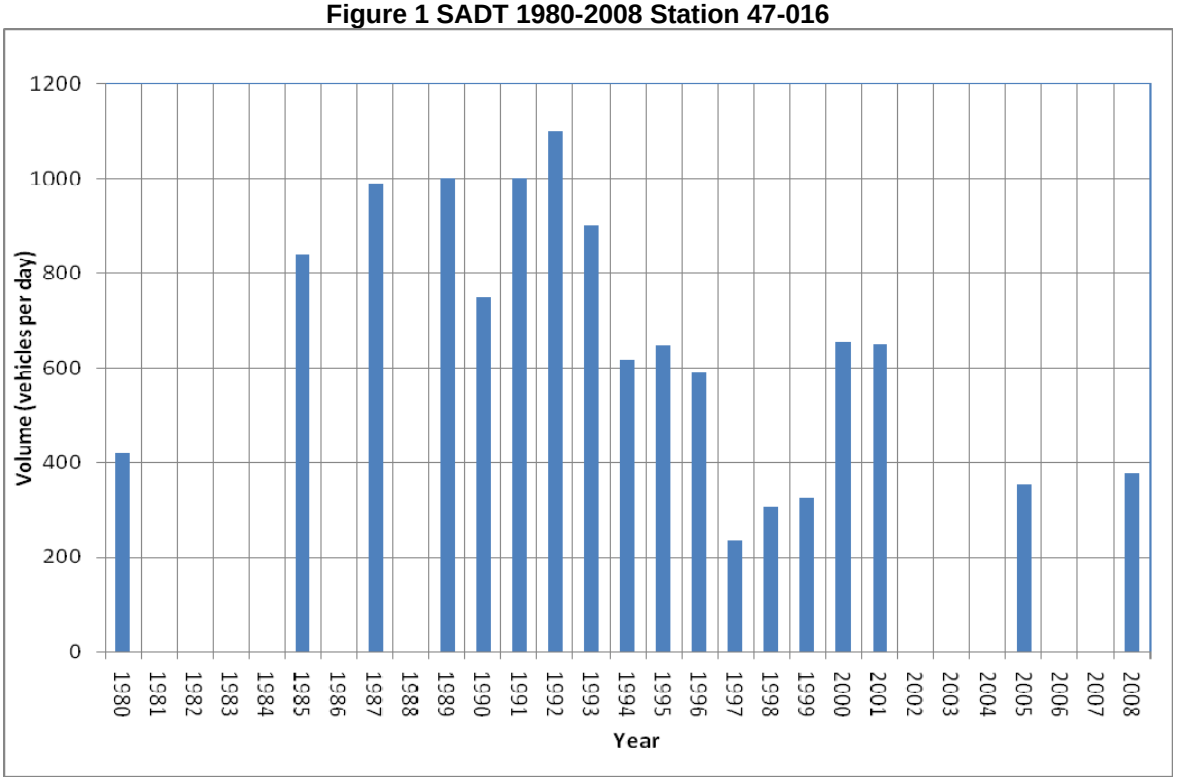
[b] Proportion of segment length in which passing is prohibited.

[c] Assuming rural two lane highway, this value adjusts hourly volumes to an equivalent 15 minute flow rate.

[d] Two-way segmental analysis is only valid for segments with grades less then 3%.

Using the "Two-Way Two-Lane Highway Segment Worksheet" the two-way flow rates (V_p) were calculated to be 90 pc/h[2] in 2008 and 261 pc/h in 1992.

Figure 1 SADT 1980-2008 Station 47-016



2 pc/h = equivalent number of passenger cars per hour, one truck = 2.5 passenger cars

Analysis

Using methodologies outlined in the Highway Capacity Manual (HCM) 2000 Edition, the capacity of Highway 37 was estimated for both 1992 and 2008 conditions. As the methodology of analyzing the Level of Service (LOS) changed between the 1994 and 2000 editions, some adjustments were required to estimate the ultimate capacity of the Highway. The fundamental difference between HCM 2000 edition and HCM 1994 edition is that the HCM 1994 used the volume to capacity ratio (v/c) as its primary performance measure while the HCM 2000 uses the Average Travel Speed method. The Level of Service (LOS) and highway capacity were calculated using methods from HCM 2000. The calculated highway capacity was adjusted to present the data as a passenger car equivalent flow rate instead of an average travel speed.

The indicated capacity of Highway 37 is a two-way volume of 1260 pc/h (630 pc/h in each direction). For reference purposes, the base level capacity of a two-lane highway assuming ideal conditions is 1700 passenger cars per hour (pc/h) for each direction of travel or a two-way capacity of 3200 pc/h[3]. Short sections of highways such as bridges may reach a capacity of up to 3200 – 3400 pc/h. The capacity of the highway occurs when the road is at LOS "E". This level of service represents a situation where operating conditions are unstable and difficult to predict, travel speeds tend to be less than posted, and travel delays occur more than 80 percent of the time. Passing at LOS "E" is virtually impossible.

Table 2 outlines the approximate ranges of traffic volumes required to meet a particular Level of Service requirement. The third column represents the number of vehicles travelling in both directions including trucks (assuming approximately 40% of vehicles are trucks). The fourth column represents the total number of vehicles expressed in equivalent passenger cars during a peak 15 minute interval on a grade up to 3%.

3 Two-way capacity slightly less than twice the one-way capacity for extended analysis sections. (Highway Capacity Manual, 2000)

Table 2 Volume Based Requirement for Each Level of Service

Level of Service	Percent Time Following (%)[1]	Two-way hourly Volume (vph)[2]	Two-way flow rate V_p (pc/h)[3]
A	≤ 35	< 115	< 223
B	>35-50	115 - 218	233 - 423
C	>50-65	218 - 343	423 - 666
D	>65-80	343 -870	666 - 1260
E	>80	>870	> 1260
F	Undetermined		

[1]Percent time following represents the percentage of the time a driver is driving immediately behind another vehicle.

[2]Two-way Volume assumes 40% Trucks

[3] Pc/h – Equivalent Passenger Cars per hour

Note: The above table is unique and is only valid per the analysis criteria outlined in Table 1.

For a rural highway such as Highway 37 the desired LOS is "A" which represents the highest level of service that can be achieved. At LOS "A" motorists are able to travel at their desired speed, the need for passing other vehicles is well below the capacity for passing, and few (if any) platoons of three or more vehicles are observed. Also, the 2000 edition of the Highway Capacity Manual states that the LOS of a two-lane highway is calculated based on the percentage of time traffic is travelling in platoons of three or more vehicles. The roadway operates at LOS "A" if vehicles are travelling in platoons less than 35% of the time.

Using the "Two-Way Two-Lane Highway Segment Worksheet" the two-way flow rates (V_p) were calculated to be 198 pc/h[1] vph in 1992 and 73 pc/h[1] in 2008. From the worksheets, Highway 37 had platooning 33.6% of the time in 1992 and 23.4% of the time in 2008. Therefore based on the criteria, the highway operated at LOS "A" in both 1992 and 2008. It is predicted that traffic volumes would have to increase by 300% over 2008 volumes for the highway to operate at LOS "B". Analysis for both 1992 and 2008 has been included in Appendix B.

Summary

- Highway 37 has significant excess capacity for the majority of the year as this analysis was performed to study the typical peak hour during the summer.
- Traffic volumes in 2008 were approximately one third of the traffic experienced in 1992.
- Because the hourly volume in 1992 of 198 pc/h (102 vph) was less than the highway capacity of 1260 pc/h at LOS “E”, the roadway had surplus capacity.
- Because the hourly volume in 2008 of 73 pc/h (35 vph)was less than the highway capacity of 1260 pc/h at LOS “E”, the highway currently has surplus capacity.
- The highway currently operates at LOS “A”. Traffic volumes would have to more than triple from 2008 volumes to begin to operate at LOS “B”.

Closure

This report includes an assessment of Highway 37 between Meziadin Lake Junction and Dease Lake, BC. This assessment has been prepared by McElhanney Consulting Services Ltd. for the benefit of Seabridge Gold Inc. The information and data contained herein represent MCSL's best professional judgment in light of the knowledge and information available to MCSL at the time of preparation.

McElhanney Consulting Services Ltd. denies any liability whatsoever to other parties who may obtain access to this report for any injury, loss or damage suffered by such parties arising from their use of, or reliance upon, this document or any of its contents without the express written consent of MCSL and Seabridge Gold Inc.

Yours truly,

McElhanney Consulting Services Ltd.

Brendon Masson EIT
Transportation Engineer

H:\PROJ\2341\1500-1599\1506 Seabridge KSM Project\300.0 Traffic Impact Study\300.2 Documents\1506 110502 ltr - Hwy 37 Traffic Analysis.doc

McElhanney

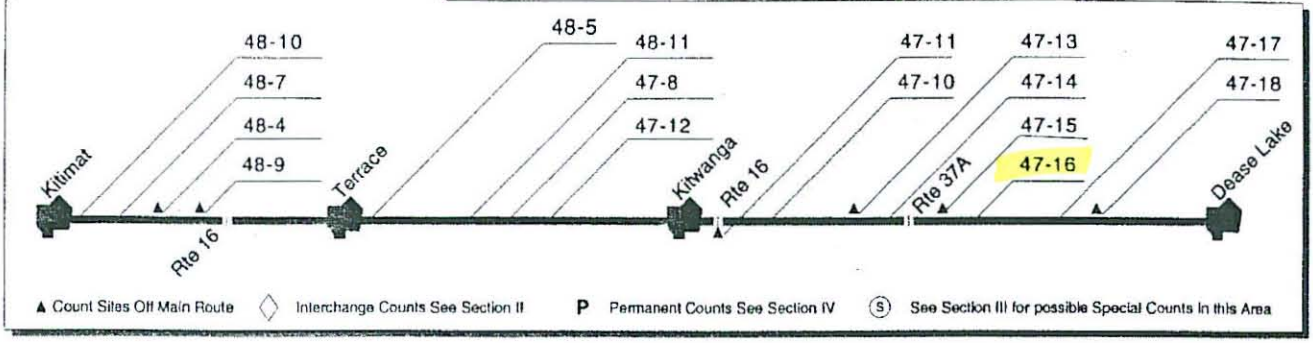
Appendix A

Historical Traffic Count Data

1986 – 1990

Kitimat to Dease Lake

Rte 37 Kitimat–Cassiar Hwy



Stn	Dir	Rte	Location description	SADT:	1986	1987	1988	1989	1990
48-10	NS	37	At Kitimat River Bridge, north of Kitimat		2100	1900	2600	2500	2400
48-7	NS	37	0.3 km south of Rte 16/37 in Terrace		4100	4300	6000	5800	5500
48-4	EW		On west end of Old Skeena River Bridge in Terrace		5300	6600	7300	7600	7300
48-9	EW	16	Rte 16, 0.2 km west of Rte 37 in Terrace		8300	8800	11900	11200	11700
48-5	EW	16/37	0.2 km east of Rte 37 in Terrace		9900	11400	13100	13300	13500
48-11	EW	16/37	On Kleanza (Gold) Creek Bridge, west of Kleanza Creek Provincial Park		2800	3200	2700	2600	2500
47-8	EW	16/37	On Coyote Creek Bridge, west of Cedarvale Rd		1500	2200	2600	2900	2800
47-12	EW	16/37	0.3 km west of Rte 37, near Kitwanga		1800	1900	2700	2400	2200
47-11	EW	16	Rte 16, 0.3 km east of Rte 37, near Kitwanga		1500	2100	2200	2200	2000
47-10	NS	37	At Skeena River Bridge at Kitwanga		1700	2100	2400	3800	3800
47-13	NS		Nass River Rd, 0.1 km south of the entrance to Rte 37		n/a	110	n/a	n/a	80
47-14	NS	37	16 km south of Meziadin Junction		700	890	n/a	1500	1200
47-15	EW	37A	Stewart-Meziadin Hwy, 18 km west of Meziadin Junction		1100	1200	n/a	2100	1300
47-16	NS	37	1.0 km north of Meziadin Junction		n/a	990	n/a	1000	750
47-17	NS	37	0.5 km south of Dease Lake Junction		n/a	530	n/a	870	600
47-18	EW		Telegraph Creek Rd, 0.5 km west of Rte 37		n/a	600	n/a	880	600

1982 - 1985

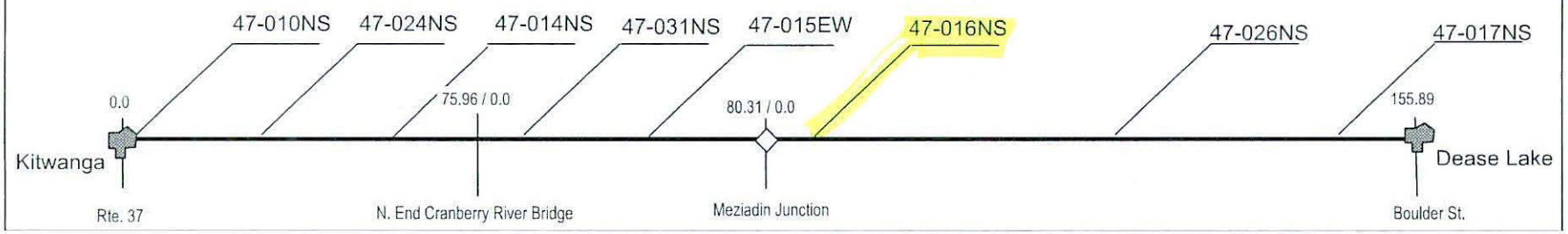
ROUTE NUMBER 37
KITIMAT - CASSIAR HIGHWAY

(Kitimat to Cassiar)

Station No.	Location Description	Class. Hwy. Ref. No.	July 1982	1983	1984	August 1985
48-10-37	At Kitimat River Bridge north of Kitimat		2,400	---	....	3,000
48-7-37	0.3 km south of Route 16&37 at Terrace		4,600	---	....	5,100
48-4E&W	**On west end of Old Skeena River Bridge at Terrace		5,700	6,100	....	7,700
48-9-16	**Route 16, 0.2 km west of Route 37 at Terrace		9,000	8,500	....	11,400
48-5-16&37	0.2 km east of Route 37 at Terrace		10,000	9,600	....	14,000
48-11-16&37	On Kleanza (Gold) Creek Bridge west of Kleanza Creek Provincial Park		2,200	2,000	....	2,000
47-8-16&37	On Coyote Creek Bridge west of Cedarvale Ferry Road		1,700	1,300	....	2,000
47-12E&W -16&37	0.3 km west of Route 37		1,800	1,700	....	1,500
47-11E&W-16	**Route 16, 0.3 km east of Route 37		1,900	1,900	....	1,700
47-10N&S-37	At Skeena River Bridge at Kitwanga		1,300	1,600	....	2,100
47-23N&S-37	0.1 km south of the southern entrance to Nass River Road		....	....	....	*50
47-14N&S-37	16 km south of Meziadin Junction		....	....	....	530
47-15E&W-37A	**Stewart-Meziadin Highway, 18 km west of Meziadin Junction		....	....	....	480
47-16N&S-37	1.0 km north of Meziadin Junction		....	....	....	840
47-17N&S-37	0.5 km south of Dease Lake Junction		....	....	....	590
47-18E&W	**Telegraph Creek Road, 0.5 km west of Route 37		....	....	....	820

1995-2005

Section: Kitwanga to Dease Lake | **Hwy. Name:** Cassiar Hwy | **Hwy. No.:** 37



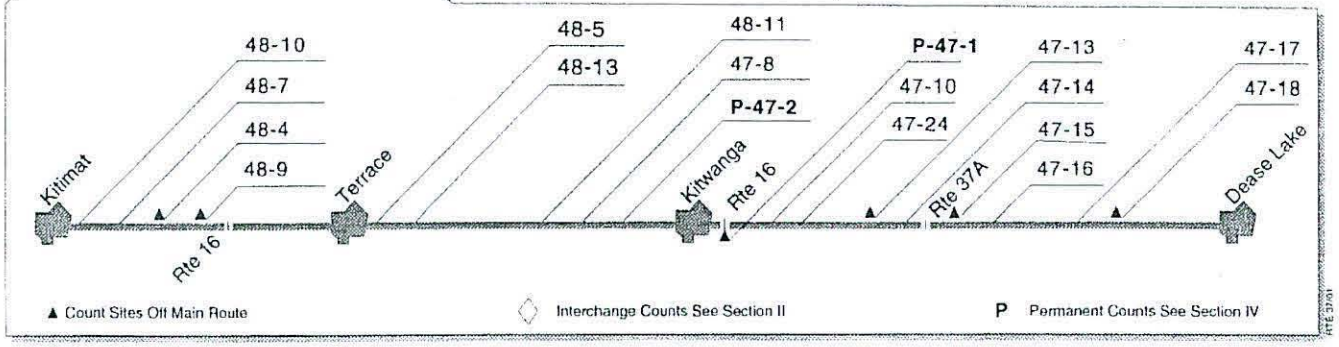
1995-2005

	Traffic Measure Pt.	L.K.I. SEG.	L.K.I. KM.	LOCATION DESCRIPTION	1995	1996	1997	SADT 1998	SADT 1999	SADT 2000	SADT 2001	2002	2003	2004	2005
D	47-010NS	3710	0.2	AT NORTH END OF SKEENA RIVER BRIDGE, 0.1 KM NORTH OF ROUTE 16, KITWANGA (DISCONTINUED - REPLACED BY P-47-1EW IN '92)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
D	47-024NS	3720	5.0	0.1 KM SOUTH OF NASS FOREST SERVICE ROAD, APPROX. 80 KM NORTH OF KITWANGA	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
C	47-014NS	3720	66.3	AT THE NASS RIVER BRIDGE, 16.0 KM SOUTH OF MEZIADIN LAKE JUNCTION	1170 1006	1268 954	1312 953	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
C	47-031NS	3725	6.8	ROUTE 37A, AT AVALANCHE GATE, STEWART	886	600	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	435 295
D	47-015EW	3725	46.8	18.0 Km. WEST OF MEZIADIN JCT. AT WINDY POINT BRIDGE	886 834	708 608	917 775	n/a	n/a	647 551	645 548	n/a	n/a	n/a	n/a
C	47-016NS	3730	1.0	1.0 KM NORTH OF OF MEZIADIN LAKE JUNCTION	647 608	591 525	n/a	n/a	n/a	655 502	650 506	n/a	n/a	n/a	355 272
C	47-026NS	3750	104.8	AT THE STIKINE RIVER BRIDGE, 49.0 KM SOUTH OF DEASE LAKE JUNCTION	749 835	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
D	47-017NS	3750	155.4	0.5 KM SOUTH OF DEASE LAKE JUNCTION	979	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

1989-1993

Kitimat to Dease Lake

Rte 37 Kitimat–Cassiar Hwy

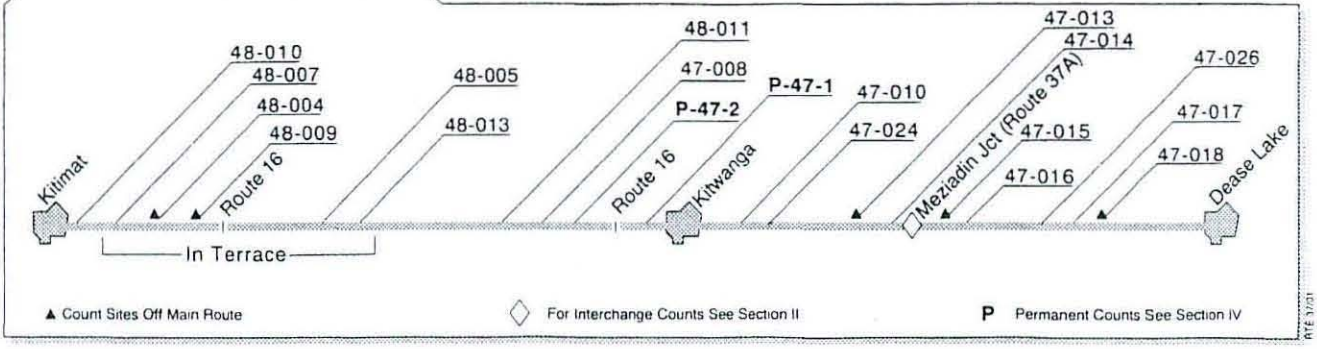


Loc	Dir	Rte	Location description	SADT:	1989	1990	1991	1992	1993
48-10	NS	37	At Kitimat River Bridge, north of Kitimat		2500	2400	2200	2300	2100
48-7	NS	37	0.3 km south of Rte 16/37 at Terrace		5800	5500	5200	5300	6200
48-4	EW		On west end of Old Skeena River Bridge at Terrace		7600	7300	6500	n/a	n/a
48-9	EW	16	Rte 16, 0.2 km west of Rte 37 at Terrace		11200	11700	11300	11700	12100
48-5	EW	16/37	0.2 km east of Rte 37 at Terrace		13300	13500	12200	13100	13000
48-13	EW	16/37	0.5 km east of Clark Street at Terrace						**6600**
48-11	EW	16/37	On Kleanza (Gold) Creek Bridge, west of Kleanza Creek Provincial Park		2600	2500	n/a	2500	n/a
47-8	EW	16/37	On Coyote Creek Bridge, west of Cedarvale Rd		2900	2800	n/a	n/a	2000
P-47-2	EW	16/37	just west of Rte 37, near Kitwanga (formerly Location 47-12)		2400	2200	2000	1900	2174
P-47-1	EW	16	Rte 16, just east of Rte 37, near Kitwanga (formerly Location 47-11)		2200	2000	2200	2200	2102
47-10	NS	37	At Skeena River Bridge at Kitwanga		3800	3800	n/a	2000	n/a
47-24	NS	37	0.1 km south of Forest Service Rd, north of Kitwanga		n/a	n/a	1000	n/a	1100
47-13	NS		Nass River Rd, 0.1 km south of the entrance to Rte 37		n/a	80	n/a	100	n/a
47-14	NS	37	16 km south of Meziadin Junction		1500	1200	1200	1400	1900
47-15	EW	37A	Rte 37A, Stewart-Meziadin Hwy, 18 km west of Meziadin Junction		2100	1300	1200	1200	1200
47-16	NS	37	1.0 km north of Meziadin Junction		1000	750	1000	1100	900
47-17	NS	37	0.5 km south of Dease Lake Junction		870	600	n/a	800	n/a
47-18	EW		Telegraph Creek Rd, 0.5 km west of Rte 37		880	600	n/a	200	n/a

1990 - 1994

Kitimat to Dease Lake

Route 37 Kitimat-Cassiar Hwy



Loc	Dir	Rte	Location description SADT:	1990	1991	1992	1993	1994
48-010	NS	37	AT KITIMAT RIVER BRIDGE, APPROX. 34.0 KM SOUTH OF ROUTE 16, SOUTH OF TERRACE	2400	2200	2300	2100	2400
48-007	NS	37	0.3 KM SOUTH OF ROUTE 16, TERRACE	5500	5200	5300	6200	6200
48-004	EW		LAKELSE ROAD, 0.2 KM WEST OF THE OLD SKEENA RIVER BRIDGE, TERRACE	7300	6500	n/a	n/a	7000
48-009	EW	16	0.2 KM WEST OF ROUTE 37, TERRACE	11700	11300	11700	12100	12900
48-005	EW	16/37	0.2 KM EAST OF ROUTE 37, TERRACE	13500	12200	13100	13000	14200
48-013	EW	16/37	0.5 KM EAST OF CLARK STREET, TERRACE				**6600**	6300
48-011	EW	16/37	ON KLEANZA CREEK BRIDGE, WEST OF KLEANZA CREEK PROVINCIAL PARK, APPROX. 13.0 KM EAST OF TERRACE	2500	n/a	2500	n/a	2700
47-008	EW	16/37	AT COYOTE CREEK BRIDGE, 1.5 KM WEST OF CEDARVALE ROAD, APPROX. 20.0 KM WEST OF KITWANGA	2800	n/a	n/a	2000	2100
P-47-2	EW	16/37	JUST WEST OF ROUTE 37, KITWANGA	2200	2000	1900	2174	2357
P-47-1	EW	16	JUST EAST OF ROUTE 37, KITWANGA	2000	2200	2200	2102	2256
47-010	NS	37	AT NORTH END OF SKEENA RIVER BRIDGE, KITWANGA	3800	n/a	2000	n/a	n/a
47-024	NS	37	0.1 KM SOUTH OF NASS FOREST SERVICE ROAD, APPROX. 80.0 KM NORTH OF KITWANGA	n/a	1000	n/a	1100	n/a
47-013	NS		NASS ROAD, 0.1 KM SOUTH OF ROUTE 37 AT CRANBERRY JUNCTION, APPROX. 80.0 KM NORTH OF KITWANGA	80	n/a	100	n/a	n/a
47-014	NS	37	AT THE NASS RIVER BRIDGE, 16.0 KM SOUTH OF MEZIADIN LAKE JUNCTION	1200	1200	1400	1400	1100
47-015	EW	37A	18.0 KM WEST OF MEZIADIN LAKE JUNCTION	1300	1200	1200	1100	900
47-016	NS	37	1.0 KM NORTH OF MEZIADIN LAKE JUNCTION	750	1000	1100	900	600
47-026	NS	37	AT THE STIKINE RIVER BRIDGE, 49.0 KM SOUTH OF DEASE LAKE JUNCTION	500	n/a	800	n/a	600
47-017	NS	37	0.5 KM SOUTH OF DEASE LAKE JUNCTION	600	n/a	800	n/a	900
47-018	EW		TELEGRAPH CREEK ROAD, 0.5 KM WEST OF ROUTE 37	600	n/a	200	n/a	n/a

1980

ROUTE NUMBER 37
CASSIAR HIGHWAY

(Kitwanga to Cassiar)

Station No.	Location Description	Class. Hwy. Ref. No.	July 1979	1980	August 1981	1982
47-12E&W-16	**Route 16, 0.3 km west of Route 37		....	*1,900	1,600	1,800
47-11E&W-16	**Route 16, 0.3 km east of Route 37		....	*2,200	1,600	1,900
47-10N&S-37	At Skeena River Bridge at Kitwanga		1,200	1,200	1,100	1,300
47-13N&S	**Nass River road, 0.1 km south of Cranberry Junction		....	*430	....	....
47-14N&S-37	16 km south of Meziadian Junction		....	*480	....	....
47-15E&W	**Stewart-Meziadian Highway, 18 km west of Meziadian Junction		....	*540	....	....
47-16N&S-37	1.0 km north of Meziadin Junction		....	*420	....	....
47-17N&S-37	0.5 km south of Dease Lake Junction		....	*650	....	....
47-18E&W	**Telegraph Creek Road, 0.5 km west of Route 37		....	*690	....	....
47-19N&S-37	2.0 km north of Dease Lake Junction		....	*480	....	....
47-20N&S-37	2.0 km south of Cassiar Junction		....	*530	....	....
47-21E&W	**Cassiar Road, 0.2 km west of Cassiar Junction		....	*700	....	....
47-22N&S-37	0.1 km north of Cassiar Junction		....	*480	....	....

* Denotes new station.
** Denotes a station on a feeder road

1980

ROUTE NUMBER 37
CASSIAR HIGHWAY
(Kitwanga to Cassiar)

Station No.	Location Description	Class. Hwy. Ref. No.	July 1977	- 1978	August 1979	1980
47-11E&W-16	**Route 16, 0.3 km east of Route 37		....	....	....	*2,200
47-12E&W-16	**Route 16, 0.3 km west of Route 37		....	....	....	*1,900
47-10N&S-37	At Skeena River Bridge at Kitwanga		810	1,500	1,200	1,200
47-13N&S	**Nass River Road, 0.1 km south of Cranberry Junction		....	....	....	* 430
47-14N&S-37	16 km south of Meziadian Junction		....	....	....	* 480
47-15E&W	**Stewart-Meziadian Highway, 18 km west of Meziadian Junction		....	....	....	* 540
47-16N&S-37	1.0 km north of Meziadian Junction		....	....	....	* 420
47-17N&S-37	0.5 km south of Dease Lake Junction		....	....	....	* 650
47-18E&W	**Telegraph Creek Road, 0.5 km west of Route 37		....	....	....	* 690
47-19N&S-37	2.0 km north of Dease Lake Junction		....	....	....	* 480
47-20N&S-37	2.0 km south of Cassiar Junction		....	....	....	* 530
47-21E&W	**Cassiar Road, 0.2 km west of Cassiar Junction		....	....	....	* 700
47-22N&S-37	0.1 km north of Cassiar Junction		....	....	....	* 480

ROUTE NUMBER 37
KITIMAT – CASSIAR HIGHWAY

(Dease Lake to Cassiar)

Station/	Dir/	Hwy	Location Description	S.A.D.T. July – August			
				1985	1986	1987	1988
47–19	NS	37	2.0 km north of Dease Lake Junction	—	....	610	....
47–20	NS	37	2.0 km south of Cassiar Junction	550	....	740	....
47–21	EW		Cassiar Road, 0.2 km west of Cassiar Junction	490	....	420	....
47–22	NS	37	0.1 km north of Cassiar Junction	410	....	440	....

