

18.7.3.1.2 Light

The mine facilities are likely to be lit continuously during night-time. This increases the potential for effects on wildlife. These effects will be mitigated by using directed/focused lighting rather than broad area lighting and by shielding lights to minimize stray light. Lighting in non-essential areas will be used only when necessary, without compromising safety of employees.

18.7.3.2 Potential for Residual Effects

Of the eight wildlife VCs evaluated for potential effects due to sensory disturbance, mountain goats will have residual effects, as described in the following sections (Table 18.7-9).

Many sources of sensory disturbance have overlapping disturbance effects. For example, an increase in traffic volume along roads is a source of noise and visual disturbance. These effects are often studied separately in scientific literature, but will occur together at the Project site. For this assessment, it is assumed that noise levels travel farther than visual disturbances; therefore, the assessment of sensory disturbance is based on the effects of increased noise from Project development.

The evaluation of how much habitat is functionally lost by wildlife VCs was conducted in a two-step process. First, a buffer of 300 m was applied around all Project infrastructure for the calculations of habitat loss and alteration (Section 18.7.1). This buffer represents habitat affected by a combination of dust, edge effects, and other stimuli (Section 18.7.1). For the sensory disturbance assessment, the area outside of the 300-m buffer that would be affected by noise was evaluated—the functionally lost habitat. Hence, in some instances, the effects due to noise (beyond the existing 300 m habitat lost buffer) may be small and rated as such, as the effect of functional habitat loss was already considered in the direct habitat loss and alteration assessment.

The potential for effects on wildlife from Project-related noise was considered and assessed based on outcomes of noise models conducted for the Project ([Appendix 19-A](#)). Noise modelling was conducted, which produced a map of sound emanating from sources. For a point source noise, this output would resemble a topographic map with decreasing sound contours with increasing distance. The area of affected wildlife habitat was calculated by choosing specific noise level contours from the modelling. Three noise levels were chosen for the construction and operation phases: 1) Project noise (45 dBA); 2) helicopter overflights during construction (75 dBA); and 3) blasting noise (108 dB Lpeak). In general, continuous noise is measured in dBA, while instantaneous noises (like blasting) are measured in Lpeak, which is a measure of sound pressure.

General Project-related noise levels are presented as “A-weighted” decibels (dBA), which incorporates the noise frequencies that are audible to the human ear. The 45 dBA distance category was selected based on chronic noise threshold values identified for birds (47 dBA; Reijnen and Foppen 1994, 1995; Reijnen, Foppen, and Meeuwssen 1996). In addition, the Environment Code of Practice for Metal Mines (Environment Canada 2010) recommends that ambient noise from mining operations and its effect on wildlife should meet the objectives for residential areas; the sound pressure level from mining activities should not exceed 55 dBA during the day and 45 dBA at night. Therefore, this assessment has taken a conservative approach and modelled the area where the sound pressure level occurs at 45 dBA and higher in wildlife habitat.

Table 18.7-9. Potential Residual Effects on Wildlife and Wildlife Habitat Valued Components due to Sensory Disturbance

Valued Component	Timing Start	Project Area(s)	Project Component(s)	Description of Effect due to Project Component(s)	Type of Project Mitigation	Project Mitigation Description	Potential Residual Effect	Description of Residuals
Moose	Construction	PTMA and Mine Site	TMF, plant site, camps, access roads, helicopters	Sensory disturbance, and therefore “functional habitat loss”, where noise and light sources would interrupt movements, habitat selection, and behaviour. Moose wintering near the Treaty, Teigen, and Unuk valleys could be affected by aircraft, industrial, and/or traffic noise. The impacts of any type of disturbance and functional habitat loss to moose can vary depending on the particular winter conditions.	Management Practices	Noise: Noise specifications will be considered when selecting equipment to purchase; Vehicles will be maintained regularly; speed limits will be imposed; mufflers will be installed on vehicles and maintained; noise dampening measures will be applied where possible; helicopter flight paths will be followed to minimize disturbance; noise will be monitored periodically at various human and wildlife receptor locations. Lights: Use of directed/focused lighting rather than broad area lighting and by shielding lights to minimize stray light. Lighting in non-essential areas will be regulated to permit use only when necessary.	No	Moose habitat within the elevated noise level areas associated with the plant site, camp, TMF, and roads may be affected. Moose may avoid these areas (functional habitat loss) due to visual and noise disturbance, which could affect individuals. However, the extent of suitable habitat that is considered functionally lost due to sensory disturbance (excluding the area already considered lost in Section 18.7-2) is less than 1% of the available winter moose habitat in the RSA. Therefore, after mitigation, no residual effect of sensory disturbance on moose is anticipated.
Mountain Goat	Construction	PTMA and Mine Site	TMF, plant site, pits, RSFs, haul site roads, camps, helicopters	Sensory disturbance, and therefore “functional habitat loss”, where noise and light sources would interrupt movements, habitat selection, and behaviour. Mountain goats are known to be sensitive to disturbance from human activity, particularly aircraft and instaneous noise (e.g., blasts).	Management Practices	Noise: Noise specifications will be considered when selecting equipment to purchase; Vehicles will be maintained regularly; speed limits will be imposed; mufflers will be installed on vehicles and maintained; noise dampening measures will be applied where possible; helicopter flight paths will be followed to minimize disturbance; noise will be monitored periodically at various human and wildlife receptor locations. Lights: Use of directed/focused lighting rather than broad area lighting and by shielding lights to minimize stray light. Lighting in non-essential areas will be regulated to permit use only when necessary.	Yes	The effect of sensory disturbance is predicted to result in a residual effect on mountain goats, mainly due to blasting noise in pits. During the winter, mean mountain goat home range size is approximately 140 ha for females and 271 ha for males (Taylor, Wall, and Kulis 2006), but can be as small as 20 ha (Fox, Smith, and Schoen 1989); the maximum functional loss of habitat (120 dB) associated with blasting in pits during Operation (604.5 ha) could be equivalent to a maximum of 30 home ranges, or a minimum of two home ranges (average of four home ranges). The area where goats may be disturbed and respond behaviourally to blasting noise (108 dB) during Operation (5,171 ha) could be equivalent to a maximum of 259 home ranges, or a minimum of 19 home ranges (average of 36 home ranges). When considering the number of goats observed during baseline surveys, approximately 13% of the winter population within the RSA and 19% of the subpopulation on the massif may be exposed to noise levels causing disturbance and/or functional habitat loss (both 108 and 120 dB exposure) during Operation. Despite mitigation, the effect of sensory disturbance on mountain goats is predicted to result in a residual effect.
Grizzly Bear	Construction	PTMA and Mine Site	TMF, plant site, camps, access roads, pits, helicopters	Sensory disturbance, and therefore “functional habitat loss”, where noise and light sources would affect habitat selection and behaviour.	Management Practices	Noise: Noise specifications will be considered when selecting equipment to purchase; Vehicles will be maintained regularly; speed limits will be imposed; mufflers will be installed on vehicles and maintained; noise dampening measures will be applied where possible; helicopter flight paths will be followed to minimize disturbance; noise will be monitored periodically at various human and wildlife receptor locations. Lights: Use of directed/focused lighting rather than broad area lighting and by shielding lights to minimize stray light. Lighting in non-essential areas will be regulated to permit use only when necessary.	No	The effect of sensory disturbance is not anticipated to have a residual affect on grizzly bears. The overall functional habitat loss (excluding the area already considered lost in Section 18.7-2) of approximately 921 ha during construction is roughly equivalent to 18% of the home range of a female coastal grizzly bear, or as little as 5% of the home range of a male grizzly bear in the interior of BC. Therefore, with mitigation, no residual effect on grizzly bears due to sensory disturbance are anticipated.
Black Bear	Construction	PTMA and Mine Site	TMF, plant site, camps, access roads, pits, helicopters	Sensory disturbance, and therefore “functional habitat loss”, where noise and light sources would affect habitat selection and behaviour.	Management Practices	Noise: Noise specifications will be considered when selecting equipment to purchase; Vehicles will be maintained regularly; speed limits will be imposed; mufflers will be installed on vehicles and maintained; noise dampening measures will be applied where possible; noise will be monitored periodically at various human and wildlife receptor locations. Lights: Use of directed/focused lighting rather than broad area lighting and by shielding lights to minimize stray light. Lighting in non-essential areas will be regulated to permit use only when necessary.	No	The effect of sensory disturbance is not anticipated to have a residual affect on black bears. A small amount of habitat (<1%) is expected to be functionally lost due to sensory disturbance (excluding the area already considered lost in Section 18.7-2); this area would be a limited area of a black bear’s large home range. Therefore, with mitigation, no residual effect on black bears due to sensory disturbance are anticipated.
Bats	Construction	PTMA and Mine Site	TMF, plant site, camps, access roads, pits	Noise disturbance may affect foraging in the Project area. Bats may also be attracted to the high abundance of insect prey associated with artificial lighting, or Myotis species may avoid bright lights as a predator avoidance strategy.	Management Practices	Noise: Noise specifications will be considered when selecting equipment to purchase; Vehicles will be maintained regularly; speed limits will be imposed; mufflers will be installed on vehicles and maintained; noise dampening measures will be applied where possible; noise will be monitored periodically at various human and wildlife receptor locations. Lights: Use of directed/focused lighting rather than broad area lighting and by shielding lights to minimize stray light. Lighting in non-essential areas will be regulated to permit use only when necessary.	No	Project lighting may affect bats indirectly; however, following mitigation such as minimizing illumination and light design, will reduce this affect. Therefore, with mitigation, no residual effect of sensory disturbance on bats is anticipated.
Raptors	Construction	PTMA and Mine Site	TMF, plant site, camps, access roads, pits	Elevated noise levels could render foraging habitat non-functional for these species if small mammal detection becomes impaired. Behavioural responses include nest abandonment, decreased egg incubation, home range shifts, and decreased energy intakes due to changes to foraging behaviour.	Management Practices	Noise: Noise specifications will be considered when selecting equipment to purchase; Vehicles will be maintained regularly; speed limits will be imposed; mufflers will be installed on vehicles and maintained; noise dampening measures will be applied where possible; noise will be monitored periodically at various human and wildlife receptor locations. Lights: Use of directed/focused lighting rather than broad area lighting and by shielding lights to minimize stray light. Lighting in non-essential areas will be regulated to permit use only when necessary.	No	A small percentage (0.3%) of the suitable habitat for raptors will be functionally lost due to sensory disturbance (excluding the area already considered lost in Section 18.7-2). Therefore, with mitigation, no residual effects for raptor sensory disturbance are anticipated.

(continued)

Table 18.7-9. Potential Residual Effects on Wildlife and Wildlife Habitat Valued Components due to Sensory Disturbance (completed)

Valued Component	Timing Start	Project Area(s)	Project Component(s)	Description of Effect due to Project Component(s)	Type of Project Mitigation	Project Mitigation Description	Potential Residual Effect	Description of Residuals
Wetland Birds	Construction	PTMA and Mine Site	TMF, plant site, camps, access roads, pits	Potential sources of wetland bird sensory disturbance associated with the Project include: elevated noise levels, increased traffic and aircraft volumes, additional light sources, and increased human presence. The potential consequences of disturbance include: functional loss of habitat due to avoidance, increased energetic costs due to decreased foraging time and increased flying time, nest abandonment and increased predation rates, and reduced reproductive success	Management Practices	Noise: Noise specifications will be considered when selecting equipment to purchase; Vehicles will be maintained regularly; speed limits will be imposed; mufflers will be installed on vehicles and maintained; noise dampening measures will be applied where possible; noise will be monitored periodically at various human and wildlife receptor locations. Lights: Use of directed/focused lighting rather than broad area lighting and by shielding lights to minimize stray light. Lighting in non-essential areas will be regulated to permit use only when necessary.	No	Wetlands within the elevated noise level areas associated with the plant site, camp, TMF, pits, and roads may be affected. Wetland birds may be flushed or avoid wetlands/waterbodies and terrestrial foraging areas due to visual and noise disturbance, which could affect breeding and nesting birds. However, the extent of wetlands, cavity nesting habitat, and riverine habitat that are considered functionally lost due to sensory disturbance (excluding the area already considered lost in Section 18.7-2) is less than 1% of the available wetland bird habitat in the RSA. Therefore, no residual effect of sensory disturbance on wetland birds is anticipated.
Forest and Alpine Birds	Construction	PTMA and Mine Site	TMF, plant site, camps, access roads, pits	Elevated noise levels have the potential to mask auditory communication of birds which include breeding calls, alarm calls, territorial calls, contact calls with flocks, and the localization of mates and young. Habitat areas have the potential to be functionally lost if elevated noise levels prevent effective auditory communication.	Management Practices	Noise: Noise specifications will be considered when selecting equipment to purchase; Vehicles will be maintained regularly; speed limits will be imposed; mufflers will be installed on vehicles and maintained; noise dampening measures will be applied where possible; noise will be monitored periodically at various human and wildlife receptor locations. Lights: Use of directed/focused lighting rather than broad area lighting and by shielding lights to minimize stray light. Lighting in non-essential areas will be regulated to permit use only when necessary.	No	Functional habitat loss due to sensory disturbance will remain within the 300 m buffer used to calculate habitat loss in Section 18.7-2. Therefore, with mitigation, no residual effects for forest and alpine bird sensory disturbance are anticipated.

Helicopter noise was only modelled for mountain goats during the construction phase due to their sensitivity to helicopter disturbance, since this was the Project phase with helicopter traffic. The helicopter noise level threshold of 75 dBA was selected based on threshold values identified for wildlife resulting in flight responses (Knight and Gutzwiller 1995; Efroymson and Suter 2001). This threshold level was also selected based on mountain goat sensitivity to helicopter overflights (Côté 1996; BC MOE 2010a), rock-breaking noises (Bears, Mak, and Spicker 2012), and ungulate response to noise (Luz and Smith 1976; Mancini et al. 1988).

Two values were chosen for the blasting noise assessment: 1) a value where wildlife are expected to avoid habitat (“functional habitat loss”; 120 dB L_{peak}), and 2) a value where wildlife are expected to be disturbed and respond behaviourally (“disturbed habitat”; 108 dB L_{peak}). The blasting noise level threshold of 108 dB (L_{peak}) represents “disturbed habitat” and was selected based on a range of threshold values (85 to 108 dB) identified for mammals resulting in flight response, freezing, or strong startle response (Mancini et al. 1988; Weisenberger et al. 1996; Reimers and Colman 2006). The threshold of 120 dB was selected to represent “functional habitat loss,” and was selected based on a range of threshold values (120 dB to 128 dB) identified as physiologically harmful to humans (Ontario Ministry of Environment 1977; Environment Canada 2010). Noise modelling considered areas where blasting noise attenuates to 108 dB and 120 dB (L_{peak}) or higher for instantaneous noise effects on moose, mountain goat, grizzly bear, and black bear during construction and operation. The peak levels (L_{peak}) are presented for the instantaneous blasting noise, which is the maximum exposure due to blasting in the pits.

Blasting noise models were conducted for the Mitchell Pit. Based on the model results, the area where goats will be exposed to 108 dB and 120 dB will extend to a maximum of approximately 5.4 km and 2.8 km, respectively, during construction, and 7.2 km and 2.5 km, respectively, during operation. These distances were then used to approximate the noise from blasting at Sulphurets and Kerr pits. These distances do not take topography around Sulphurets and Kerr pits into account and are therefore worst case scenarios. Because blasting will not occur simultaneously at all three pits, the following blasting schedule was used for noise modelling:

1. Year -2 to Year 6 (construction): both Mitchell and Sulphurets pits.
2. Year 6 to Year 23 (operation): Mitchell Pit.
3. Year 23 to Year 27 (operation): Sulphurets Pit.
4. Year 27 to Year 50 (operation): Kerr Pit.

The results of blasting noise models for moose, mountain goats, grizzly bears, and black bears are summarized in Table 18.7-10.

Table 18.7-10. Sensory Disturbance due to Blasting Noise in Mitchell, Sulphurets, and Kerr Pits for Moose, Mountain Goats, Grizzly Bears, and Black Bears during Construction and Operation

	Construction		Operation							
	Mitchell-Sulphurets (Year -2 to Year 6)		Mitchell (Year 6 to Year 23)		Sulphurets (Year 23 to Year 27)		Kerr (Year 27 to Year 50)		Total (Mitchell-Sulphurets-Kerr)	
	108 dB (ha)	120 dB (ha)	108 dB (ha)	120 dB (ha)	108 dB (ha)	120 dB (ha)	108 dB (ha)	120 dB (ha)	108 dB (ha)	120 dB (ha)
Moose	169	32	20	0	215	7	210	4	249	11
Goat	1,935	389	803	0	3,529	226	3,865	406	5,171	605
Grizzly Bear	1,226	327	0	161	1,915	149	1,888	163	2,139	297
Black Bear	244	102	7	0	610	13	562	29	610	42

18.7.3.3 Ungulates (Moose and Mountain Goats): Potential Residual Effects due to Sensory Disturbance

The various sources of sensory disturbance (noise and visual) will likely act together to result in functional habitat loss due to avoidance of high-quality habitats because of disturbance. Mammal density has been shown to decrease up to 5 km away from industrial projects and avoidance distances are greater in open versus forested habitats (Benitez-Lopez, Alkemade, and Verweij 2010). Industrial activity can cause disturbance to wildlife that varies from short term (e.g., increased vigilance and short flight response) to long term. Long-term chronic disturbance of ungulates can have several effects, including displacement of individuals or groups, earlier-than-usual migration, or changes in rates of movement (Van Dyke and Klein 1996). Mountain goats appear to react to human disturbance to a higher degree than most ungulates (BC MOE 2010a).

18.7.3.3.1 Moose

Potential sources of sensory disturbance for moose associated with the Project include: a) elevated noise levels, b) increased traffic, and c) human presence. Traffic noise and human presence could affect moose near the Treaty, Teigen, and Unuk valleys. Moose do not respond to aircraft if flights remain above 200 m above ground level (R. Andersen, Linnell, and Langvatn 1996). Moose have been shown to have large flight distances in the presence of humans. For example, direct overflights by jet aircraft did not flush moose, whereas skiers and walkers caused moose to flush at distances of 200 to 400 m; however, ungulates have shown the capability to adapt to human presence when that presence is confined to predictable areas (R. Andersen, Linnell, and Langvatn 1996).