Hourly Volumes

BC Ministry of Transportation and Infrastructure

24 Hour Roadway Summary for August 23, 2008

Ave daily volume for count duration

% of daily volume

Average peak hour volume

% of peak volume

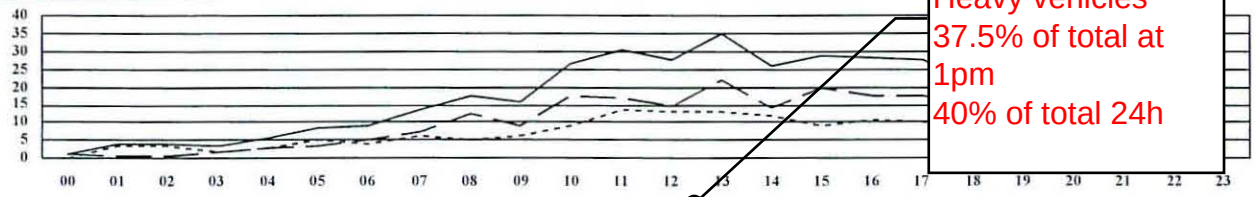
47-016NS
FC0 DIST 470 Posted Speed = 90 kph Co

Route 37 1.0 Km North Of Route 37A At Meziadin Lake Junction

	Total	Total	Peak	Peak
Private:	225.6	59.6	22.0	62.5
Single:	85.8	22.7	7.2	20.5
Combo:	67.1	17.7	6.0	17.0
Trucks:	152.9	40.4	13.2	37.5
Total:	378.5		35.2	

Peak Hour = 1PM
Vol 1PM = 35.2 vph
Vol DAILY = 378.5 vpd
% in Peak hour = 35.2/378.5 = 9.3%

Peak Hour: 13
Axle Factor:



Heavy vehicles~
37.5% of total at 1pm
40% of total 24h

	1	2	3	4	5	6	7	8	9	10	11	12	13
0	0	0.3	0.7	0	1.0	0	0	0	0.3	0	0	0	0.2
1	0	0	0.7	0	1.3	0	1.2	0	0.5	0	0	0.2	0.2
2	0	0.7	0	0.5	1.0	1.2	0.5	0	0.2	0	0	0	0
3	0	1.0	0.7	0	0	0.8	0.7	0	0	0.2	0	0.2	0
4	0	1.3	1.3	0	0.8	0.2	0	0	0.5	0.7	0	0	0
5	0	2.0	1.5	0	2.0	0	0	0	0.3	1.8	0	0.2	1.0
6	0	4.8	0.5	0	1.5	0.2	0	0	0.2	1.0	0	0	1.2
7	0	4.0	3.3	0.2	2.3	0.8	1.5	0.3	0.3	0.7	0	0.2	0
8	0.2	8.0	4.2	0.3	2.2	1.0	0.5	0.7	0	0.5	0	0	0
9	0	5.8	3.5	0	3.0	0.7	0.3	0.8	0.2	0.3	0	0	1.2
10	0.3	8.7	8.7	0	3.3	0.2	0	1.7	0.5	2.5	0	0	0.8
11	0.2	8.2	8.4	0	5.8	0.6	0.6	3.2	1.6	0.8	0	0	1.0
12	0.2	5.2	9.2	0	6.2	0.4	0.4	3.6	1.0	0.2	0	0.2	1.0
13	0.8	13.0	8.2	0.4	5.4	0.8	0.6	3.0	1.0	1.2	0	0	0.8
14	0.2	6.6	7.6	0	4.8	0.2	0.4	2.8	0.8	1.2	0	0.2	1.4
15	1.2	8.8	10.0	0	5.2	0	0	1.4	0.2	1.4	0	0	1.0
16	0.6	7.6	9.4	0	7.0	0.2	0	1.8	0	0.8	0	0	0.8
17	0	7.0	10.6	0	6.4	0	0	1.0	1.4	0.4	0	0.2	0.8
18	1.4	6.0	8.4	0	4.4	0	0	0.8	0.2	0.2	0	0	0.2
19	0.5	4.2	4.8	0.3	2.8	0	0	1.3	0.8	0.5	0	0	0.7
20	0	2.3	2.5	0	2.2	0	0	0.3	0.3	0.5	0.2	0.2	0.3
21	0.2	4.0	1.8	0	1.3	0.2	0	0.2	0.8	0.3	0	0	0.5
22	0	1.7	1.2	0	0.5	0	0	0.2	0.8	0.5	0	0	0.3
23	0	0.5	1.0	0	0.5	0	0	0.3	0.2	0.2	0	0	0.2
Total	5.8	111.7	108.1	1.7	70.0	7.4	6.7	23.4	12.0	15.9	0.2	1.4	14.2
%	1.5	29.5	28.6	0.5	18.5	1.9	1.8	6.2	3.2	4.2	0.0	0.4	3.7

sum of all in row

= 35.2 vph

Appendix B

HCM 2000 Analysis

1992 Analysis

time-spent-following is estimated by adjusting the base percent time-spent-following value for the percentage of no-passing zones. Finally, LOS is determined by average travel speed, percent time-spent-following, or both, depending on the highway classification.

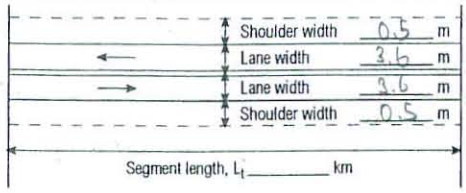
EXHIBIT 20-28. TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET

TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		***Site Information***	
Analyst	Brendan Massey	Highway	Highway 37
Agency or Company	McElhaney	From/To	Medford → Davis Lake
Date Performed	April 19, 2011	Jurisdiction	Northern Region
Analysis Time Period		Analysis Year	2011

☐ Operational (LOS) ☐ Design (v_p) ☐ Planning (LOS) ☐ Planning (v_p)

Input Data



☒ Class I highway ☐ Class II highway
Terrain ☐ Level ☒ Rolling
Two-way hourly volume 102 veh/h
Directional split 50 / 50
Peak-hour factor, PHF 0.88
% Trucks and buses, P_T 40 %
% Recreational vehicles, P_R 0 %
% No-passing zone 40 %
Access points/km 0.1 /km

Average Travel Speed	
Grade adjustment factor, f_G (Exhibit 20-7)	0.71
Passenger-car equivalents for trucks, E_T (Exhibit 20-9)	2.5
Passenger-car equivalents for RVs, E_R (Exhibit 20-9)	1.8
Heavy-vehicle adjustment factor, f_{HV} $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$	0.625
Two-way flow rate,[1] v_p (pc/h) $v_p = \frac{V}{PHF * f_G * f_{HV}}$	261
v_p * highest directional split proportion[2] (pc/h)	130
Free-Flow Speed from Field Measurement	Estimated Free-Flow Speed
Field measured speed, S_{FM} ____ km/h	Base free-flow speed, BFFS 90 km/h
Observed volume, V_f ____ veh/h	Adj. for lane width and shoulder width, f_{LS} (Exhibit 20-5) 6.6 km/h
Free-flow speed, FFS ____ km/h	Adj. for access points, f_A (Exhibit 20-6) 0 km/h
$FFS = S_{FM} + 0.0125\left(\frac{V_f}{f_{HV}}\right)$	Free-flow speed, FFS 83.2 km/h
	$FFS = BFFS - f_{LS} - f_A$
Adj. for no-passing zones, f_{np} (km/h) (Exhibit 20-11)	2.91
Average travel speed, ATS (km/h) $ATS = FFS - 0.0125v_p - f_{np}$	86.8 km/h
Percent Time-Spent-Following	
Grade adjustment factor, f_G (Exhibit 20-8)	0.77
Passenger-car equivalents for trucks, E_T (Exhibit 20-10)	1.8
Passenger-car equivalents for RVs, E_R (Exhibit 20-10)	1.5
Heavy-vehicle adjustment factor, f_{HV} $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$	0.76
Two-way flow rate,[1] v_p (pc/h) $v_p = \frac{V}{PHF * f_G * f_{HV}}$	198 pc/h
v_p * highest directional split proportion[2] (pc/h)	99 pc/h
Base percent time-spent-following, BPTSF (%) $BPTSF = 100(1 - \exp(-0.000879v_p))$	15.9%
Adj. for directional distribution and no-passing zone, $f_{d/np}$ (%) (Exhibit 20-12)	17.7% linear interpolated
Percent time-spent-following, PTSF (%) $PTSF = BPTSF + f_{d/np}$	33.6%
Level of Service and Other Performance Measures	
Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II)	A 33.6% < 35 20.2
Volume to capacity ratio, v/c $v/c = \frac{v_p}{3,200}$	0.08
Peak 15-min vehicle-kilometers of travel, $VkmT_{15}$ (veh-km) $VkmT_{15} = 0.25L_t\left(\frac{V}{PHF}\right)$	
Peak-hour vehicle-kilometers of travel, $VkmT_{60}$ (veh-km) $VkmT_{60} = V * L_t$	
Peak 15-min total travel time, TT_{15} (veh-h) TT_{15} $\frac{VkmT_{15}}{ATS}$	
Notes	

1. If $v_p \geq 3,200$ pc/h, terminate analysis—the LOS is F.
2. If highest directional split $v_p \geq 1,700$ pc/h, terminate analysis—the LOS is F.

SADT = 1100 vpd
Volume = 1100 * 0.093
Two-way hourly volume = 102 vph

$f_{HV} = \frac{1}{1 + 0.4(2.5-1) + 0}$ $f_{HV} = 0.625$

$Vp = \frac{102}{(0.88)(0.71)(0.625)}$

Vp = 261 vph

ATS = 90 - 0.0125(261) - 2.91
ATS = 86.8 kmph

$f_{HV} = \frac{1}{1 + 0.4(1.8-1)}$ $f_{HV} = 0.76$

$Vp = \frac{102}{(0.88)(0.77)(0.76)}$

Vp = 198 vph

BPTSF = 100(1 - exp(-0.000879Vp))
BPTSF = 15.9%

PTSF = 17.7% + 15.9 = 33.6%
PTSF = 33.6%

Vp = 261 pc/h

time-spent-following is estimated by adjusting the base percent time-spent-following value for the percentage of no-passing zones. Finally, LOS is determined by average travel speed, percent time-spent-following, or both, depending on the highway classification.

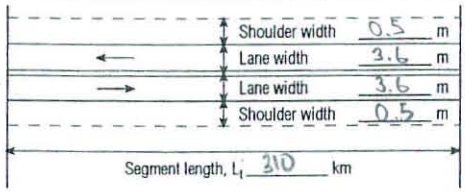
EXHIBIT 20-28. TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET

TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		***Site Information***	
Analyst	Brendan Masson	Highway	Highway 37
Agency or Company	McElhanney	From/To	Meziadin Jct to Dease Lake
Date Performed	April 19, 2011	Jurisdiction	Northern Region
Analysis Time Period		Analysis Year	

☐ Operational (LOS) ☐ Design (v_p) ☐ Planning (LOS) ☐ Planning (v_p)

Input Data



☒ Class I highway ☐ Class II highway
Terrain ☐ Level ☒ Rolling
Two-way hourly volume 35* veh/h
Directional split 50 / 50
Peak-hour factor, PHF 0.88
% Trucks and buses, P_T 40 %
% Recreational vehicles, P_R 0 %
% No-passing zone 40 %
Access points/km 0.1 /km

Average Travel Speed	
Grade adjustment factor, f_G (Exhibit 20-7)	0.71
Passenger-car equivalents for trucks, E_T (Exhibit 20-9)	2.5
Passenger-car equivalents for RVs, E_R (Exhibit 20-9)	1.8
Heavy-vehicle adjustment factor, f_{HV} $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$	0.625
Two-way flow rate,[1] v_p (pc/h) $v_p = \frac{V}{PHF * f_G * f_{HV}}$	90 pc/h
v_p * highest directional split proportion[2] (pc/h)	45 pc/h
Free-Flow Speed from Field Measurement	Estimated Free-Flow Speed
Field measured speed, S_{FM} ____ km/h	Base free-flow speed, BFFS 90 km/h
Observed volume, V_f ____ veh/h	Adj. for lane width and shoulder width, f_{LS} (Exhibit 20-5) 6.8 km/h
Free-flow speed, FFS ____ km/h	Adj. for access points, f_A (Exhibit 20-6) 0 km/h
$FFS = S_{FM} + 0.0125(\frac{V_f}{f_{HV}})$	Free-flow speed, FFS 83.2 km/h
	$FFS = BFFS - f_{LS} - f_A$
Adj. for no-passing zones, f_{np} (km/h) (Exhibit 20-11)	2.3
Average travel speed, ATS (km/h) $ATS = FFS - 0.0125v_p - f_{np}$	80.3

Percent Time-Spent-Following	
Grade adjustment factor, f_G (Exhibit 20-8)	0.77
Passenger-car equivalents for trucks, E_T (Exhibit 20-10)	1.8
Passenger-car equivalents for RVs, E_R (Exhibit 20-10)	1.0
Heavy-vehicle adjustment factor, f_{HV} $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$	0.71
Two-way flow rate,[1] v_p (pc/h) $v_p = \frac{V}{PHF * f_G * f_{HV}}$	73
v_p * highest directional split proportion[2] (pc/h)	37
Base percent time-spent-following, BPTSF (%) $BPTSF = 100(1 - exp(-0.000879v_p))$	6.2%
Adj. for directional distribution and no-passing zone, $f_{d/np}$ (%) (Exhibit 20-12)	17.2%
Percent time-spent-following, PTSF (%) $PTSF = BPTSF + f_{d/np}$	23.4%

Level of Service and Other Performance Measures	
Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II)	A 23.4 < 35
Volume to capacity ratio, v/c $v/c = \frac{v_p}{3,200}$	0.03
Peak 15-min vehicle-kilometers of travel, $VkmT_{15}$ (veh-km) $VkmT_{15} = 0.25L_t(\frac{V}{PHF})$	N/A
Peak-hour vehicle-kilometers of travel, $VkmT_{60}$ (veh-km) $VkmT_{60} = V * L_t$	N/A
Peak 15-min total travel time, TT_{15} (veh-h) TT_{15} $\frac{VkmT_{15}}{ATS}$	N/A

Notes

1. If $v_p \geq 3,200$ pc/h, terminate analysis—the LOS is F.
2. If highest directional split $v_p \geq 1,700$ pc/h, terminate analysis—the LOS is F.

SADT = 378 vpd
Volume = 378 * 0.093
Two way volume = 35 vph

$f_{HV} = \frac{1}{1 + 0.40(2.5 - 1) + 0}$

$f_{HV} = 0.625$

$v_p = \frac{35}{(0.88)(0.71)(0.625)}$

$v_p = 89.6 \approx 90$ vph

AST (km/h) = 83.2 - 0.0125(45) - 2.3

ATS = 80.3 km/h

$f_{HV} = \frac{1}{1 + 0.5(1.8 - 1) + 0}$ $f_{HV} = 0.71$

$v_p = \frac{35}{(0.88)(0.77)(0.71)}$ $v_p = 73$ vph

$BPTSF = 100(1 - exp(-0.000879 * v_p))$

BPTSF = 6.2%

$v_p = 90$ pc/h

Appendix C

KSM Project Traffic Volume Study

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Engineers and Scientists

TETRA TECH WARDROP

Memo

To	Elizabeth Miller, Seabridge Gold Inc.
From	Peter Udovicic, Tetra Tech-Wardrop
Date	May 29, 2012
Document No.	1252880100-MEM-R0001-03
Project Name	Kerr-Sulphurets-Mitchell (KSM) Pre-feasibility Study Update 2012
Subject	Traffic Volume Study –May 2012 Final

Introduction

Tetra Tech-Wardrop (Tt WEI) performed an updated assessment of the potential traffic volumes on the access roads to the Kerr-Sulphurets-Mitchell (KSM) project site as well as on Highways 16, 37, and 37A.

The information provided in this memo is Tt WEI's interpretation of the data that was provided by various consultants who are currently working on the KSM Project.

Assumptions

This memo is based on the following assumptions:

- This memo is based on 130,000 t/d throughput, a 6-year Construction phase, a 55-year Operation phase, and a 3-year Decommissioning phase. Post-closure data is provided on a per annum basis and no duration was assumed.
- The Construction phase of the project has been broken down into quarterly averages to more accurately reflect the seasonality of this phase. The Operation, Decommissioning, and Post-closure phases are presented by year.
- All figures are based on 'trips'; for example, one trip equals a loaded truck delivering cargo to site and then returning empty via the same route.
- All trips will be made by vehicles that are permitted to operate within the laws of the Province of British Columbia.
- Equipment, materials, reagents, and supplies will be shipped using standard commercial trucks. Personnel will be transported in standard coach-type busses or passenger vehicles.
- Grinding media will be shipped on super-B trucks from a staging yard/warehouse in Smithers, BC, in trucks with 40-tonne capacity.
- Diesel fuel is assumed to be sourced from Terrace, BC, and delivered in super-B tanker trucks with a capacity of 45,000 litres per truck.

555 West Hastings Street, Suite 800, Vancouver, British Columbia V6B 1M1, Canada
Tel 604.408.3788 Fax 604.408.3722 www.tetratech.com

- Explosives will be delivered by super-B trucks with a capacity of 40 tonnes per truck.
- Copper concentrate will be shipped in bulk form in super-B trucks with a capacity of 50 tonnes to Stewart Bulk Terminals. The heavier payload assumes the allowance of heavier loads under the Bulk Haul Program introduced by the Ministry of Transportation and Infrastructure in 2010. Under the Bulk Haul Program, shipping companies can enter into agreements with the Province to operate trucks that comply with axle weight limits, but exceed gross vehicle weight restrictions.
- Molybdenum concentrate will be loaded in 2 tonne bags and transported on super-B flat deck trucks to Prince Rupert, BC.
- Gold and silver doré will be shipped from site via air transport for security reasons.
- Major mining equipment will be replaced every 10 years.
- The KSM plant site will be accessed via the proposed Treaty Creek access road, which will connect to Highway 37.
- Traffic on the Frank Mackie Winter Access Road will originate in Stewart, BC. Half of the cargo will be delivered to Stewart by barge, and the other half will be delivered to Stewart by truck (via Highway 16, Highway 37, and Highway 37A). Any traffic travelling along the Frank Mackie Winter Access Road will not travel along the Eskay/Coulter Creek or Treaty Creek access roads.
- During initial construction, the KSM site will be accessed via the Frank Mackie Winter Access Road. During the remaining years of construction, the Eskay/Coulter Creek or Treaty Creek access roadswill provide site access, oncethey are commissioned.
- During Operation, liners, diesel fuel, lubricants, personnel, camp supplies, and parts/machinery have been assumed to be shipped via the Mitchell-Teigen Tunnel (MTT) from the Teigen side to the Mitchell side. Explosives and major mine equipment will be routed via the Coulter Creek access road.
- During Decommissioning, all equipment and material except foundations (concrete and rebar) will be removed.
- Volumes for the Decommissioning phase are estimated at approximately 70% of material/equipment from the Construction phase.
- During Decommissioning and Post-closure, it is assumed that all traffic will move via the MTT and Treaty Creek access road as it is assumed that the Eskay/Coulter Creek access road will be decommissioned at this time.
- During Post-closure, it is assumed that activities and traffic volumes are consistent throughout the entire phase.

The following assumptions were provided by Moose Mountain Technical Services regarding the movement of explosives materials:

- Assuming the potentially hazardous materials are AN prill, diesel fuel, initiation systems, ANFO, and emulsion:
  - Approximately 80% of the traffic on the explosive facilities road will carry potentially hazardous materials.
  - Less than 5% of the traffic on the mine site will carry potentially hazardous explosives materials.

Notes

It should be noted that during the 55-year Operation period, the annual traffic volumes for both diesel fuel and explosives will vary significantly from year to year. Table 1 outlines average traffic volumes during 10-year increments (except Years 51 to 55).

Table 1 Average Fuel and Explosives Traffic during Operation

Vehicle Type	Cargo	Year 1-10	Year 11-20	Year 21-30	Year 31-40	Year 41-50	Year 51-55
Tanker (45,000 L)	Diesel Fuel	4,489	2,812	3,184	756	894	442
Vans (Enclosed Trailers)	Explosives	1,828	912	1,384	606	360	0

Appendices

The following appendices are included with this memo:

- **Appendix A:** Summary of the Average Quarterly Traffic for the 6-year Construction Phase
- **Appendix B:** Summary of the Average Annual Traffic for the 55-year Operation Phase
- **Appendix C:** Summary of the Average Annual Traffic for the 3-year Decommissioning Phase
- **Appendix D:** Summary of the Average Annual Traffic for Post-closure Phase

APPENDIX A

SUMMARY OF THE AVERAGE QUARTERLY TRAFFIC FOR THE 6-YEAR CONSTRUCTION PHASE

Traffic Study 2012 (MAY FINAL)
SEABRIDGE - KSM PROJECT
Average Quarterly Traffic for Construction Phase by Route/Cargo

Frank Mackie Winter Access Road						
Average Quarterly Traffic for Construction Phase by Route/Cargo		Route				
		Frank Mackie Winter Access Road				
Vechicle Type	Cargo	Q4	Q1	Q2	Q3	Total
48' Flat-Deck	Infrastructure	218	218	0	0	**436**
Vans (Enclosed Trailers)	Infrastructure	73	73	0	0	**146**
48' Flat-Deck	Camps & Support Facilities	0	0	0	0	**0**
Vans (Enclosed Trailers)	Camps & Support Facilities	0	0	0	0	**0**
48' Flat-Deck	Mine Site	375	375	0	0	**750**
Vans (Enclosed Trailers)	Mine Site	125	125	0	0	**250**
48' Flat-Deck	Plant Site	0	0	0	0	**0**
Vans (Enclosed Trailers)	Plant Site	0	0	0	0	**0**
Bus & Passenger Vehicles	Crew Transport	10	10	0	0	**20**
48' Flat-Deck	Equipment	29	29	0	0	**58**
Vans (Enclosed Trailers)	Equipment	10	10	0	0	**20**
48' Flat-Deck	Materials	0	0	0	0	**0**
Vans (Enclosed Trailers)	Materials	0	0	0	0	**0**
48' Flat-Deck	Flocculant	0	0	0	0	**0**
Bulk Tanker	Lime	0	0	0	0	**0**
Tanker (45,000 L)	Fuel	30	30	0	0	**60**
Vans (Enclosed Trailers)	Explosives	10	10	0	0	**20**
	Grand Total	**880**	**880**	**0**	**0**	**1,760**

ACCESS ROADS: Treaty & Eskay/Coulter											
Average Quarterly Traffic for Construction Phase by Route/ Cargo		Route					Route				
		Treaty					Eskay/Coulter				
Vechicle Type	Cargo	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4	Total
48' Flat-Deck	Infrastructure	74	84	69	57	**284**	25	33	28	25	**111**
Vans (Enclosed Trailers)	Infrastructure	25	28	23	19	**95**	8	11	9	8	**36**
48' Flat-Deck	Camps & Support Facilities	160	137	108	80	**485**	69	75	74	74	**292**
Vans (Enclosed Trailers)	Camps & Support Facilities	53	46	36	27	**162**	23	25	25	25	**98**
48' Flat-Deck	Mine Site	2	2	4	5	**13**	268	209	176	121	**774**
Vans (Enclosed Trailers)	Mine Site	1	1	1	2	**5**	89	70	59	40	**258**
48' Flat-Deck	Plant Site	851	678	513	338	**2,380**	0	0	0	0	**0**
Vans (Enclosed Trailers)	Plant Site	284	226	171	113	**794**	0	0	0	0	**0**
Bus & Passenger Vehicles	Crew Transport	88	103	117	126	**434**	95	105	112	115	**427**
48' Flat-Deck	Equipment	18	21	26	29	**94**	55	44	35	24	**158**
Vans (Enclosed Trailers)	Equipment	6	7	9	10	**32**	18	15	12	8	**53**
48' Flat-Deck	Materials	98	74	58	33	**263**	52	39	27	14	**132**
Vans (Enclosed Trailers)	Materials	33	25	19	11	**88**	17	13	9	5	**44**
48' Flat-Deck	Flocculant	0	0	0	0	**0**	5	5	5	5	**20**
Bulk Tanker	Lime	0	0	0	0	**0**	59	48	36	136	**279**
Tanker (45,000 L)	Fuel	70	56	52	39	**217**	61	50	49	38	**198**
Vans (Enclosed Trailers)	Explosives	4	4	4	4	**16**	2	1	1	1	**5**
	Grand Total	**1,767**	**1,492**	**1,210**	**893**	**5,362**	**846**	**743**	**657**	**639**	**2,885**

HIGHWAY ACCESS																
Average Quarterly Traffic for Construction Phase by Route/ Cargo		Route					Route					Route				
		Highway 37					Highway 37A					Highway 16				
Vechicle Type	Cargo	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4	Total
48' Flat-Deck	Infrastructure	208	117	97	191	**613**	109	0	0	109	**218**	208	117	97	191	**613**
Vans (Enclosed Trailers)	Infrastructure	69	39	32	64	**204**	36	0	0	36	**72**	69	39	32	64	**204**
48' Flat-Deck	Camps & Support Facilities	229	212	182	154	**777**	0	0	0	0	**0**	229	212	182	154	**777**
Vans (Enclosed Trailers)	Camps & Support Facilities	76	71	61	51	**259**	0	0	0	0	**0**	76	71	61	51	**259**
48' Flat-Deck	Mine Site	457	211	180	314	**1,162**	188	0	0	188	**376**	457	211	180	314	**1,162**
Vans (Enclosed Trailers)	Mine Site	152	70	60	105	**387**	63	0	0	63	**126**	152	70	60	105	**387**
48' Flat-Deck	Plant Site	851	678	513	338	**2,380**	0	0	0	0	**0**	851	678	513	338	**2,380**
Vans (Enclosed Trailers)	Plant Site	284	226	171	113	**794**	0	0	0	0	**0**	284	226	171	113	**794**
Bus & Passenger Vehicles	Crew Transport	188	208	229	246	**871**	5	0	0	5	**10**	188	208	229	246	**871**
48' Flat-Deck	Equipment	87	65	62	67	**281**	14	0	0	14	**28**	87	65	62	67	**281**
Vans (Enclosed Trailers)	Equipment	29	22	21	22	**94**	5	0	0	5	**10**	29	22	21	22	**94**
48' Flat-Deck	Materials	149	113	85	47	**394**	0	0	0	0	**0**	149	113	85	47	**394**
Vans (Enclosed Trailers)	Materials	50	38	28	16	**132**	0	0	0	0	**0**	50	38	28	16	**132**
48' Flat-Deck	Flocculant	5	5	5	5	**20**	0	0	0	0	**0**	5	5	5	5	**20**
Bulk Tanker	Lime	59	48	36	136	**279**	0	0	0	0	**0**	59	48	36	136	**279**
Tanker (45,000 L)	Fuel	146	106	101	92	**445**	15	0	0	15	**30**	146	106	101	92	**445**
Vans (Enclosed Trailers)	Explosives	11	5	5	10	**31**	5	0	0	5	**10**	11	5	5	10	**31**
	Grand Total	**3,050**	**2,234**	**1,868**	**1,971**	**9,123**	**440**	**0**	**0**	**440**	**880**	**3,050**	**2,234**	**1,868**	**1,971**	**9,123**