Noise modelling was completed to determine the area of moose habitat that may be functionally lost due to sensory disturbance during construction and operation. The total area of High and Moderately High suitability (high quality) winter habitat (early and late winter combined) that falls outside of the 300-m buffer area of direct habitat lost and alteration due to the footprint (Section 18.7.1.3), but within the noise level contours of 45 dBA (for Project noise), 108 dB

Lpeak (disturbed habitat from instantaneous blasting noise potentially resulting in behavioural response), and 120 dB Lpeak (functionally lost habitat from instantaneous blasting noise, resulting in abandonment of habitat) or greater was calculated.

Project Noise: The total amount of high-quality habitat affected by elevated Project noise levels (outside of the 300-m buffer already considered to be lost in Section 18.7.1.3) during construction is 138.8 ha (Figure 18.7-13a), and 65.1 ha during operation (Figure 18.7-13b). The majority of sensory disturbance during construction will be associated with the TMF, Processing Plant, and camps (90 ha) and the TCAR (31 ha). During operation, the majority (57 ha) of functional habitat loss will be associated with the TMF, power plant, and camps.

Blasting Noise: During construction, noise from blasting in Mitchell and Sulphurets pits will result in behavioural disturbance to moose in 169 ha of habitat (108 dB), and functional loss of 32 ha (120 dB) of high-quality winter habitat (outside of the 300-m buffer already considered to be lost in Section 18.7.1.3; Table 18.7-10; Figure 18.7-13a).

During operation, the three pits will be mined successively. During the first 23 years, blasting will occur in Mitchell Pit and result in disturbance to 20 ha (108 dB) and no functional loss (120 dB) of high-quality habitat. From year 23 to 27 (over five years), blasting will occur in Sulphurets Pit, when 215 ha will be exposed to 108 dB and 7 ha to 120 dB, and from year 27 to 50, blasting in Kerr Pit will result in 210 ha within 108 dB and 4 ha within 120 dB (Table 18.7-10; Figure 18.7-13b). When all three pit blasting scenarios are combined (i.e., total of affected habitat without double counting the habitat where noise exposure overlaps), a total of 249 ha of high-quality habitat could be disturbed exposed to noise levels of 108 dB, and 11 ha will be functionally lost, exposed to 120 dB (Figure 18.7-13b); however, it is important to note that this disturbance to habitat will not occur all at once, as pits will not be mined simultaneously.

Residual Effects for Moose due to Sensory Disturbance

Moose habitat within the elevated Project noise level areas associated with the Processing Plant site, camps, TMF, and roads may be affected. Noise from blasting may result in the functional loss of 11 ha and disturbance to 249 ha of habitat in the valleys within the Mine Site. Moose may avoid these areas due to visual and noise disturbance, which could affect individuals. However, the extent of suitable habitat that is considered functionally lost due to sensory disturbance is less than 1% of the available winter moose habitat in the RSA. The majority of the area of moose habitat that was modelled as above the 45 dBA and 108 and 120 dB Lpeak values was within the 300-m buffer already assessed as part of habitat loss and alteration (Section 18.7.1.3). After mitigation, no residual effect of sensory disturbance on moose is anticipated.

18.7.3.3.2 Mountain Goat

Potential sources of sensory disturbance for mountain goats associated with the Project include: a) elevated noise levels, b) increased aircraft volumes, and c) human presence. Mountain goats are known to be sensitive to disturbance from human activity; studies have been carried out on the effects of noise, such as aircraft noise particularly from helicopters, on mountain goats (Côté 1996; Goldstein et al. 2005). Goats have been observed responding to helicopter noise up to 2 km away (Côté 1996; BC MOE 2010a; Cadsand 2012). On the other hand, some studies have

suggested that mountain goats can habituate to disturbances associated with oil and gas development (Wilson and Shackleton 2001), but sudden and novel events continue to evoke startle reactions. Other studies, however, have found no evidence of habituation, and have found that goats become more sensitive over time with continued noise exposure (Foster and RaHS 1983; Côté 1996; Gordon and Wilson 2004).

Mountain goats may also be displaced from preferred habitat, or they may return after the disturbance is removed. Mountain goat habitat directly abuts the proposed Mine Site, which will be the site of daily blasting, helicopter activity during the construction phase, avalanche control, heavy trucks, and other industrial noise and visual disturbances. For example, in northern BC, mountain goats were observed to abandon an area that was within 3 km of mining disturbances (helicopters, drilling, noise), but returned after the disturbance was removed (Foster and RaHS 1983; Gordon and Wilson 2004). The level of disturbance planned in the Mine Site will likely result in the displacement of mountain goats that use adjacent habitats. A distribution shift may increase the probability of mortality for individuals unfamiliar with predation risks and foraging opportunities in the new range.

Noise modelling was completed to determine the area of mountain goat summer and winter habitat that may be functionally lost due to sensory disturbance during construction and operation and due to instantaneous noise from helicopter overflights and blasting. The total area of High and Moderately High suitability (high quality) winter and summer habitat that falls outside of the area of direct habitat lost due to the Project footprint (Section 18.7.1.3), but within the noise level contours of 45 dBA (Project noise), 75 dBA (helicopter noise during construction), 108 dB (disturbed habitat from instantaneous blasting noise potentially resulting in behavioural response), and 120 dB (functionally lost habitat from instantaneous blasting noise, resulting in abandonment of habitat) or greater was calculated.

Project Noise: The total amount of high-quality summer and winter habitat affected by elevated Project noise levels (outside of the 300-m buffer already considered to be lost in Section 18.7.1.3) during construction is 851.4 ha (Figure 18.7-14a), and 573.7 ha during operation (Figure 18.7-14b). The majority of sensory disturbance will be associated with the Mine Site development (pits, camps, roads) during construction (582.2 ha) and operation (493.7 ha).

Blasting Noise: During construction, noise from blasting in Mitchell and Sulphurets pits will result in behavioural disturbance to goats in 1,935 ha of habitat (108 dB), and functional loss of 389 ha (120 dB) of high-quality summer and winter habitat (outside of the 300-m buffer already considered to be lost in Section 18.7.1.3; Table 18.7-10; Figure 18.7-14a).

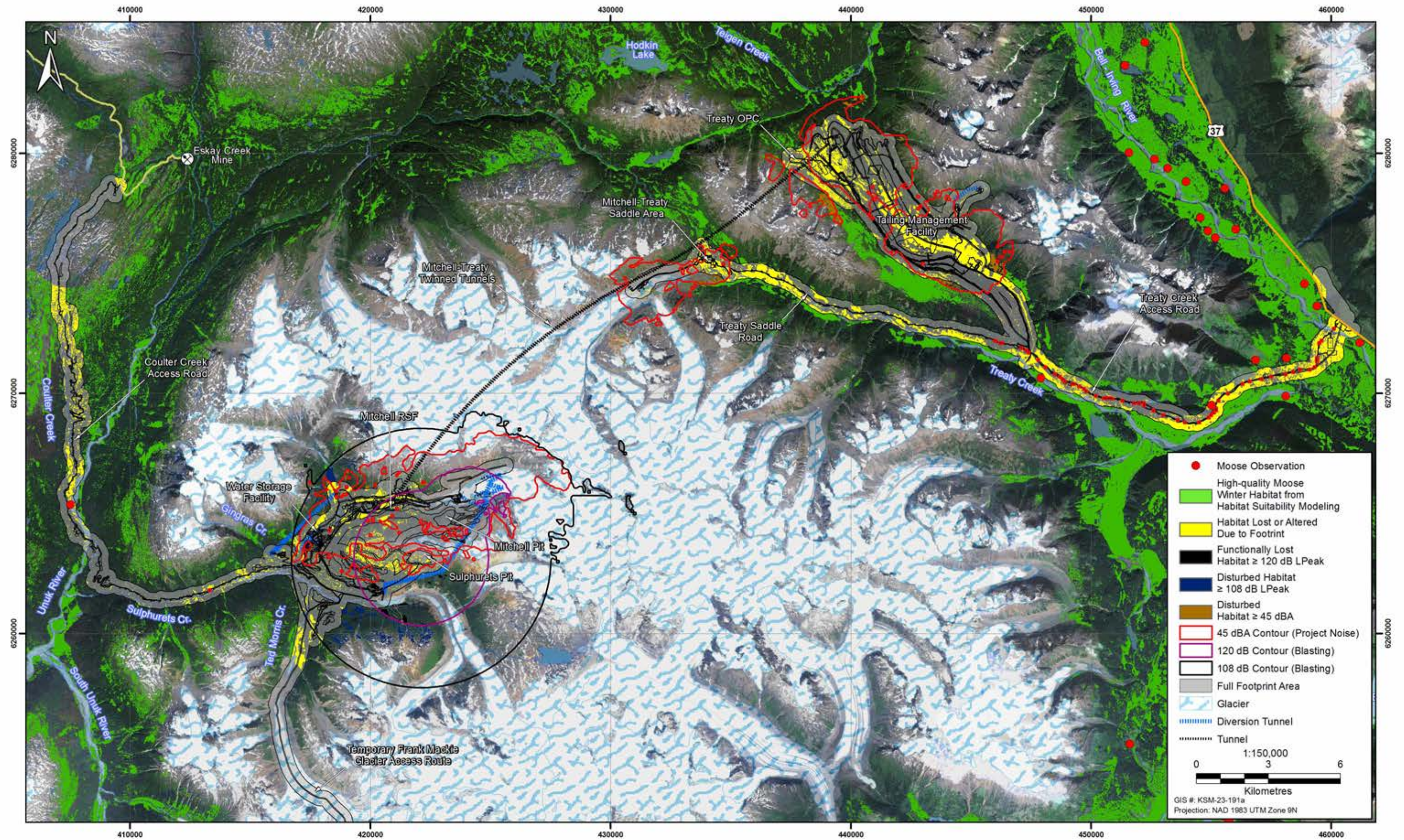


Figure 18.7-13a

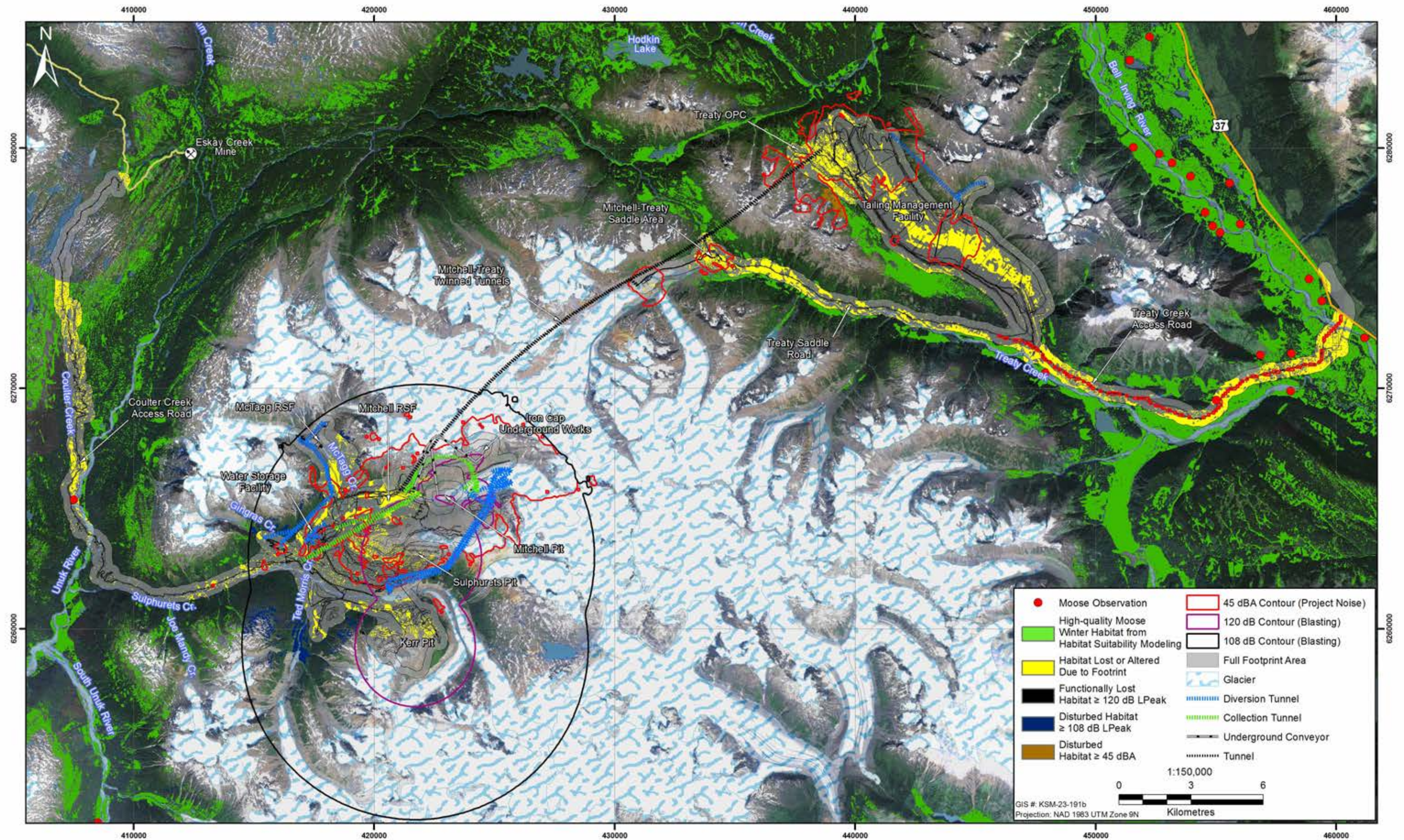


Figure 18.7-13b

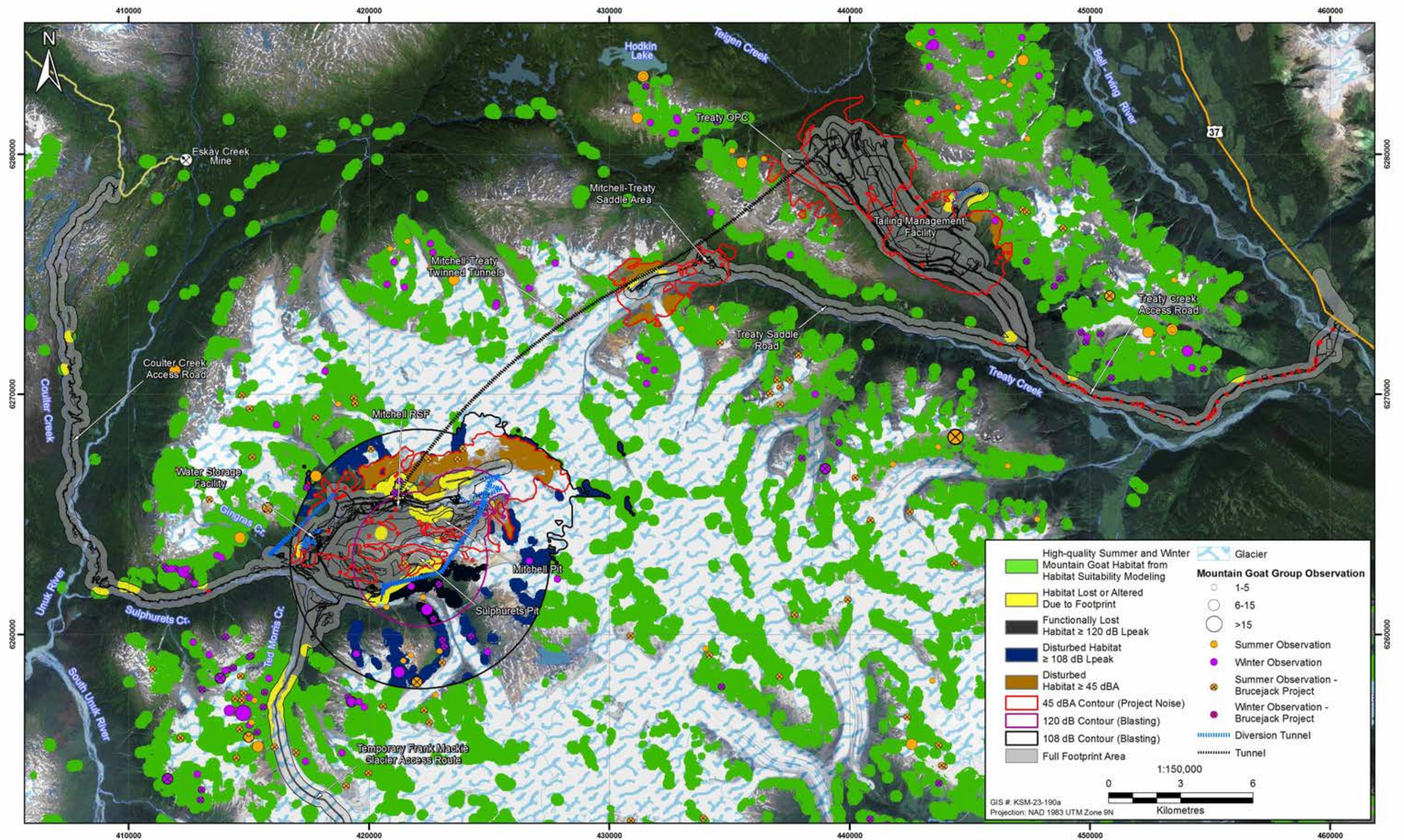


Figure 18.7-14a

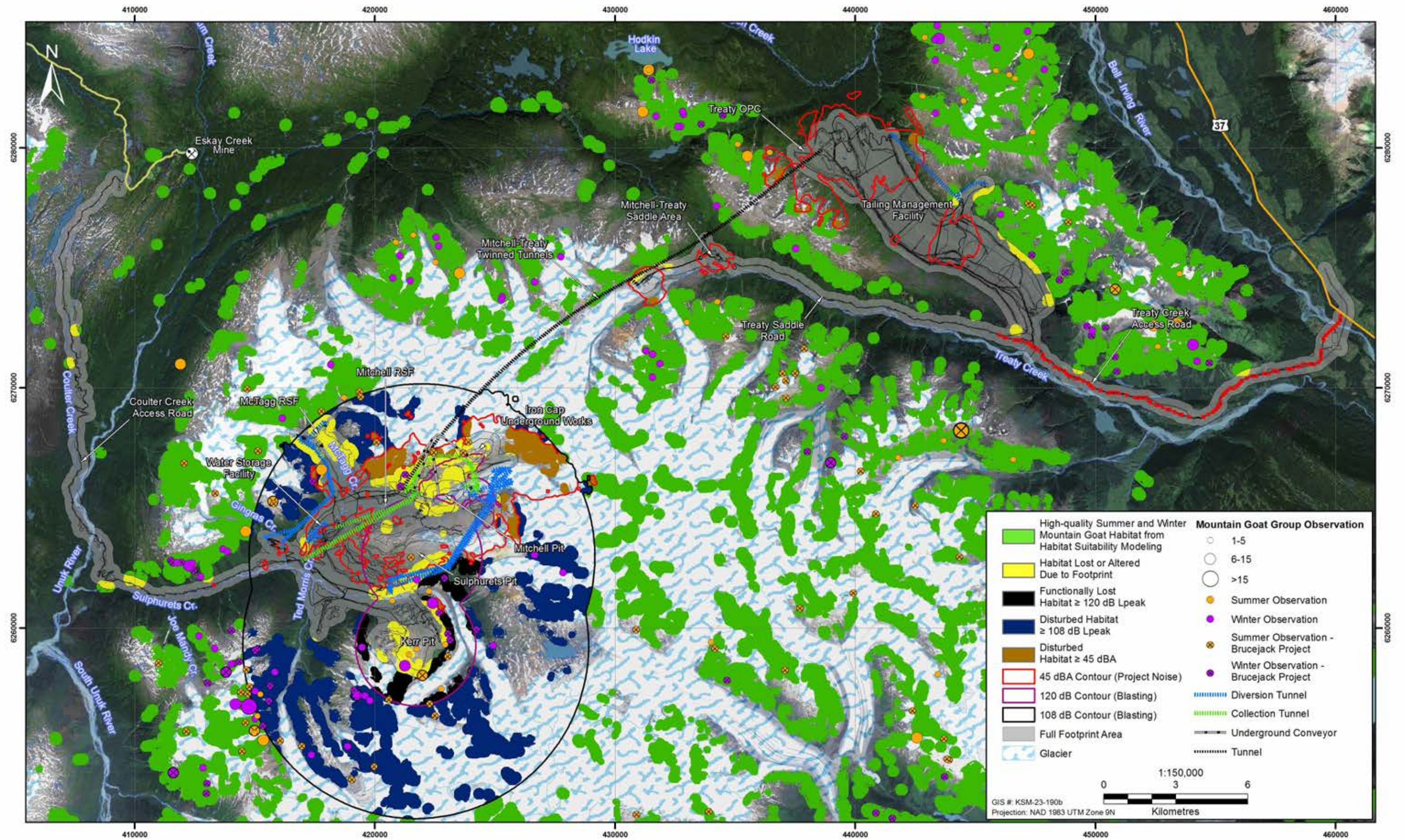


Figure 18.7-14b

During operation, the three pits will be mined successively. During the first 23 years, blasting will occur in Mitchell Pit and result in disturbance to 803 ha (108 dB) and functional loss of 0.2 ha (120 dB) of high-quality habitat. From year 23 to 27 (over five years), blasting will occur in Sulphurets Pit, when 3,529 ha will be exposed to 108 dB and 226 ha to 120 dB, and from year 27 to 50, blasting in Kerr Pit will result in 3,866 ha within 108 dB and 406 ha within 120 dB (Table 18.7-10; Figure 18.7-14b). When all three pit blasting scenarios are combined (i.e., total of affected habitat without double-counting the habitat where noise exposure overlaps), a total of 5,171 ha of high-quality habitat will be exposed to noise levels of 108 dB, and 605 ha to 120 dB (Figure 18.7-14b); however, it is important to note that this disturbance to habitat will not occur all at once, as pits will not be mined simultaneously.

During KSM and Brucejack baseline surveys, an average of 273 mountain goats were observed in the RSA during summer 2008 and 2010, 130 of which were on the massif outlined by the Unuk, Treaty, and Bowser rivers. An average of 214 mountain goats were observed during winter surveys conducted in 2009 and 2011 for the KSM Project and Brucejack Mine, 149 of which were observed on the massif. During operation, an average of 20 mountain goats may be exposed to blasting noise based on summer surveys (16 goats within 108 dB and four within 120 dB), representing 7% of the population within the RSA and 15% of the massif subpopulation that may respond to noise disturbance. During the winter, an average of 28 goats may be exposed to blasting noise (21 goats within 108 dB and seven within 120 dB), representing 13% of the population within the RSA and 19% of the massif subpopulation. The majority of blasting noise disturbance and functional habitat loss for goats will be due to blasting in Sulphurets Pit during years 23 through 27 and Kerr Pit during years 27 through 50.

Helicopter Noise (construction phase): The Province of BC provides guidance on helicopter activities in and near goat habitat (Management Plan for the Mountain Goat in British Columbia; BC MOE 2010a). The current guidelines state that helicopters should avoid flying within a 2 km buffer either horizontally or vertically from mountain goat habitat. Previous guidelines indicated a 1.5-km buffer during winter (November 1 to April 30) and kidding season (May 1 to July 15) and 1.0 km for the summer and fall periods. At the KSM Project site, helicopter management had occurred through the exploration phase by defining preferred helicopter flight lines in larger valleys (the Treaty and Unuk valleys) that maintain this 2-km buffer. Where these flight lines approach the Mine Site, they travel through a series of valleys narrower than the large Unuk Valley, where the total width of the valley is 1.5 to 2 km, preventing helicopters from maintaining the 2 km horizontal buffer distance. In some cases, the coastal-influenced area of the RSA, including the Mine Site, experiences low cloud which forces helicopters down into the valleys and prevents them from maintaining a 2 km vertical buffer from mountain goat habitat. This scenario, where topography and weather force helicopters into the 2 km suggested buffer around goat habitat, is considered the worst case scenario for helicopter noise at the Project. This worst-case scenario was modelled for the effects assessment to evaluate the potential effects of helicopter noise on mountain goats during the construction phase. Noise from helicopter overflights, 75 dBA using the worst-case scenario, will result in an area of 2,014 ha where goats may be disturbed in high-quality habitat during construction (outside of the 300-m buffer already considered to be lost in Section 18.7.1.3). Under better weather conditions than the worst-case scenario, this area is reduced substantially. The majority of sensory disturbance due to helicopters will be associated with flights near the Mine Site (524 ha; Figure 18.7-15).

Residual Effects for Mountain Goats due to Sensory Disturbance

The effect of sensory disturbance is predicted to result in a residual effect on mountain goats. While some of the sources of disturbance can be mitigated (e.g., helicopter flight paths), noise effects are still expected. Monitoring of the mountain goat population will form an important component of the Wildlife and Wildlife Habitat Management Plan (Section 26.21.1). During the winter, mean mountain goat home range size is approximately 140 ha for females and 271 ha for males (Taylor, Wall, and Kulis 2006), but can be as small as 20 ha (Fox, Smith, and Schoen 1989); therefore, the maximum functional loss of habitat (120 dB) associated with blasting in pits during operation (604.5 ha) could be equivalent to a maximum of 30 home ranges, or a minimum of two home ranges (average of four home ranges). The area where goats may be disturbed and respond behaviourally to blasting noise (108 dB) during operation (5,171 ha) could be equivalent to a maximum of 259 home ranges, or a minimum of 19 home ranges (average of 36 home ranges). When considering the number of goats observed during baseline surveys, approximately 13% of the winter population within the RSA and 19% of the subpopulation on the massif may be exposed to noise levels causing disturbance and/or functional habitat loss (both 108 and 120 dB exposure) during operation. Despite mitigation, the effect of sensory disturbance on mountain goats is predicted to result in a residual effect.

18.7.3.4 Bears: Potential Residual Effects due to Sensory Disturbance

Potential sources of sensory disturbance for bears associated with the Project include: a) elevated noise levels, b) increased traffic volumes, and c) human presence. Bears do not generally respond to aircraft if flights remain above 200 m above ground level (B. N. McLellan and Shackleton 1989a, 1989b). Grizzly bears are reported to avoid areas (78 to 80% of the time) with continuous noise levels greater than 60 dBC (Archibald, Ellis, and Hamilton 1987). Grizzly bears frequently alter their behaviour and avoid areas with human activity (such as high-use roads) and periods when humans are most active (Mueller 2001), with grizzly bear avoiding habitat within 100 to 900 m of roads (Mattson, Knight, and Blanchard 1987; B. N. McLellan and Shackleton 1988; Kasworm and Manley 1990). For this assessment, a threshold of 45 dBA was used for Project noise as a conservative estimate. Some bears will avoid areas when there is noise, particularly new disturbances and areas where crews are working.

Noise modelling was completed to determine the area of grizzly and black bear habitat that may be functionally lost or degraded due to sensory disturbance during construction and operation. For grizzly bears, the total area of high-quality spring, summer, fall, and denning habitat that falls outside of the area of habitat lost or altered due to the Project footprint (Section 18.7.1.4), but within the noise level contours of 45 dBA (for Project noise), 108 dB (disturbed habitat from instantaneous blasting noise potentially resulting in behavioural response), and 120 dB (functionally lost habitat from instantaneous blasting noise, resulting in abandonment of habitat) or greater was calculated. For black bears, the total area of High and Moderately High suitability denning habitat that falls outside of the area of direct habitat lost due to the footprint, but within the noise level contours of 45 dBA (for Project noise), 108 dB (disturbed habitat from instantaneous blasting noise potentially resulting in behavioural response), and 120 dB (functionally lost habitat from instantaneous blasting noise, resulting in abandonment of habitat) or greater was calculated.

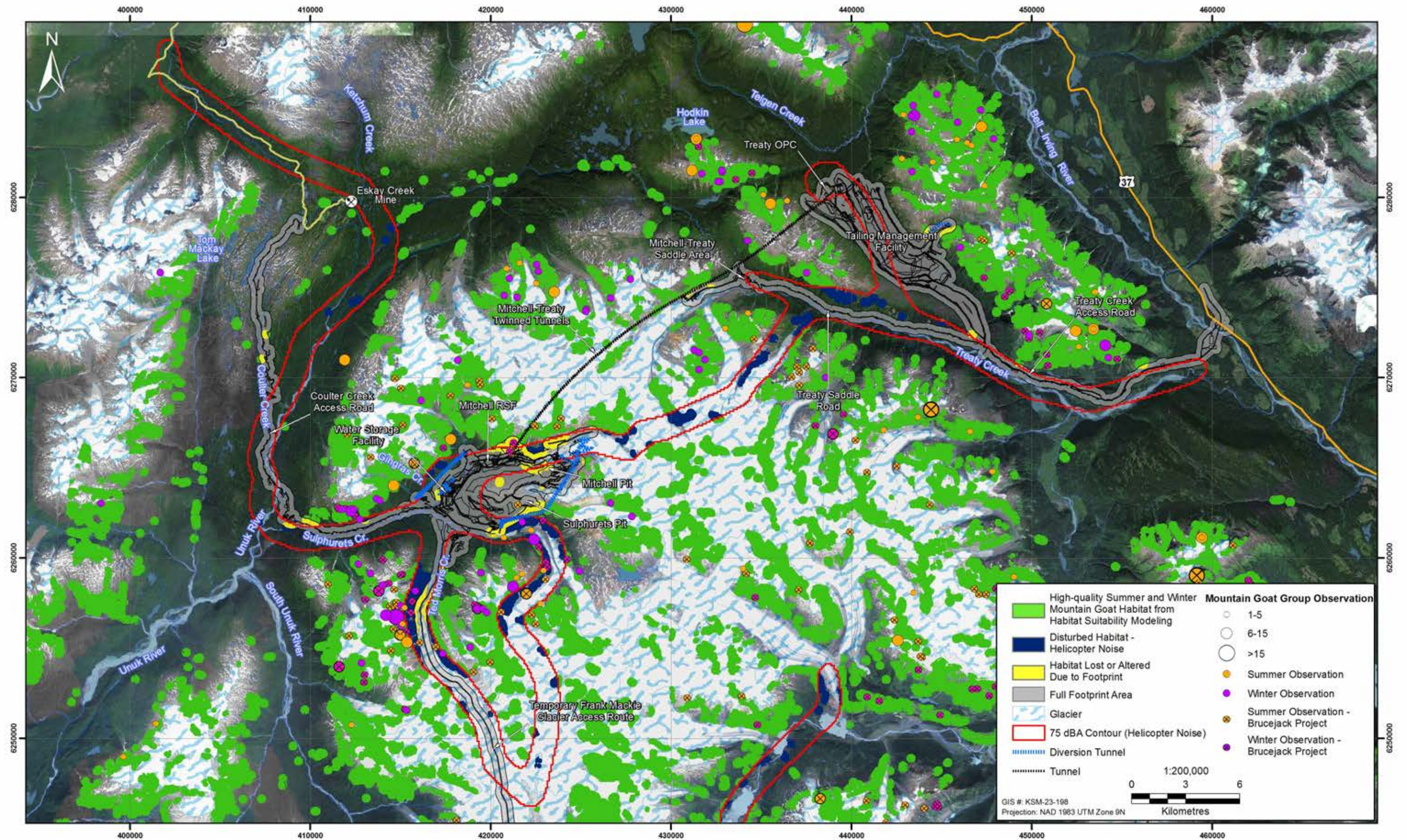


Figure 18.7-15

18.7.3.4.1 Grizzly Bears

Project Noise: The total amount of high-quality grizzly bear habitat affected by elevated noise levels (outside of the 300-m buffer already considered to be lost in Section 18.7.1.4) is 920.9 ha during construction (Figure 18.7-16a) and 439.1 ha during operation (Figure 18.7-16b). The majority of sensory disturbance will be associated with the PTMA development (TMF, process plant, camps) during construction (571.6 ha) and operation (361.9 ha).

Blasting Noise: During construction, noise from blasting in Mitchell and Sulphurets pits will result in behavioural disturbance to grizzly bears in 1,226 ha of habitat (108 dB), and functional loss of 327 ha (120 dB) of high-quality habitat (outside of the 300-m buffer already considered to be lost in Section 18.7.1.4; Table 18.7-10; Figure 18.7-16a).

During operation, the three pits will be mined successively. During the first 23 years, blasting will occur in Mitchell Pit and result in no disturbance to habitat (108 dB), and 161 ha of high-quality habitat will be functionally lost (120 dB). From year 23 to 27 (over five years), blasting will occur in Sulphurets Pit, when 1,915 ha will be disturbed, exposed to 108 dB, and 149 ha will be functionally lost (120 dB), and from year 27 to 50, blasting in Kerr Pit will result in 1,888 ha disturbed (108 dB) and 163 ha functionally lost (120 dB; Table 18.7-10; Figure 18.7-16b). When all three pit blasting scenarios are combined (i.e., total of affected habitat without double counting the habitat where noise exposure overlaps), a total of 2,139 ha of high-quality habitat will be considered disturbed, exposed to noise levels of 108 dB, and 297 ha will be functionally lost, exposed to 120 dB (Figure 18.7-16b); however, it is important to note that this disturbance to habitat will not occur all at once, as pits will not be mined simultaneously.

18.7.3.4.2 Black Bears

Project Noise: For black bears, 80 ha of denning habitat will be functionally lost due to noise during construction (Figure 18.7-17a and b), and 23 ha will be functionally lost during operation (outside of the 300-m buffer already considered to be lost in Section 18.7.1.4). This represents less than 1% of the available denning habitat in the RSA.

Blasting Noise: During construction, noise from blasting in Mitchell and Sulphurets pits will result in behavioural disturbance to black bears in 244 ha of denning habitat (108 dB), and functional loss of 102 ha (120 dB) of high-quality denning habitat (outside of the 300-m buffer already considered to be lost in Section 18.7.1.4; Table 18.7-10; Figure 18.7-17a).

During operation, the three pits will be mined successively. During the first 23 years, blasting will occur in Mitchell Pit and result in disturbance to 7 ha (108 dB) and no functional loss (120 dB) of high-quality denning habitat. From year 23 to 27 (over five years), blasting will occur in Sulphurets Pit, when 610 ha will be disturbed (108 dB) and 13 ha will be functionally lost (120 dB), and from year 27 to 50, blasting in Kerr Pit will result in 562 ha of disturbed habitat (108 dB) and 29 ha will be functionally lost (120 dB; Table 18.7-10; Figure 18.7-17b). When all three pit blasting scenarios are combined (i.e., total of affected habitat without double-counting the habitat where noise exposure overlaps), a total of 610 ha of high-quality denning habitat will be considered disturbed, exposed to noise levels of 108 dB, and 42 ha will be functionally lost, exposed to 120 dB (Figure 18.7-17b); however, it is important to note that this disturbance to habitat will not occur all at once, as pits will not be mined simultaneously.

Residual Effects for Bears due to Sensory Disturbance

The effect of sensory disturbance is not anticipated to have a residual effect on grizzly bears or black bears. Overall, an estimated 31 grizzly bears use the RSA ([Appendix 18-C](#)). Grizzly bear home ranges cover a large area. The overall functional loss of grizzly bear habitat due to daily Project noise is approximately 921 ha during construction, which is roughly equivalent to 18% of the home range of a female coastal grizzly bear, or as little as 5% of the home range of a male grizzly bear in the interior of BC. The majority of the area assessed as being above noise guidelines for both grizzly and black bears is within the 300-m buffer area and already assessed as lost or altered habitat in Section 18.7.1.4.