APPENDIX B

SUMMARY OF THE AVERAGE ANNUAL TRAFFIC FOR THE 55-YEAR OPERATION PHASE

Traffic Study 2012 (MAY FINAL)
SEABRIDGE - KSM PROJECT
Average Annual Traffic for Operation Phase by Route/ Cargo (55-year Period)

Average Annual Traffic for Operation Phase by Route/Cargo (55 year period)		Route				
Vechicle Type	**Cargo**	**Treaty**	**Eskay/ Coulter**	**Highway 37**	**Highway 37A**	**Highway 16**
Bulk B-Train	Copper Concentrates	13,200	-	13,200	13,200	-
Super-B Trucks	Molybdenum Concentrates	86	-	86	-	86
Vans (Enclosed Trailers)	Lime & All Other Reagents	8,440	-	8,440	-	8,440
Super-B Trucks	Grinding Media	2,810	-	2,810	-	2,810
48' Flat-Deck	Liners	226	-	226	-	226
Tanker (45,000 L)	Diesel Fuel	2,246	-	2,246	-	2,246
Vans (Enclosed Trailers)	Lubricants	50	-	50	-	50
Bus & Passenger Vehicles	Personnel and Visitors & Maintenance	408		408	-	408
Vans (Enclosed Trailers)	Camp Supplies	480	-	480	-	480
Super-B Trucks	Explosives	-	925	925	-	925
Bulk Tanker	Lime - Water Treatment	1,278	-	1,278	-	1,278
48' Flat-Deck	Flocculant - Water Treatment	10	-	10	-	10
48' Flat-Deck	Parts & Machinery	910	-	910	-	910
48' Flat-Deck	Major Mine Equipment	-	79	79	-	79
	Grand Total	**30,144**	**1,004**	**31,148**	**13,200**	**17,948**

APPENDIX C

SUMMARY OF THE AVERAGE ANNUAL TRAFFIC FOR THE 3-YEAR DECOMMISSIONING PHASE

Traffic Study 2012 (MAY FINAL)
SEABRIDGE - KSM PROJECT
Average Annual Traffic for Decommissioning Phase by Route/Cargo (3-year Period)

Average Annual Traffic for Decommissioning Phase by Route/Cargo (3-year Period)		Route				
Vechicle Type	**Cargo**	**Treaty**	**Eskay/ Coulter**	**Highway 37**	**Highway 37A**	**Highway 16**
48' Flat-Deck	Infrastructure	221	0	221	0	221
48' Flat-Deck	Camps & Support Facilities	250	0	250	0	250
48' Flat-Deck	Mine Site	662	0	662	0	662
48' Flat-Deck	Plant Site	1,511	0	1,511	0	1,511
48' Flat-Deck	Materials	143	0	143	0	143
Bus & Passenger Vehicle	Personnel	210	0	210	0	210
Super-B Trucks	Infrastructure	74	0	74	0	74
Super-B Trucks	Camps & Support Facilities	84	0	84	0	84
Super-B Trucks	Mine Site	221	0	221	0	221
Super-B Trucks	Plant Site	504	0	504	0	504
Super-B Trucks	Materials	48	0	48	0	48
Super-B Trains	Lime	1,000	0	1,000	0	1,000
48' Flat Deck	Flocculant - Water Treatment	18	0	18	0	18
Tanker (45,000 L)	Fuel	888	0	888	0	888
Grand Total		**5,834**	**-**	**5,834**	**-**	**5,834**

APPENDIX D

SUMMARY OF THE AVERAGE ANNUAL TRAFFIC FOR THE POST-CLOSURE PHASE

Traffic Study 2012 (MAY FINAL)
SEABRIDGE - KSM PROJECT
Average Annual Traffic for Post-closure Phase by Route/Cargo

Average Annual Traffic for Post-closure Phase by Route/Cargo		Route				
Vechicle Type	**Cargo**	**Treaty**	**Eskay/ Coulter**	**Highway 37**	**Highway 37A**	**Highway 16**
Bulk Truck	Reagent (Lime)	2,190	0	2,190	0	2,190
Lowboy Flat Deck	Sludge Haul & Maintenance Equipment	20	0	20	0	20
48' Flat Deck	Flocculant	18	0	18	0	18
Bus & Passenger Vehicles	Personnel	24	0	24	0	24
Vans	Food & Misc Supplies	12	0	12	0	12
Tanker (45,000 L)	Fuel	16	0	16	0	16
Passenger Vehicles	Visitors & Maintenance	8	0	8	0	8
Grand Total		**2,288**	**-**	**2,288**	**-**	**2,288**

Appendix D

Moose and Highway 37/37A Traffic; a Population Viability Approach

Rescan™
Engineers and Scientists

Executive summary

This report contains a population viability assessment of the Nass moose population. A population dynamics model received from the British Columbia Ministry of Environment was used to perform a historical reconstruction of the Nass population under known harvests and demographic rates. A statistical reconstruction produced a best fitting model to empirical trends of abundance survey data and harvest survey data. A moose vehicle collision model was imbedded into the population dynamics model to emulate the fraction of moose mortality that could be explained by the current level of vehicle collisions. The parameters estimated in the statistical reconstruction were treated as predictors of how the Nass population behaves, and used to perform a sensitivity analysis of population predictions under future assumed conditions of harvest and vehicle traffic. The harvest examined was a continued annual harvest of 50 bulls per year.

The vehicle traffic examined several traffic scenarios, including 1) the addition of traffic from the KSM Project during operations and 2) the addition of KSM and other foreseeable mining and hydroelectric projects along the Highway 37 corridor. Finally, the moose population was modeled under a variety of possible future survival rates and hunting rates to examine the models sensitivity to these variables. Monte-Carlo simulations of future scenarios were then conducted using variable inter-annual survival to predict a possible future moose populations under each of the traffic scenarios.

This modeling exercise makes several assumptions about the moose population. Whenever possible, conservative assumptions were made:

- The analysis makes the assumption that birth rates and survival rates in the future will differ from the past only in proportion to vehicle collisions, but will otherwise be the same as the average rates over the period 2001 to 2011.

- The current rate of moose mortality was estimated from the Wildlife Accident Reporting System database where it was assumed that reported moose mortality accounted

for only 30% of the true moose mortality on the highway and with this correction yielded a projected current value of 18.5 moose/year in the traffic assessment area.

- It is assumed that hunting will continue on the moose population with a base harvest rate of 30 bulls from 2012 onward. The model incorporates historic hunting of females, but assumes that initiatives to alter hunting practices towards males are successful going forward from 2012.

This report describes the process of historical reconstruction, parameter estimation, modeling of future traffic scenarios and discusses the data limitations and assumptions in the model. The primary limitation was in the scarcity of data to fit the historical reconstruction. Only three moose estimates have been conducted during the period of 2000-2012. Historical licensed hunting, Nisgaa Nation and First Nations hunting, and mortality due to poaching, existing traffic and carnivores (wolf and black bear) are poorly defined or unknown. Also, assumptions about moose distribution and movement rates were made that likely over-estimate the sensitivity of the population to increased mortality. Results of the historical reconstruction and Monte-Carlo simulations of future scenarios are:

- Overall, the modeled population is very sensitive to small changes in survival rate. This result is partly due to the many age classes (20) used in the BC MOE model yielding a modeled population which is likely more sensitive to changes in mortality than the true Nass moose population. Typical moose models use only 3 age classes and are typically less sensitive to small changes in survival.

- Historic reconstruction of the moose population indicates that hunting rates were the likely initial cause of the moose population decline from 1595 to 517 animals during 2001 - 2011.

- Under a scenario of current traffic and hunting levels, the model predicts that the Nass moose population will not decline substantially, on average, by 2030.

- The addition of traffic from the KSM project is projected to cause an additional 0.89% mortality to the moose population at the current population size, a mortality rate that does not predict a substantial decline from the base case scenario.

- Results indicate that additional mortality of as little as 1% more than the predicted KSM traffic (from vehicles or otherwise) could be enough to cause the population to decline which is less than the projected scenario if all projects in the region were to concurrently enter operations which is unlikely to happen.

- Under a scenario of baseline traffic plus KSM traffic, if the modeled survival rate of moose is increased a small amount (1-2%) and/or if hunting rates are altered, the model predicts an increase in the Nass moose population by 2030 from current conditions.

1 Introduction

1.1 The Issues

During the 2012 working group meetings for KSM Project Traffic, members of the working group expressed concern over the potential effect that increased traffic from the KSM Project on Highway 37 and 37A may have on moose populations. Since the Nass moose population may have already declined from estimated abundance of 1595 animals in 2001 to 638 animals in 2004, and then to 517 animals in 2011 (DeMarchi and Shultze 2011), members of the working group expressed concern that the population might not be able to recover if traffic increases lead to significantly higher mortality rates from vehicle collisions. The concern arises from two factors: 1. the potential increase in the amount of road, and 2. the potential increase in traffic on those roads. Also, since collisions between moose and heavy trucks have a higher mortality rate for moose than with lighter vehicles, and since the majority of mining traffic will involve heavy vehicles, whatever collisions occur will likely be fatal to moose. If both the amount of road with which moose come into contact increase, as well as

the amount of traffic on said road, then the expectation is that vehicle collisions will increase and so will the moose vehicle mortality rate.

1.2 Objectives

The goal of this project is to develop a tool to explore the effect of increased highway traffic and vehicle collisions on the Nass moose population. The Nass moose population is considered to inhabit the Nass Wildlife Area, with a Northern extent at Bell II. The population assessment and analysis contained in this report describes the historical population trends of the Nass moose population, and predicts the effect of increased highway traffic caused mortality on the potential for the Nass population to be sustainable under planned moose harvest management.

The basis for predicting moose population dynamics was an existing model used by the British Columbia Ministry of Environment in Smithers, BC. The moose population dynamics model was originally developed in Excel (i.e.: Moose Model 2000.xls) by BC MOE. Rescan Environmental Services Ltd. (Rescan) contracted model improvement work to include a sub-model that simulates moose vehicle collision mortality under assumed traffic conditions, as well as have the capability to perform extensive sensitivity analysis using various assumptions about variability in survival, harvest rates, and collision mortality.

The MOE moose model was re-coded into the Open Source R statistical language so that the additional highway dynamics could be included, as well as for the statistical and graphical capabilities in R. The goal was to examine the effect of the KSM project on the Nass moose population, and to examine the threshold of activities that the populations may potentially be able to sustain. The updated model is included in Appendix 1.

2 Methods

The population assessment draws upon a broad range of empirical evidence and statistical model fitting. Hunter survey data and abundance survey data are both used to calibrate the model so that it can reconstruct empirical trends. Historical traffic collision data were used to construct a future predictor of vehicle collisions that weds past collision rates with future traffic patterns in a way that makes best use of the spatial heterogeneity of encounters and traffic patterns. The result is a predictive tool that examines population patterns across a range of assumptions and management options.

2.1 Data and trends

The Nass moose population spans management units (MUs) 614, 615, 616, and 630. The British Columbia natural resource managers allocate harvest in conjunction with Nisga'a Nation and Gitanyow First Nation. The Nass population abundance was assessed in 2001, 2007, and 2011. Estimated abundance was 1595, 638, and 517 animals respectively (DeMarchi and Shultze 2011), a 68% decline in 10 years ($\lambda = 0.89$). Since the official Nass population spans all four MUs, a closer look at population trends was warranted. Provided in Figures 1 and 2 are kill per hunter-day (KPHD) trends from 1975 to 2010, which represent a relative population abundance index. It is assumed that the kill rate per hunter remains constant with the number of hunters, so a change in the kills per hunter-day translates to a change in moose abundance. The indices were obtained from provincial hunter survey records, and only account for a portion of the total kills sustained by the Nass populations. The index was obtained by dividing the number of resident kills by the total number of hunter-days in each MU, for each year. The trends are shown in Figure 1 for each MU. Figure 2 shows kills per hunter-day when the kills and hunter days are aggregated across all MUs. The individual MU indices and the aggregated index both show variability around an approximate mean of 0.05 kills per hunter-day. The apparent pattern is that there was

an increase in the relative abundance of moose from the late 1970's until the early 1990's. The trend seems to have been driven by MU 615. The opposite trend seems to be apparent in MU 630. The largest average number of annual reported kills over the surveyed period occurred in MU 615, with 65 kills per year. MUs 614, 616, and 630 had 8, 21, and 23 kills per year respectively. Since MU 615 has more kills per hunter day, it is probably a more influential component of the Nass trend than MU 614. Despite the increase apparent in MU 615 from the late 1970's, and despite the relatively high variability in KPHD, MU 615 is still trending downward. The downward trend in MU 630 appears to have begun in the early 1990's, whereas a decline in MU 615 does not appear to have begun until the early 2000's.

Figure 1: Kills per hunter-day represents inter-annual relative abundance of moose in each MU.

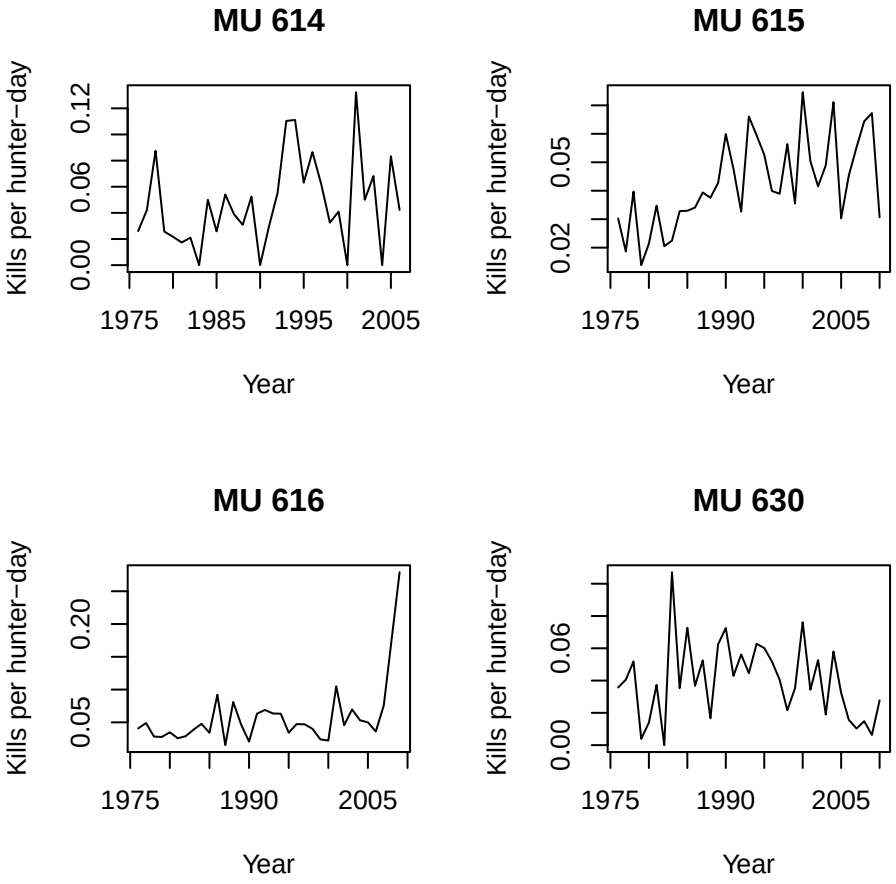
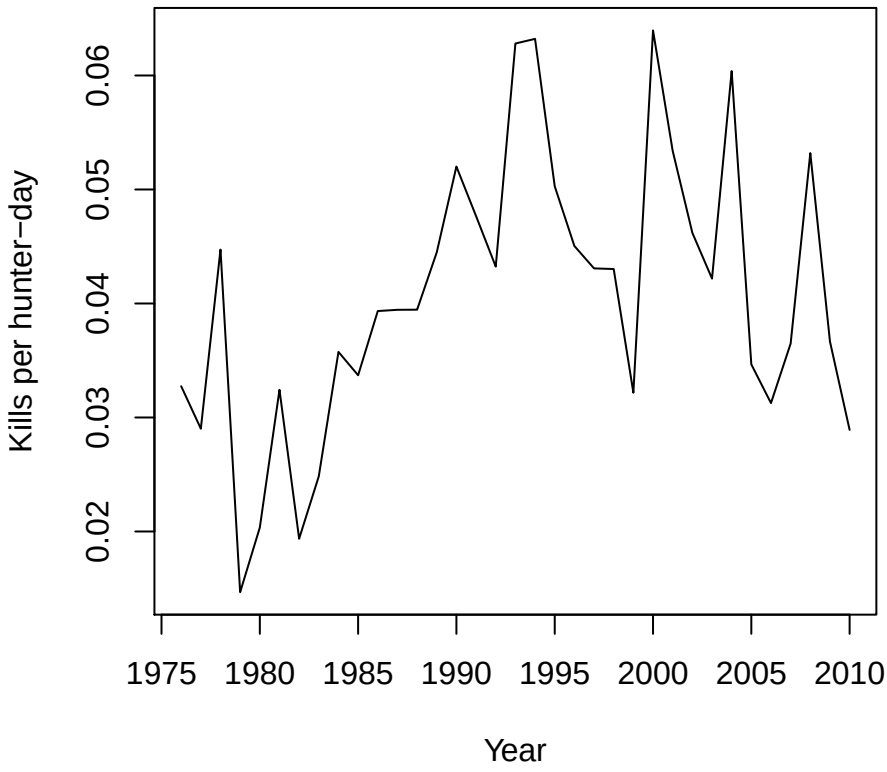


Figure 2: Kills per hunter-day represents inter-annual relative abundance of moose aggregating across all MUs.



2.2 Moose modelling methods

The BC MOE moose model used to evaluate population dynamics is an age-specific fecundity model coupled with age-specific mortality. The model predicts the number of animals from ages zero to twenty, with age-zero being sub-yearlings. In spring, the model predicts an abundance at age from the abundance at the previous age the previous year. Within a given year, the model predicts animals at a series of life stages more or less corresponding to seasons. The first life stage is births, followed by fall females and males, then mid-winter males and females, and finally spring males and females. Harvest is sex-specific, such that harvests can be allocated according to total males and females. Relative numbers at each

age predicts the numbers of males and females at a given age that are harvested.

The model has the capability to scale harvest by vulnerability at age and sex, but by default, all adults of all sexes are equally vulnerable to harvest, with the exception of sub-yearlings. For a set harvest quota, animals at each age are harvested in proportion to their abundance. For example, if 100 males are scheduled for harvest, and if age 5 males accounted for 10 percent of the total male abundance, then 10 age 5 males would be harvested and the remaining 90 moose would come from the remaining age classes in proportion to their relative abundances.

Some critical assumptions are imbedded in the BC MOE model, and include:

Sex ratio threshold parameter Below a certain ratio of bulls to cows, there will be an insufficient number of bulls for every cow to find a mate. The value of this parameter is set to 35 bulls per 100 cows in the BC MOE model. Once the ratio falls below that number, the fecundity of each age class of females begins to drop linearly, until fecundity reaches zero when there are no bulls.

Age specific fecundities of females Age zero cows do not mate. All other ages do, with fecundity rates rising to an average of 5% twinning rate by age 6. Fecundity as defined by the BC MOE values begins to decline by age 13. The fecundity schedule from the BC MOE model is provided in Table 1.

Reproductive multiplier parameter The age specific fecundities are in fact just relative numbers at age. A multiplier parameter can be used to scale all fecundities higher to match observed birth rates. This number is currently set to 0.95, meaning that fecundities are 5% lower than the values in Table 1.

Winter survival scaling parameters It is assumed that overwinter survivals are lower than summer survivals. A scaling parameter is estimated in this analysis to capture this relative quantity. The statistical fitting procedure will confirm if there is a winter effect if the value of the scaling parameter is below 1.

Female survival scaling parameters It is assumed that overwinter survival of females is lower than males, owing to the increased stress of maternity and the demonstrated relative rate of vehicle collisions. A scaling parameter is estimated in this analysis to capture this relative quantity. The statistical fitting procedure will confirm if there is a winter effect if the value of the scaling parameter is below 1.

Historic and Future Hunting It is assumed that historic hunting consisted of a mixture of males and females. The exact mixture is unknown but the historic reconstruction process is robust to a variety of sex ratios. Future hunting in this analysis is conducted with and all male harvest, and with a mixture of male and female harvest.

Table 1: Age specific fecundity table. Fecundities indicate an average number of births per female, i.e., numbers above 1 indicate some females are twinning, and numbers below 1 indicate substantial number of females not producing calves.

Age	Fecundity
0	0
1	0.17
2	0.76
3	0.8
4	0.9
5	1
6	1.05
7	1.05
8	1.02
9	1
10	1
11	1
12	1
13	0.9
14	0.8
15	0.8
16	0.7
17	0.7
18	0.7
19	0.7
20	0.7

2.2.1 Moose model fitting

To estimate the moose model parameters, a maximum likelihood estimation was implemented. The method involved fitting the model to both survey data and relative abundance data. Log-normal observation error models were constructed for both data sources. The survey data assumed an unknown level of observation error as did the relative abundance data. The equations for each likelihood are shown below. Beginning with the relative abundance data, Equation 1 shows a linear relationship between abundance and an index of relative abundance.

$$Y_i = qN_i e^{\beta} \quad where \quad \beta \sim N(0, \sigma_\beta) \tag{1}$$

$\{Y_i\}$ (the index) is an empirical quantity (kills per hunter-day). q is a scaling quantity used to describe the relationship between the actual values $\{N_i\}$ and the set of observed quantities $\{Y_i\}$. β is a gaussian random variable with mean 0 and standard deviation σ_W. Taking the log of both sides we get:

$$\log(\frac{Y_i}{N_i}) = \log(q) + \beta \tag{2}$$

Setting $Z_i = \log(Y_i/N_i)$ and using the MLE $\hat{q'} = \widehat{log(q)} = \frac{1}{n}\sum_i^n {Z_i}^2$ minimises the following negative log-likelihood function:

$$L = \frac{(n-1)}{2} \log \sum_i^n (Z_i - \hat{q'})^2 \tag{3}$$

This generic likelihood kernel will self-weight to the reciprocal of the variance of the observation process. The abundance estimate likelihood is given by

$$N_{obs,i} = N_{pred,i} e^{\gamma} \quad where \quad \gamma \sim N(0, \sigma_\gamma) \tag{4}$$

where it is assumed that the model makes an accurate prediction of the dynamics, but

that the data are prone to being incorrectly observed by an amount proportional to σ_γ, the observation error term. Adding up the two likelihoods and searching for parameter combinations that maximize the likelihood provides a statistically credible evaluation of the relative rates of the parameters that most likely predict population dynamics, i.e., the highest likelihood that parameters could explain the data observed.

A proper computational search of parameters (an exhaustive algorithmic optimization) would have required more abundance data than was available, but a profile of the relative likelihoods shows that there are parameter combinations that do a much better job than others at predicting empirical trends. Figure 3 shows the relative likelihoods as parameters are adjusted away from the optimal value. These plots are showing negative log-likelihood (NLLs) profiles, so the smaller the NLL, the more likely the parameter is the right choice. Thus the model fits the data best with a male survival rate of just under 94%. The female survival rate is approximately 10% lower, i.e., 0.90 of the male rate. The reproductive multiplier is a scaling factor that accounts for observation uncertainty in birth surveys. It's value is estimated to be 0.95. The fitting procedure estimates that the population in mid winter prior to the first surveyed year was 1800 animals. The 1800 animals were subject to mortalities and were then compared to the surveyed abundance in 2001 (1595 total animals). When the optimal parameter values are used, the model is considered a "best fit". The best fitting model is shown in Figures 4 and 5.

2.3 Vehicle collision modelling methods

Moose vehicle collisions (MVCs) are a documented source of moose mortality, both in the broad literature as well as in the British Columbia Wildlife Accident Reporting System (WARS) (Sielecki 2007). Typically, the frequency of collisions is higher in winter months (see Figure 6). Additionally, surveys conducted by Gitanyow resource managers from 2009-2011 show that females account for the greatest portion of identifiable kills, and the greatest proportion (70%) of sightings on the road. Vehicle collision modelling involved integrating

Figure 3: Likelihood profiles of key estimate population parameters. Each panel shows the negative log of the likelihood of predicting the data given the parameters.

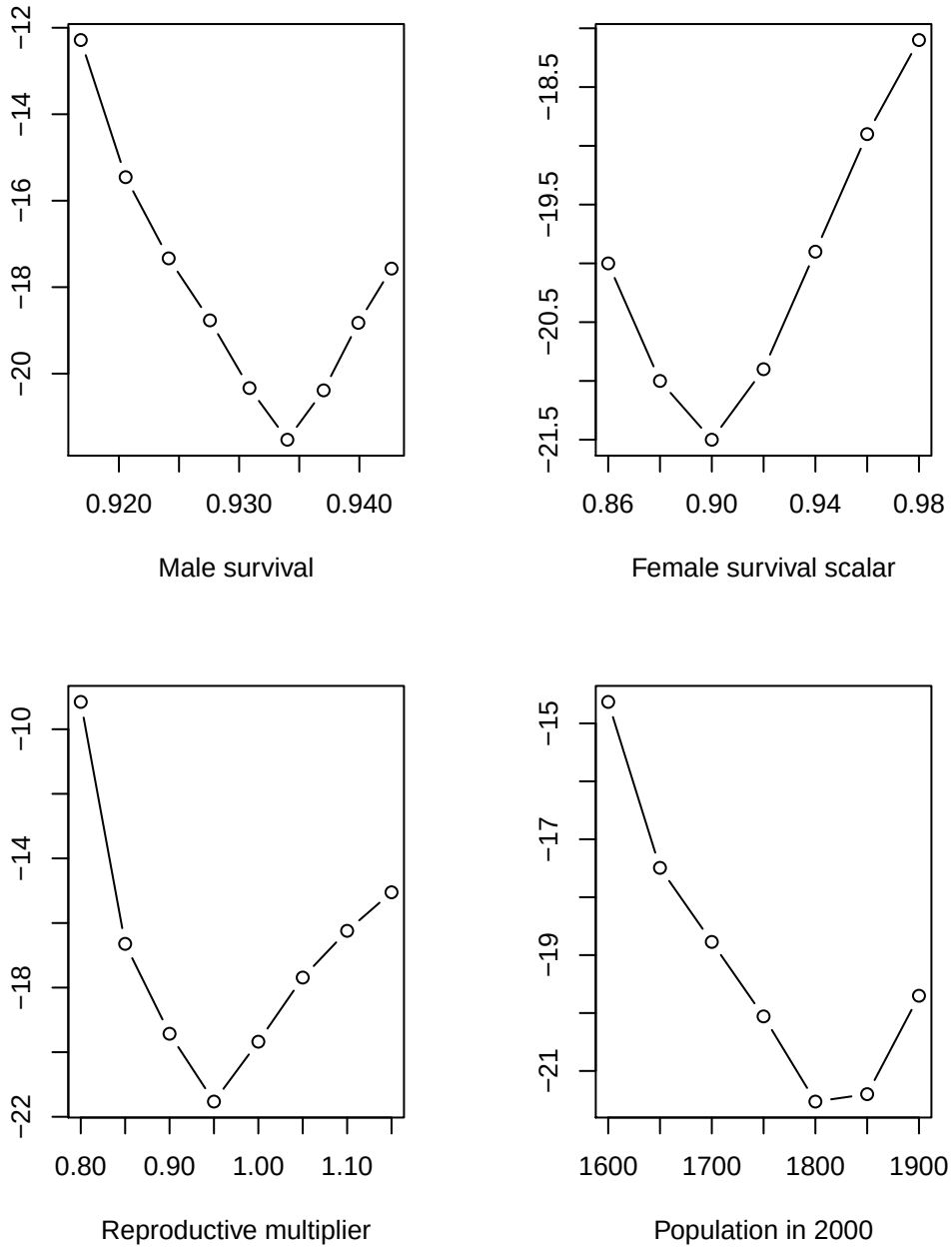
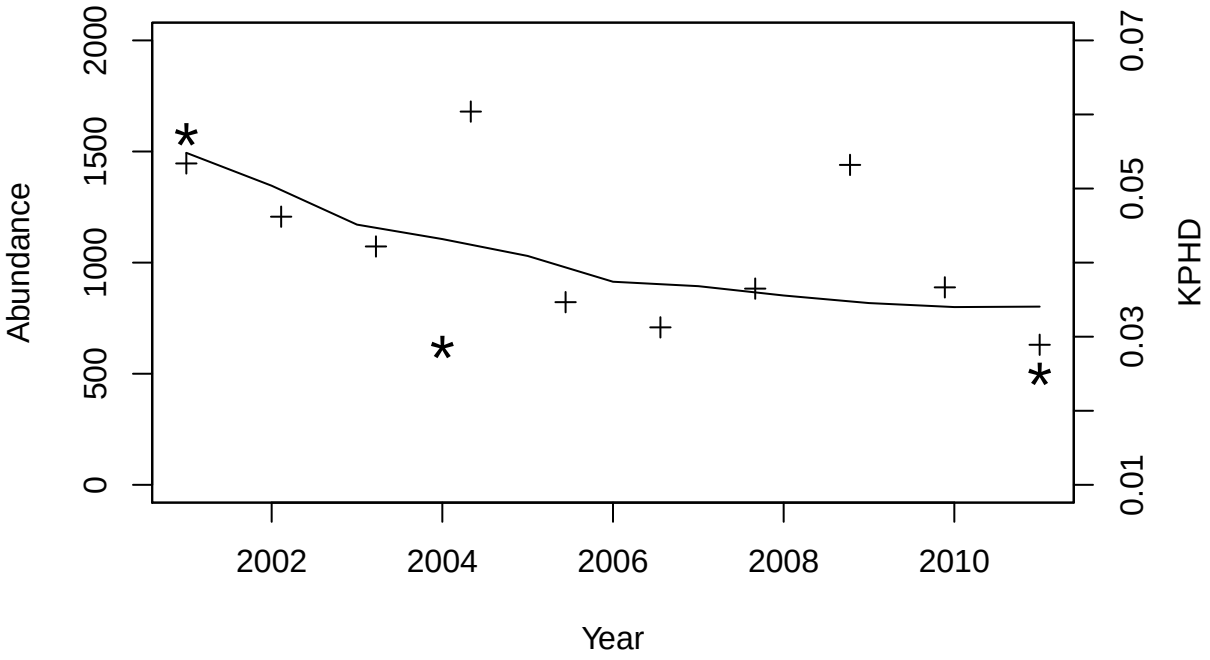


Figure 4: Plot of predicted and observed trends. Line shows the best fitting model using maximum likelihood parameter estimates. The star symbols show the abundance survey values. The plus symbols show the relative abundance trends from kills per hunter-day.



two sources of vehicle collision data (WARS database and Gitanyow survey) with a result obtained from the scientific literature (Seiler 2005). The regional WARS data indicate that collision rates are higher in the Southern part of highway 37 than in the Northern part (see Figure 6). The Gitanyow survey covers approximately 25% of Highway 37 and reported 14 kills in 2010 and 2011 between fall and spring. The WARS database recorded 111 moose vehicle collisions across the entire stretch of Highway 37 from Kitwanga to Bell II between 1991 and 2010, an average of 5.8 collisions per year with incident, but averaging 5.55 collisions if years without collisions are included.