Noise from blasting may result in functional loss and disturbance to habitat. The total functional loss of habitat (120 dB; 297 ha) and disturbance to habitat (108 dB; 2,139 ha) associated with blasting in pits during operation is less than 2% of the available grizzly bear habitat in the RSA. The amount of black bear denning habitat functionally lost (42 ha) or disturbed (610 ha) is less than 1% of available denning habitat in the RSA. After mitigation, no residual effect of sensory disturbance on grizzly or black bears is anticipated.

18.7.3.5 Bats: Potential Residual Effects due to Sensory Disturbance

Potential sources of sensory disturbance for bats associated with the Project include elevated noise levels and additional light sources. Bats rely on acoustics, specifically echolocation, for detecting prey while foraging; therefore, bats may be affected by noise disturbance in the Project area. Bats may also be attracted to the abundance of insect prey associated with artificial lighting, or *Myotis* species may avoid bright lights as a predator avoidance strategy (Bat Conservation Trust 2008).

Little brown myotis, for example, forage over open area such as water, forest trails, or meadows. Over aquatic habitat their diet consists of aquatic insects and over terrestrial habitat their diet consists of a wide variety of insects such as moths and beetles (Kunz and Reichard 2012). Studies have indicated that bats that find prey primarily by listening to prey sounds rather than echolocation can be disturbed up to approximately 50 m from noise disturbance from roads (Schaub, Ostwald, and Siemers 2008). Although the little brown myotis relies primarily on echolocation to find prey, the precautionary approach is taken for this assessment and it is assumed that noise may affect foraging up to 50 m from noise sources. Therefore, the direct habitat loss assessment (Section 18.7.1.7) incorporates the functional loss of bat habitat due to noise, as noise disturbance to bats will not extend outside of the 300-m habitat loss buffer.

The potential effect of lights on bats can be minimized by modifying light design and use. For example, using low-pressure sodium lamps, or fitting lamps with UV filters can reduce the effect on bats. Similarly, limiting times during which lighting is used, particularly between April and September when bats are active, and using directional lighting can also limit the effects on bats (Fure 2006).

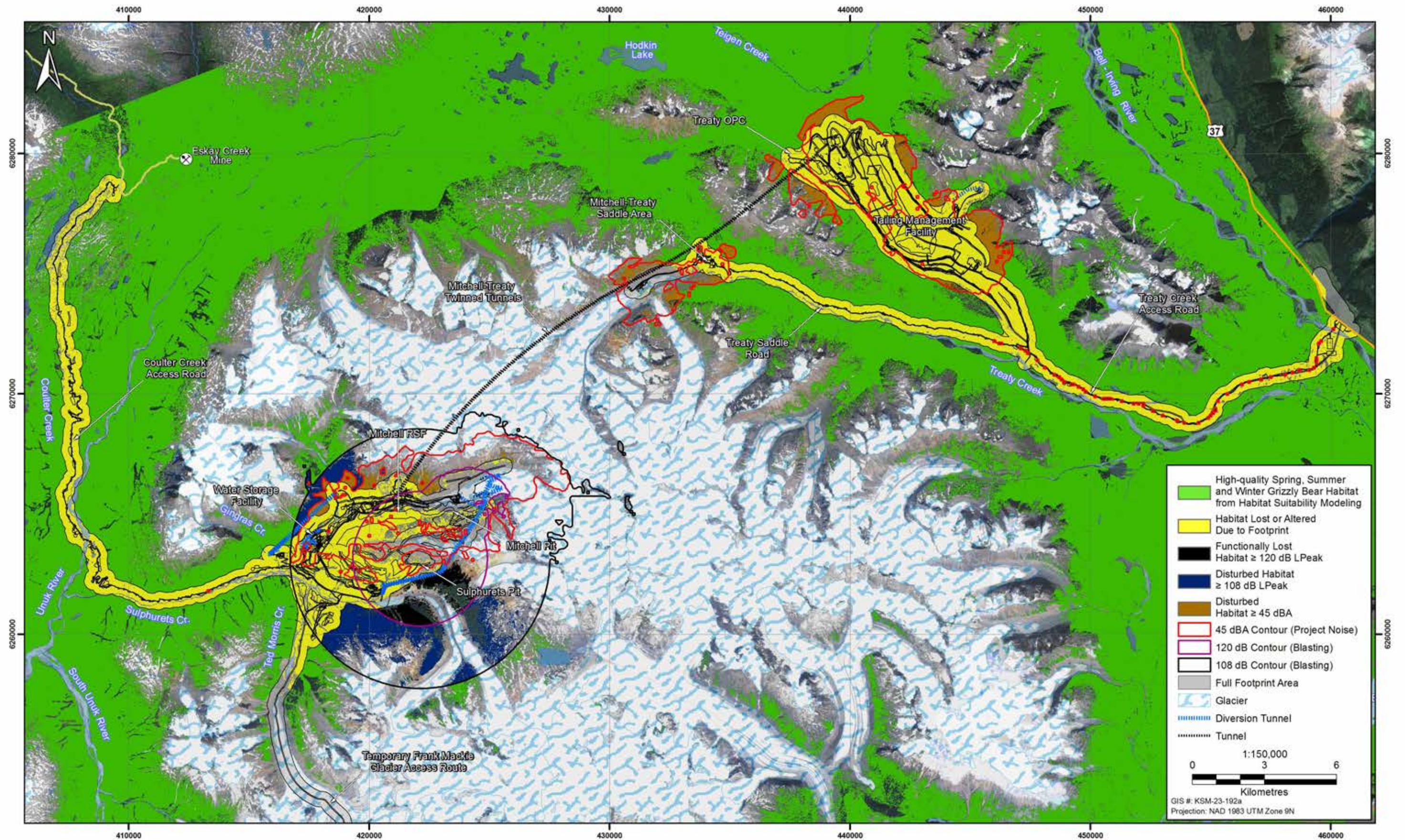


Figure 18.7-16a

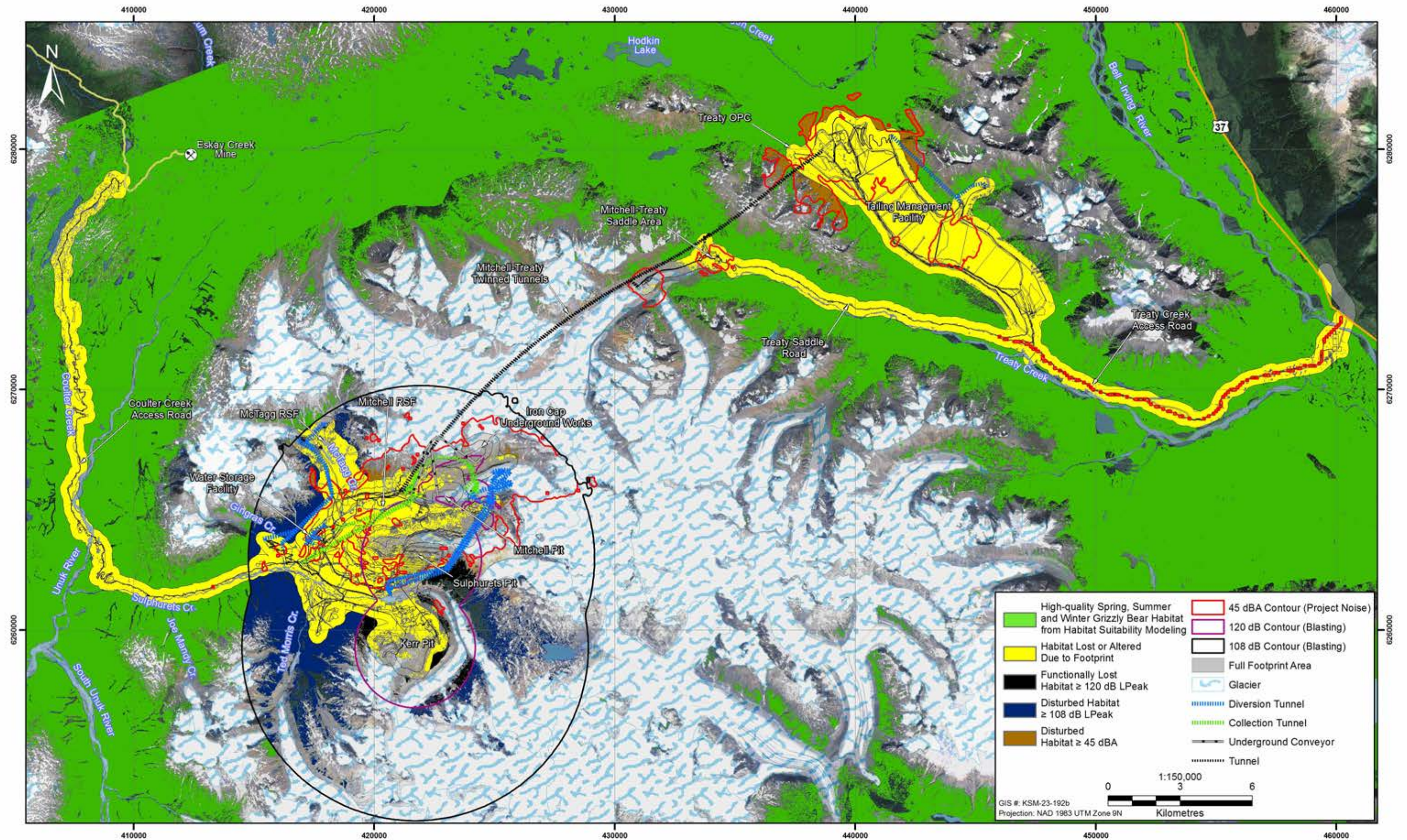


Figure 18.7-16b

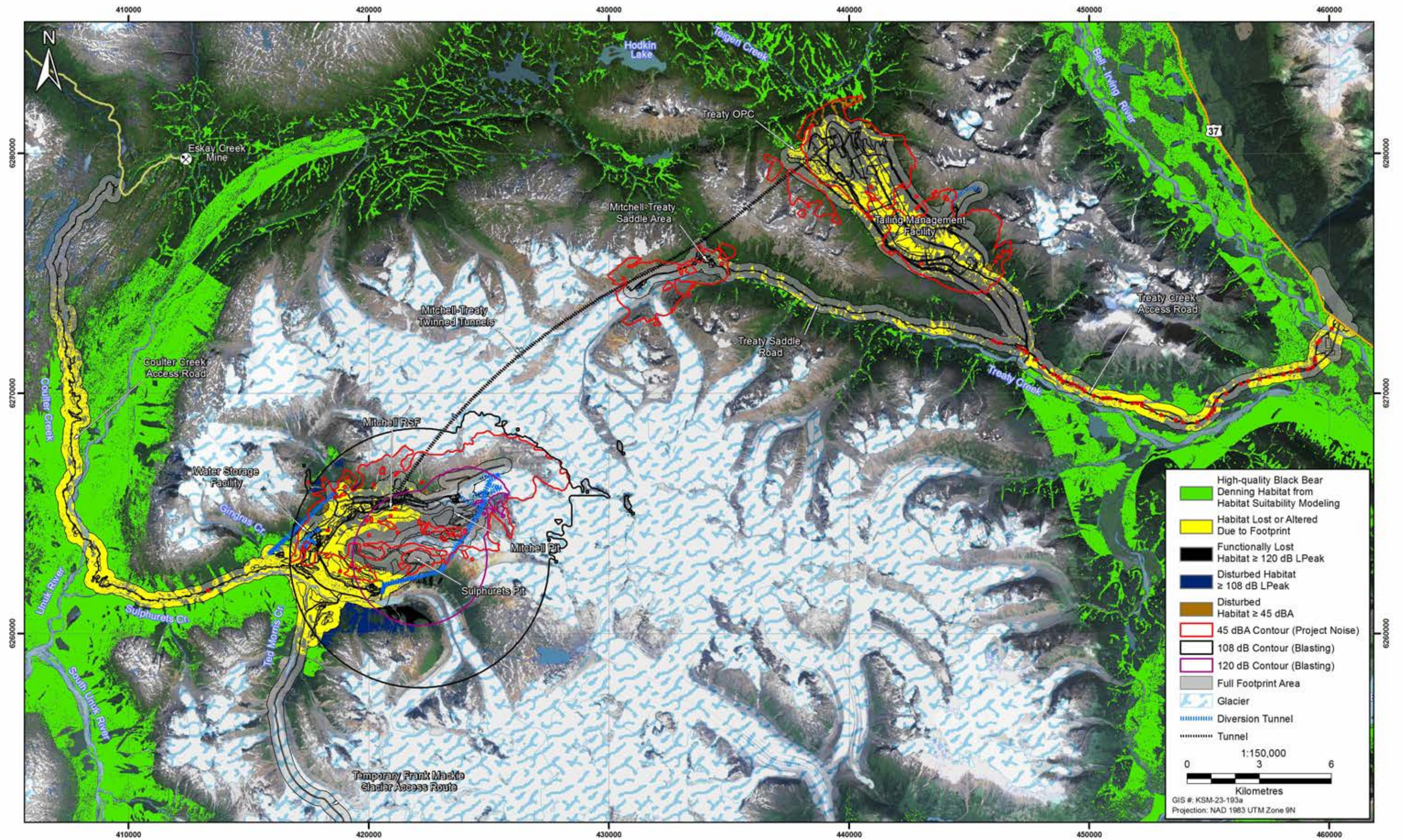


Figure 18.7-17a

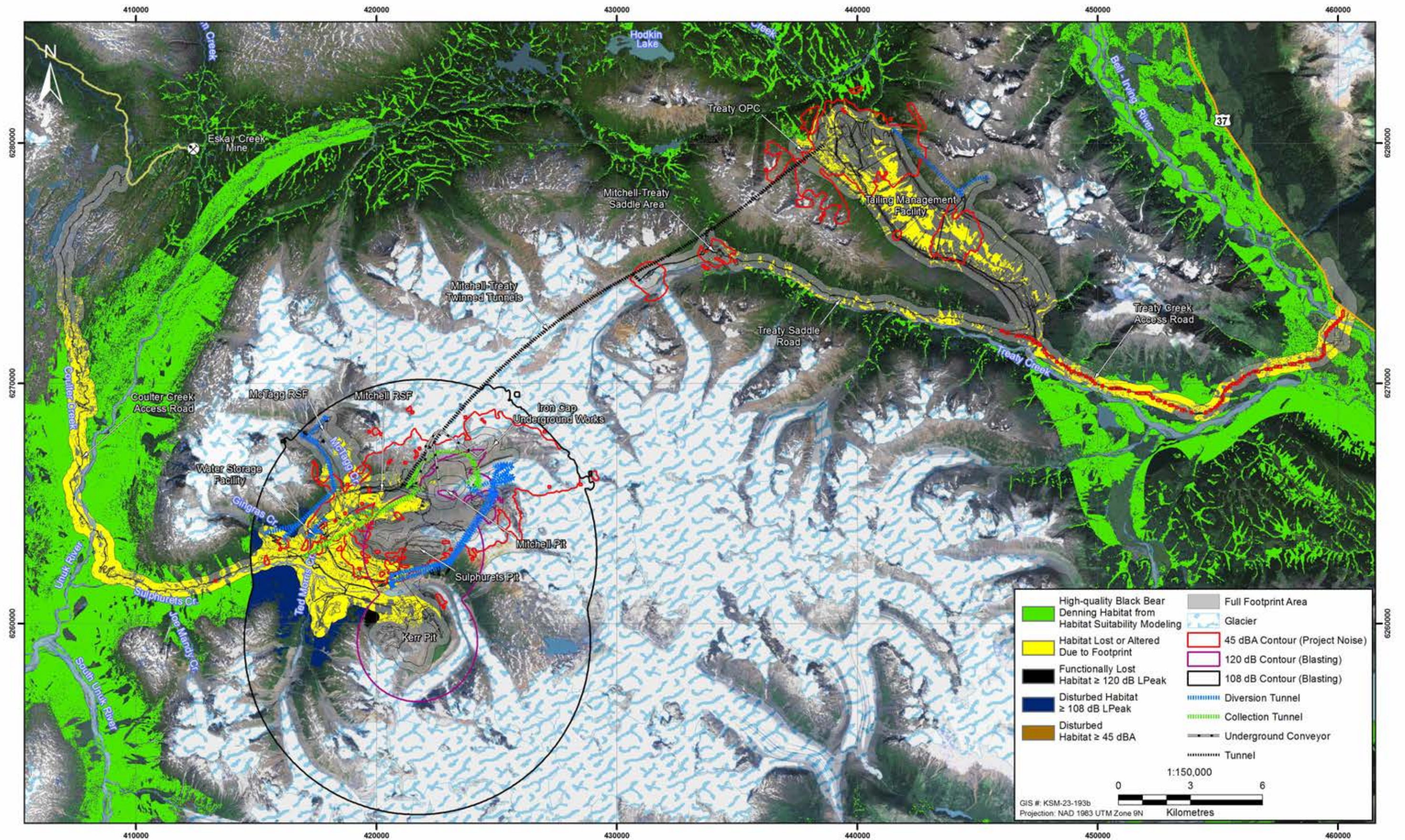


Figure 18.7-17b

Residual Effects for Bats due to Sensory Disturbance

Project lighting may affect bats indirectly; however, following mitigation such as minimizing illumination and light design will reduce this effect. Therefore, with mitigation, no residual effect of sensory disturbance on bats is anticipated.

18.7.3.6 Birds: Potential Residual Effects due to Sensory Disturbance

Forty-five dBA was used as the threshold noise level at which birds may be affected because research has indicated that bird densities reduce after the 47 dBA level is reached, and also because the recommended federal management limit for night-time mining activity noise levels is 45 dBA as related to wildlife (Reijnen, Foppen, and Meeuwssen 1996; Environment Canada 2010). Many avian species, including raptors, are generally resilient to instantaneous noise disturbances (e.g., blasting) during brooding and incubation (Holthuijzen and Eastland 1985; Cade and Bird 1990). With 45 dBA chosen as a threshold for effects on birds, the 75 dBA and 108 dB instantaneous noise models were not used to calculate avian species' functional habitat loss.

18.7.3.6.1 Raptors

Potential sources of sensory disturbance for raptors associated with the Project include: a) elevated noise levels, b) increased traffic volumes, c) additional light sources, and d) human presence. Elevated noise levels are a particular concern for raptor species that use sound for prey location. Elevated noise levels could render foraging habitat non-functional for these species if small mammal detection becomes impaired.