Data on moose vehicle collisions are sparse, but a rough estimate is possible. The assumption is that vehicle mortalities can be partitioned into different sections of the highway, where the sections are defined by relative lengths and relative amounts of historical and forecasted vehicle traffic. A study by Rolandsen et al. (2011) showed a rough estimate 0.07-0.09

Figure 5: Plot of predicted and observed trends of bulls, cows and calves. Lines show trend in predicted abundances. Plus symbols show the survey abundances.

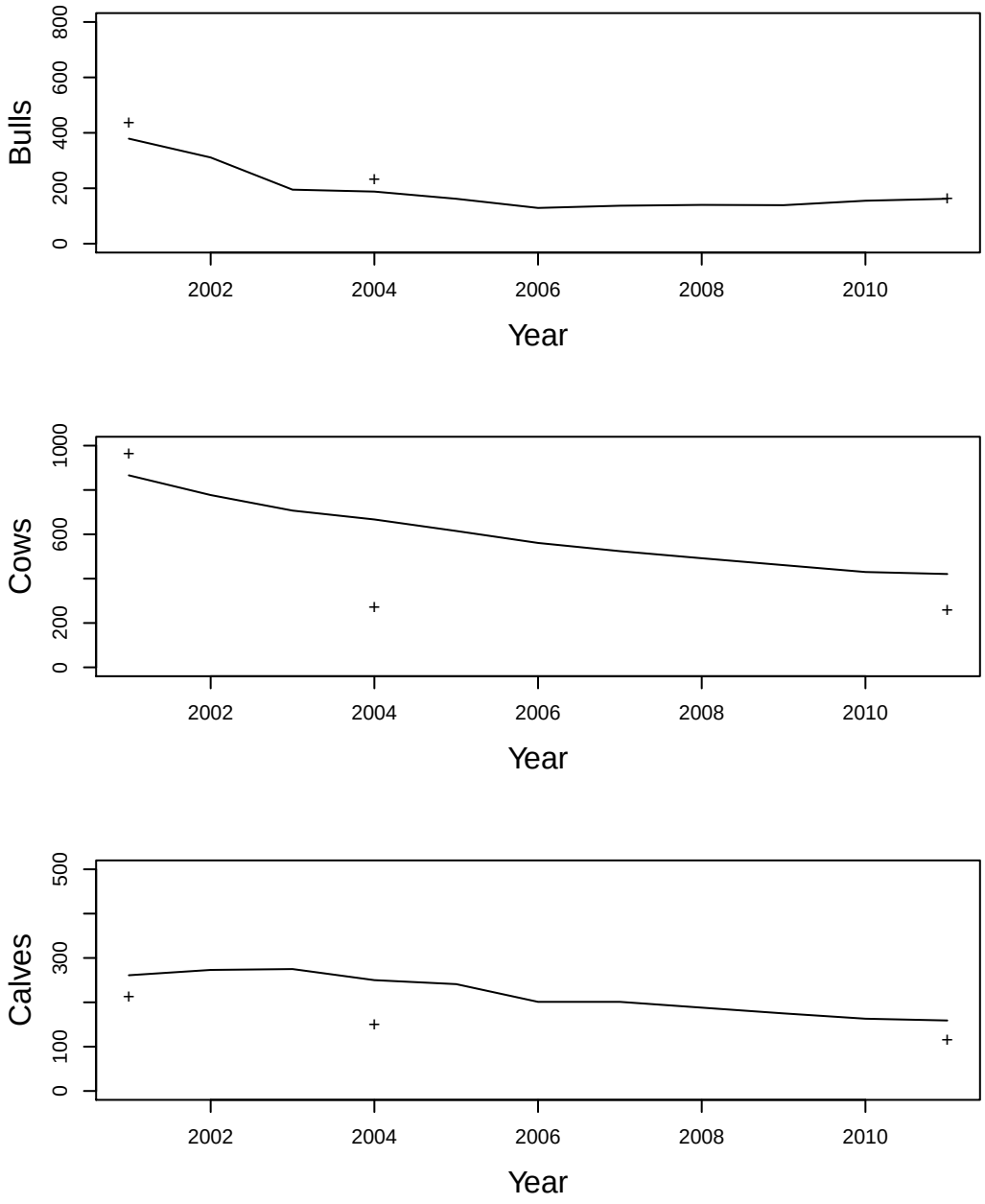
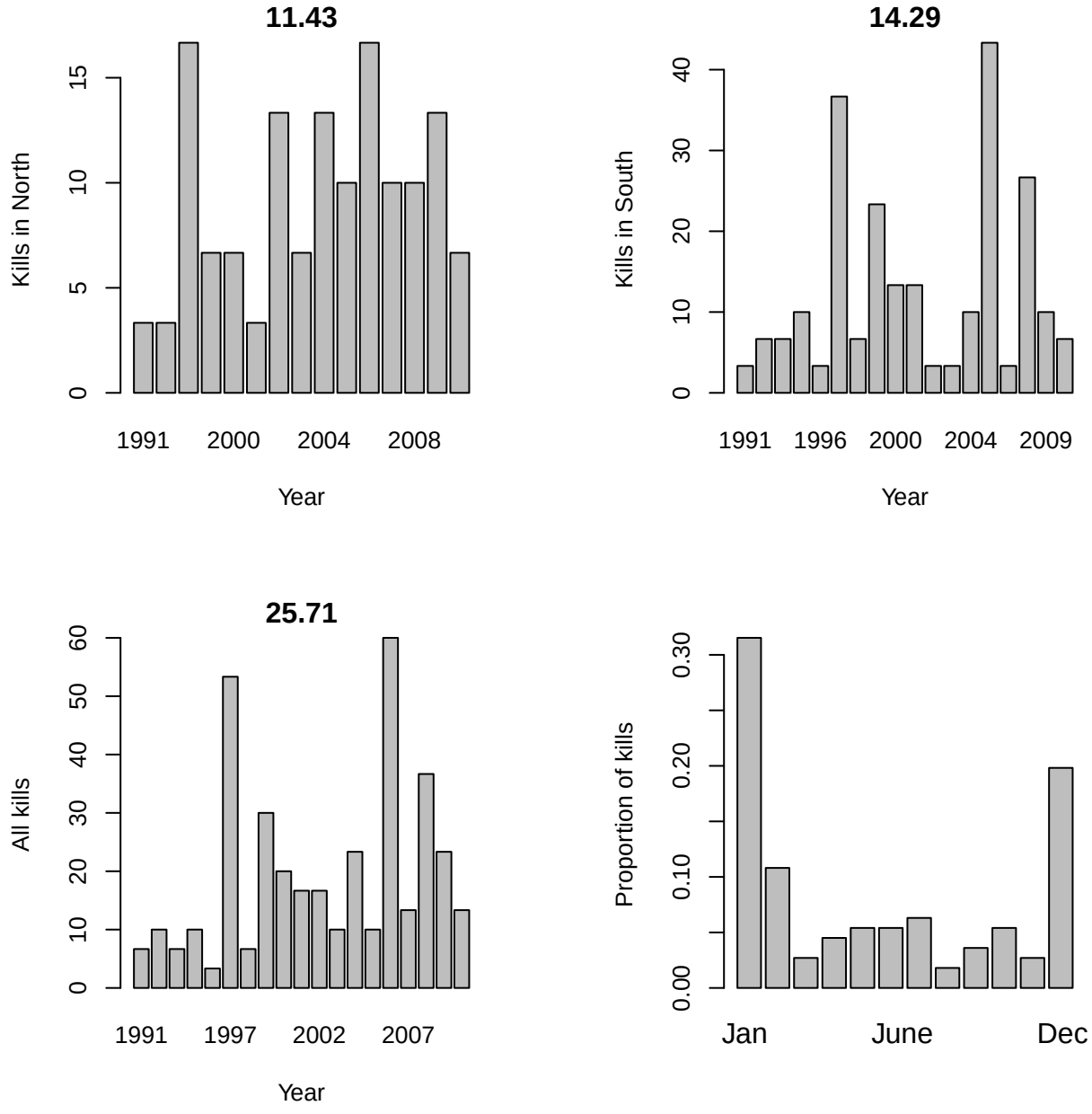


Figure 6: Wildlife accident reporting system recorded moose kills North and South of Meziadin junction from 1991 to 2010. Figures show the reported number of kills, corrected for a reporting rate of approximately 30% of actual kills. Mean 2004-2010 values are shown in bold above each panel.



moose kills per 10 km of road, which would translate to only about 3 moose kills in the KSM transportation corridor. However, the study was conducted over an area well beyond the Nass population range and may have reflected lower average moose densities. To convert projected increases in amount of road into MVCs, along with projected increases in amount of traffic, assumptions need to be made about how those projections translate into kills. This analysis builds upon first principles of probability and exposure to mortality risk, to construct a rough estimate of the effect of changes to traffic conditions from the perspective of moose distribution.

The first assumption is that moose are randomly distributed across distinct areas in some assumed density. For the purpose of addressing traffic dynamics in conjunction with moose population dynamics, we will make no assumption about the distribution of moose across the entire Nass Wildlife Area, but rather assume that the relative probabilities of being hit per vehicle will reflect the relative moose densities. As vehicle traffic increases, the relative number of kills will also increase. This is based on the simple assumption that kills are a product of the relative magnitude of risk and the availability of moose to that risk. The availability of moose is a product of their relative distribution and how many per unit area will be exposed, i.e., $K = N\ p\ \alpha\ L\ T$, where K is kills, N is total moose, p is portion of moose within an area, α is the number of kills per vehicle trip per km, L is length of road with said traffic, and T is trips. Note that $p\ \alpha$ can be collapsed into a single parameter if all you know is N, so the number of kills can be predicted with an increase in either L or T. More importantly, if K and N are known, we can assume that as long as L and T don't change, that the proportion of moose killed with be equal to $p\ \alpha\ L\ T$.

Research on moose collisions in Sweden (Seiler 2005) indicates that the number of kills increases linearly with the amount of traffic at low traffic volumes, but curvilinear at higher traffic volumes. The study was conducted over more than 10 years, where abundance changed, so there is some variability in the kill rates, but the trend still suggests linearity in relation to traffic (again, at low traffic volumes similar to those on highway 37). Only

sparse population abundance is available for the Nass population, and the WARS road kill surveys are known to include as little as 25-35% of kills (WARS 1988-2007 Special annual report), but recent years were surveyed within the Gitanyow area as well. If the WARS database only reports 30% of kills, the number of kills per year would be $5.55/0.30 = 18.5$ kills per year. If the Gitanyow survey covers only 50% of the entire stretch of Highway 37 from Kitwanga to Meziadin, then the 9 observed kills South of Cranberry in 2011 translate to 18 kills per year just in the Kitwanga to Meziadin stretch, which is higher than the WARS database average of 12 in the Southern segment alone once corrected for underreporting, but not higher than some of the peak years reported in the WARS data (summarized in this section). It might be said that densities varied throughout the multiple decades of WARS data, but since the KPHD trends indicate that abundance may now be similar to what it was in the mid 1970's, the the average number of 5.55 is credible (especially since it was recently reported in that range).

If we assume that the MVC is a probabilistic process, then we can translate the kills into a mortality rate and thus make the abundance implicit in the model. The 2001 abundance estimate for the Nass moose population was 1595 animals. Since the abundance was 638 animals in 2004, $\lambda = 0.97$ between 2001 and 2004. If the recent trend of $\lambda = 0.97$ is assumed then the 2010 population would have been 532 animals (and the average abundance across year 2010-2011 would have been 524.5). Therefore, the mean rate of mortality at an assumed status quo traffic volume across the entire range of highway 37 that spans the Nass moose territory would be 18.5 / 524.5, or about 3.5% mortality from vehicle collision.

This estimate constitutes the simplest possible assumption, i.e., that that moose are distributed evenly across a long uniform road length from Kitwanga, past Meziadin junction, and all the way to Bell II. It makes no assumption about different traffic patterns, nor does it allow for traffic conditions to change or for more roads to be built. We will refine the assumptions about the traffic model to account for some spatial variability so traffic increases can be encapsulated. We will assume three different road segments: 1. Highway 37 from

Kitwanga to Meziadin junction (156 km), 2. Highway 37 from Meziadin North, including Eskay Creek and Treaty Creek areas (177 km), and 3. Highway 37A (65 km).

The WARS database is subdivided into highway Landmark Kilometre Inventory (LKI) segments. These data are also an under-representation of the actual number of wildlife collisions, mainly due to reporting error; however, they are the best available data, but numbers must be interpreted with caution.

The KSM transport route covers a portion of Highway 37 from Kitwanga to the Eskay Creek Mine Access Road, which is included in LKI segments 3710, 3720, 3730, and 45 km of 3740 (LKI 3740 extends north from Bell II to Burrage, approximately 39 km north of the Eskay Creek Road). LKI segment 3740 will be included in this assessment, as the Study Area includes 54% of this segment. The transport route along Highway 37A is LKI segment 3725.

An aggregate of all moose kills in the WARS database relevant to the Nass is shown in Figure 6. Kills have been corrected for the approximate reporting rate of 30%, i.e., 3 reported kills representing 10 actual kills. There is no demonstrable evidence for an increase or decline in MVCs between 1991 and 2010, but if anything, there may have been an increase until around 2000, and subsequently a decrease. This would be consistent with MVCs representing a constant percentage of moose mortality assuming constant traffic conditions. To construct a baseline vehicle mortality rate useful for making forward projections, it is useful to look at recent MVC rates and abundances. Since 2004 the population has averaged 577 animals if you assume a linear decline from 638 to 517 in 7 years. To convert this to a mortality rate per km per VPD, we only need to divide proportion of population killed by km of road and by VPD. The portion of the total population killed by vehicles in the North segment equates to 11.43/577 = 1.98%. The southern portion equates to 14.29/577 = 2.45%. These would be scaled using Equation 5.

$$\alpha = \frac{K}{NLT} \tag{5}$$

The historical patterns for the three segments are shown in Table 2. For simulation purposes, it is assumed that there will be traffic increases on all three segments. The North segment traffic represents the average of the Treaty-Meziadin portion and the Eskay-Treaty section (227 and 313 VPD). The number of kills per km per VPD during historical traffic conditions is given by α. During the KSM operation phase, there will be both more traffic and also more operation road km being driven, therefore the predicted MVC will be scaled accordingly. For example, when vehicle traffic increases to 313 VPD (an extra 89 VPD from KSM traffic), the vehicle mortality rate would increase to 0.0198 x (309/224) = 0.0273 and the southern rate would increase to 0.0245 x (848/799) = 0.0259, representing a 40% increase in vehicle mortalities in the North and a 6% increase in the South.

Table 2: Historical and projected trends in road vehicle traffic. Vehicle traffic per day (VPD) and the number of km of active road are used to scale MVC rates. The KSM data in the North segment represent an average of the VPD from Eskay to Treaty and that from Treaty to Meziadin. The peak foreseeable traffic volumes (including KSM traffic) are shown in the bottom row with estimated moose kills rates.

		North	South	37A
Historical	VPD	224	799	244
	km	177	156	65
	Mortality rate	1.98%	2.45%	NA
	Moose kills	10	12	NA
Historical	VPD	313	848	280
+ KSM	km	177	156	65
	Mortality rate	2.73%	2.59%	NA
	Moose kills	14	13	NA
Historical	VPD	722	1121	492
+ KSM	km	177	156	65
+ all foreseeable projects	Mortality rate	6.4%	3.4%	NA
	Moose kills	32	17	NA

Additional projects that will add traffic to the North and South segments of Highway 37 are Bronson Slope, Brucejack, Forrest Kerr Hydroelectric, Galore Creek, Kitsault, Kutcho, McLymont Creek Hydroelectric, Red Chris, Schaft Creek, Snowfield, Storie Moly, Turnagain, and Wolverine mines. Each project will add traffic for a period of time beginning as early as

2014, and lasting anywhere from approximately 10 to 30 or 35 years. Reasonable foreseeable project schedules show traffic gradually increasing to an additional 300-400 VPD by the year 2030, adding an additional 4-5% winter mortality from MVCs when cumulative traffic is at its highest level in the North and South segments.

The estimated survival overwinter rates from model fitting were 90% for males and 88% for females. To incorporate the additional vehicle traffic, we need to add another 0.0273 - 0.0198 = 0.75% for the increase coming from the North and another 0.0259 - 0.0245 = 0.14% for the South, translating to a total decrease in survival of 0.89%. The KSM traffic will therefore reduce overwinter survival by just under 1%.

3 Results and discussion

3.1 Simulation analysis

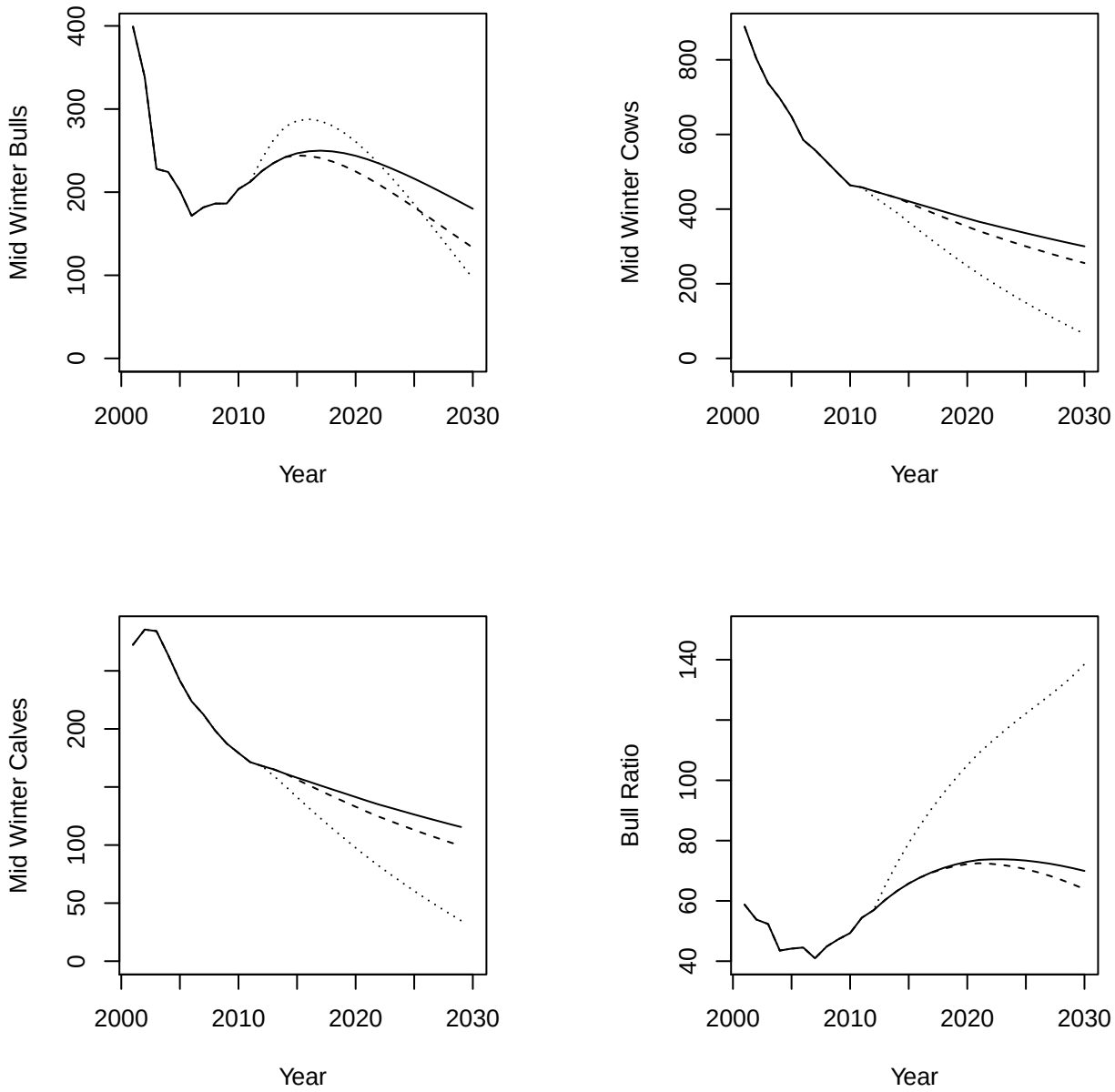
A simulation analysis was performed to examine the long term viability of the Nass moose population under alternative management assumptions and alternative assumptions about natural variability. The two management variables examined were the bull harvest rate and the rate by which the population can sustain additional mortality from vehicle collisions. Figure 7 shows a comparison of the *status-quo* situation without any further road construction or vehicle traffic, and the basic assumption of the increases in project operations traffic shown in Table 2 effective 2014. Operational traffic levels are simulated effective 2014 despite the fact that operational level traffic may not occur until 2019, but simulating those levels a few years earlier partially compensates for the fact that construction traffic levels will be effective as well as accounting for potential early operations (i.e., a precautionary prediction).

The simulation assumes the maximum likelihood parameter estimates obtained using the likelihood profiles in Figure 3, and using the historical bull, cow and calf harvests as well as the 2012 and forward harvest of 40 bulls per year. Survival rates are assumed to be

deterministic. These simulations show that KSM road traffic is predicted to result in about 23% fewer bulls, 14% fewer cows, and 14% fewer calves in 2030 with a 30 bull harvest than if no traffic increase had not occurred. If the harvest is split 50:50 among bulls and cows, the bull abundance improves on the short term, but then declines to a lower abundance than when the harvest was purely bulls. Harvesting cows also causes calf abundance to decline faster than when only bulls are harvested. This comparison accounts for no variability in inter-annual survival. It is the maximum likelihood estimator of future abundance, but in no way accounts for the range of possible outcomes. For this we look to a Monte-Carlo simulation analysis.

To account for inter-annual variability in survival, random draws from a normal distribution with N(μ_s,σ_s) were taken to produce survival rates of μ_s where 95% of random draws are contained in the ranged plus or minus σ_s/μ_s (see Figure 8). Using an average survival rate of $\mu_s = 0.94$ and $\sigma_s = 0.30$ produces annual survival rates that fluctuate around the mean by about plus or minus 5%. When simulations are performed under variable survival assumptions, outcomes are different in each simulation. Monte-Carlo simulations were performed 1000 times by drawing different random values of the survivals in Figure 8 and using those survivals in each year of the 1000 different simulations. 1000 different 30-year predicted outcomes were simulated, each of which implements KSM road traffic conditions in 2014 (except the *status-quo* simulation, which maintains current road conditions). Figure 9 shows the frequencies of 2030 predicted abundances for 1000 Monte-Carlo simulations under variable survival assumptions for three cases: one case with no change in traffic or survival (survival = 93.4%, top row), a second case with KSM projected traffic patterns and the same survival rate (middle row) , and a third case with a different assumed survival rate one percent higher but also with the KSM traffic (bottom row). Panels show the distribution of predicted abundances of bull, cow and calves when 1000 simulations are performed. The *status-quo* scenario shows a distribution of abundances of bulls, cows and calves that spans the MLE prediction shown in Figure 7. A small fraction of the simulations predict

Figure 7: Simulated trends in mid-winter abundances. Solid lines show abundance projections if there is no additional traffic. The dashed line shows abundance projections with 30 bulls harvested and with the traffic situation described in Table 2 becoming active in 2014. The dotted line shows abundance projections with 15 bulls and 15 cows harvested and with the traffic situation described in Table 2 becoming active in 2014



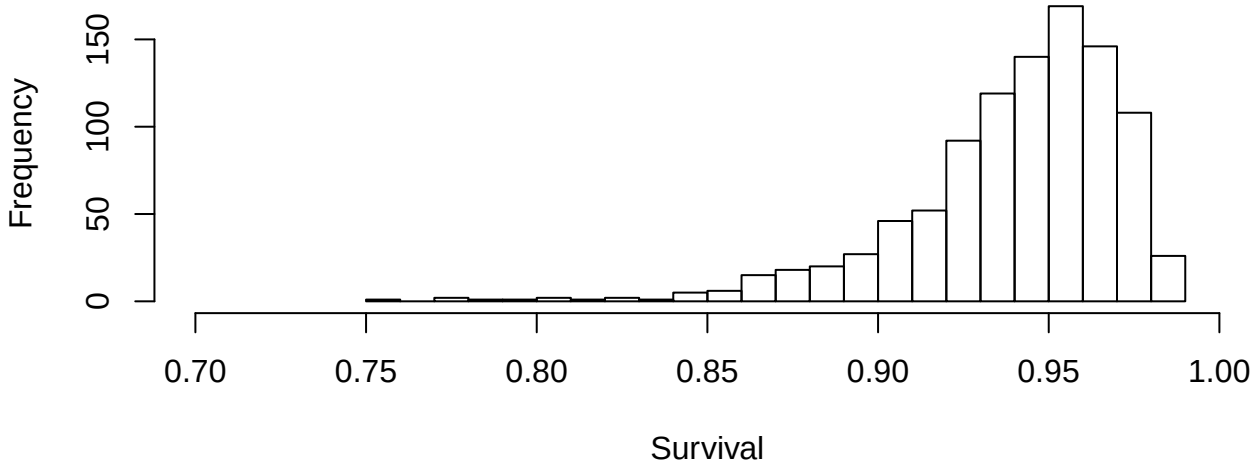
2030 bull populations near zero. This could easily result when abundances approach the 30 bulls being harvest harvested. Under the KSM traffic scenario with MLE survival estimate of 93.4% (middle row), there are soome outcomes which involve very low abundances and overall, mean 2030 abundances are somewhat lower than without the KSM traffic.

The bottom row shows a simulated outcome when survival rates are assumed to be fully 1% higher than the MLE estimate, which is shown to demonstrate a case where the MLE survival rate may biased low, or that we may be overestimating the effect of the KSM traffic (i.e., we should be assuming a higher overall survival rate accounting for statistical bias and/or traffic effects). Most importantly, we see that there is a dramatically different outcome with an adjustment of a mere 1% in survival (note that survival is summer survival, and that winter survivals for males and females are scaled downward).

Since cumulative traffic from all projects is predicted to add well over 300 additional vehicles per day by 2030, which translates to more than 4% additional mortality from project traffic, this analysis predicts a total MVC mortality rate approaching 9% (accounting for historic, KSM, and all other projects). Using the BC MOE model with these results, we predict that the Nass moose population will decline if traffic levels increase to the levels projected for all projects.

A more comprehensive view of projected population abundance can be obtained by tabulating summaries of the results of Monte-Carlo simulations across a broader range of survival rates and harvest rates. Table 3 shows the mean abundances from simulating 1000 times for each of five harvest rates between 10 and 50 bulls. Results between 93% and 94% survival are closest to the maximum likelihood estimate and should be viewed as the baseline range of prediction. The 93% results are equivalent to a situation where either the survival rate is actually lower than the estimated rate, or that traffic volume is higher by an amount that would translate to about a 0.5% decline in survival. We see from these tabulated results that small changes in the survival rate translate to large changes in long-term abundance, much more so than from variation in the bull harvest. Variation in bull harvests at the 94% level

Figure 8: Distribution of survival rates with inter-annual variability estimated by σ_s.



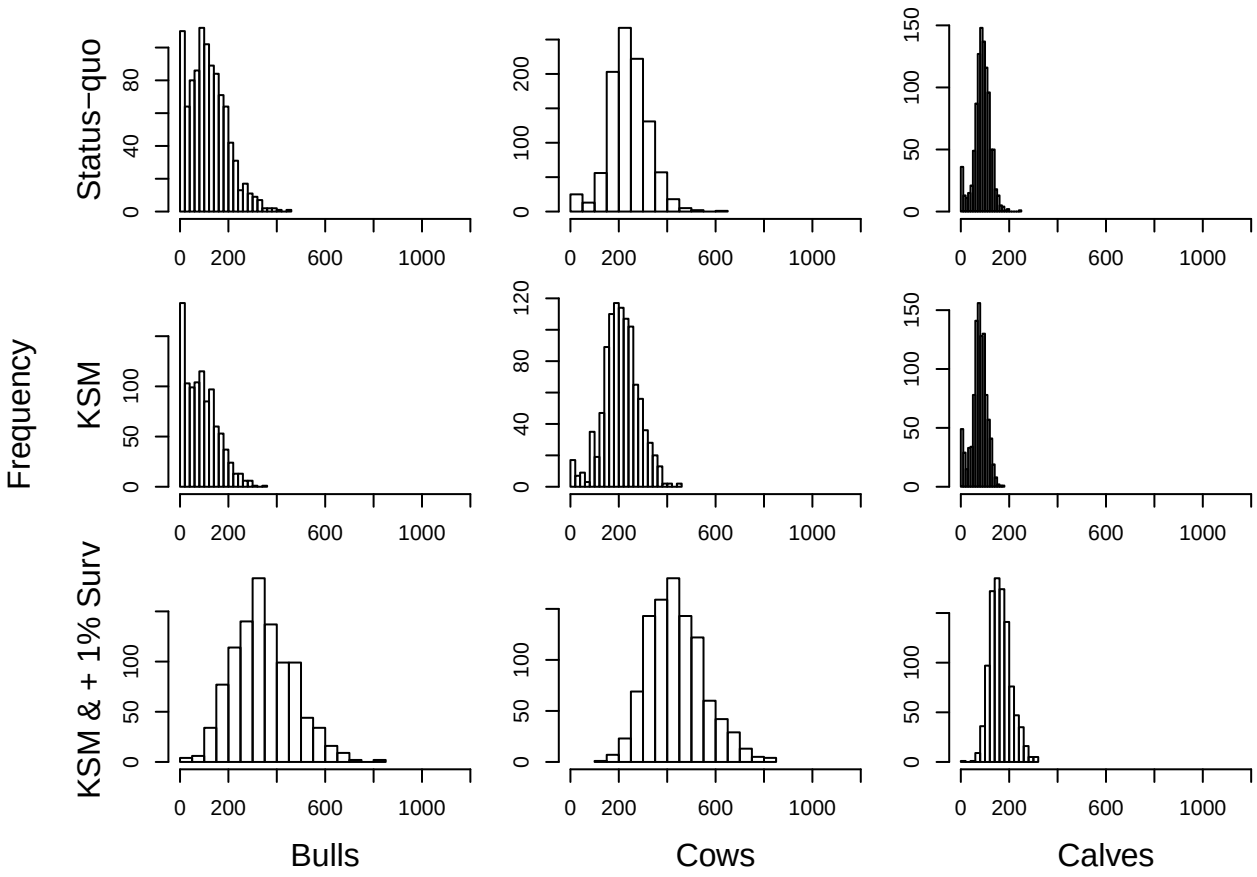
do, however, translate to mean abundance difference of 50% in bulls, though bull harvest has little effect on cows at that survival level.

These results suggest that the level of traffic arising from the KSM project will not likely lead to a substantial decline in the Nass population in the next 20 years. If the MLE survival rate is even 0.5% underestimated, it makes a substantial difference in the sustainable bull harvest. At 93% survival, a harvest of more than 30 bulls causes near extirpation. At 94%, the population appear to be able to sustain harvest of 50 bulls without any effect on cows or calves. The main concern is that the predictions change drastically with a small change in survival, and that the MLE survival rate appears to be the threshold rate at which harvest is just sustainable. The difference between 95% and 93% is the difference between a viable population and one at risk of declining if harvest is higher than 30 bulls.

3.2 Discussion

Moose population dynamics were reconstructed using a stage-structure and age-structured survival model. Vital parameters were estimated using maximum likelihood profiling tech-

Figure 9: Frequencies of 2030 population abundances under maximum likelihood survival estimate (MLE) and *status-quo* traffic conditions with a 2012-2030 bull harvest of 30 bulls (top row), MLE survival and KSM traffic conditions from Table 2 (middle row), and MLE survival + 1% and KSM traffic conditions from Table 2 (bottom row).



niques and subsequently used to simulate population trends. A moose vehicle collision model was constructed such that increases to vehicle traffic within the Nass moose territory resulted in commensurate increases in moose vehicle collision mortality. A Monte-Carlo simulation analysis indicates that under the proposed road construction and traffic volume increases projected to occur as a result of the KSM project, the Nass moose population is predicted to remain stable at a constant moose harvest of approximately 30 bulls per year. Results also indicate that the population is unlikely to be able to sustain additional mortality as a result of further vehicle traffic on roads.

Table 3: Mean of 1000 simulated bull, cow and calf abundances. Simulations involve KSM road traffic effective 2014 and 2012-2030 bull harvests of 10, 20, 30, 40 and 50 bulls. Each row block corresponds to an assumed base summer survival rate. Shown in bold are results of a 30 bull harvest when survival rates are approximately plus or minus 0.5% of the MLE survival rate (0.934), i.e, the results from Figures 7 and 9 are roughly between the two results in bold.

Survival	Mean 2030 Abundance	10	20	30	40	50
0.93	Bulls	123	69	**25**	4	1
	Cows	142	140	**126**	93	66
	Calves	53	52	**40**	18	8
0.94	Bulls	324	258	**189**	131	74
	Cows	308	305	**302**	305	282
	Calves	116	115	**113**	111	93
0.95	Bulls	721	659	577	513	441
	Cows	637	643	637	641	641
	Calves	238	240	238	239	239
0.96	Bulls	1564	1491	1402	1330	1235
	Cows	1343	1355	1348	1355	1341
	Calves	500	504	502	504	499

It is possible that survival rate estimates are biased low, and that the true long-term effect of MVCs on survival rates is higher, but the structure of the model, with constant survivals rate across all ages has the effect of forcing estimation to attribute higher mortality to younger age classes, which has the compound effect of predicting fewer births. Additionally, the survival rates may have changed over time, i.e., the effective survival rate excluding hunting may not be the same in earlier vs. later years. One possible possible interpretation for this is that unreported harvests may have been higher in earlier years that in later years. If unreported harvest was higher in earlier years, which could be expected because there would have been less concern for the population, then the statistical fitting method used to obtain parameter estimates would have biased the survival rate downward to compensate. If actual harvest rates were truer to reported rates in years following the decline in the Nass population, the estimated survival parameters calculated in this report would be lower than in reality.

The overarching message to be taken away from this analysis is that using statistically estimated survival rates, which account for the average exogenous mortality sources between 2001 and 2011, the population will remain relatively stable even if the KSM project is implemented with the traffic patterns described. At a bull harvest of 30 bulls annually, abundances are expected to decline only slightly from the most recent survey in 2011. This would not be the expected result if cows were also harvested, since the cows survival rate is lower than that of bulls, and also because fewer cows means fewer fecund females to calve (see Figure 7).

The results assume approximately 93.5% summer survival, with winter survivals of bulls and cows commensurate with the scaling factors estimated. This also assumes survival will be reduced by the MVC rate projected to take place from 2014 onward. It also assumes that the Nass population is present in the areas where those roads will be built, and this is not necessarily the case. DeMarchi and Shultze (2011) only surveyed South of Bell II, and some of the vehicle traffic will be outside of that area. The potential dynamics of moose vehicle collisions should be viewed as occurring in the 93-95% range of survival in Table 3. Within this range we see a broad range of outcomes which include an MVC mortality factor of 0.89%, which means that as long as the 94% is the baseline scenario, any interpretation that the MVC factor should be higher or lower need only look at the relative numbers in Table 3.

The predicted future traffic effect when all scheduled projects are operational can be interpreted by assuming that the cumulative MVC rate will increase about an additional 4% by 2030. The long-term predicted population abundance from Table 3 would be predicted using a survival rate up to 4% lower than 94%, which would obviously be as low as 90%. Since 2030 abundances are already low at just 93%, they would be predicted to be much lower in the 90-92% range when more projects add traffic. Not all traffic is necessarily high risk traffic though, and it may not be as simple as just accumulating traffic volume and scaling the MVC mortalities linearly.

There are a few moderating factors worth considering in the interpretation of rate scaling: 1) Moose may not redistribute themselves fast enough spatially to place more animals at risk once a mortality occurs, so it may well be that ten times more vehicles does not predict ten times more kills. This is what was shown in (Seiler 2005), 2) More and more of the cumulative traffic will actually be of the speed-limited variety anyway, so there is reason to believe it won't generate the same relative mortality as historically observed MVCs, and 3) Most of the Northern segment traffic will occur outside of the surveyed population (DeMarchi and Shultze 2011).

3.3 Data limitations

The statistical reconstruction of Nass moose population and the prediction of future trends should be interpreted carefully. The data used to fit the model empirically were very limited, with only three years of abundances and kill per hunter day being averaged over statistical areas that may have extended beyond the range of the Nass population. Some of the Nass population may also have existed beyond where the trend data were sampled, so part of the true trend may not have been accounted for. Additionally, the model structure itself had more detail than the data used to parameterize it. Specifically, the model predicted moose at every age between 1 and 20 years old, whereas the data only distinguished between juveniles and adults without regard to adult age. As a result, the detailed age-specific birth rates may have created a structural imbalance between birth rates and age at survival. This structural problem is further complicated by the fact that the survival rates of adults are all assumed to be the same regardless of age, which realistically should be not be constant. Nonetheless, a reasonable fit was achieved using the likelihood profiling method. Reconstructed patterns are credibly within the range of observed abundances and simulated results are reasonable.

A preferable approach to modeling the Nass moose population would be to use a model that incorporates only three age classes, uses average birth rates for adult females, and limits the number of stages to just summer and winter. There is no need to simulate stages and

ages that cannot be empirically compared for statistical validation. A more parsimonious model would have greater management utility, and despite the loss in biological resolution, it would be a more robust analytical tool.

It would also be useful to account for loss due to predation. The most recent survey (DeMarchi and Shultze 2011) found 37 wolves in 9 packs, meaning that there are 10 wolves per 1000 square kilometers in 9 distinct hunting units. This can translate to substantial amounts of moose mortality, if moose were the only source of food for the wolf pack, it is not out the range of possibility to have each pack consuming a moose per week in winter, translating to over 100 kills per winter. Even half that number would translate to 10% winter mortality at current densities. While these are crude estimates, it demonstrates the potential severity of wolf predation at current densities. With no knowledge of the historical pattern of wolf densities it is difficult to ascertain the potential impact. The wolf predation may have been increasing or decreasing during the period 2001-2011.

Bear predation is another factor. Bears prey on moose juveniles while they are unable to run fast enough to evade capture. At the very least, if there can be any improvement to the estimation of abundances of predators, the model fitting could account for the relative impacts over time, and thus explain some of the variation in inter-annual survival.

The model's excessive accounting for age structure, the parcity of data, and the fact that there was no accounting for predation are sources of bias in model fitting. Without a sense of the relative magnitudes of biases, it is difficult to ascertain how overall results would be affected, but it is apparent that the model simulations are extremely sensitive to small changes in survival. The range of predictions is quite broad across a relatively small range of survivals, and that range is completely within the range of variation expected from the MVC modelling, i.e., 0.89% MVC and large predicted differences in behaviour between 93-95% survival. A modelling approach that accounts for other sources of variability such as predation and accounts for less age structure may be more robust predictor and should be considered if there is concern that the MVC rate may exceed 1%.

The moose vehicle collision model does not adequately address the potential saturation effect when traffic volumes increase substantially. Traffic from project operations alone are scheduled to increase from KSM levels in the 50-100 VPD levels (once averaged spatially) to levels in the 300-400 range. There is no way of calculating the saturating effect of vehicle collision mortality without actually observing it, since it would be a property of the Nass populations movement and migration patterns. The Seiler (2005) result can't be applied directly. Only if animals move around quickly and uniformly would we expect a non-saturating linear increase in MVCs with increased traffic. When only small fractions of animals are dying from collisions, it's reasonable to assume linearity because the density remains about the same, but as the fraction increases, there are fewer animals around to move toward a road as soon as an animal dies on that road. A potential source of information to explain this would be GPS collar data, which could be used to better account for the distribution of moose spatially and temporally. This would be useful for both spatial overlap analysis as well as the rate of replacement of at-risk animals on roads.

4 Conclusions

This analysis offers a statistical reconstruction of population dynamics and simulated population prediction of the Nass moose population subject to assumptions about the dynamics of vehicle collisions and harvest policies. The tabulated long-term abundance simulation results can be used as a guideline to view the relative impacts of harvest and traffic effects. The overarching result is that the population appears to be sustainable with the projected KSM traffic pattern. It also appears that the population will decline if either MVC rates increase substantially beyond the 0.89% mortality assumed from 2014 onward, or if the actual survival rate was overestimated at 93.4%. There is no reason to believe that traffic patterns resulting in less than 0.5% additional mortality, or occurring earlier or later than 2014 would cause the population to decline significantly more than predicted as long as harvests are

not higher than 30 bulls, but the margin is very slim. All predictions are predicated on the assumption of a 93.4% summer survival and the parameters estimated.

References

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Seiler, A. (2005). Predicting locations of moose–vehicle collisions in sweden. *Journal of Applied Ecology 42*, 371–382.

Sielecki, L. E. (2007). WARS: Wildlife accident reporting and mitigation in british columbia. Technical report, British Columbia Ministry of Transportation and Infrastructure.

Appendix: Model Code

The following contains the R code for the moose population dynamics model.

```
nYears <- 30 #var: The number of years to simulate dynamics
nAges <- 20 #var: The number of ages of the population
iniPop <- 1800 # #var: The number of animals in the population at beginning of run
iniBullRatio <- 45 #var: The number of bulls per 100 cows in the population
iniCalfRatio <- 55 #var: The number of calves per 100 cows in the population
# Bull Ratios at Birth permits sex ratios at birth to be adjusted to those measured in calf surveys or fetus analyses.
# There is reason to expect that more males are born, and most analyses indicate this to be true, but statistical
# significance is usually low.  This variable is expressed as bull calves per 100 births, and permissable values range from 0 to 100.
# Potentially realistic values range from 50 to 65.
birthBullRatio <- 50 #var: Adjustment for survey results
# Reproductive Multiplier can be used to adjust the equilibrium calf ratios in the simulated population to match ratios measured
# in a surveyed population.  Using 1.0 means that the fecundity listed by age in the natality/mortality table is used to
# calculate births.  Multipliers greater or lower than 1.0 raise or lower age specific natality proportionally.
reprodMult <- 0.95 #par: Reproductive multiplier.
yrBullEffectiveness <- 1 #var:
mortMidWinter <- 0 #par: The proportion of the mortality that occurs before mid winter.
sexRatioThreshold <- 35 #par: The number of bulls per 100 cows below which the reproductive success begins to decline on (0,100) and 20-50 realistic
sexRatioExp <- 1
dummyRate1 <- .761 # used for back calculation for initialization
dummyRate2 <- .24 # used for back calculation for initialization
SurvSig <- 0.3 #var:
varSurv <- array(0,c(2,nYears)) #var: An array containing the juvenile and adult survivals for each year once process error has been applied
iniBulls <- 0
iniCows <- 0
iniCalves <- 0
MVCrate <- rep(0,nYears+1) # the additional mortality that will come from vehicle collisions
simMVC <- 0 # a boolean operator to add mortality for vehicle collisions

hBulls <- array(0,nYears)
hCows <- array(0,nYears)
hCalves <- array(0,nYears)
mwBulls <- array(0,nYears)
mwCows <- array(0,nYears)
mwCalves <- array(0,nYears)
mwPop <- array(0,nYears)
pBulls <- array(0,nYears)
pCows <- array(0,nYears)
pCalfs <- array(0,nYears)
BullRatio <- array(0,nYears+1)

BreedingSuccess <- array(0,nYears+1)
birthRate <- array(0,nAges+1) #par: The number of calves per female at age
ssBulls <- array(0,nAges+1) #par: The summer survival of bulls at age
ssCows <- array(0,nAges+1) #par: The summer survival of cows at age
wsBulls <- array(0,nAges+1) #par: The winter survival of bulls at age
wsCows <- array(0,nAges+1) #par: The winter survival of cows at age
wsBullsTS <- array(0,c(nAges+1,nYears+1)) #par: The winter survival of bulls at age with variability for each year simulated
wsCowsTS <- array(0,c(nAges+1,nYears+1)) #par: The winter survival of cows at age with variability for each year simulated

vulnBulls <- array(0,nAges+1) #par: The vulnerability of Bulls to harvest at age
vulnCows <- array(0,nAges+1) #par: The vulnerability of Cows to harvest at age
```

```
mwBullsAge <- array(0,c(nAges+1,nYears+1)) #var: The number of bulls in mid winter at age
mwCowsAge <- array(0,c(nAges+1,nYears+1)) #var: The number of cows in mid winter at age
sprBullsAge <- array(0,c(nAges+1,nYears+1)) #var: The number of bulls in spring at age
sprCowsAge <- array(0,c(nAges+1,nYears+1)) #var: The number of cows in spring at age
BirthsAge <- array(0,c(nAges+1,nYears+1)) #var: The number of births from cows at age
fallBullsAge <- array(0,c(nAges+1,nYears+1)) #var: The fall bulls at age
fallCowsAge <- array(0,c(nAges+1,nYears+1)) #var: The number of fall cows at age
hvBullsAge <- array(0,c(nAges+1,nYears+1)) #var: The number of bulls vulnerable to harvest
hvCowsAge <- array(0,c(nAges+1,nYears+1)) #var: The number of cows vulnerablee to harvest
hBullsAge <- array(0,c(nAges+1,nYears+1)) #var: The number of bulls of each age harvested
hCowsAge <- array(0,c(nAges+1,nYears+1)) #var: The number of cows of each age harvested
wBullsAge <- array(0,c(nAges+1,nYears+1)) #var: The number of bulls early winter at age
wCowsAge <- array(0,c(nAges+1,nYears+1)) #var: The number of cows early winter at age
varSurv <- rep(0,nYears+1)

birthRate <- scan("alcesRates.txt",skip=3,nlines=1,sep=",",quiet=TRUE)
ssBulls <- scan("alcesRates.txt",skip=4,nlines=1,sep=",",quiet=TRUE)
ssCows <- scan("alcesRates.txt",skip=5,nlines=1,sep=",",quiet=TRUE)
wsBulls <- scan("alcesRates.txt",skip=6,nlines=1,sep=",",quiet=TRUE)
wsCows <- scan("alcesRates.txt",skip=7,nlines=1,sep=",",quiet=TRUE)
vulnBulls <- scan("alcesRates.txt",skip=8,nlines=1,sep=",",quiet=TRUE)
vulnCows <- scan("alcesRates.txt",skip=9,nlines=1,sep=",",quiet=TRUE)
BreedingSuccess <- scan("alcesRates.txt",skip=12,nlines=1,sep=",",quiet=TRUE)

iniPop <- scan("alcesRates.txt",skip=13,nlines=1,quiet=TRUE)
iniBullRatio <- scan("alcesRates.txt",skip=14,nlines=1,quiet=TRUE)
iniCalfRatio <- scan("alcesRates.txt",skip=15,nlines=1,quiet=TRUE)
birthBullRatio <- scan("alcesRates.txt",skip=16,nlines=1,quiet=TRUE)
reprodMult <- scan("alcesRates.txt",skip=17,nlines=1,quiet=TRUE)
yrBullEffectiveness <- scan("alcesRates.txt",skip=18,nlines=1,quiet=TRUE)
mortMidWinter <- scan("alcesRates.txt",skip=19,nlines=1,quiet=TRUE)
sexRatioThreshold <- scan("alcesRates.txt",skip=20,nlines=1,quiet=TRUE)
sexRatioExp <- scan("alcesRates.txt",skip=21,nlines=1,quiet=TRUE)
dummyRate1 <- scan("alcesRates.txt",skip=22,nlines=1,quiet=TRUE)
dummyRate2 <- scan("alcesRates.txt",skip=23,nlines=1,quiet=TRUE)

hBulls <- scan("alcesHarvests.txt",skip=1,nlines=1,sep=",",quiet=TRUE)
hCows <- scan("alcesHarvests.txt",skip=2,nlines=1,sep=",",quiet=TRUE)
hCalves <- scan("alcesHarvests.txt",skip=3,nlines=1,sep=",",quiet=TRUE)

PopDy <- function()
{
  iniCows <<- iniPop * 100 / (100 + iniBullRatio + iniCalfRatio)
  iniCalves <<- iniPop * iniCalfRatio / (100 + iniBullRatio + iniCalfRatio)
  iniBulls <<- iniPop * iniBullRatio / (100 + iniBullRatio + iniCalfRatio)

  mwBullsAge[3,1] <<- dummyRate1 * iniBulls * dummyRate2
  mwCowsAge[3,1] <<- dummyRate1 * iniCows * dummyRate2
  for (a in 4:(nAges+1)){
    mwBullsAge[a,1] <<- dummyRate1 * mwBullsAge[a-1,1]
    mwCowsAge[a,1] <<- dummyRate1 * mwCowsAge[a-1,1]
  }
  mwBullsAge[1,1] <<- (birthBullRatio/100.) * iniCalves
  mwCowsAge[1,1] <<- (1-birthBullRatio/100.) * iniCalves
  mwBullsAge[2,1] <<- iniBulls - sum(mwBullsAge[3:(nAges+1),1])
```

```
  mwCowsAge[2,1] <<- iniCows - sum(mwCowsAge[3:(nAges+1),1])
  BullRatio[1] <<- 100 * (yrBullEffectiveness * mwBullsAge[2,1] + sum(mwBullsAge[3:(nAges+1),1]) + hBulls[1]) / (sum(mwCowsAge[2:(nAges+1),1]) + hCows[1])

  for (yr in 2:(nYears+1)){
    if (yr == 2){
      for (age in 1:(nAges+1)){
        sprBullsAge[age,yr] <<- mwBullsAge[age,1] - (mwBullsAge[age,1]/(1-mortMidWinter*(1-wsBulls[age])))*(1-mortMidWinter)*(1-wsBulls[age])
        sprCowsAge[age,yr] <<- mwCowsAge[age,1] - (mwCowsAge[age,1]/(1-mortMidWinter*(1-wsCows[age])))*(1-mortMidWinter)*(1-wsCows[age])
      }
    }
    else
    {
      sprBullsAge[,yr] <<- wBullsAge[,yr-1] * (wsBullsTS[,yr] - simMVC * (yr>14) * MVCrate[yr] )
      sprCowsAge[,yr] <<- wCowsAge[,yr-1] * (wsCowsTS[,yr] - simMVC * (yr>14) * MVCrate[yr] )
    }
    BreedingSuccess[yr] <<- 1 - (BullRatio[yr-1]<sexRatioThreshold) * (1-BullRatio[yr-1]/sexRatioThreshold)
    BirthsAge[,yr] <<- sprCowsAge[,yr] * BreedingSuccess[yr] * birthRate * reprodMult
    fallBullsAge[1,yr] <<- birthBullRatio * sum(BirthsAge[,yr]) * ssBulls[1] / 100
    fallBullsAge[2:(nAges+1),yr] <<- sprBullsAge[1:nAges,yr] * ssBulls[2:(nAges+1)]
    fallCowsAge[1,yr] <<- (100 - birthBullRatio) * sum(BirthsAge[,yr]) * ssCows[1] / 100
    fallCowsAge[2:(nAges+1),yr] <<- sprCowsAge[1:nAges,yr] * ssCows[2:(nAges+1)]
    hvBullsAge[,yr] <<- vulnBulls * fallBullsAge[,yr]
    hvCowsAge[,yr]  <<- vulnCows * fallCowsAge[,yr]
    # Harvest bulls
    hBullsAge[1,yr] <<- min(hCalves[yr-1] * fallBullsAge[1,yr]
    / (fallBullsAge[1,yr]+fallCowsAge[1,yr]), fallBullsAge[1,yr])
    MatureBulls <- sum(hvBullsAge[2:(nAges+1),yr])
    for (age in 2:(nAges+1))
      hBullsAge[age,yr] <<- min(hBulls[yr-1] * hvBullsAge[age,yr] / MatureBulls, fallBullsAge[age,yr])
    # Harvest cows
    hCowsAge[1,yr] <<- min(hCalves[yr] * fallCowsAge[1,yr] /
    (fallCowsAge[1,yr]+fallCowsAge[1,yr]), fallCowsAge[1,yr])
    MatureCows <- sum(hvCowsAge[2:(nAges+1),yr])
    for (age in 2:(nAges+1))
      hCowsAge[age,yr] <<- min(hCows[yr-1] * hvCowsAge[age,yr] / MatureCows, fallCowsAge[age,yr])

    BullRatio[yr] <<- 100 * (yrBullEffectiveness * fallBullsAge[2,yr] + sum(fallBullsAge[3:(nAges+1),yr]))
     / sum(fallCowsAge[2:(nAges+1),yr])
    # Bulls and cows at age early winter following harvest
    wBullsAge[,yr] <<- fallBullsAge[,yr] - hBullsAge[,yr]
    wCowsAge[,yr] <<- fallCowsAge[,yr] - hCowsAge[,yr]
    # Mid winter bulls and cows at age surviving early winter mortality
    mwBullsAge[,yr] <<- wBullsAge[,yr] - mortMidWinter * (1 - wsBullsTS[,yr]) * wBullsAge[,yr]
    mwCowsAge[,yr] <<- wCowsAge[,yr] - mortMidWinter * (1 - wsCowsTS[,yr]) * wCowsAge[,yr]
    # Total mid winter bulls, cows and calves
    mwBulls[yr] <<- sum(mwBullsAge[2:(nAges+1),yr])
    mwCows[yr] <<- sum(mwCowsAge[2:(nAges+1),yr])
    mwCalves[yr] <<- mwBullsAge[1,yr] + mwCowsAge[1,yr]
    }
}

setSurvivalVariation <- function(){
  for (y in 1:(nYears+1)){
    s <- wsBulls[1:2]+.006 # correct for logit bias in variation simulation
    mm <- log(s/(1-s)) # Get the invlogit trasformed value
    ll <- log((1-.5*SurvSig)*s/(1-(1-.5*SurvSig)*s)) # get a range around the invlogit
```

```
    sig <- (mm - ll)/mm    # convert invlogit range to a CV
    ls <- rnorm(2,mm,sig) # draw the invlogit of survival
    surv <- 1/(1+exp(-ls)) # logit transform
    wsBullsTS[,y] <<- c(surv,rep(surv[2],length(wsBulls)-2))

    s <- wsCows[1:2]+.006
    mm <- log(s/(1-s)) # Get the invlogit trasformed value
    ll <- log((1-.5*SurvSig)*s/(1-(1-.5*SurvSig)*s)) # get a range around the invlogit
    sig <- (mm - ll)/mm    # convert invlogit range to a CV
    ls <- rnorm(2,mm,sig) # draw the invlogit of survival
    surv <- 1/(1+exp(-ls)) # logit transform
    wsCowsTS[,y] <<- c(surv,rep(surv[2],length(wsCows)-2))
    varSurv[y] <<- wsBullsTS[2,y]
  }
}

Modify <- function(logits,hb,sig,simvc){
  # This function contains code that overides key parameters
  #eg: ssCows <- ssCows * 1.25 would increase cow summer survival rates by 25%
  #eg: ssBulls <- ssBulls * 0 + 0.90 would set all bull summer survivals to 0.90
  #eg: ssBulls <- .95*(x+1)*exp(1-(x+1)/5)/5 is a survival curve
  #plot(x<-seq(0,20), .95*(x+1)*exp(1-(x+1)/5)/5)
  ssCows[2:(nAges+1)] <<- rep(1/(1+exp(-logits)),nAges)
  ssBulls[2:(nAges+1)] <<- rep(1/(1+exp(-logits)),nAges)
  wsCows[2:(nAges+1)] <<-rep(1/(1+exp(- .82 * .9 * logits)),nAges)
  wsBulls[2:(nAges+1)] <<- rep(1/(1+exp(- .82 * logits)),nAges)
  SurvSig <<- sig # alter the process error for survival variation
  iniPop <<- 1800 # use the maximum likelihood estimated value
  iniBullRatio <<-  45 # 56 is default value used in Moose 200 Spreadsheet model
  iniCalfRatio <<- 55 # 68 is default value used in Moose 200 Spreadsheet model
  birthBullRatio <<- 50 # 50 is default value used in Moose 200 Spreadsheet model
  reprodMult <<- .95 # 1 is default value used in Moose 200 Spreadsheet model
  yrBullEffectiveness <<- 1 # 1 is default value used in Moose 200 Spreadsheet model
  mortMidWinter <<- 0 # 0 is default value used in Moose 200 Spreadsheet model
  sexRatioThreshold <<- 35 # 35 is default value used in Moose 200 Spreadsheet model
  hBulls[12:nYears] <<- hBulls[12:nYears] * 0 + hb # in years 2013 onward, user set value
  MVCrate <<- rep(0.0146,nYears+1)
  simMVC <<- simvc
}

runModel <- function(ss,hb,sig,simvc,doplots=FALSE){
  setup()
  s <- ss
  hbulls <- hb
  Modify(ss,hbulls,sig,simvc)
  setSurvivalVariation()
  PopDy()
  if (doplots==TRUE){
    par(mfrow=c(2,2),mai=c(1.1,1.1,.3,.3),omi=c(.1,0,0,0))
    plot(2001:(2001+nYears-1),BullRatio[2:(nYears+1)],ylab="Bull Ratio",type="l",xlab="Years")
    plot(2001:(2001+nYears-1),mwCalves[2:(nYears+1)],ylab="Mid Winter Calves",type="l",xlab="Years",ylim=c(0,max(mwCalves[2:nYears])))
    plot(2001:(2001+nYears-1),mwBulls[2:(nYears+1)],ylab="Mid Winter Bulls",type = "l",xlab="Years",ylim=c(0,max(mwBulls)))
    plot(2001:(2001+nYears-1),mwCows[2:(nYears+1)],ylab="Mid Winter Cows", type = "l",xlab="Years",ylim=c(0,max(mwCows)))
  }
}
# The main call to the model with 50 bulls harvested, 30\% variability, and 94\% survival
```

```
s <-  0.94
runModel(log(s/(1-s)),50,0.3,1,TRUE) #model assumes logit transform of survival, so logits = log(s/(1-s))

# End of main program file

# Beginning of data file section.

# This contains two data files: 1. alcestHarvest.txt and 2. alcesRates.txt

The contents of file alcestHarvest.txt

# ====== Beginning of alcesHarvest.txt. The harvests from first year to last. Rows contain bull, cow and calf harvest
155,118,182,92,101,109,56,60,58,36,37,50,50,50,50,50,50,50,50,50,50,50,50,50,50,50,50,50,50,50
55,45,46,30,38,45,22,22,22,22,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
33,24,15,15,8,30,8,8,8,8,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
# ======== End of alcesHarvest.txt . This is the last line

The contents of the file alcesRates.txt

# ====== Beginning of alcesRates.txt. These are the vital rates in rows for age 0 to age 20.
# In order: birth rate, summer cow survival, summer bull survival, winter cow survival, winter bull survival,
#           cow harvest vulnerability, bull harvest vulnerability, cow annual survival, bull annual survival, breeding success
0,0.17,0.76,0.8,0.9,1,1.05,1.05,1.02,1,1,1,1,0.9,0.8,0.8,0.7,0.7,0.7,0.7,0.7
0.56, 0.952574127, 0.952574127, 0.93461985, 0.952574127, 0.957561426, 0.869784962, 0.893723997,
 0.881754479, 0.829886569, 0.776023739, 0.724155828, 0.567554637, 0.505712128, 0.60446065,
 0.60446065, 0.60446065, 0.60446065, 0.60446065, 0.60446065, 0.60446065
0.56, 0.952574127, 0.952574127, 0.967938225, 0.963841133, 0.954622674, 0.955646946, 0.901360464,
 0.814297238, 0.83068561, 0.742598109, 0.589981395, 0.633000871, 0.436340406, 0.332888808,
 0.332888808, 0.332888808, 0.332888808, 0.332888808, 0.332888808, 0.332888808
0.9, 0.91497878, 0.91497878, 0.897733106, 0.91497878, 0.919769245, 0.835457064, 0.858451295,
 0.846954179, 0.797133345, 0.745396326, 0.695575491, 0.545154896, 0.485753132, 0.580604336,
 0.580604336, 0.580604336, 0.580604336, 0.580604336, 0.580604336, 0.580604336
0.9, 0.933391964, 0.933391964, 0.948446673, 0.944432084, 0.935399259, 0.936402906, 0.883209601,
 0.797899583, 0.813957939, 0.727644273, 0.57810083, 0.620254015, 0.427553738, 0.326185364,
 0.326185364, 0.326185364, 0.326185364, 0.326185364, 0.326185364, 0.326185364
0,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
0,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
0.504,0.9215,0.9215,0.9215,0.9215,0.9215,0.9215,0.9215,0.9215,0.9215,0.9215,0.9215,0.9215,0.9215,
 0.9215,0.9215,0.9215,0.9215,0.9215,0.9215,0.9215
0.504,0.9215,0.9215,0.9215,0.9215,0.9215,0.9215,0.9215,0.9215,0.9215,0.9215,0.9215,0.9215,0.9215,
 0.9215,0.9215,0.9215,0.9215,0.9215,0.9215,0.9215
0,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
1800
45
68
50
.95
1
0
35
1
0.761
0.24
# ======== End of alcesRates.txt . This is the last line
```