Studies have reported that raptors are affected by disturbances as varied as pedestrian foot traffic to military training procedures (D. E. Andersen, Rongstad, and Mytton 1990; Richardson and Miller 1997; Schueck, Marzluff, and Steenhoff 2001). Behavioural responses can be as straight forward as nest abandonment or decreased egg incubation leading to mortality of embryos or nestlings to more subtle effects such as home range shifts and decreased energy intakes due to changes to foraging behaviour (White and Thurow 1985; D. E. Andersen, Rongstad, and Mytton 1990; Richardson and Miller 1997). Spatial and temporal buffer distances have been recommended surrounding nest sites in order to minimize disturbance effects (Richardson and Miller 1997; SKCDC 2003; BC MWLAP 2004a).

A GIS analysis was conducted to determine the areas where sensory disturbance may be the most prevalent during construction and operation. The total area of suitable nesting and foraging habitat identified for the habitat loss calculations (Section 18.7.1.8) was used for the analysis. The area of habitat that falls outside of the area of direct habitat lost due to the footprint, but within the noise level contours of 45 dBA or greater was calculated.

The total area within the RSA that will be functionally lost due to sensory disturbance (outside of the 300-m buffer already considered to be lost in Section 18.7.1.8) is 228.3 ha during construction (Figure 18.7-18a) and 116.9 ha during operation (Figure 18.7-18b). The majority of this functional loss will be associated with the PTMA during both construction (181 ha) and operation (115 ha). When this is compared to the total potential raptor habitat within the RSA it is less than 1% of foraging and nesting habitat available.

Residual Effects for Raptors due to Sensory Disturbance

A total of 0.3% of the suitable habitat for raptors will be functionally lost due to sensory disturbance. Therefore, with mitigation, no residual effects for raptor sensory disturbance are anticipated.

18.7.3.6.2 Wetland Birds

Potential sources of wetland bird sensory disturbance associated with the Project include: elevated noise levels, increased traffic and aircraft volumes, additional light sources, and increased human presence. The potential consequences of disturbance include: functional loss of habitat due to avoidance, increased energetic costs due to decreased foraging time and increased flying time, nest abandonment and increased predation rates, and reduced reproductive success (Hockin et al. 1992).

A GIS analysis was conducted to determine the amount of wetland habitat, cavity-nesting habitat, and riverine habitat that could be functionally lost or degraded due to noise and visual disturbance. The number and area of wetlands that fall within the 45 dBA noise modelling areas were calculated; wetlands lost due to infrastructure were not included in these calculations as they were considered in Section 18.7.1.8.

The total wetland area that will be functionally lost (outside of the 300-m buffer already considered to be lost in Section 18.7.1.8) as wetland bird habitat within the 45 dBA and greater sound contour is 1 ha during construction (Figure 18.7-19a) and 1.1 ha during operation (Figure 18.7-19b).

The total area of cavity-nesting habitat that will be functionally lost (outside of the 300-m buffer already considered to be lost in Section 18.7.1.8) within the 45 dBA and greater sound contour is 191.1 ha during construction (Figure 18.7-20a) and 106.4 ha during operation (Figure 18.7-20b). The majority of this functional loss will occur in association with the PTMA (169 ha during construction).

The total riverine area that will be functionally lost (outside of the 300-m buffer already considered to be lost in Section 18.7.1.8) as habitat within the 45 dBA and greater sound contour is 1.5 ha (35 streams) during construction (Figure 18.7-21a) and 0.7 ha (21 streams) during operation (Figure 18.7-21b). The majority of this loss during construction is associated with the TCAR, and during operation is associated with the Mine Site.

Residual Effects for Wetland Birds due to Sensory Disturbance

Wetlands within the elevated noise level areas associated with the PTMA, pits, and roads may be affected. Wetland birds may be flushed or avoid wetlands/waterbodies and terrestrial foraging areas due to visual and noise disturbance, which could affect breeding and nesting birds. However, the extent of wetlands, cavity-nesting habitat, and riverine habitat that are considered functionally lost due to sensory disturbance is less than 1% of the available wetland bird habitat in the RSA. Therefore, no residual effect of sensory disturbance on wetland birds is anticipated.