Appendix E

Updated KSM Project Highway Traffic Noise Predictions including Cumulative Effects

Rescan™
Engineers and Scientists

MEMORANDUM

To: Justine Greenwood - Rescan Date:January 23, 2013

From: Brizi Coetzer

Copies To: Tina Liu

Subject: Updated Highway 37 traffic noise predictions for KSM project at nearby residences including cumulative effects from nearby projects

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The purpose of this memo is to provide Highway 37 traffic noise predictions based on available traffic counts. BKL has made calculations based on traffic estimates for the Operation phase of the KSM Project on Highway 37 between the Treaty Creek Access Road and Meziadin Junction.

The following "nearby projects" were included in the cumulative effects assessment using data provided by Rescan on January 23th , 2013:

- Forrest Kerr Hydroelectric
- Red Chris Mine
- Wolverine Mine
- Bronson Slope Mine
- Brucejack Mine
- Galore Creek Mine
- Kitsault Mine
- Kutcho Mine
- McLymont Creek Hydroelectric
- Schaft Creek Mine
- Snowfield Project
- Storie Moly Mine
- Turnagain Mine

The source of data for current traffic conditions is the BC Ministry of Transportation and Infrastructure (MoT).The Canadian Mortgage and Housing Corporation (CMHC) provides guidance on the prediction and assessment of the effects on housing from road and rail noise. CMHC's methodology was used to determine noise levels at the nearest receivers, at two locations. Existing noise levels at the northern location, are low. Accordingly, the acceptability of Project related noise was measured against the 'absolute' criteria of 55 dBA set by the CMHC for 'Outdoor Recreation Areas'. The southern location was inherently noisier than the northern location. As prescribed by

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MOT, a more appropriate measure using the 'relative' change in noise levels was used. This criteria defines the maximum permissible increase in noise level as a result of Project related activity. According to these methods, the following outcome is predicted for each location:

Station 47-016-NS (Northern Segment of Highway 37)

Current Traffic Conditions

The current traffic conditions for count station 47-016NS averaged over the years 2005, 2008 and 2010 for AADT, and averaged over the years 2005 and 2008 for SADT are as follows:

- Annual Average Daily Traffic (AADT) - 224 vehicles per day
- Summer Average Daily Traffic (SADT) - 362 vehicles per day
- Approximately 40% heavy vehicles.

Future Traffic Conditions with KSM project only

The traffic estimates for *Project related* activity were given as follows:

- 31,158 Total Average Annual Trips along the specific route. This equates to approximately 85 vehicles per day passing count station 47-016NS
- 367 of the Total Average Annual Trips are light passenger vehicles (approximately 1 vehicle per day), and the rest heavy vehicles (84 vehicles per day).

Based on these traffic counts, the estimated total number of vehicles per day (project related + current traffic conditions) at location 47-016NS will be:

- Annual Average Daily Traffic (AADT) - 309 vehicles per day.
- Summer Average Daily Traffic (SADT) - 447 vehicles per day
- Approximately 56% will be heavy vehicles (based on AADT).

Cumulative Future Traffic Conditions from all Nearby Projects

Since the other reasonably foreseeable projects do not start operation at the same time, two future cumulative cases are assessed: maximum cumulative and expected cumulative. The traffic estimates for *total cumulative projects* activity were given as follows:

Maximum cumulative (KSM + Other projects) total Average Annual Trips of 181,903 and expected cumulative (KSM + Other projects) total average annual trips of 170,223 along the specific route. This equates to a maximum of 498 vehicles per day, and expected 466 vehicles per day passing count station 47-016NS. The same % heavy vehicle ratio is assumed as in the KSM project data above (99%) which gives:

- 2140 of the Total Average Annual Trips as light passenger vehicles (approximately 6 vehicles per day), and the rest heavy vehicles (492 vehicles per day) for the maximum case; and
- 2003 of the Total Average Annual Trips as light passenger vehicles (approximately 5 vehicles per day), and the rest heavy vehicles (461 vehicles per day) for the expected case.

Based on these traffic counts, the estimated total number of vehicles per day (cumulative project related + current traffic conditions) at location 47-016NS will be:

- Annual Average Daily Traffic (AADT) – maximum of 722 vehicles per day, and expected 690 vehicles per day.
- Summer Average Daily Traffic (SADT) – maximum of 860 and expected 828 vehicles per day
- Approximately maximum of 81% will be heavy vehicles, and expected 80% will be heavy vehicles (based on AADT).

Sound Level at Closest Receiver

The designated 'closest receiver' is noted to be a house 50m from the road at the same level as the road. For comparative purposes the 24-hour equivalent noise level ($L_{eq}24$) at the receiver location for the current condition is estimated to be in the region of 47-49 dBA[1], depending on whether AADT or SADT are used. The additional KSM-related traffic is estimated to increase noise levels at this location by 2-3 dB based on a road traffic speed of 90km/h. This is a noticeable increase, but will still be well below the limit of 55 dBA for an 'Outdoor Recreation Area' or where 'indoor conditions are unacceptable unless adequate sound insulation is provided' as recommended in the CMHC guideline.

The cumulative effect of nearby project related traffic (including KSM traffic) at this location is estimated to increase noise levels above the current condition by approximately 6-8 dB (to 55 dB) as shown in Table 1. This is equal to the guideline limit set forth by the CMHC.

Table 1: Traffic Noise Predictions at Closest Receiver – North Section 47-016-NS

Case	Present Noise Level (dBA)	Future Noise Level with KSM project (dBA)	Max Cumulative Noise Level from all Nearby Projects (dBA)	Expected Cumulative Noise Level from all Nearby Projects (dBA)	Receiver distance (m)
AADT	47	50	55	54	50
SADT	49	52	55	55	

Station P 47-9-NS (Southern Segment of Highway 37)

Current Traffic Conditions

The current traffic conditions for count station P 47-9-NS averaged over the years 2004 to 2011 are shown as:

- Annual Average Daily Traffic (AADT) - 799 vehicles per day
- Summer Average Daily Traffic (SADT) - 1093 vehicles per day
- Approximately 40% heavy vehicles.

Future Traffic Conditions with KSM project only

The traffic estimates for *Project related* activity were given as follows:

- 17,958 Total Average Annual Trips along the specific route. This equates to approximately 49 vehicles per day passing count Station P 47-9-NS
- 366 of the Total Average Annual Trips are light passenger vehicles (approximately 1 vehicle per day), and the rest heavy vehicles (48 vehicles per day).

Based on these traffic counts, the estimated total number of vehicles per day (project related + current traffic conditions) at location 47-016NS will be:

- Annual Average Daily Traffic (AADT) - 848 vehicles per day.
- Summer Average Daily Traffic (SADT) - 1142 vehicles per day
- Approximately 43% will be heavy vehicles (based on AADT).

Cumulative Future Traffic Conditions from all Nearby Projects

The traffic estimates for *total cumulative projects* activity (KSM + other projects) were given as follows:

- 117,603 Total Average Annual Trips along the specific route. This equates to 322 vehicles per day passing count station 47-016NS
- 2400 of the Total Average Annual Trips are estimated to be light passenger vehicles (approximately 7 vehicles per day), and the rest heavy vehicles (315 vehicles per day).

Based on these traffic counts, the estimated total number of vehicles per day (cumulative project related + current traffic conditions) at location 47-016NS will be:

- Annual Average Daily Traffic (AADT) - 1121 vehicles per day.
- Summer Average Daily Traffic (SADT) - 1415 vehicles per day
- Approximately 57% will be heavy vehicles (based on AADT).

Sound Level at Closest Receiver

The designated ‘closest receiver’ is noted to be a house 25m from the road at the same level as the road. For comparative purposes the current noise level at the receiver location is estimated to be in the region of 58-59 dBA, depending on whether AADT or SADT are used. This is already above the 55 dBA limit for an ‘Outdoor Recreation Area’ and is in the region where 'indoor conditions are unacceptable unless adequate sound insulation is provided' as recommended in the CMHC guideline. We therefore suggest using a different criteron as published by the MoT. This gives guidance as to the maximum allowable increase in environmental noise due to project related activity, and has been used on similar mining projects in the past. This is useful in this case where the existing environment is already noisy. For a pre-project environment with an $L_{eq}24$ of 59 dBA, the maximum allowable increase in total noise is 4.2 dBA before mitigation is required. The additional KSM Project related traffic is estimated to increase noise levels at this location by 1 dBA based on a road traffic speed of 90km/h. This is well below the 4.2 dBA allowance.

The cumulative project related traffic is estimated to increase noise levels at this location by 3-4 dBA above the current condition based on a road traffic speed of 90km/h. This is within the 4.2 dBA allowance.

Table 2 below summarizes the present and future noise levels for the south section.

Table 2: Traffic Noise Predictions at Closest Receiver – South Section P 47-9-NS

Case	Present Noise Level (dBA)	Future Noise Level with KSM project (dBA)	Future Cumulative Noise Level from all Nearby Projects (dBA)	Receiver distance (m)
AADT	58	59	61	25
SADT	59	60	63	

In our assessment of additional traffic at two locations, both locations meet the appropriate criteria for noise levels at the nearest receiver when viewing KSM-related noise contributions. When assessing cumulative noise levels from all nearby projects, the noise levels are very close to guideline limits, and may have potential for disturbance.

Please don't hesitate to contact me if you have any questions regarding this memo.

Sincerely,

BKL Consultants Ltd.

per:
Briét Coetzer MMus(Technology), EIT

This does not include the effects of road gradient. This effect ranges from 1 dB (gradient of 1%) to 4 dB (gradient of 5%) in addition to the existing levels.

Appendix F

Working Group Comment Tracking Table

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Proposed KSM Project
July 9, 2012 Working Group Meeting
KSM Project Highway 37 and 37A Traffic Effects Assessment Report: Responses to Questions and Comments Raised by the Working Group

June 29, 2012 NLG Comments

No.	Commenter / Date Received	Report	Comment	Seabridge Response
1.	NLG/June 29, 2012	KSM Highway Traffic Effects Assessment	Please confirm whether the gold is mixed in with the copper concentrate and the silver with the molybdenum concentrate resulting effects on toxicity to aquatic systems may differ between the two (which will be going to different parts)	The Project will produce three different products: copper concentrate, molybdenum concentrate, and gold-silver doré bullion. The copper concentrate will comprise the majority of product produced at the Project. The concentrates are considered hazardous material and handling will follow appropriate procedures to prevent spills.
2.	NLG/June 29, 2012	KSM Highway Traffic Effects Assessment	There needs to be more detail in the fish and aquatic risk section, including a description of the specific areas (streams, lakes, and wetlands) along the transportation routes where there will be increased risk to aquatic values either due to high fisheries or wetland values or due to an increased risk of an accident – these areas and risks should be identified/explained further along with proposed mitigation measure (e.g. guard rails, speed limits, restrictions on travel during certain times of the day etc…)	All fish-bearing streams were treated with an equally high value in the assessment. Therefore, the weight of risk is the maximum applied in the event of increased traffic or accidents. Please refer to Table 5.2-1 and Figure 5.2-1 for a table map of important fish bearing streams in the Traffic Study Area. A discussion of risks to wetlands is discussed in section 5.5. Erection of guard rails are the responsibility of BC MOTI. Mitigation to minimize effects from traffic and accidents is found in the Traffic and Access Management Plan and the Spill Prevention and Emergency Response Plan, which be part of the EA Application.

No.	Commenter / Date Received	Report	Comment	Seabridge Response
3.	NLG/June 29, 2012	KSM Highway Traffic Effects Assessment	There needs to be a description of how BMPs will be enforced in respect trucking contractors	Enforcement of adherence to speed limits and other safe driving practices for contractors will be described in the Traffic and Access Management Plan of the EA. Enforcement may be in the form of radar guns, vehicle monitoring systems, or other similar methods. Truck drivers will be actively monitored to ensure they accurately record all wildlife sightings and incidents along the roads. Contractors as well as employees will be required to follow a specified Journey Management Procedure, including departure and arrival check-ins.
4.	NLG/June 29, 2012	KSM Highway Traffic Effects Assessment	There needs to be a description of the risk of a complete dumping of cargo into aquatic environments and the proposed response to such an incident, including how such an incident would be contained.	A Fish and Aquatic Habitat Risk Assessment Matrix for Traffic Accidents is provided in Table 5.2-6 of the report, including a description of the potential risk, mitigation measures, and the likelihood and severity of the risk. The Spill Prevention and Emergency Response Plan will be included in the EA. Road users will be trained in relevant spill response techniques and protocols. Spill kits will be available on vehicles transporting dangerous goods or hazardous materials and spill kits will also be set up at select points along the haul route.
5.	NLG/June 29, 2012	KSM Highway Traffic Effects Assessment	The Traffic Effects Assessment amounts to a generalized, qualitative impact assessment (without the usual conclusion of whether a given effect is significant or not) in that results of the study are distilled into a single figure depicting a highly generalized assessment of the severity and likelihood of a number of traffic-related risks to wildlife	A discussion of the potential effects of traffic and accidents on Wildlife is outlined in section 5.3 of the report. This includes a baseline data overview, issues scoping, and risk analysis. A Wildlife Risk Assessment Matrix is found in Table 5.3-5 for traffic and Table 5.3-6 for accidents. These matrices include potential risk to wildlife VC's, mitigation measures, and the likelihood and severity of the risk. A conclusion of significance is part of an assessment of residual effects to VC's, and will be included in the wildlife chapter of the EA/EIS.

No.	Commenter / Date Received	Report	Comment	Seabridge Response
6.	NLG/June 29, 2012	KSM Highway Traffic Effects Assessment	A quantitative analysis with respect to project VEC pathways should be undertaken given that it would provide a more comprehensive and complete understanding of the likelihood and significance of expected effects of the project, an example of which is more fully described as follows: Table 5.3-5 contains the following statement: "An average of approximately 20 moose are killed per year due to vehicle collisions along Highway 37 between Kitwanga and Burrage (within the Project study area). Project traffic will increase the traffic volume along the highways and direct mortality to moose is possible. However, even through traffic volumes will be increasing considerably, the number of animal collisions will not increase by an equal percentage." From Table 5.3-4, the definition of a Moderate severity risk is one that "Differs substantially from the average value for baseline conditions and approaches the limits of natural variation, but below or equal to a guideline or threshold value. Effect limited to the local population." Then section 5.3.3.2, the following conclusion is drawn: "Because of the current status of the moose population in the area (i.e., declining), the high value habitat along Highway 37, and the uncertainty around the WARS data and the current numbers of vehicle/moose interactions, the severity is expected to be moderate."	In response to comments received during the traffic study working group meetings in Terrace (July 9, 2012), a quantitative assessment of the likely increase in moose mortality due to increased traffic was completed. The assessment analyzes the sensitivity of the current moose population to increased mortality. The assessment involved collaboration with and/or receiving data from Nass moose surveys, Nisga'a and Gitanyow hunting rates, Gitanyow road monitoring studies, and the results of non-resident hunting tags. The analysis will provides a quantitative evaluation of the effects on the moose population and is included in the final report (Appendix D).

No.	Commenter / Date Received	Report	Comment	Seabridge Response
(6.)	(continued)		Note that no indication of a guideline or threshold value for moose is presented (or at least discernible). Absent some quantitative backing or assessment, a risk of "Moderate" is not particularly informative and is subject to varying degrees of interpretation regarding the overall significance of the effect in the context of the project (i.e.: what does this mean for the population? Will it go down? Will hunter opportunity diminish as a result? By potentially how much?). A risk assessment which included a quantitative assessment would estimate a range of potential roadkill mortality rates and feed that into a moose population model that would be built using readily available data such as the population parameters presented in the Nisga'a moose survey reports. Through a process of Mote Carlo simulations, the range of potential outcomes of the project's effects on the moose population would be drawn. A corresponding sensitivity analysis would examine for any tipping points (i.e., mortality [or guideline/threshold values in the case of the Proponent's definition] levels that would cause the population to decline as opposed to being within the limits of a sustainable level of mortality). Such a method provides a basis for predicting whether the effects will be such that there is an effects on population dynamics; and by how much.	

July 9, 2012 Working Group Meeting Comments

No.	Commenter / Date Received	Presentation	Comment	Seabridge Response
7.	Joanna Tombs, BC Environmental Assessment Office (EAO)	Elizabeth Miller, Seabridge Gold	What type of concurrent permitting is Seabridge referring to?	Seabridge is planning to submit applications for provincial permits, licences and approvals for concurrent review with the EA Application for the proposed Coulter Creek and Treaty Creek access roads, construction camps and preliminary construction access and earthworks associated with Mine Site and the Processing and Tailing Management Area (pursuant to the BC Environmental Assessment Act, Concurrent Approval Regulation, B.C. Reg. 371/2002 (O.C. 1158/2002).
8.	Mark Cleveland, Gitanyow Hereditary Chiefs Office(GHCO)	Elizabeth Miller, Seabridge Gold	Will changes in the Multiple Accounts Analysis be highlighted, so that we don't have to review the whole report?	Changes to the Multiple Accounts Analysis (Assessment of Alternatives for KSM Project Tailing Management Facility) will be highlighted in a question and answer table which will be appended to the report.
9.	Mark Cleveland, GHCO	Elizabeth Miller, Seabridge Gold	Will there be information in Seabridge's pre-feasibility report that we have not seen as the Working Group?	Seabridge files public reports on the project pursuant to NI43-101 guidelines . These reports are broader than the EA. It is possible that the updated 2012 Preliminary Feasibility Report (released in May 2012) may contain information that the Working Group has not seen. Report summaries are available here: http://www.seabridgegold.net/ksm_engineer.php#2012
10.	Jennifer Wilson, Environment Canada (EC)	Elizabeth Miller, Seabridge Gold	What are the proposed locations for next sub-Working Group meetings?	The locations for the Working Group meetings are decided by the EAO/CEA Agency. The locations depend on who is attending the meeting.
11.	Mansell Griffin, Nisga'a Lisims Government (NLG)	Elizabeth Miller, Seabridge Gold	The Nisga'a want to be part of the meeting related to fish habitat compensation, but the end of August is challenging because we go fishing at that time.	Comment noted. Seabridge met with NLG representatives on September 12, 2012 in Smithers.
12.	Mansell Griffin, NLG	Elizabeth Miller, Seabridge Gold	Will there be seasonal variations in mine traffic?	During construction, seasonal fluctuations in traffic are expected. Higher traffic levels are anticipated during the summer. During operations, traffic is not expected to fluctuate seasonally because the majority of the traffic will be from copper concentrate haul trucks operating 24 hours per day, 7 days a week, year round.

No.	Commenter / Date Received	Presentation	Comment	Seabridge Response
13.	Sherrie Applegate, BC Ministry Transportation and Infrastructure (MoTI)	Elizabeth Miller, Seabridge Gold	Did the "Review of Historical Traffic Patterns and Capacity on Highway 37 in Proximity to the Proposed KSM Project" (McElhanney, May 2011) consider the section of Highway 37 north of Meziadin Junction? The highway narrows north of Bell 1.	The purpose of McElhanney's report was to review historical traffic volumes and estimate the capacity of Highway 37. The report did not consider specific highway segments. Traffic count data is available at five locations along the Highway. The analysis in the report used traffic count data from station 47-016NS as this data is available since 1980 and it is situated at a midpoint between Kitwanga and Dease Lake (see Appendix B).
14.	Bob Bocking, LGL for NLG	Elizabeth Miller, Seabridge Gold	Is there a memo on McElhaney's Highway 37 Capacity Report?	A copy of the report is appended to the final Highway 37 and 37A Traffic Effects Assessment (see Appendix B).
15.	Dwayne Day, Tahltan Heritage Resource Environmental Assessment Team (THREAT)	Elizabeth Miller, Seabridge Gold	Do KSM project traffic estimates include all trucks or only ore trucks?	KSM Project-related traffic estimates include all traffic types. Tables-2.4-1 through 2.4-4 list the vehicle types and cargo that were included in the traffic estimates in the report.
16.	Sherrie Applegate, MoTI)	Elizabeth Miller, Seabridge Gold	Do you have any sense of traffic volumes during construction versus operation?	The report considers traffic volumes for the Project, including construction, operation, closure and post-closure phases (see Tables 2.4-1 through 2.4-4 for the estimates).
17.	Mark Cleveland, GHCO	Elizabeth Miller, Seabridge Gold	Section 5-50 of the report shows different numbers and the way it is written; in particular "additional" is confusing.	The language on pg.5-50 of the report will be revised to provide further clarity. Project traffic will add a maximum of four vehicles per hour along Highway 37, remaining below volumes reported in 2000.
18.	Chris Schell, BC Ministry of Environment (MOE)	Elizabeth Miller, Seabridge Gold	Is access required along Teigen Creek?	Road access is no longer required along Teigen Creek.
19.	Sherrie Applegate, MoTI)	Elizabeth Miller, Seabridge Gold	The forestry service road near Treaty Creek may not meet current provincial standards. Seabridge will be required to discuss intersection designs with MoTI.	Seabridge consultants are currently working on a study of the proposed Project-related access road intersections with Highway 37, which will include more information on the forestry service road near Treaty Creek. Seabridge provided an intersection study to MOTI prior to submitting the EA Application.
20.	Sherrie Applegate, MoTI	Elizabeth Miller, Seabridge Gold	The speed limit on the road from Meziaden to Yukon border has changed to 90 km an hour.	Comment noted. The Highway posted speed limit noted on page 2-13 will be revised.
21.	Mansell Griffin, NLG	Elizabeth Miller, Seabridge Gold Presentation	Will KSM employees be driving themselves to work?	Shuttles will transport personnel to and from the Project. Employees will not be driving their personal vehicles to the Mine Site.