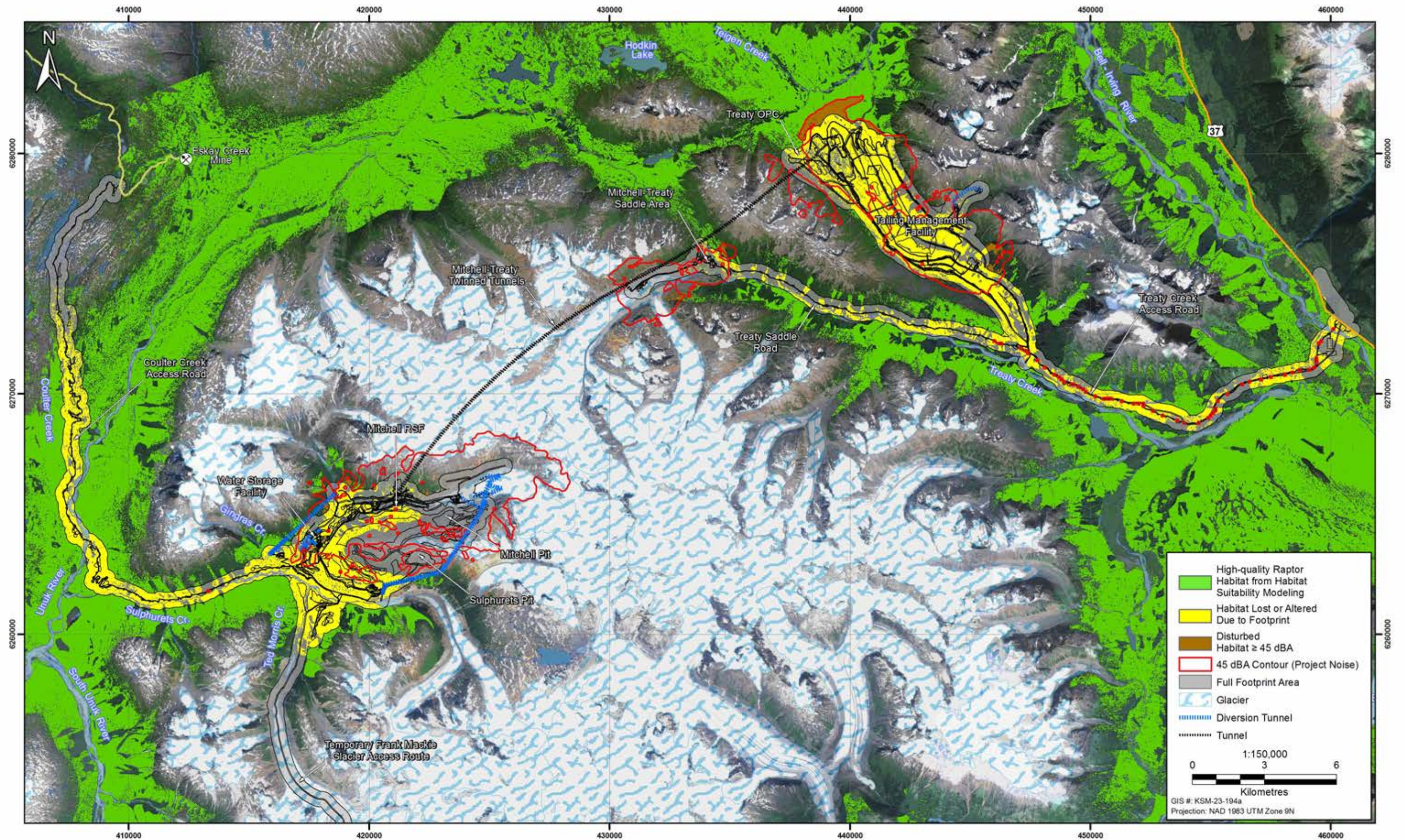


Figure 18.7-18a

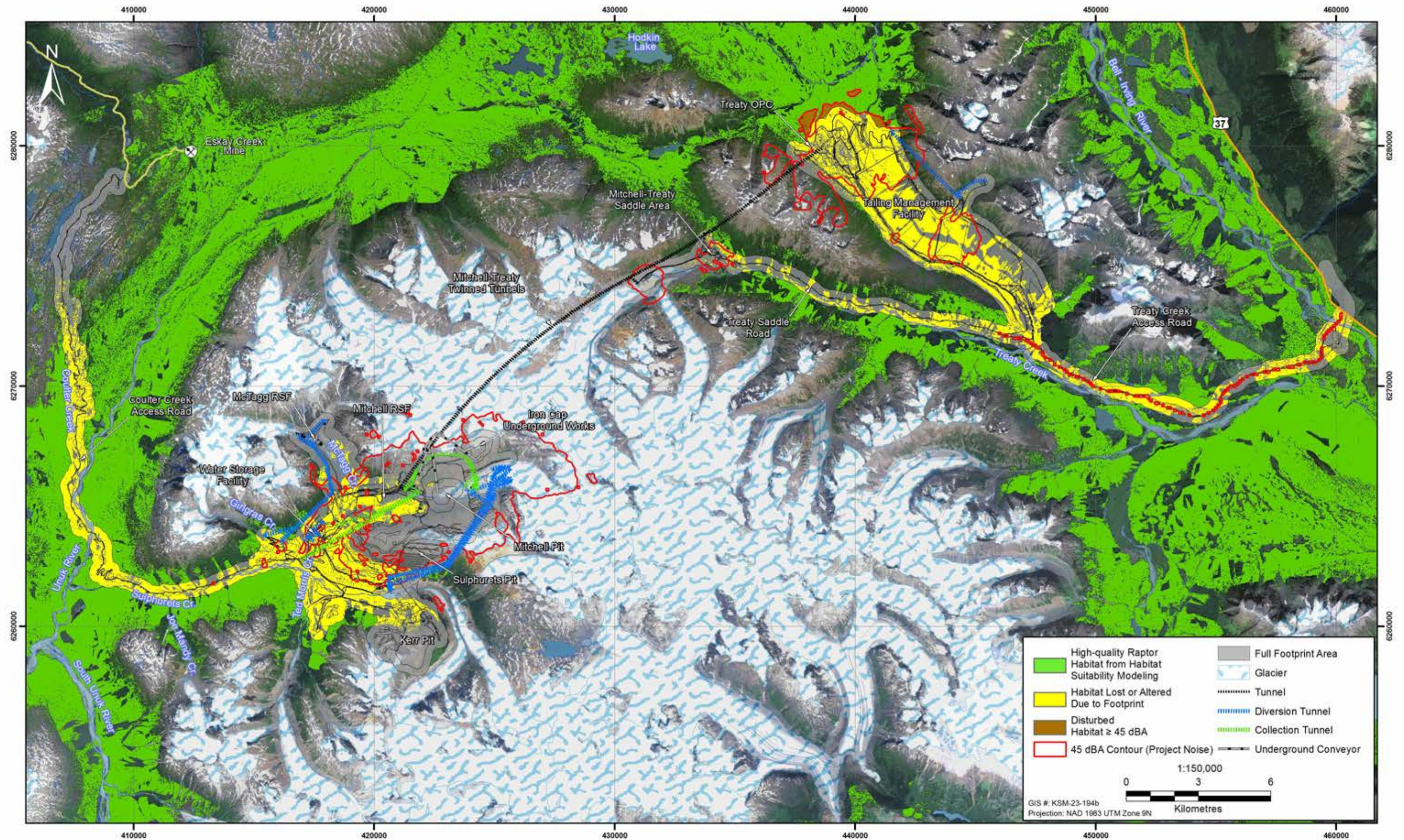


Figure 18.7-18b

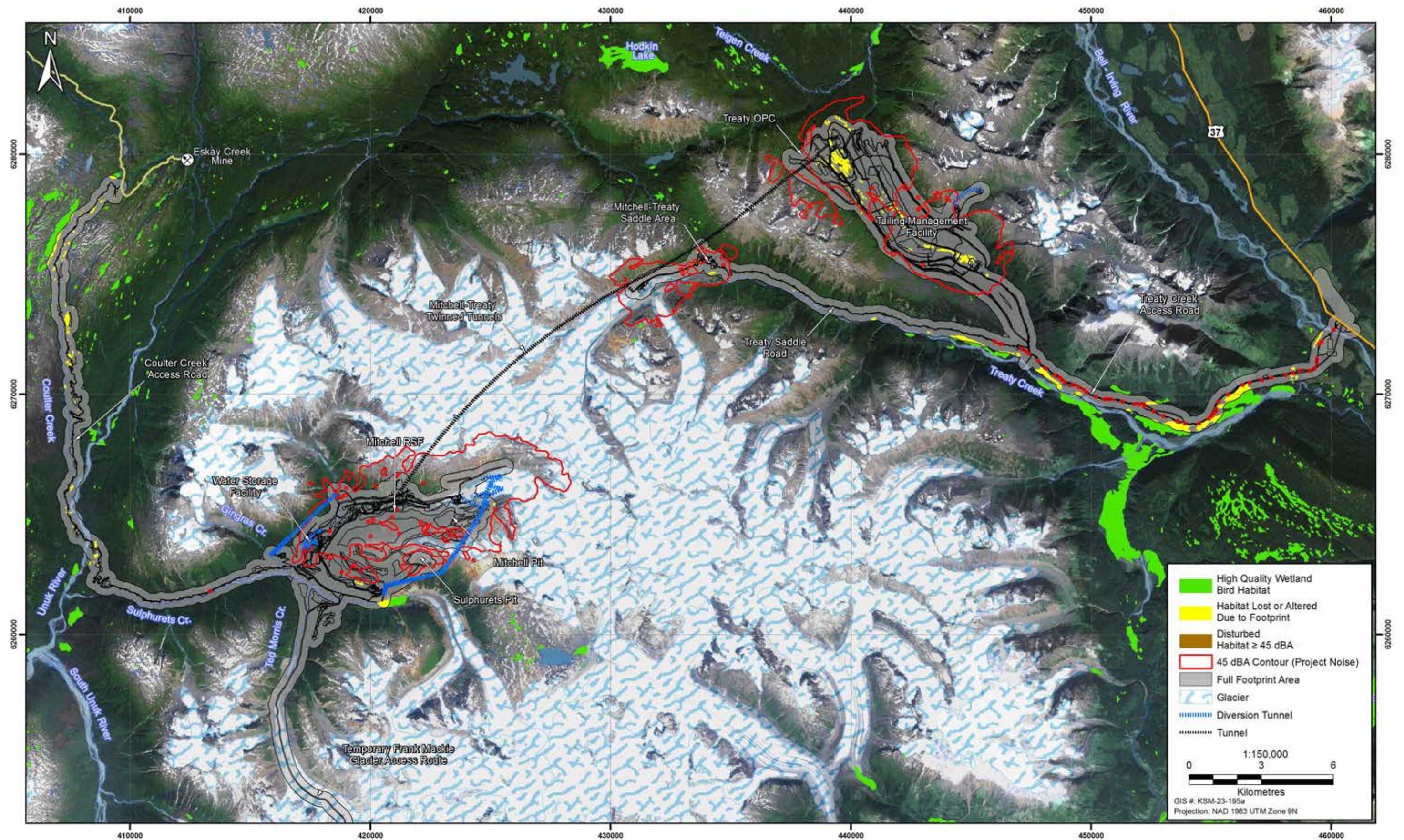


Figure 18.7-19a

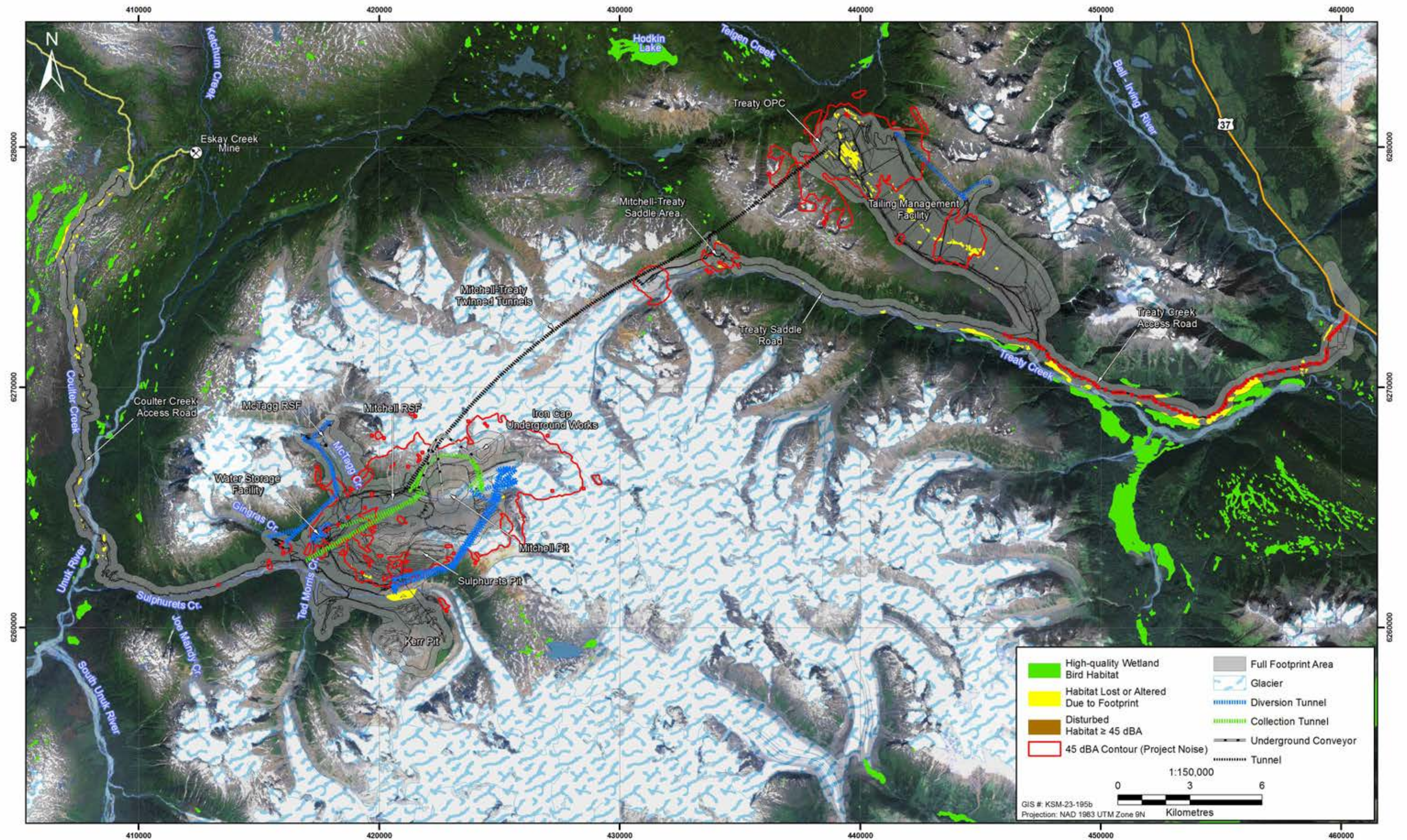


Figure 18.7-19b

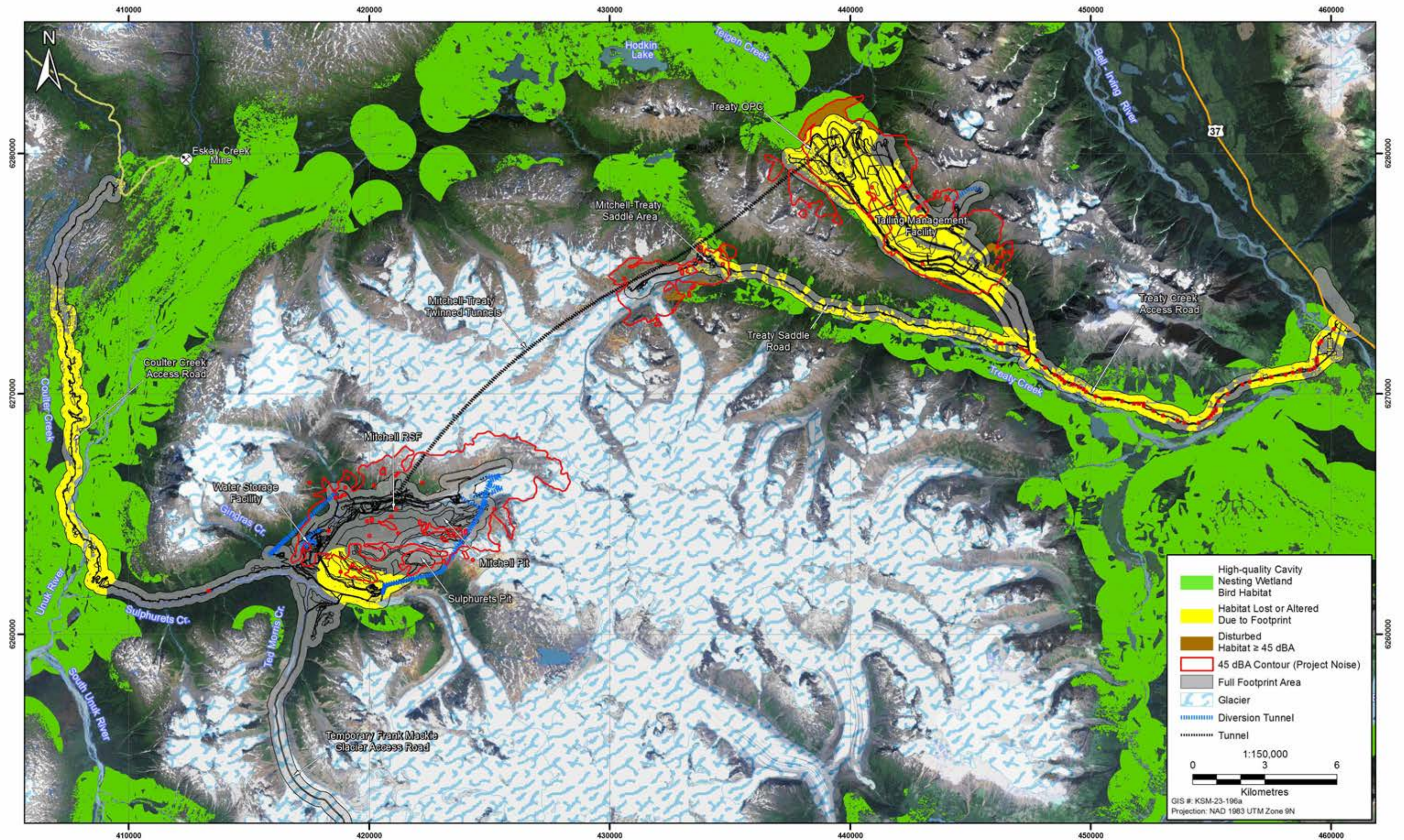


Figure 18.7-20a

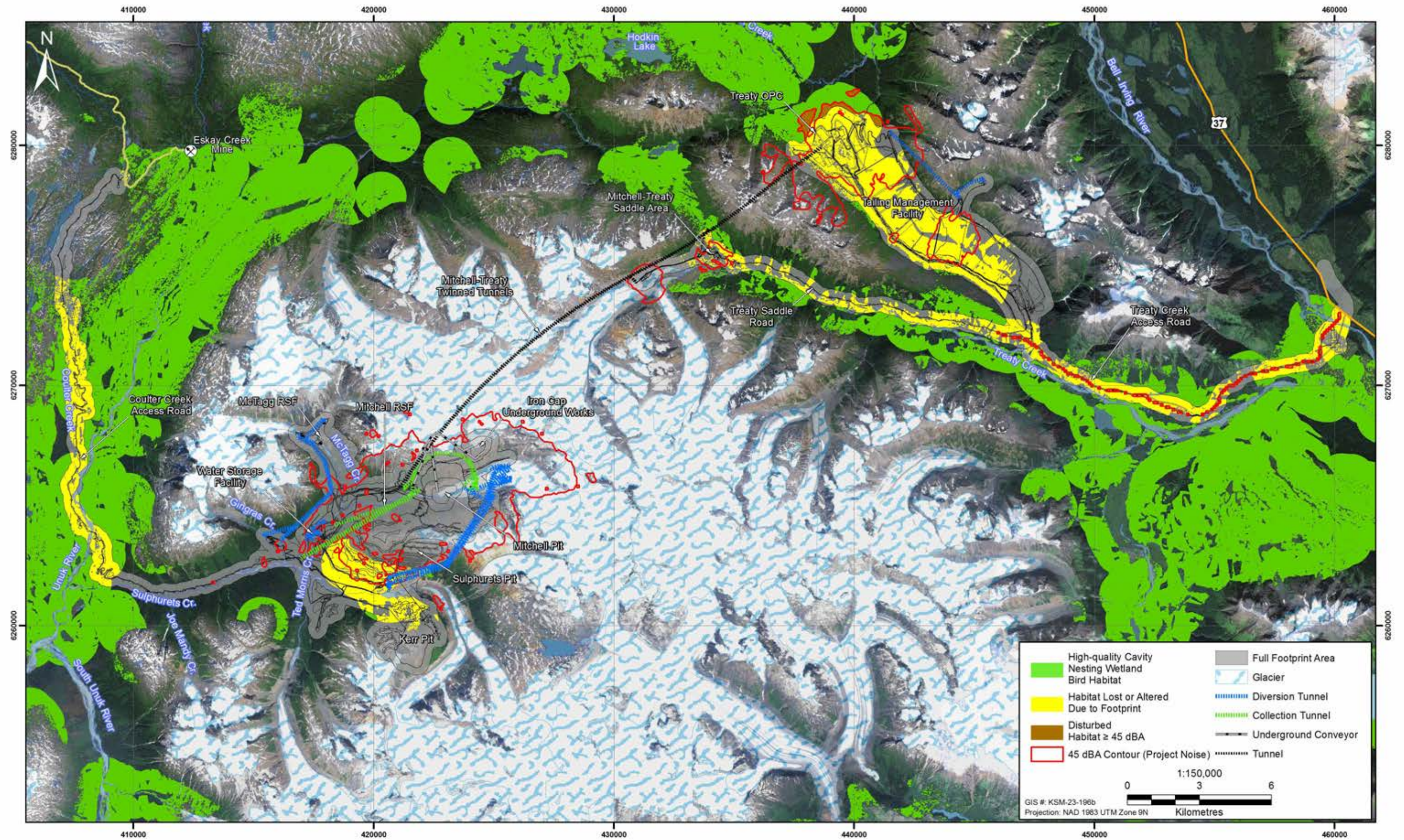


Figure 18.7-20b

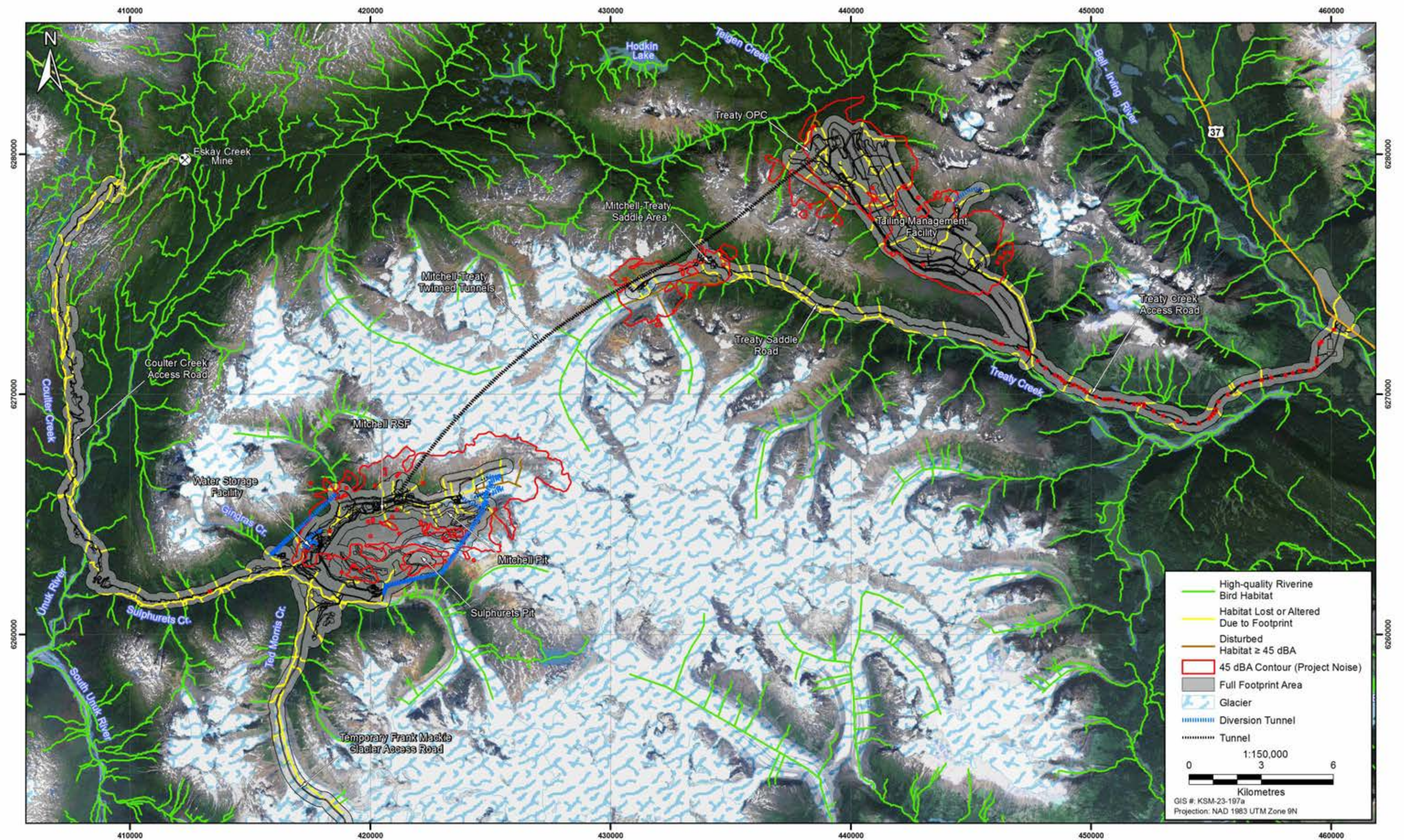


Figure 18.7-21a

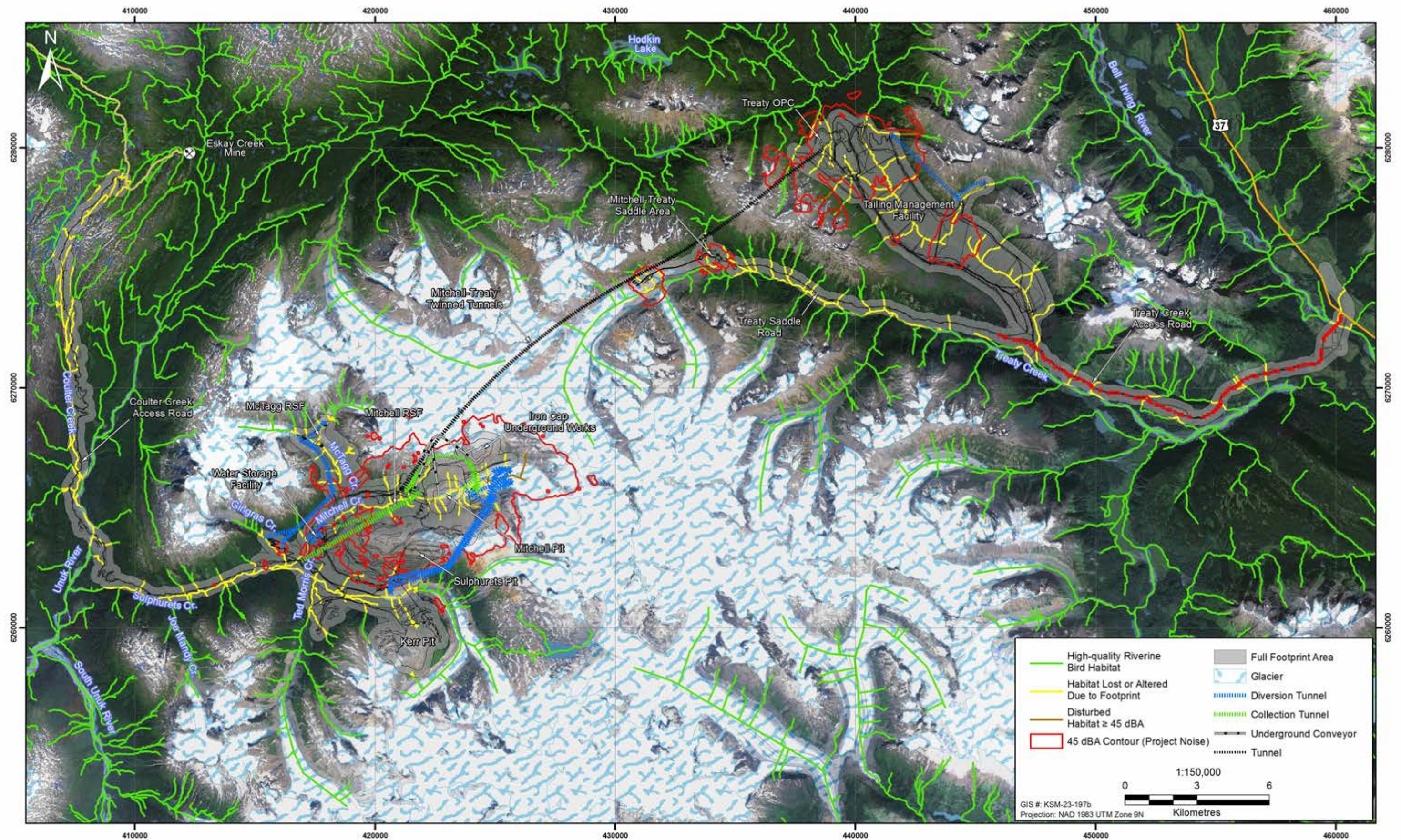


Figure 18.7-21b

18.7.3.6.3 Forest/Alpine Birds

Elevated noise levels have the potential to mask auditory communication of birds which include breeding calls, alarm calls, territorial calls, contact calls with flocks, and the localization of mates and young (Farabaugh, Dent, and Dooling 1998; Katti and Warren 2004). Habitat areas have the potential to be functionally lost if elevated noise levels prevent effective auditory communication or if visual disturbance renders them of lower value.

Sensory disturbance to forest and alpine birds can occur due to noise, artificial light, and visual disturbance (Reijnen and Foppen 1995; Fernandez-Juricic, Jimenez, and Lucas 2001; Longcore and Rich 2004). A study of grassland bird density along roads reported that the density of two bird species (skylark and meadow pipit) was lower in areas that had a traffic noise levels above 48 and 59 dBA for each of the species respectively (Reijnen, Foppen, and Meeuwsen 1996). A study in Illinois reported that horned lark densities was reduced up to 100 m from country roads (Clark and Karr 1979). Other passerine species in Europe have shown similar disturbance distances, with reduced densities within 100 m of roads (Reijnen, Foppen, and Meeuwsen 1996). Because the effect of noise on forest and alpine birds generally remains within 100 m of the source, the amount of habitat that will be functionally lost will remain within the 300-m buffer used to calculate habitat loss (Section 18.7.1.8). Therefore, no additional habitat will be functionally lost due to noise.

Residual Effects for Forest and Alpine Birds due to Sensory Disturbance

Functional habitat loss due to sensory disturbance will remain within the 300-m buffer used to calculate direct habitat loss. No additional habitat will be functionally lost; therefore, no residual effects for forest and alpine bird sensory disturbance are anticipated.

18.7.4 Direct Mortality

Direct mortality may affect all 11 wildlife VCs, as is described in Section 18.7.4.

Direct mortality of wildlife could occur during the following activities (Table 18.7-11):

- vehicle-wildlife collisions;
- vegetation clearing/pit construction;
- avalanche control; and
- wildlife interactions with the transmission line.

Vehicle-wildlife Collisions

Vehicle-wildlife collisions are evaluated on the two Project access roads (the CCAR from the Mine Site to the junction with the Eskay Creek Mine road and the TCAR) and along the portion of Highway 37 that is within the RSA. The portion of Highway 37 that is evaluated for this assessment is from the highway crossing over the Ningunsaw River in the north of the RSA to the Bell I bridge at the southeast corner of the RSA.

Table 18.7-11. Potential Effects that May Cause Direct Mortality to Wildlife Valued Components

Wildlife Valued Component	Potential Effects that May Cause Direct Mortality			
	Vehicle-Wildlife	Vegetation Clearing	Avalanche Control	Transmission Line
Moose	X			
Mountain goats	X		X	
Grizzly bears	X			
Black bears	X	X		
American marten	X	X		
Hoary marmots	X	X		
Bats		X		
Waterfowl	X	X		X
Raptors	X	X		X
Forest and alpine birds	X	X		
Western toads	X	X		

Records of mortalities of several wildlife species along the highway are kept by the Province of BC (Sielecki 2004). This information is compiled in the Wildlife Accident Reporting System (WARS) database, which is maintained by the British Columbia Ministry of Transportation and Infrastructure. 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 kilometre references (Sielecki 2010). Therefore, although WARS data are the best available information, they must be interpreted with caution.

Vehicle-wildlife collisions are cited as a significant cause of direct mortality for a variety of wildlife species, in some cases with population-scale consequences (Vieira 1999; Kerley et al. 2002; Deem and Emmons 2005). Collisions between large animals and vehicles can also have implications for human safety. Many wildlife species in BC are more susceptible to vehicle collisions during certain times of the day and year. Some species are more active at dawn and dusk (crepuscular), while others are more active at night (nocturnal). Most casualties occur near water sources where shrub and vegetation cover is greater, at curves in the road, and during seasons corresponding to highest animal activity (i.e., breeding and dispersing; Drews 1995; Romin and Bissonette 1996; Main and Allen 2002; Nielsen, Anderson, and Grund 2003; E. Lee et al. 2004; Saeki and MacDonald 2004; Guter et al. 2005; Hell et al. 2005). Wildlife may also be attracted to roads due to de-icing salts, attractive roadside vegetation, and as a travel corridor, further increasing the likelihood of vehicle-wildlife interactions. In some cases, animals can become trapped on plowed roads where high snowbanks prevent exit from the road surface.

The proposed Project will contribute to traffic volumes on Highway 37, as well as new access roads. Currently, the main users of Highway 37 are residents of Terrace, Gitwangak (Kitwanga), Gitlaxt'aamiks (New Aiyansh), Nass Camp, Bob Quinn, Bell II, Telegraph Creek, Dease Lake, and neighbouring communities; visiting recreational users (e.g., hunters, park visitors,

heli-skiers); and mining and forestry vehicles. During construction, Project-related vehicle traffic will average 14 one-way trips/vehicles per day along the TCAR and eight per day along the CCAR. This will increase to 82 one-way trips per day along the TCAR during operation, and decrease along the CCAR to three vehicles per day (Table 18.7-7); therefore, potential vehicle interactions with wildlife could occur. During operation, 85 trucks per day (82 from TCAR and three from CCAR for a total of 85) will be travelling along Highway 37 within the RSA.

Vegetation Clearing

During construction, some wildlife species such as black bears, American marten, hoary marmots, bats, birds, and western toads may be susceptible to direct mortality caused by vegetation clearing. Removal of mature trees that support marten and black bear dens may cause mortality to these species during the denning period (generally between October and April). Clearing trees or vegetation that support active bird nests during construction could also cause direct mortality of bird species. Bird nests are sensitive elements protected under the *Wildlife Act* (1996c) and *Migratory Birds Convention Act* (1994). Clearing riparian vegetation and moving large construction machinery near or within riparian areas could cause direct mortalities of western toads/toadlets and other amphibians.

Avalanche Control

During the winter, mountain goats occupy habitat in or near areas prone to avalanche. Natural avalanches may result in direct mortality to mountain goats, although this is relatively uncommon (BC MOE 2010a). Avalanche control measures along the access roads and in the Mine Site will increase the frequency of avalanches and may put goats at a higher risk of avalanche-associated mortality.

Transmission Line

Transmission lines may cause direct mortality of birds through collisions and electrocutions (Savereno et al. 1996; Bevanger 1998; Ledger and Hobbs 1999). Birds with larger wingspans, such as raptors and swans, are most vulnerable to collisions because they are less manoeuvrable (APLIC 2006). Collisions are recognized as a cause of waterfowl mortality (Manitoba Hydro 1995) with many species of ducks vulnerable due to their high flight speed, wing loading, and their behaviour of travelling in flocks (Sundararajan and Gorur 2005). Effects may be greatest when transmission lines are located near wetlands, lakes, and other habitats where birds congregate in winter, when breeding, or migrating. In addition, some wildlife may be attracted to vegetation re-growth in the ROW, such as bears and moose, and may be at an increased risk for vehicle collisions from the adjacent TCAR.

18.7.4.1 Mitigation for Direct Mortality

Vehicle-related mortality will be mitigated through the following measures along Project roads and/or Highway 37:

- communicating locations of wildlife observed along roads (Project access roads and highways);
- yielding to wildlife observed along roads (Project roads and highways);

- appropriate provisions will be made along Project roads to facilitate wildlife (e.g., toad) movement without risk of collisions;
- creating breaks in snowbanks along plowed Project roads;
- providing signage along Project roads in high-value wildlife areas or known wildlife travel corridors to warn vehicle operators of the potential to encounter wildlife;
- designing and placing transmission structures to minimize strikes and electrocutions, following guidelines for bird protection (APLIC 2006);
- cutting vegetation low at Project road crossings to ensure visibility of animals; and
- scheduling vegetation clearing activities outside of sensitive periods (e.g., breeding from April 1 to July 31 for general breeding birds), where feasible, and conducting pre-clearing surveys before vegetation is removed during the nesting season.

18.7.4.2 Potential for Residual Effects

Of the 11 wildlife VCs, 10 (moose, mountain goats, grizzly bears, black bears, American martens, hoary marmots, raptors, wetland birds, forest and alpine birds, and western toad) have the potential for residual effects due to direct mortality, as described in the following sections (Table 18.7-12).

18.7.4.3 Ungulates (Moose and Mountain Goats): Potential Residual Effects due to Direct Mortality

This assessment focuses on two ungulate species: moose and mountain goat. There could be potential effects on moose of direct mortality from vehicle collisions in areas where roads used by the Project overlap high-quality moose habitat. There have been very few incidents of goat mortality attributable to vehicles (Singer 1978; Sielecki 2004), primarily due to the lack of high velocity roads in their natural range (BC MOE 2010a). Mortality associated with winter terrain management (avalanche control) is, however, assessed for mountain goats.

18.7.4.3.1 Moose

Vehicle Collisions

Direct mortality of moose caused by vehicle collisions may occur during the proposed Project construction, operation, and closure phases. Vehicle-moose collisions may occur along Project roads including the CCAR and TCAR, as well as along Highway 37.

In general, vehicle-moose 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; and with moose density (Seiler 2005).

Table 18.7-12. Potential Residual Effects on Wildlife and Wildlife Habitat Valued Components due to Direct Mortality

Valued Component	Timing Start	Project Area(s)	Project Component(s)	Description of Effect due to Project Component(s)	Type of Project Mitigation	Project Mitigation Description	Potential Residual Effect	Description of Residuals
Moose	Construction	PTMA and Mine Site	TCAR, CCAR, Highway 37	Moose/vehicle collisions may occur along Project roads including the CCAR, TCAR, the Eskay Creek Mine road, as well as along Highway 37.	Management Practices, Monitoring and Adaptive Mangement	Prevent the seeding or planting of attractive vegetation near roads; maintain ROW clearing; speed limits implemented and monitored; road signs warning of moose along road; additional precautions taken during high moose activity hours (crepuscular hours); monitoring and adaptive management of wildlife-vehicle interactions.	Yes	The effect of direct mortality is predicted to result in a residual effect on moose. High quality moose habitat occurs along the access road corridors; therefore individual moose may be killed as a result of collisions with Project vehicles despite mitigation. The highest potential for moose/vehicle interactions will be along the TCAR and Highway 37, particularly during the winter, given the high density of moose in the vicinity of these road corridors.
Mountain Goat	Construction	PTMA and Mine Site	CCAR, Mine Site roads at high elevation. Avalanche control along Sulphurets access road, throughout the Mine Site, near the pits, TMF, and TCAR.	Direct mortality due to collisions with vehicles and incidental mortality during avalanche control activities.	Management Practices, Monitoring and Adaptive Mangement	Speed limits implemented and monitored; road signs warning of mountain goats along road; additional precautions taken during high mountain goat activity hours; monitoring and adaptive management of wildlife-vehicle interactions; partial reclamation of CCAR post-closure; an avalanche hazard plan will be produced in consultation with the BC MFLNRO, or the applicable government agency, to minimize the effects of avalanche control on mountain goats.	Yes	Individual mountain goats may be killed as a result of collisions with Project vehicles despite mitigation, although small likelihood. There is also a possibility that mountain goats may be killed as a result of avalanche control in high quality habitat and within approved UWRs. Despite mitigation, residual effects are anticipated for mountain goats due to direct mortality.
Grizzly Bear	Construction	PTMA and Mine Site	TCAR, CCAR, Highway 37	The potential source of grizzly bear mortality in association with the Project will be vehicle collisions along the access roads, haul roads, and Highway 37.	Management Practices, Monitoring and Adaptive Mangement	Prevent the seeding or planting of attractive vegetation near roads; maintain ROW clearing; speed limits implemented and monitored; road signs warning of bears along road; additional precautions taken during high bear activity hours; partial reclamation of CCAR post-closure; monitoring and adaptive management of wildlife-vehicle interactions.	Yes	Grizzly bears may be killed as a result of collisions with Project vehicles. Despite mitigation, a residual effect is predicted for grizzly bear direct mortality.
Black Bear	Construction	PTMA and Mine Site	TCAR, CCAR, Highway 37, TMF, RSFs, Project infrastructure in denning habitat	The potential sources of black bear mortality in association with the Project will be vehicle collisions along the access roads, haul roads, and Highway 37, and destruction of active black bear den sites.	Management Practices, Monitoring and Adaptive Mangement	Prevent the seeding or planting of attractive vegetation near roads; maintain ROW clearing; speed limits implemented and monitored; road signs warning of bears along road; additional precautions taken during high bear activity hours; partial reclamation of CCAR post-closure; monitoring and adaptive management of wildlife-vehicle interactions; clearing outside of the denning period or if this is not possible, pre-clearing surveys for dens in identified denning habitat.	Yes	Black bears may be killed as a result of collisions with Project vehicles despite adherence to speed limits and pre-clearing surveys for den sites. Despite mitigation, a residual effect is predicted for black bear direct mortality.
American Marten	Construction	PTMA and Mine Site	TCAR, CCAR, Highway 37, TMF, RSFs, Project infrastructure in denning habitat	Direct mortality due to destruction of active dens during construction during the breeding season and due to marten/vehicle collisions along access roads and the highways.	Management Practices, Monitoring and Adaptive Mangement	Timing construction outside of the breeding season and/or conduct pre-clearing surveys for dens; speed limits implemented and monitored; additional precautions taken during high marten activity hours; monitoring and adaptive management of wildlife/vehicle interactions.	Yes	Incidental mortality may occur as a result of vehicle collisions or den disturbance. Although population level effects are not anticipated, residual effects are predicted despite mitigation.
Hoary Marmot	Construction	Mine Site	Kerr, Mitchell, and Sulphurets pits	Direct mortality due to destruction of active colonies during construction of the Mine Site, particularly the pits.	Management Practices	There are limited ways to mitigate mortality of marmots during construction of the pits and roads. Translocation of wild animals to alternate areas is a labour intensive and expensive technique that has been met with limited success (Armstrong and Seddon 2008; Massei et al. 2010); therefore, translocation may not be a viable option to prevent mortality of marmots as a result of construction and operation.	Yes	Mortality may affect colonies; population level effects not anticipated. However, a residual effect is anticipated for hoary marmots as a result of direct mortality.
Bats	Construction	PTMA and Mine Site	TMF, TCAR, CCAR, RSFs	Direct mortality during construction vegetation clearing	Management Practices	Mitigation covered during pre-clearing surveys for bear and marten dens in mature forests	No	Incidental mortality may occur; population level effects not anticipated. No residual effect is anticipated.
Raptors	Construction	PTMA and Mine Site	TMF, TCAR, CCAR, RSFs, transmission line	Direct mortality during construction vegetation clearing and due to collisions with the transmission line.	Alternative, Management Practices, Monitoring and Adaptive Mangement	Clearing of vegetation will occur outside the breeding period if possible; if not feasible in all instances, pre-clearing surveys will be conducted to monitor for nests during the breeding period. Implementation of design features to reduce the risk of collisions and electrocutions with the transmission line, including increasing visibility of the line; prevent raptor nesting on posts; monitoring for effects and adaptive management where areas with a higher incidence of bird strikes are identified.	No	Incidental mortality may occur as a result of construction or collisions with the transmission line; however, population level effects not anticipated.
Wetland Birds	Construction	PTMA and Mine Site	TMF, TCAR, CCAR, RSFs, transmission line	Direct mortality during construction vegetation clearing, direct mortality due to collisions with transmission line	Management Practices, Monitoring and Adaptive Mangement	Clearing of vegetation outside the breeding period if possible; if not feasible in all instances, conduct pre-clearing surveys to monitor for nests during the breeding period. Implementation of design features to reduce the risk of collisions and electrocutions with the transmission line, including increasing visibility of the line near wetlands, monitoring for effects and adaptive management where areas with a higher incidence of bird strikes are identified.	No	Incidental mortality may occur as a result of contruction or collisions with the transmission line; however, population level effects not anticipated.
Forest and Alpine Birds	Construction	PTMA and Mine Site	TMF, TCAR, CCAR, RSFs	Direct mortality during construction vegetation clearing, and mortality of small flocking birds due to collisions with vehicles.	Management Practices, Monitoring and Adaptive Mangement	Clearing of vegetation outside the breeding period if possible; if not feasible in all instances, conduct pre-clearing surveys to monitor for nests during the breeding period. Follow spead limits on roads.	No	There is a potential residual effect of direct mortality for raptors, wetland birds, and forest and alpine birds. Some mortality due to construction activities or due to collisions with vehicles is expected, particularly in high use areas, such as near large waterbodies, wetlands, or gullies.
Western Toad	Construction	PTMA and Mine Site	TMF, TCAR, CCAR, RSFs	Direct motality could occur due to impacts from heavy machinery involved in Project-related construction an operation, or near roads close to wetlands during the breeding season.	Management Practices, Monitoring and Adaptive Mangement	Pre-clearing surveys conducted on identified ponds that would likely be affected by construction during the breeding (May) and emergence periods (mid-July to mid-August) to identify western toad breeding ponds. Use of machinery and associated construction activities (i.e., tree felling) would be avoided in identified breeding ponds during those periods. During operation, appropriate protection for toads will be provided to minimize collisions with vehicles, which may include toad tunnels or other effective mitigation. The effectiveness of mitigation measures, if implemented, will be monitored.	Yes	The effect of direct mortality is predicted to result in a residual effect on western toads. Despite mitigation, residual effects are anticipated for western toads due to direct mortality.

During the growing season (spring, summer, and fall), moose may frequent edge habitats, such as road verges, because they contain high-quality forage and provide easy movement. During the winter, access roads will require snow removal. Moose will preferentially use plowed roads when the winter snowpack is deep. High snowbanks of 60 cm or more (Peek et al. 1982) can trap moose on access roads, putting them at greater risk of vehicle strikes. At relatively low traffic densities, increases in traffic are predicted to increase the number of moose mortality from vehicle strikes (Seiler 2005). For example, in Norway, moose vehicle collisions increased from 0.07 moose per 10 km of road in 1977 to 0.19 moose per 10 km of road in 2007 while traffic increased by 1.9 times during the same time period (Rolandsen et al. 2011).

Vehicle-moose collisions occur throughout the species range and are highlighted as a problem from both wildlife management and traffic safety perspectives (Sielecki 2004; R. V. Rea et al. 2006). Evidence suggests that vehicle-moose collisions are less severe when speed limits are below 70 km/hr (Lavsund and Sandergren 1991). Along highways in the Bulkley-Stikine District (District 10, which includes highways 16, 35, 37, 37A, and 118 and is approximately 201,700 km² in size), moose were the most commonly recorded road accident between 1988 and 2007 (1,022 moose collisions), representing 38% of all wildlife collision, and an average of approximately 51 moose/year in the entire region (Sielecki 2010).

Within the Bulkley-Stikine District, the WARS database is subdivided into highway Landmark Kilometre Inventory (LKI) segments. These data may under-represent 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 portion of Highway 37 within the RSA is included in approximately 60 km of LKI segments 3730 (64% of the LKI segment), and approximately 17 km of 3740 (LKI 3740 extends north from Bell II to Burrage, approximately 66 km north of the RSA boundary). LKI segment 3740 is not included in this assessment, as the RSA includes only 20% of this segment. Wildlife accidents in LKI segment 3730 along Highway 37 between 1991 and 2010 consists primarily of moose (N = 27; average 1.42 moose/year; BC MOTI 2011b), the majority (N = 11; 41%) of which occurred in January (BC MOTI 2011b). Studies of highway vehicle-moose collisions in Norway calculated a rate of 0.19 vehicle-moose collisions per 10 km of road (Rolandsen et al. 2011). Using this rate for the 77 km of Highway 37 within the RSA would result in an average of 1.46 vehicle-moose collisions per year, which agrees with the 1.42 moose/year listed in the WARS database. Therefore, for this assessment, an average of 0.19 vehicle-moose collisions per 10 km of road is used.