No.	Commenter / Date Received	Presentation	Comment	Seabridge Response
22.	Mark Cleveland, GHCO	Elizabeth Miller, Seabridge Gold Presentation	Where in the report are you assessing the effects of helicopter emissions related to the transport of doré?	Environmental effects related to the use of helicopters will be assessed in the EA Application.
23.	Will Foster, Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) Teleconference	Elizabeth Miller, Seabridge Gold	Do you have traffic estimates for other mine projects to use in the cumulative impact assessment?	The cumulative effects assessment in the EA Application will use publicly available traffic estimates. An approximation will be used when information is not publicly available. Estimates of product-related haul traffic will be calculated based on available concentrate production amounts or production rates, ore grades, and/or concentrate grades and on the assumption that 50 tonne trucks are used. Estimates of other mine traffic will be calculated based on the KSM ratio between trips per day and production rate. It will be assumed that travel along Highway 37 south to Highway 16.
24.	Dwayne Day, THREAT	Elizabeth Miller, Seabridge Gold	Does the cumulative effects assessment consider potential increases in population over the next 50 years?	The EA Application will include an evaluation of cumulative environmental effects of residual effects that are likely to result from the proposed development and how they may combine with environmental effects from other past, present and reasonably foreseeable projects and activities. The cumulative effects assessment does not include population increases because it is difficult to forecast population changes 50 years from now.
25.	Norm McLean, THREAT	Elizabeth Miller, Seabridge Gold	Is traffic from the Wolverine mine in the Yukon considered?	Traffic from the Wolverine Mine in the Yukon will be included in the cumulative effects assessment.
26.	Mansell Griffin, NLG	Elizabeth Miller, Seabridge Gold	Does the traffic effects assessment consider the number of large sized Project vehicles on Highway 37 compared to historic counts of large vehicles?	The KSM Project assessment considers different vehicle types that will be used (Tables 2.4-1 through 2.4-4). Traffic counters do not record the size of vehicle.
27.	Mansell Griffin, NLG	Elizabeth Miller, Seabridge Gold	Will there be Project traffic along Highway 37A during closure and post-closure?	Project traffic is not expected to use Highway 37A during closure and post-closure.
28.	Dwayne Day, THREAT	Elizabeth Miller, Seabridge Gold .	Do you have a list of hazardous materials and the routes that will be used to transport them?	Tables 2.4-1 through 2.4-4 identify the hazardous materials to be transported along Highway 37. The average annual one-way trips expected along each segment of Highway 37 are detailed in the tables. Table 2.4-6 identifies lime and other reagents to be transported.

No.	Commenter / Date Received	Presentation	Comment	Seabridge Response
29.	Mark Cleveland, GHCO	Elizabeth Miller, Seabridge Gold	Are project traffic estimates averaged over 8 hours or 24 hours? I would like to see more on peak travel times because there is a big difference in terms of impacts if all of the trucks are driving at dusk or dawn. Attention should be paid to the specific times of traffic to reduce impacts on wildlife.	The report looks at daily averages over a 24 hour period.
30.	Bob Bocking, LGL for NLG	Elizabeth Miller, Seabridge Gold	The report specifies actual accident numbers; what is the actual rate of accidents compared to the number of vehicles?	Accident rates have been updated to show rates for commercial and non-commercial vehicles by year between 1996 and 2011. Where there were gaps in historical data, AADT was extrapolated in excel where viable. These tables are incorporated in the final report (Table 3.1-3 and 3.1-4).
31.	Jennifer Wilson, EC	Elizabeth Miller, Seabridge Gold	Do commercial and non-commercial vehicles have different accident rates? Is there a threshold number of vehicles, above which, accidents increase?	Accident rates vary between commercial and non-commercial vehicles (see Table 3.1-3 and 3.1-4).
32.	Andrew Webber, Regional District of the Kitimat-Stikine	Elizabeth Miller, Seabridge Gold	In the section that describes collisions versus accidents, does this involve more than one vehicle?	Collision and accident are used interchangeably throughout the report. Both terms refer to a “crash incident” to be consistent with the ICBC data. The raw ICBC data counts “crash incidents” but does not specify the number of vehicles involved in each incident.
33.	Bob Bocking, LGL for NLG	Elizabeth Miller, Seabridge Gold	Is there accident data prior to 1996?	Seabridge is not aware of any accident data prior to 1996.
34.	Mike Demarchi, LGL for NLG	Elizabeth Miller, Seabridge Gold	What is the confidence interval of predicted accident numbers?	The final report figures for the Collision Prediction Model will include bands surrounding the predicted collision numbers, indicating the range of values encompassed by a 95% confidence level (Figures 3.2-1 through 3.2-3, and 8.3-1 through 8.3-3).
35.	Dwayne Day, THREAT	Elizabeth Miller, Seabridge Gold	Is there accident data available from other operating mines in the region?	Seabridge is not aware of accident data being available from operating mines.
36.	Mansell Griffin, NLG	Elizabeth Miller, Seabridge Gold	Does the collision data include information on whether or not an animal was involved in the incident?	The ICBC police collision data does not include information on whether or not an animal was involved in a ‘crash incident’. Incidents involving wildlife fatalities are recorded in MoTI’s “Wildlife Accident Reporting System” (WARS).

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37.	Mark Cleveland, GHCO	Elizabeth Miller, Seabridge Gold .	Do concentrate trucks have higher collision rates?	The ICBC police collision data distinguishes between commercial and non-commercial vehicles, but does not provide details on the types of commercial vehicles involved in incidents. In general, accidents rates are higher for non-commercial vehicles than for commercial vehicles (see tables 3.1-1 and 3.1-2) (ICBC 2011a, b).
38.	Mansell Griffin, NLG	Elizabeth Miller, Seabridge Gold	Would drivers be employed by the mine?	Drivers will be subcontractors or employees. Sub-contractors will be required to meet the same safety standards as mine drivers.
39.	Bob Bocking, LGL for NLG	Elizabeth Miller, Seabridge Gold	Was ICBC collision data or police collision data used?	Police collision data from ICBC was used in the report because it is more comprehensive than ICBC collision data.
40.	Dwayne Day, THREAT	Elizabeth Miller, Seabridge Gold .	Does accident near miss data exist?	Seabridge is not aware of near miss data existing for operating mines.
41.	Dwayne Day, THREAT	Elizabeth Miller, Seabridge Gold	Is there information regarding wildlife accidents vs. incidents not involving wildlife?	See response to comment #30.
42.	Chris Hamilton, EAO	Anne Currie, Rescan, Risk Assessment Presentation	How does the Working Group know that the mitigation being proposed by Seabridge is going to be enforced?	Proposed mitigation will be detailed in management plans to be presented in the EA Application. Enforcement measures are outside of a proponent's control (e.g., the number of RCMP patrolling highways 37 and 37A to enforce speed limits)

No.	Commenter / Date Received	Presentation	Comment	Seabridge Response
43.	Norm Maclean, LGL for NLG and Mansell Griffin, NLG	Anne Currie, Rescan	What is the context when looking at risk in relation to the local versus regional wildlife population levels? What is the definition of moderate? For example, a moderate risk may more severe in a local context, but would be diluted in a regional context because of the larger area. A small effect on a regional population has an impact on local populations. For example, moose populations in the Cranberry area are declining and this population is important locally.	The KSM project is committed to limiting any effects on moose, particularly due to direct mortality. The Project is limiting and quantifying its effects in three ways: 1. The KSM Project will not construct any new roads that are open to the public, hence no new areas will be open for hunters. 2. The KSM Project is not located in the Cranberry area – the sole effect on moose in NLG territory will be due to increased traffic – to levels below historic highs in the 1990s. 3. To understand the effects of increased traffic on moose KSM completed a quantitative assessment of the likely increase in moose mortality due to increased traffic. This analysis examines the sensitivity of the current moose population to this increased mortality. Rescan collaborated with and/or received data from Nass moose surveys, Nisga'a and Gitanyow hunting rates, Gitanyow road monitoring studies, and the results of non-resident hunting tags. This analysis provides a quantitative evaluation of the effects on the moose population. The information from this analysis is included in the final report as Appendix D.
44.	Mark Cleveland, GHCO	Anne Currie, Rescan Assessment	There is a risk to sockeye populations in Brown Bear Creek. A fuel spill should be rated as major or catastrophic as there is no barrier on the downstream side of Highway 37 at Bear Creek.	While all streams are considered important, the report (Figure 5.1-1a through I, Table 5.2-1 and Figure 5.2-1) highlights important fish-bearing streams identified by the working group (such as Brown Bear Creek). For the accidents risk assessment, the severity rating varies depending on the proximity of a spill to a watercourse, the volume of material spilled, how quickly spilled material is cleaned up, whether the spill is localized or not, etc. Potential risks from spills will be mitigated through actions described in the Spill Prevention and Emergency Response Plan, which provides specifications for preventing spills and controlling the release of spills during traffic accidents. The plan will minimize response time (e.g. by locating spill kits at strategic locations along the haul route) and maximize clean-up efficiency, preventing long-term or geographically extensive effects. As a result fuel spills are rated as moderate severity Considering the range of potential events that could occur, the report will be revised to make a rage of severity ratings clearer.

No.	Commenter / Date Received	Presentation	Comment	Seabridge Response
45.	Bob Bocking, LGL for NLG	Anne Currie, Rescan	The report is too general with respect to potential risks to specific salmon populations. Interested in seeing more detail in the risk assessment. Suggest specific populations be assessed individually in a different chart where risk conclusions and mitigation are adjusted based on effects on local salmon species.	During the meeting, the Working Group identified the key salmon-bearing watercourses along the traffic route. The baseline section if the fish and aquatic habitat risk assessment section discusses these areas with particularly high fisheries values. The probability of a spill happening is low, and the probability of a spill happening at one a sensitive location during a sensitive time is even lower. Regardless, such an event in these areas may have a higher severity rating, because they're so important to the system. Risk conclusions and mitigation are made considering the most sensitive streams and local salmon species (see Table 5.2-1).
46.	Mark Cleveland, GHCO	Anne Currie, Rescan	Is additional mitigation such as guard rails at stream crossings being considered?	Sherrie Applegate (MoTI) noted that highway improvements including installation of new guard rails is dependent on the ministry's budget. She also noted that public safety needs to be assessed when considering installing new guard rails.
47.	Kevin Koch, GHCO	Anne Currie, Rescan	The time to respond to an accident or spill in the north is not the same as the south. Response time is limited by geography and available resources.	Seabridge is committed to installing spill response stations at strategic locations along the highways in order to reduce the time to respond to accidents or spills. The locating of spill kits will be done in consultation with First Nations, Nisga'a, MoTI, and MOE.
48.	Mike Demarchi, LGL for NLG	Anne Currie, Rescan	The method and conclusion seem to be based on qualitative information rather than quantitative information (e.g., population estimates) and there is no indication of a threshold value. The report looks at historical wildlife numbers and needs to consider the current status of wildlife populations along the traffic route.	To understand the effects of increased traffic on moose KSM completed a quantitative assessment of the likely increase in moose mortality due to increased traffic. This analysis examines the sensitivity of the current moose population to this increased mortality. Rescan collaborated with and/or received data from Nass moose surveys, Nisga'a and Gitanyow hunting rates, Gitanyow road monitoring studies, and the results of non-resident hunting tags. This analysis provides a quantitative evaluation of the effects on the moose population. The information from this analysis is included in the final report as Appendix D.
49.	Chris Schell, MOE	Anne Currie, Rescan	It would be best to provide funding to an existing program (Northwest Invasive Plant Council) which does invasive plant surveys and spraying along the highway. These techniques are more effective than washing trucks.	MoTI is responsible for controlling invasive plants on public highways. Seabridge will consider working with the Northwest Invasive Plant Council if invasive plants are unintentionally introduced on Seabridge controlled access roads.

No.	Commenter / Date Received	Presentation	Comment	Seabridge Response
50.	Dwayne Day, THREAT	Anne Currie, Rescan	There are some areas where people (e.g., farmers) don't want spraying for invasive plants.	Sherrie Applegate (MoTI) noted that spraying is based on species. Weeds are pulled by hand within MoTI's right-of-way where farmers do not want any spraying.
51.	Mark Cleveland, GHCO	Anne Currie, Rescan	Concerned about accidents in areas where people park along the highway to access pine mushroom and berry sites. For example, in the fall, between Meziadin Junction and Kitwanga, there are mushroom pickers park in this area for six weeks.	Seabridge is interested in establishing a communication mechanism to work with the Gitanyow to identify mushroom and berry picking sites along Highway 37.
52.	Dwayne Day, THREAT	Anne Currie, Rescan	Will industrial vehicles be using pull-outs near points of interest?	Sherrie Applegate (MoTI) indicated the ministry is considering increasing the number of rest areas along the highway, in consultation with First Nations.
53.	Mark Cleveland and Kevin Koch, GHCO	Anne Currie, Rescan Presentation on Cumulative Effects	Why is cumulative effects information not included in the report? Will we need to review the whole EA Application to review the cumulative traffic effects assessment?	Cumulative effects of traffic are considered in the final report (see chapter 8 of the KSM Project highways 37 and 37A Traffic Effects Assessment).
54.	Mark Cleveland, GHCO	Anne Currie, Rescan	Is there any reason the report doesn't include potential forestry data in the slide showing cumulative traffic estimates? If the forest industry picks up this could have an effect.	The cumulative effects assessment in the EA Application will consider other projects and activities, including forestry.
55.	Kevin Koch, GHCO	Anne Currie, Rescan	We don't really have data or know what the wildlife impacts were when vehicle traffic was at historic highs. What definition of cumulative effects are you using? I don't think historical data provides any value because wildlife impact is not known.	Chapter 8 of the KSM Project Highways 37 and 37A Traffic Effects Assessment considers cumulative effects, including a description of the assumptions used to prepare the assessment.
56.	Bob Bocking, LGL for NLG	Anne Currie, Rescan	The risk assessment methodology seems to deviate from Section 10.9 of the approved Application Information Requirements.	The methodology used in the Highways 37 and 37A Traffic Effects Assessment Report used likelihood and severity indices.
57.	Mike Demarchi, LGL for NLG	Anne Currie, Rescan	Is the report a draft or final? Will the discussions today be incorporated into the report?	The Highways 37 and 37A Traffic Effects Assessment was a draft report at the time of July 9 Working Group meeting. The final report considers comments from the July 9 Working Group meeting, and the final report is submitted as an Appendix (22-C) of the EA Application.

No.	Commenter / Date Received	Presentation	Comment	Seabridge Response
58.	Jennifer Wilson, EC	Anne Currie, Rescan	Is there an opportunity to comment on the report as part of Environmental Impact Statement (EIS)?	Yes as the final report will be included as an appendix of the EIS/EA Application (Appendix 22-C).
59.	Bob Bocking, LGL for NLG	Anne Currie, Rescan	In the Likelihood Scale, what is the distinction between the 'rare' and 'unlikely' categories? Maybe rare should be "nil" or zero or collapse the scale to four points.	The Likelihood scale is described in section 4.4.3 of the report The definitions of the 'rare' and 'unlikely' have been modified for clarity in final version of the Report.
60.	Chris Hamilton, EAO	Greg Sharam, Rescan Presentation on Wildlife	In terms of moose-vehicle collisions, do cows get hit more often than bulls?	In the winter the bulls tend to be at higher altitudes because they can handle deeper snow while the cows are lower in the valley where the highway is located. As a result, cows are hit more often. Gitanyow representatives noted that since January 1, 2012 environmental monitors reported six road kills of cows. Approximately 70% of the moose observed around the highway were cows.
61.	Mark Cleveland, GHCO	Greg Sharam, Rescan	WARS data is deficient and I am glad this has been highlighted.	Comment noted.
62.	Kevin Koch, GHCO	Greg Sharam, Rescan	The report says that there are no Ungulate Winter Ranges (UWR) in the Cranberry area. UWRs are identified in this area as they are included in the Gitanyow reconciliation agreement.	Chris Schell noted the UWRs in the Cranberry area have not been legally designated. Moose winter range has been identified near the Cranberry Junction and Cranberry River (BC ILMB 2011). This has been considered in the risk assessment and will be discussed in the EA Application.
63.	Mike Demarchi, LGL for NLG	Greg Sharam, Rescan	An agency needs to take the lead to harmonize the different wildlife-vehicle collision datasets (WARS, ICBC and RCMP). Maybe the population model can factor in harvest rates and predation rates. Is there a tipping point where road kill could influence the population?	The Working Group acknowledged there would be benefits to amalgamating the different datasets. A quantitative assessment of the increase in moose mortality due to increased traffic is included in the final report.
64.	Norm Maclean, THREAT	Greg Sharam, Rescan	There is varying information on different moose populations. The company and government should be thinking of ways to re-start survey work.	Comment noted. As part of the Project Seabridge will be undertaking appropriate wildlife surveys in the Mine and TMF areas. Rescan collaborated with and/or received data from Nass moose surveys, Nisga'a and Gitanyow hunting rates, Gitanyow road monitoring studies, and the results of non-resident hunting tags and part of the quantitative evaluation of the effects on the moose population.

No.	Commenter / Date Received	Presentation	Comment	Seabridge Response
65.	Dwayne Day, THREAT	Greg Sharam, Rescan	One of my concerns is the long term effects of predators on access roads. These new rights-of-way will change the migration routes of these animals now that they have access to these roads. This will increase the number of predators. The reasons for these effects have not been captured in the report. New roads could destroy good moose habitat areas, and should be compensated somehow.	The report focuses on highways 37 and 37A. The potential effects of the proposed Coulter Creek and Treaty Creek access roads on wildlife will be considered in the EA Application.
66.	Chris Schell, MOE / Mansell Griffin, NLG	Greg Sharam, Rescan	It is better to mitigate/prevent moose from being killed first, rather than to start by considering compensation for moose kills.	Comment noted.
67.	Mark Cleveland, GHCO	Greg Sharam, Rescan	I have heard from the Conservation Officers past that truck convoys can reduce strikes	Comment noted.
68.	Kevin Koch, GHCO	Greg Sharam, Rescan	Suggested holding a focused meeting with experts to discuss mitigation that might work in the proposed Project area.	Comment noted.

September 14, 2012 GHCO Comments

No.	Commenter / Date Received	Report	Comment	Seabridge Response
69.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment	Gitanyow would like to frame the following comments in the context of the *Gitanyow Huwilp Recognition and Reconciliation Agreement*, signed by the eight Gitanyow Chiefs and the BC Ministers of Aboriginal Relations and Forest, Lands and Natural Resource Operations on March 28, 2012. This agreement includes the *Gitanyow Lax'yip Land Use Plan* which provides detailed management objectives and land use zones for the entire Gitanyow Lax'yip (territory). This Agreement represents a partial accommodation of Gitanyow Aboriginal Rights, and as such it is expected that the KSM Project will uphold and adhere to the relevant management objectives therein. We have attached the appropriate maps for the affected Wilp for reference.	Comment noted.
70.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment	While the KSM TEA adequately outlines the various Valued Components that are potentially impacted by the transportation of products and supplies related to the KSM Project, Gitanyow holds significant concern over the potential effects on wildlife (primarily moose) from vehicle collisions and about the potential negative effects on aquatic ecosystems and human safety in the event that a commercial vehicle is involved in an accident, and deleterious substances are released into the environment.	Comment noted.

No.	Commenter / Date Received	Report	Comment	Seabridge Response
71.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment	The transport route, throughout much of its length, parallels and crosses many small streams and rivers that support fisheries that Gitanyow rely upon for food security (see photo 5). Among some of the most important streams include the Kitwanga River, Cranberry River, Meziadin River, Nass River and Bell Irving River. Many other smaller streams and creeks are also very important producers of salmon and other fish species and they include Brown Bear Creek, Hanna Creek, Tintina Creek and numerous other unnamed but highly productive tributary streams. Many of the fish stocks in all these water bodies are protected under Canada's *Wild Salmon Policy* and listed for special management by the province of BC. Furthermore, the route parallels dozens of kilometers of wetlands, which also serve an extremely valuable function to the hydrology of the larger river systems. The combination of these wetlands, streams and rivers support some of the most productive aquatic and terrestrial ecosystems in British Columbia. These ecosystems have supported the Gitanyow culture and way of life for thousands of years. All these streams and rivers are found within Gitanyow Lax'yip (Traditional Territory) and provide the Gitanyow wilp with much of their food fishery. The Gitanyow have aboriginal rights to fish in all these watersheds and the watersheds are protected under the constitution of Canada.	Comment noted.

No.	Commenter / Date Received	Report	Comment	Seabridge Response
72.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment	In addition to salmon, moose meat makes a significant contribution to Gitanyow food security and plays an important role in Gitanyow culture and ceremonial systems. As such, Gitanyow Wilp members hold an Aboriginal right to access, utilize, and manage the moose populations within the Lax'yip. Through conducting the Gitanyow Wilp-Based Socio-Cultural Needs Assessment, Marsden (2010) determined that, although 69% of Gitanyow Wilp members were satisfied with the amount of traditional food they had access to, moose meat was the one food that was considered difficult to access. One of the reasons behind this difficulty in accessing moose is the approximately 68% decline over the past 10 years in moose populations over a large portion of the Nass watershed. (Demarchi 2001, 2007, 2011). Gitanyow is extremely concerned that the moose population is at a 'tipping point', and that any additional impacts or stressors on the moose population will have significant and potentially irreversible consequences. In a study conducted over a two-year period where First Nations people in 21 B.C. communities were surveyed, Chan et al. (2011) concluded that: 1. 41% of B.C. First Nations people experience food insecurity.	Comment noted. Wildlife values have been addressed in the report.

No.	Commenter / Date Received	Report	Comment	Seabridge Response
(72.)	(continued)		2. Overall, the nutritional value of food intake is below what is required for optimal health, however, **that nutritional quality is improved when traditional food is eaten.** Moose meat cannot be simply replaced with market foods. The nutritional value of moose meat is superior to domestic meat such as cattle. Not only does moose meat contain roughly 1.1% fat in the muscle, compared to 30% fat in the muscle of beef, but moose contains eicosapentaenoic acid: a natural antifreeze that aids bloodflow of moose in frigid weather, and when consumed by humans protects against heart attack, atherosclerosis (hardening of arteries) and certain forms of arthritis (Rowland, 1989). Considering dietary concerns leading to heart disease and obesity were found to be major health issues for First Nations people in B.C. (Chan et al., 2011), the importance of having access to moose cannot be overstated.The Gitanyow have a constitutionally protected aboriginal right to harvest moose from the Lax'yip. Currently, this right is already threatened because moose populations are so low, which was demonstrated in the results of a moose survey conducted by the GHCO in 2011/2012. This survey showed only one moose harvested from the Gitanyow Territory by a Gitanyow Wilp member, despite significant efforts. Another 15 moose were harvested by Gitxsan Wilp members (who currently reside in Gitanyow) and one by an unknown hunter (Koch 2012). These numbers prove two important points: 1) Gitanyow Wilp members are having difficulty harvesting moose from the Gitanyow Territory, and: 2) there is a significant amount of moose being harvested on Gitanyow Territory by non-Gitanyow Wilp members.	
73.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment	Although the Gitanyow are taking significant action with limited resources to deal with unauthorized hunting of moose on Gitanyow Territory, this problem is complex and finding solutions will take time and additional resources. To further put the results from this study into perspective, the total harvest number of 17 is very low compared to an average harvest of 34 moose reported in previous surveys conducted during the 2000/2001 and the 2001/2002 hunting seasons (Hamelin 2002). Furthermore, decreasing harvest levels reported this fall and winter support the ongoing winter population estimates that indicate moose populations have significantly declined.	Comment noted. Wildlife values have been addressed in the report.

No.	Commenter / Date Received	Report	Comment	Seabridge Response
74.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment	Because of the multiple stressors and impacts on the moose population, Gitanyow requests that any project proposed within the Lax'yip or adjacent to it undergo a rigorous and jointly-designed cumulative impacts/effects assessment process. It is concerning that within the KSM TEA there is no mention of cumulative impacts/effects. It is our position that cumulative impacts assessment will likely be the most important part of the KSM TEA.	A cumulative effects assessment will be included in the final report (see Chapter 8 of the KSM Project Highways 37 and 37A Traffic Effects Assessment).
75.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment	Cumulative effects as defined by CEAA are "changes to the environment that are caused by an **action** in combination with other past, present and future human actions (Hegmann et al. 1999)". An "action" is further defined as "any project or activity of human origin (Hegmann et al. 1999)". With respect to moose, we know the population has declined by close to 70% from 2001 to 2011 (Demarchi 2011) and Demarchi (2007) concluded that the largest single contributing factor to the decline of the Nass moose population was the overharvest of cow moose. Therefore, moose harvesting, which is a human activity, should be considered an action within a properly conducted CEA. In conducting a thorough CEA, the proponent must consider **all** current impacts to moose and other Valued Components (VCs), in combination with potential effects from the KSM project, and other reasonably foreseeable projects. We believe this is necessary to place the potential effects of the KSM project into the proper context, and thus have a complete understanding of the potential impacts and consequently how best to mitigate or avoid them. To adequately address the concerns outlined above, and to begin to frame a CEA, Gitanyow poses the following questions to the proponent: 1. How might the increase in traffic from the KSM project, in combination with other projects in the region and in consideration of other impacts, combine to further reduce moose numbers? 2. Will these reductions in moose numbers prevent the moose population from rebuilding or slow that rebuilding process? 3. What can the proponent do to offset this reduction in moose numbers?	In response to comments received during the traffic study working group meetings in Terrace (July 9, 2012), a quantitative assessment of the likely increase in moose mortality due to increased traffic was completed. The model includes a sensitivity analysis to different levels of traffic and different hunting regimes. Rescan collaborated with and/or receiving data from Nass moose surveys, Nisga'a and Gitanyow hunting rates, Gitanyow road monitoring studies, and the results of non-resident hunting tags. This analysis provides a quantitative evaluation of the effects on the moose population, and is summarized in the report and included as Appendix D. A cumulative effects assessment is also included in the final report (see Chapter 8 of the KSM Project Highways 37 and 37A Traffic Effects Assessment).

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76.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment	A further concern with the KSM TEA relates to the use of traffic data. Throughout the document there are many references made to historical traffic volumes, and how the traffic volumes will not exceed historical levels as a result of the KSM project. We are requesting further clarification from the proponent on the relevance of this comparison. From the Gitanyow perspective, we are unaware of any scientific evaluation of the effects on the environment during the historical traffic volume peaks of the '80s and '90s. The records of wildlife mortalities during this time are of very limited value because as we know, the WARS database is extremely incomplete. The proponent appears to be comparing projected levels to historical peaks because it makes the projected levels seem less significant. We do not see the value in trying to create the illusion of lesser impact. In the future, if comparisons are going to be made to historical traffic volumes, the proponent should include some solid data on the environmental impacts that occurred at the time of those historical traffic volumes.	Historical peaks of traffic volumes in the 1980s and 1990s have contributed to the baseline conditions currently along highways 37 and 37A. As the risk assessment evaluates potential changes to baseline conditions, this comparison is used to provide the reader historical context. The limitations of the WARS database are acknowledged in the study.
77.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment	Furthermore, until such time as there is additional data collection conducted on traffic volumes, we consider all the traffic volume data to be very suspect and limited. We expect the proponents to be collecting data on traffic volumes in order to conduct a rigorous traffic effects assessment. We are pleased that the BCEAO and the Ministry of Transportation and Infrastructure (MoTI) are starting to move in this direction.	Comment noted. Seabridge has used available data from the Ministry of Transportation (traffic data and WARS data) and Gitanyow data. Seabridge has agreed to consider participating in MOTI-led initiatives for Highway 37 and 37A. The limitations of the WARS database are acknowledged in the study.
78.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment	Gitanyow also notes that the TEA does not accurately predict the potential increase in traffic volume that is indirectly related to the project. Any project of this magnitude will result in a significant increase in **other** traffic along the corridor in question. There will be more workers and people in the area than just those transporting materials, supplies, product and workers to and from the minesite. People who move to the area to work at the mine will likely use Highway 37 for recreation (including hunting, fishing, snowmobiling, etc.) and accessing service centers. Further to the abovementioned concerns regarding potential impacts to moose from all types of vehicle traffic, we feel it is incumbent on the proponent to accurately reflect all potential traffic increases along the transportation corridor.	Current and reasonably foreseeable future project traffic along highways 37 and 37A is considered, in addition to estimated baseline traffic, in the cumulative risk assessment of the report. Traffic estimates are based on publicly available information. The cumulative risk assessment assumes all reasonably foreseeable mine and hydro projects will become operational and that all projects will occur at the same time Due to the uncertainty of whether or not other projects will proceed, and if they will overlap in time scale, this estimate ensures a conservative approach.

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79.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment	We appreciated the inclusion of data on current mining related traffic through the corridor (Section 2.1.3.1) as it is important for us to have an idea of the current levels of ore-truck traffic. As well, the data provided on historical forestry traffic was of value (Section 2.1.3.2). However, it is not just ore trucks that can have negative effects on wildlife/humans along the road, as other mine related traffic is extremely important as well. From our experience, it is the light-duty pickups that travel at reckless speeds along Hwy 37. This was echoed at the recent Kitsault transportation working group meeting by Corporal Mario Cloutier of the RCMP who stated that his staff have documented pickup trucks going as fast as 200 km/hour down Highway 37. Current levels of all industrial traffic should be included as part of the baseline.	All KSM related traffic estimates are included in the effects assessment.
80.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment	The Gitanyow are hopeful that the KSM and other transportation working groups are going to determine and implement the appropriate mitigation strategies that will result in an improvement from the current situation with respect to negative transportation related impacts to human health and the environment. We realize the mining sector, although very significant, will not be the only industrial user of Highway 37 and that agreements with the forest industry and other sectors must be sought as well. The Gitanyow feel strongly that the solutions to transportation problems will occur through the engagement and participation of all active industrial partners, as well as various departments within the Provincial and Federal governments. Outside assistance from various researchers and other jurisdictions will prove valuable as well.	Comment noted. Seabridge would be willing to participate in a government-led, multi-stakeholder initiative with other highway users to discuss possible mitigation strategies for negative effects of traffic along the KSM haul route.
81.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/Pg ii, Fig 1/ Exec Summ	Requesting clarification - why are some topics (such as wildlife relating to project traffic) listed under 3 different severity ratings?	Severity ratings can differ by VC and by type of risk. For example, in the wildlife risk assessment for Project traffic (matrix in Table 5.3-5), it is noted that the severity of impact to moose from direct mortality would be moderate, the impact to bears from direct mortality would be minor.
82.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/ Pg iii/Para 1	Can the proponent confidently state that over the lifetime of this mine (55 years plus 100's of years of post-closure) that "[p]otential social and environmental risks from traffic accidents are expected to be rare and unlikely occurrences."? Given the magnitude and duration of the proposed project, this statement requires substantiation.	The final report will include figures for the Collision Prediction Model indicating the range of values encompassed by a 95% confidence level (see Figures 3.2-1 through 3.2-3).

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83.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/ Pg 2-1/Sect 2.1.1, para 2	Gitanyow proposes that the proponent has mischaracterized the winter driving conditions along Highway 37 throughout this report, starting in this section. In theory, Hwy 37 is sanded and plowed in the winter as it states here. In reality, Hwy 37 receives a very low amount of daily road maintenance in comparison to other regional highways such as Hwy 16. This is critically important because the weather conditions along this corridor are exceptional (high snowfalls, frequent winter rains, freeze-thaw) and create extremely challenging road conditions on an annual basis. Because of the poor level of road maintenance, this creates very dangerous driving conditions. Gitanyow would like the proponent to produce data on the resources and time spent on road maintenance on Hwy 37 in comparison to other regional highways over the last 2 decades for comparison.	BC MOTI was contacted regarding the availability of road maintenance data along Highway 37. MOTI's response follows: "Hwy 37 and Hwy 37A are both classified as Class B highways and receive maintenance based on Ministry of Transportation Class B highway maintenance specifications. Hwy 16 in the Hazeltons/Kitwanga area is also a Class B highway as a comparison. For reference, generally a Class A highway is a highway with traffic volumes of over 5,000 vehicles a day which Hwy 37 does not receive. As noted in the Gitanyow report, the weather conditions for Hwy 37 and Hwy 37A along this corridor are exceptional (high snowfalls, frequent winter rains, freeze-thaw) and this poses challenges for the Maintenance Contractors. The ministry takes its commitment to provide a safe, effective transportation network very seriously and the performance of our maintenance contractors is an integral part of our commitment and we hold them accountable for the services they deliver. Ministry staff routinely audit and evaluate our maintenance contractors on Hwy 37 and 37A. In regards to data on the resources and time spent on road maintenance on Hwy 37 in comparison to other regional highways over the last two decades for comparison, our district office does not have that data readily available if at all available. This data would have to be compiled through the cooperation of the Maintenance Contractors and would be a time consuming effort. What we can say is that Hwy 37 and 37A have a lot of resources spent on it. For example, the maintenance contractor spends significant amounts of time and resources in snowblowing, daylighting and using equipment like snowcats to remove and store the extreme amounts of snow that falls in certain areas of Hwy 37 and Hwy 37A. The Ministry and Maintenance Contractor also put a lot of resources into avalanche control on one of the most active avalanche areas in North America. These types of resources certainly differ from areas like the Lakes or Nechako Service Areas."

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84.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/ Pg 2-13/Sect 2.1.3.4	While the results of the BC MoTI (2006) study are useful, it did only include heavy commercial vehicles. Other mine related traffic is important as well, such as light duty pickups. Hwy 37 is known as a relatively high-speed highway for several reasons. 1) There are long straight stretches. 2) Level of enforcement by RCMP is low because of the remoteness of the highway. 3) Workers have long distances to travel, and tend to not follow posted speed limits.	Comment noted.
85.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/ Pg 2-17/Fig 2.4-1	In this table and throughout the report it appears the proponent has only mentioned one-way trips. Including the number of two-way trips provides a clearer indication of the actual amount of traffic on the roads each day. Again, this appears to be a strategy to minimize the appearance of potential impacts.	Traffic counters along the highway measure one-way trips; the data has been presented in this way for the sake of consistency and not to minimize the appearance of potential effects. For example 44 one-way trips equals 22 return or two-way trips.
86.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/ Pg 3-10/Sect 3.2.1	It is important when using models to discuss the weakness of the assumptions of the model. The effectiveness of any model is directly related to the quality of the data used in the model. In the case of the Collision Prediction Model (CPM) there are two key problems with the model inputs: 1) Although Hwy 37/37A are classified as RAU2, our collective experience is that the maintenance level is lower than that of neighboring RAU2 highways such as Hwy 16. 2) The AADT volumes are acknowledged to be based on very poor and limited data. This is not to say that the model shouldn't be used, but the proponent should acknowledge the limitations.	The limitations of the model are reported in Section 3.2.2 of the Highways 37 and 37A Traffic Effects Assessment.
87.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/ Pg 5-21/Sect 5.1.1.2	Should say Gitanyow Lake, not Kitwancool Lake.	The official gazetted name of this lake, as it appears on maps of British Columbia, is Kitwancool Lake. Seabridge is using the official, legal name for all named places in the study area. Please refer to the following URL: http://apps.gov.bc.ca/pub/bcgnws/names/40670.html However, we have also noted in the report that this lake is also known as Gitanyow Lake.

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88.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/ Pg 5-25/Table 5.1-7	In several areas of the report including this table, the proponent references that speed limits will be enforced. As we know the RCMP clearly say it is very difficult to effectively enforce speed limits along Hwy 37. Seabridge stated at the July 9th, 2012 meeting that trucks would be equipped with satellite tracking systems to monitor speeds travelled. Questions regarding reliance on this method include: 1. Is the accuracy of these units tested? 2. Will all mine employees and contractors be equipped with these units, including drivers of light-duty and heavy commercial trucks? 3. How exactly is speed monitored using these units (i.e. is the company alerted automatically if an employee/contractor is speeding?)? 4. What will be the consequences for an employee or a contractor who is found to be speeding? The proponent could improve on speed limit enforcement by financially contributing to creation of new RCMP positions dedicated to patrolling Hwy 37. Other mitigation measures that will be needed to ensure protection of Community Well Being include: 1. Increased road maintenance, including potential financial contribution by the proponent. 2. The construction of more roadside pull-outs or increasing the shoulder width of the highway. Currently the shoulders are very narrow on Hwy 37 and this leads to serious safety issues when people pull over for conducting food/medicine harvesting, firewood gathering, vehicle breakdowns, etc.	Seabridge will enforce speed limits on KSM Project access roads via radar and security personnel. Seabridge has not stated that satellite tracking systems will be installed in vehicles.
89.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/ Pg 5-28/Sect 5.1.3.4	Under Risk Characterization: The report states that "higher traffic volumes generally result in a greater number of accidents", but then it follows by saying "importantly, however, increases and decreases in the rate of traffic accidents have not and are not anticipated to be concurrent with any level increase or decrease in traffic". This appears to be a conflicting statement. Please clarify.	Comment noted. The paragraph has been re-worded in the report to state that" "Increases and decreases in the rate of traffic accidents have not and are not anticipated to be concurrent with any level increase or decrease in traffic."

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90.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/ Pg 5-28/Sect 5.2.1	The proponent lists "Northern Rivers" as one of three major watersheds affected by project traffic. We have never heard of a watershed known as the "Northern Rivers" watershed. Please clarify. The proponent states that "the largest Skeena River sockeye runs are in watercourses along highways 37 and 37A". This is incorrect, as the largest Skeena River sockeye runs are in the Babine River watershed. The proponent states that "Skeena coho do not have any particularly large, significant stocks in the Study Area", however Kitwanga coho should be considered a significant coho stock within the Skeena watershed. Bull trout are located not only in the Kitwanga, but also in the Cranberry River and in Hanna and Tintina Creeks. Dolly Varden, also blue-listed, are found all along the transportation corridor. Also, Meziadin Lake should be mentioned in the baseline data section considering a spill into either Hanna or Tintina Creeks would immediately pollute Meziadin Lake, which at a minimum contains Chinook, coho, pink, sockeye and kokanee salmon, as well as blue listed Dolly Varden, mountain and round whitefish, rainbow trout, steelhead and bull trout (blue-listed).	"Northern Rivers" is a typo. It meant to say "North Coast Rivers (coastal rivers near Stewart e.g. Bear River)". This has been corrected in the report. Seabridge acknowledges that the salmon runs in the Babine watershed are the largest on the Skeena River. The next draft will be corrected to say "The largest Skeena River sockeye runs are not along the proposed Project traffic routes." The importance of Kitwanga coho, bull trout, and Meziadin Lake have been highlighted in the report.
91.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/ Pg 5-33/Sect 5.2.3.1	Risk Mitigation: The proponent's listed risk mitigation equates simply to status quo measures which we believe are not adequate. Gitanyow will need to see additional mitigation measures including: 1. Guard rails along certain watercourses including, at a minimum, Bell Irving River, Nass River, Hanna and Tintina Creeks, Cranberry River, Brown Bear Creek and the Kitwanga River. An assessment should be conducted on the transportation route to determine specific locations of risk to aquatic habitat, similar to that conducted by Gitanyow and Avanti for the Kitsault project (Cleveland and Koch, 2012). 2. Actions taken towards increasing the regional capacity for spill response. Compared to areas that are closer to major centres, there is an insufficient capacity for spill response in the northwest region (Pers. Comm., Norm Fallows, 2012). There is nothing listed under risk mitigation that relates to prevention of spills. Prevention should be the primary objective.	The prevention of spills is listed as the primary objective of the Spill Prevention and Emergency Response Plan. Guard rails along a provincial highway are not included as proponent-led initiatives. Seabridge has committed to strategically locate spill response stations along Highway 37.

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92.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/ Pg 5-34/Sect 5.2.3.2	Risk Mitigation: Again, nothing about prevention is listed.	This section has been revised to include prevention as the first form of mitigation for spills.
93.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/ Pg 5-35/Table 5.2-6	The proponent should explain how a spill of diesel or ore concentrate into watercourses such as Hanna or Tintina Creeks, or the Cranberry or Kitwanga Rivers would only constitute a **moderate severity** impact. During the spawning season for sockeye, Hanna and Tintina Creeks will hold the majority of sockeye that spawn in the Nass Watershed. These watersheds drain into Meziadin Lake where two year classes of sockeye fry rear into smolts, therefore sockeye are present year round in Meziadin Lake. From fall to spring each year, these creeks have hundreds of millions of sockeye eggs incubating. Hundreds of Gitanyow people rely heavily on sockeye from the Meziadin system for their food security and for economic gain. The severity of impact of a potential spill into this system would be more accurately portrayed as extreme, not moderate.	It is understood that severity will vary depending on the size, location, timing of the spill, and effectiveness mitigation, and all streams in the assessment are considered important. The general determination of moderate severity on a spill of concentrate is supported by the fact that a concentrate spill would be highly localized, concentrate would be nearly insoluble in water because of low moisture content, and could therefore be cleaned up with relative ease. The determination of moderate severity on a diesel spill is supported by the fact that a fuel spill would be highly localized, and spill kits would be provided on all trucks transporting fuel. BMPs relating to petroleum spills will be described in detail in the Spill Prevention and Emergency Response Plan. Adherence to the plan will minimize response time and maximize clean-up efficiency, preventing long-term or geographically extensive effects.
94.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/ Pg 5-37/Sect 5.2.3.3	Risk Mitigation: Why is this the first time prevention has been mentioned under mitigation for traffic accidents?	Comment noted. This will be addressed in the next draft of the report.
95.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/ Pg 5-39/Sect 5.3.1.1	The proponent states that “there are no approved UWR for moose along the highways 37 and 37A”. Gitanyow directs the proponent to the Gitanyow Lax’yip Land Use Plan, previously mentioned, to identify the UWR which was approved by the Gitanyow and the province of BC in March of 2012. Moreover, that Gitanyow has already legalized this land use zone within our Ayookxw (Gitanyow Law). As such, in order to avoid infringement of an Aboriginal right, it is imperative that the proponent acknowledge the UWR identified in the Gitanyow Lax’yip Land Use Plan.	The Cranberry area has been identified and recognized as high quality ungulate habitat.

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96.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/ Pg 5-39/Sect 5.3.1.2	The Kitwanga and Cranberry watersheds, along which the transportation route runs parallel for a significant distance, are both very high value areas for grizzly bears. During spring, both these valleys contain abundant early forage and during fall provide salmon for grizzlies. In and around the village of Gitanyow, grizzly bears are commonly observed from spring through to fall.	Comment noted.
97.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/ Pg 5-41/Table 5.3-2	Under Moose and Bears, why does it only specify Wilp Wii Litsxw?	This has been modified in the report.
98.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/ Pg 5-45/Sect 5.3.3	The proponent states that the assessment to wildlife populations is generally qualitative because "the geographic population boundaries for the local populations considered in this assessment are both unknown and dynamic". Modelling of potential impacts to the moose population are required that takes into account the best available data for model inputs, in order to provide a quantitative assessment of impacts to moose populations.	In response to comments received during the traffic study working group meetings in Terrace (July 9, 2012), a quantitative assessment of the likely increase in moose mortality due to increased traffic was conducted. The model analyzes the sensitivity of the current moose population to this increased mortality. Seabridge's consultant is collaborating with and/or receiving data from Nass moose surveys, Nisga'a and Gitanyow hunting rates, Gitanyow road monitoring studies, and the results of non-resident hunting tags. This analysis provides a quantitative evaluation of the effects on the moose population, and is included in Appendix D.
99.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/ Pg 5-46/5.3.3.1	Risk Mitigation: Reference to future mitigation strategies, without specific detail of what those strategies entail does not allow for meaningful review by Gitanyow.	This statement is revised for clarity in the report. Details of mitigation, including BMPs, plans and strategies are included in the EA.
100.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/ Pg 5-47/Table 5.3-5	For Moose under Description of Consequence of Realized Risk the proponent concludes that "even though traffic volumes will be increasing considerably, the number of animal collisions will not increase by an equal percentage." How did the proponent arrive at this conclusion and where are the references for this?	A quantitative assessment of the likely increase in moose mortality due to increased traffic was conducted. The model analyzes the sensitivity of the current moose population to this increased mortality, and provides a quantitative evaluation of the effects on the moose population. The model assumes a linear response of mortality to traffic at the current (low) traffic levels. At higher levels (such as those expected if all projects go) we would expect a curviliear response with less mortality per unit of traffic than the current scenario. References are provided in Appendix D.

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101.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/ Pg 5-51/5.3.3.2	Risk Characterization: The proponent has not fully characterized the potential for direct mortality of moose due to vehicle collisions. They estimate there could be an average of 20 moose per year (range of 17 to 23) based on the estimate that the WARS data actually accounts for 25-35% of moose collisions. Data from one year of roadkill and roadside wildlife monitoring showed that cow moose comprised at least 50% of the roadkill (it was likely higher but sex was not reported for all roadkill). Cow moose comprised 70% of all live moose observed beside the highway during the 2011/12 winter (Koch 2012). Cow moose are known to winter lower than bulls especially when they are with calves, because snow levels are less at lower elevations (Pers. Comm., Len Vanderstar, 2012). When cow moose are killed it has a disproportionately negative effect on the overall moose population. A further negative factor that is not considered is that if a cow that has a calf is killed during winter, the likelihood of the calf surviving the winter is very slim. Often calves will remain near the dead cow which increases its chances of getting hit or preyed upon by wolves which are attracted to the kill site (Pers. Comm., Gary Olson, 2012). The mortality levels of orphaned calves should be accounted for in any roadkill estimate. Another factor that should be considered is the increased levels of roadkill during extreme snowfall winters. In 2007/08 and again in 2011/12 there were extremely high snow levels. Climate change predictions are that we should expect more of these types of winters, in addition to more freezing rain events during winter. During winters of extreme snowfall there will need to be additional mitigation measures in place.	A quantitative assessment of the likely increase in moose mortality due to increased traffic was conducted. The model analyzes the sensitivity of the current moose population to this increased mortality, and provides a quantitative evaluation of the effects on the moose population. The traffic mortality submodel accounted for the current sex ratio and carried that forward to the future scenarios (Appendix D).

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102.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/ Recommended Mitigation & Prevention Strategies:	From the Gitanyow perspective, a threat to the moose population is a threat to Gitanyow food security, and a potential infringement of our constitutionally protected Aboriginal rights. Gitanyow refers the proponent to the following relevant sections of the Gitanyow Huwilp Recognition and Reconciliation Agreement (including the Gitanyow Lax'yip Land Use Plan) as guidance for protecting both the food security and Aboriginal rights of the Gitanyow: Plan Goals for Moose (Objective 2.0; Measure/Management Considerations) "Moose winter range management plans should be prepared by all non-forestry industries that plan developments within the plan area, prior to any development clearing or construction activities, as a condition to receiving a license or permit from the Province of BC to proceed with the project." (pg 47). Gitanyow proposes that a moose winter range management plan should be developed jointly with the proponent and Gitanyow to address the issues related to potential impacts on the moose population. Management Direction for the Area to be Protected [Hanna Tintina Conservancy] (Objective 1.0) "Maintain conservation, recreation, and cultural heritage values and features within the area to be protected identified as the Hanna-Tintina Area to be Protected in Schedule A Map 1." And "A comprehensive management plan shall define management objectives for the area as well as acceptable uses and levels of use, zoning and other strategies to minimize conflicts and help ensure the integrity of important protected-area values." As a portion of Highway 37 and adjacent area will soon become a conservancy, with a joint Management Plan developed and implemented by Gitanyow and the Province, Gitanyow proposes that the proponent pro-actively work with Gitanyow to address the aforementioned concerns regarding traffic and potential spills in the Hanna Tintina area to be protected (see attached map).	Comment noted. A quantitative assessment of the likely increase in moose mortality due to KSM traffic was conducted. Results of the moose population dynamics model and imbedded moose vehicle collision model indicated that the addition of traffic from the KSM project is projected to cause an additional <1% mortality to the moose population at the current population size, a mortality rate that does not predict a substantial decline from the base case scenario. Indirect effects of moose mortality on hunting and trapping are assessed in the Socio-economic and Land Use Section of the report (Section 5.1). While possible, hunting and trapping activities are not predicted to be at risk from a change in traffic volumes as a result of the Project. As such, the severity of the risk for hunting and trapping as a result of change in traffic is expected to be minor.

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(102.)	(continued)		To protect Gitanyow food security and Aboriginal rights, the following mitigations will be required: • Significantly increased levels of vegetation management along Highway 37. Although this is the responsibility of MoTI, all industrial users of the highway should be contributing to this. The current level of vegetation management allows vegetation to encroach to the point where shrubs are overhanging the road shoulders, therefore visibility is almost nil in many locations, and consequently cover and food for moose is excellent along much of the highway ROW (Photos 6 and 7). Longer term solutions are needed for vegetation management and these should include: • Brushing to widths that are shown by the best available research to be effective at reducing collisions. This includes a potential widening of the ROW. • Chipping of woody debris along the ROW to suppress vegetation growth. • Planting of plant species that are not palatable to moose. • Time brush cutting to reduce the palatability of the re-growing brush for moose. • Work with Gitanyow and DFO to develop vegetation management solutions along the many riparian areas alongside the highway. Although the abovementioned strategies will be costly in the short term, they will have long- term benefits that will benefit moose and other wildlife, as well as all users of the highway.	

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103.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/ Recommended Mitigation & Prevention Strategies:	Significantly improved road maintenance. Currently Hwy 37 receives much less plowing and sanding than other busier highways in this region. The southern part of Highway 37 passes through the Interior Cedar Hemlock and Coastal Western Hemlock Biogeoclimatic (BEC) Zones, and these BEC zones are known for extremely high moisture levels year round, with snow being the dominant precipitation type in winter. However, as our climate changes we are seeing numerous freezing rain events during winter and climate modelers expect we will see more of the same for decades to come for this region. These freezing rain events frequently occur over snow-packed roads leading to extremely dangerous driving conditions. Extreme rain or rain-on-snow events can cause flooding and washout roads, leading to vehicle accidents – evident in the case of the Maple Leaf Trucking accident which resulted in 49 tonnes of zinc ore entering Strohn Lake (Nov 2011 – on western boundary of Gitanyow Territory).	Road maintenance on provincial highways is the responsibility of BC MOTI. Please refer to response on comment number 83 regarding road maintenance information provided by MOTI..
104.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/ Recommended Mitigation & Prevention Strategies	Prior to the project being constructed, conduct research into wildlife hotspots along thehighway. This should be conducted year round for at least one year prior to the project commencing, and could consist of a weekly drive of the transport route from the Hwy 37/16 junction to where the transport route leaves Hwy 37, as well as Hwy 37A. This type of survey would also be useful for collecting roadkill data. As the project construction commences, continue with this research to refine the knowledge on hotspots using a proven methodology such as that developed by Hesse et al. 2010.	Comment noted. Mitigation and monitoring of effects on wildlife will be detailed in the Wildlife Management and Monitoring Plan, and the Traffic and Access Management Plan, and will require that Project personnel (including drivers) will communicate locations of observed wildlife to drivers; and locations of collisions between wildlife and vehicles will be documented. These plans will be included in the EA.
105.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/ Recommended Mitigation & Prevention Strategies	Following the research into wildlife hotspots, place effective signage along key parts of the highway to alert drivers.	Highway signage is the responsibility of BC MOTI. Seabridge will place signage, as required on KSM access roads.

No.	Commenter / Date Received	Report	Comment	Seabridge Response
106.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/ Recommended Mitigation & Prevention Strategies	During winters of extreme snowfall, create diversionary trails parallel to the highway, and additional trails that lead away from the highway into areas where there is moose forage. In Alaska they have had success with supplementary feeding by placing bales of silage at the ends of these diversionary trails which keep the moose back away from the highway (Grauvogel 1990). In a Swedish study they concluded that "supplementary feeding can be used under certain conditions to redistribute moose in relation to browsing, or to traffic (Sahlsten et al. 2010). When moose are consistently near highways because of 1) abundant forage and 2) the highway allows for easy walking, they are in a dangerous situation of both high predation risk and high risk for vehicle collisions.	Mitigation regarding effects on wildlife due to disruption of movement or attractants will be included in the Wildlife Management and Monitoring Plan, which will be included in the EA. Refuge areas will be ploughed along the road during winter; gaps in snow banks on roads will be created at best spacing to allow an escape for wildlife.

No.	Commenter / Date Received	Report	Comment	Seabridge Response
107.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/ Recommended Mitigation & Prevention Strategies	Work with Gitanyow, the Province, and other proponents that use Highway 37 to establish a Food Security Trust Fund that supports the following: 1. A budget for wildlife monitors to patrol the highway and other forestry roads, record roadkills and monitor hunting. The Gitanyow are leading the way in B.C. with our work in 2011/2012 in terms of conducting moose harvest surveys and developing a harvest permitting system (Koch 2012). Currently there is funding from B.C. for the 2012/13 season, however, for the program to continue additional funding will be needed. Small financial contributions from industrial partners would go a long way towards wildlife conservation and rebuilding of the moose populations. 2. In Alaska they have had great success with a moose salvage program. Volunteer groups are equipped with 4WD pickup trucks with flatbeds and winches. When there is a report of a moose kill on the highway, these groups are able to load the moose within 30 minutes of arriving on the scene. This greatly reduces the time spent by police or conservation officers, and is also a much safer option for those who salvage moose. A moose/wildlife salvage program goes hand in hand with overall wildlife/roadkill monitoring. Industrial partners could contribute by means of providing funding for capital costs (ie. work truck and winch). 3. Funds for a food processing facility including a cooler, freezer and butchering area. This would enable retrieval of road kill during the warm season where people cannot cool meat properly without taking it to butcher shops in Terrace or Smithers, which is not affordable for most Gitanyow people. Although projects such as the KSM will likely result in increased roadkilled moose, effects to overall food security could be partially mitigated by increasing the capacity of Gitanyow to retrieve and process moose that would otherwise be wasted on the highway	Comment noted. Seabridge acknowledges the concerns associated with moose harvest. Seabridge proposes to use a currently existing public Highway (highways 37 and 37A). Discussions on food security trusts are best directed at the provincial government as managers of the public highway.

No.	Commenter / Date Received	Report	Comment	Seabridge Response
108.	GHCO/ September 14, 2012	KSM Highway Traffic Effects Assessment/ Recommended Mitigation & Prevention Strategies	Development of a Cumulative Impacts/Effects Assessment for the KSM TEA. Involving Gitanyow, other proponents, and MoTI and other relevant ministries. In order to fully assess, prevent, and mitigate potential impacts from the traffic associated with the KSM project, a full-scale CEA is required. Gitanyow further requests direct involvement in the methodology design, baseline data collection, assessment, and drafting of final results.	A cumulative effects risk assessment is now included in the report (see Chapter 8 in the Highways 37 and 37A Traffic Effects Assessment).

References

ICBC. 2011a. *Corridor Crashes for Hwy 37 from Bob Quinn Camp to Hwy 16*. Insurance Corporation of British Columbia: North Vancouver, British Columbia.

ICBC. 2011b. *Corridor Crashes for Hwy 37A from Stewart to Meziadin Lake Junction, Meziadin*. Insurance Corporation of British Columbia: North Vancouver, British Columbia.