Traffic along TCAR (33 km) and CCAR (35 km) combined (68 km) could result in 1.3 vehicle-moose collisions per year, assuming 0.19 vehicle-moose collisions per 10 km of road. However, the rate of vehicle-moose collisions is heavily dependent on the speed of vehicles involved, with mortality rate increasing above 70 km/hr (Seiler 2005). Hence, vehicle-related mortality along the TCAR and CCAR is expected to be lower per km than on Highway 37.

Residual Effects for Moose due to Direct Mortality

Direct mortality from vehicle-moose collisions is predicted to result in a residual effect on moose. The highest potential for vehicle-moose interactions will be along Highway 37 and the TCAR, particularly during the winter, because of the high density of moose in these areas. This effect may be magnified by moose using the plowed road as a movement corridor during

the winter; thus increasing the chances of a vehicle-moose collision. Vegetation regrowth on roadsides and the ROW will also attract moose and increase the collision risk during the summer.

The potential effects of vehicle-related moose mortality will be mitigated by adherence to a Wildlife Management and Monitoring Plan (Section 26.21) and Traffic and Access Management Plan (Section 26.25). Mitigation along the TCAR and CCAR will include adherence to speed limits, yielding to wildlife observed on roadways, creating breaks in snowbanks along the plowed roads, and providing signage in high-value wildlife areas or known wildlife travel corridors. In addition, vegetation will be kept low along the access roads to ensure drivers see wildlife along the sides of the roads, if they are present. After mitigation, it is anticipated that vehicle-moose collisions may still occur resulting in direct mortality due to increased traffic; therefore, residual effects of direct mortality on moose are anticipated.

18.7.4.3.2 Mountain Goat

Vehicle Collisions

In contrast with moose, there is a lower likelihood of vehicle-related mortality for mountain goats on Project roads (access, haul, and service roads) or Highway 37. These transportation corridors are largely located at elevations below suitable goat habitat, thereby limiting the possibility of goats being present on or near roads. Mountain goat sensitivity to disturbance may also ensure that they remain a safe distance away from transportation and development infrastructure. This assessment is supported by the absence of reported vehicle incidents involving mountain goats along highways in the Bulkley-Stikine District from 1983 to 2007 (Sielecki 2004, 2010).

However, goats may be at risk of vehicle collisions in areas where proposed roads are located at high elevation near or within suitable goat habitats, such as high-quality summer and winter habitats, within provincially-designated UWR, or along traditional trails to mineral licks. These areas may include the entrance of Sulphurets Canyon and around the mouth of Joe Mandy Creek in the Mine Site, and along the Snowslide Range and isolated mountain blocks within the PTMA.

Avalanche Control

During winter, mountain goats occupy habitat in or below areas prone to avalanches, including alpine areas above the Mine Site, CCAR, TCAR, and the PTMA. There are recorded accounts of mountain goat being killed in avalanches, although it is not considered a frequent cause of mortality (e.g., Macgregor 1977; Chadwick 1983). Due to the increase in avalanche control, and consequently in the number of avalanches in the LSA, it is therefore possible that goats may be incidentally killed during avalanche control activities. The numbers of goats involved in this type of mortality cannot be predicted; however, it is expected that these events will be infrequent. Goats may also abandon habitat due to disturbance caused by avalanche control (i.e., the noise associated with blasting and the resulting avalanches; Section 18.7.5, Indirect Mortality).

Residual Effects for Mountain Goats due to Direct Mortality

The effect of direct mortality is predicted to result in a residual effect on mountain goats. The potential effects of vehicle-related wildlife mortality will be mitigated for mountain goat by adherence to a Wildlife and Wildlife Habitat Management Plan (Section 26.21.1) and Wildlife

Effects Monitoring Program (Section 26.21.3). Mitigation will include adherence to speed limits, yielding to wildlife observed on roadways, creating breaks in snowbanks along plowed access roads, and providing signage in high-value wildlife areas or known wildlife travel corridors. In addition, the salt content of road grit will be minimized, as they may act as attractants (Section 18.7.7).

Avalanche control may result in incidental death of mountain goats. Incidental observations of mountain goats during avalanche control procedures will be recorded whenever possible, to provide information on the locations of goats in relation to avalanche terrain. However, no mitigation measures can be implemented, e.g., delaying avalanche blasting until goats have moved out of the area, as this poses a safety risk to the Project and Project personnel. Monitoring of the mountain goat population in the RSA will form an important component of the Wildlife and Wildlife Habitat Management Plan (Section 26.21.1) and Wildlife Effects Monitoring Program (Section 26.21.3), as well as monitoring at the toe of avalanches in the spring to record mortality, where possible. Despite mitigation, residual effects are anticipated for mountain goats due to direct mortality.

18.7.4.4 Bears: Potential Residual Effects due to Direct Mortality

The potential sources of bear mortality in association with the Project will be vehicle collisions along Project roads (access, haul and service roads) and Highway 37, and destruction of active black bear dens during vegetation clearing. Vehicle collisions will be of concern for both grizzly and black bears, whereas the destruction of den sites was evaluated for black bears, which den in trees that may be removed during construction.

Vehicle Collisions

Vehicle collisions were considered for both grizzly and black bears. Direct mortality caused by vehicle collisions may occur along Project roads (access, haul, and service roads) and Highway 37. During 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). There also appears to be a seasonal trend, with the majority of strikes occurring during 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 29 reported vehicle accidents with bears in the LKI segment 3730 along Highway 37 within the RSA (average 1.5 bears/year; BC MOTI 2011b). The majority (45%) of bear collisions occurred in September (N = 13).

Project-related vehicles will add to traffic on public highways and Project roads, increasing the probability of vehicle-bear collisions. Bears may be at elevated risk of vehicle collision in areas with higher speed limits and in high-quality habitats, as identified by the habitat suitability mapping ([Appendix 18-B](#)). High-value spring, summer, and fall foraging habitat occurs along both the TCAR and CCAR ([Appendix 18-B](#); McElhanney 2007a). The Treaty Creek Valley is considered high-quality habitat, and is a proposed grizzly bear WHA, due to good quality early seral vegetation, wetlands, and salmon spawning in the creek during the late summer and fall ([Appendix 18-B](#)). Bears are likely to occupy this valley and be at risk of vehicle-bear collisions,

based on the high-quality habitat in the fall and the results of the DNA baseline study ([Appendix 18-C](#)). However, the rate of vehicle-wildlife collisions is heavily dependent on the speed of vehicles involved, with mortality rate increasing above 70 km/hr (Seiler 2005). Hence, vehicle-related mortality along the Project roads is expected to be lower per km than on Highway 37. Other attractants to the road could include vehicle-killed wildlife or waste from vehicles.

Vegetation Clearing

Direct mortality may also occur through felling of trees with black bear dens. Cavities in old-growth structures, including large old trees, stumps, root balls, and logs are often selected as suitable den sites (H. Davis 1996; Van Damme et al. 2007; Baldwin and Bender 2008). There is high value black bear denning habitat (i.e., areas of moist, mature, and old-growth forests within the ICH or CWH BEC zones, including large diameter cottonwood, fir and spruce within riparian and riparian-associated habitats) along the CCAR and TCAR, as well as within the PTMA. Clearing for roads and other infrastructure has the potential to destroy active den sites for black bears. Clearing in habitats which support trees that may be high-quality dens will be conducted outside of the denning season if possible, or pre-clearing surveys will be conducted.

Direct mortality from tree felling is not considered a potential effect on grizzly bears, which typically den at higher elevations than the valley bottoms where the roads are located. Grubbing and soil collection will occur at higher elevations where grizzly bears are known to den and will be conducted outside of the grizzly bear denning period.

Residual Effects for Bears due to Direct Mortality

The effect of direct mortality is predicted to result in a residual effect on grizzly and black bears. Potential Project-related vehicle interactions with bears will be mitigated through adherence to road and traffic signs, and cutting vegetation low along access road ROWs to ensure visibility of animals. To minimize potential mortality from tree felling, pre-clearing surveys to identify and avoid active black bear dens will be conducted within high-quality bear denning habitat (i.e., areas of moist, mature and old-growth forests within the ICH or CWH BEC zones, including large-diameter cottonwood, fir, and spruce along riparian and riparian-associated habitats) prior to any logging during the denning period (December to April; Section 26.21). If an active den site is identified, the tree will not be felled and a suitable buffer zone (50 m minimum) will be maintained during the denning period, or BC MFLNRO (or the appropriate governing agency) will be contacted for guidance.

Despite implementation of mitigation measures, the possibility of grizzly and black bear collisions with Project vehicles during construction and operation may occur. A residual effect is predicted for grizzly bear direct mortality. After mitigation for black bears, residual effects are also anticipated due to the combination of vehicle collisions and potential den disturbance.

18.7.4.5 American Marten: Potential Residual Effects due to Direct Mortality

Direct mortality of American marten could occur as a result of vehicle interactions and tree felling during construction and operation. Specifically, during the course of clearing for construction, the Project may remove old-growth trees that are used by denning American marten. There is also potential for vehicle collisions with marten along Project roads.

Vehicle Collisions

Marten will be susceptible to vehicle strikes during foraging periods while hunting along the ground. Marten foraging activity patterns vary seasonally. During winter, martens predominately hunt during the night; during the snow-free months, marten may switch to a diurnal hunting pattern (Zielinski, Spencer, and Barrett 1983; Zielinski 2000). However, the risk of American marten to vehicle collisions is anticipated to be relatively low along Project roads because marten tend to avoid roads and areas that lack overhead cover (Poole et al. 2004). This conclusion is supported by the low reported mortality rates of marten along low and high use highways, with three vehicle-marten collisions in the Bulkley-Stikine District collected between 1983 and 2007 (Sielecki 2004, 2010). Similarly, in Banff National Park, American marten made up 2% of small vertebrate road kills (Clevenger, Chruszcz, and Gunson 2003). Therefore, marten mortality due to vehicle collisions is expected to be an infrequent event.

Vegetation Clearing

Female American marten select sites in old-growth trees, hollow logs, and underneath rocks for the birth of their young (Ruggiero et al. 1994). Typically, young are born in late March (Powell, Buskirk, and Zielinski 2003). Female martens usually move young to a second den site (maternal den) during the period following parturition (Powell, Buskirk, and Zielinski 2003). Young are able to leave the den site in late spring after approximately 50 days, although they depend on parental care for several more weeks (Ruggiero et al. 1994). Therefore, Project infrastructure and access road preparation activities such as felling old-growth trees (e.g., large cottonwoods and/or spruce trees) and removing coarse woody debris could cause incidental mortality of female martens or females and their offspring if these activities are scheduled during the birthing and rearing periods.

Residual Effects for American Marten due to Direct Mortality

The effect of direct mortality is predicted to result in a residual effect on American marten. To prevent direct mortality of American martens, site clearing activities in highly suitable denning habitat (low elevation older growth forests) will be scheduled outside of the birthing and rearing periods (March to May), where possible. If unfeasible, pre-clearing surveys should be conducted prior to clearing activities to identify active den sites. To limit marten mortality along Project roads, speed limits will be implemented. Marten may become diurnal during the summer; however, a vehicle-marten interaction can be more easily avoided during daylight hours. With mitigation, residual effects are still predicted. However, Project-related mortality is unlikely to contribute to population-level effects on marten.

18.7.4.6 Hoary Marmot: Potential Residual Effects due to Direct Mortality

There are two predicted avenues of direct mortality of hoary marmot during construction and operation: vehicle collisions with marmots along roads and destruction of marmot burrows during access road construction and pit excavations. Direct mortality effects are only expected to occur in high elevation areas (Mine Site) as marmots are an alpine-dwelling species.

Vehicle Collisions

The Ted Morris Creek road, the CCAR, and TCAR intersect areas modelled as high-quality hoary marmot habitat and areas where active colonies have been recorded ([Appendices 18-A and 18-B](#)).

Hoary marmots occupy relatively small home ranges (approximately 13.5 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, there is a reduced chance that these animals, if present, will cross the haul roads, the Ted Morris Creek road, or the CCAR and TCAR, thereby reducing the risk of vehicle interactions. These predictions follow from the data gathered from the highways in the Bulkley-Stikine District over 24 years, where only two marmots are reported struck on roads (Sielecki 2004, 2010).

Vegetation Clearing/Pit Construction

The Kerr, Mitchell, and Sulphurets pits and their supporting road networks will overlap identified marmot colonies ([Appendix 18-A](#)). Two marmot colonies were identified directly overlapping Project infrastructure associated with the pit area; these two would be directly impacted during operation. Additional marmot habitat and colonies occur within a 300-m buffer of the Project footprint, and new colonies may become established between baseline surveys and construction. The number of marmots per colony is variable. One study reported that marmot social groups can contain 2 to 30 or more individuals (Karels, Koppel, and Hik 2004). Therefore, the number of animals removed during development of the Mine Site cannot be accurately predicted.

Residual Effects for Hoary Marmots due to Direct Mortality

The effect of direct mortality is predicted to result in a residual effect on hoary marmots. There are limited ways to mitigate mortality of marmots during construction of the pits and roads. Translocation of wild animals to alternate areas is a labour-intensive and expensive technique that has met with limited success (Armstrong and Seddon 2008; Massei et al. 2010); therefore, translocation may not be a viable option to prevent mortality of marmots as a result of construction. Despite mitigation, a potential residual effect of direct mortality due to vegetation clearing and pit construction is predicted for hoary marmots; however, the mortality is not expected to result in a population-level effect for marmots in the region.

18.7.4.7 Bats: Potential Residual Effects due to Direct Mortality

Vegetation Clearing

The primary source of direct mortality identified for bats is incidental destruction of cave or tree roosts during vegetation clearing and Project construction. Day roosts of bats species in the RSA (e.g., little brown myotis and western long-eared myotis) are typically found in tree cavities and crevices, or beneath exfoliating bark in both living trees and snags (Nagorsen and Brigham 1995).

The sizes of roosts are variable; day and night roosts tend to be smaller while nursery roosts may support tens to hundreds of bats (Nagorsen and Brigham 1995; Kunz and Lumsden 2003). Large roosts are unlikely to occur in the RSA due to the colder temperatures in northern BC (Kalcounis and Hecker 1995). Therefore, incidental destruction of bat roosts due to vegetation clearing would not likely affect a large number of bats.

Residual Effect for Bats due to Direct Mortality

Mitigation measures suggested for black bears and marten (pre-clearing surveys of old-growth trees) will also mitigate the potential for direct mortality effects on bats. See management and

mitigation for cave-based roosts in Section 18.7.1.7, Habitat Loss. After mitigation, no residual effects of mortality in association with vegetation clearing are expected for bats.

18.7.4.8 Birds: Potential Residual Effects due to Direct Mortality

The potential sources of bird mortality in association with the Project will be mortality resulting from collisions with vehicles, the destruction of active nest sites for forest birds and raptors during tree and vegetation clearing, and mortality resulting from collisions and electrocutions along the Project transmission line.

Vehicle Collisions

Direct mortality of birds, particularly flocking species such as pine siskins and crossbills, may occur because of increased traffic along the highways. Most road mortalities to these species occur during winter or early spring (Campbell et al. 1997). Carduelinae finches (i.e., 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 higher traffic volume roads can have a repelling or avoidance effect on small vertebrates, thus potentially decreasing the risk of mortality to birds on Highway 37 (Clevenger, Chruszcz, and Gunson 2003).

Vegetation Clearing

Construction activities could result in direct mortality of raptors, wetland birds, and forest and alpine birds through clearing of vegetation actively used for nesting. The habitat selected by nesting birds is described in Section 18.7.1.8, as well as a quantitative analysis of the amount that will be cleared during construction and operation. The *Wildlife Act* (1996c) specifically protects birds, their nests, and their eggs from possession, molestation, or destruction. Therefore, mitigation measures will be implemented including timing of vegetation clearing and pre-construction surveys as required.

Transmission Line

The majority of bird collisions occur in specific habitats, including next to wetlands (Bevanger 1998), between resting and foraging areas (Savereno et al. 1996), near and parallel to shores (Cooper and Day 1998), in valleys and river valleys (Bevanger 1998; Moritzi et al. 2001), and along ridge lines where soaring birds congregate on thermal updrafts (Barrios and Rodriguez 2004). Waterfowl are sensitive to collisions with transmission lines because of their poor manoeuvrability (Bevanger 1998; Cooper and Day 1998; Moritzi et al. 2001; Erickson, Johnson, and Young Jr. 2005; Barrett and Weseloh 2008). Birds with poor manoeuvrability are the most susceptible to collisions, including species with large wingspans (e.g., swans, raptors) or juveniles that have not yet mastered the flight capabilities of adults (Bevanger 1998). Poor weather and visibility may increase the frequency of collisions with transmission line infrastructure, particularly in regularly used areas (e.g., migration corridors, approach flyways to nests).

The risk of electrocution is mostly based on the type of transmission line and the configuration of electrical hardware and support structures (Lehman, Kennedy, and Savidge 2007). The KSM Project transmission line will be constructed using best management guidelines

presented by the Avian Power Line Interaction Committee (APLIC 2006) to minimize any effects on bird populations.

Residual Effects for Birds due to Direct Mortality

The effect of direct mortality is not anticipated to result in a residual effect on birds. The mitigation proposed to limit the effects of habitat loss (Section 18.7.1.8) for raptors, wetland birds, and forest and alpine birds will assist in mitigating the potential for direct mortality effects. Pre-clearing surveys for active nests would be conducted before clearing if development activities take place during the breeding season (April 1 to July 31; Section 26.21).

In addition, transmission line designs will follow established guidelines for bird protection (APLIC 2006). The frequency of bird electrocutions and collisions with the Project transmission lines and structures is expected to be rare and is not expected to adversely affect local populations. Some mortality due to collisions with vehicles and the transmission line is possible, particularly in high use areas such as near large waterbodies, wetlands, or gullies, but this mortality is not expected to adversely affect the population. Thus, a residual effect of direct mortality for raptors, wetland birds, and forest and alpine birds is not anticipated.

18.7.4.9 Western Toad: Potential Residual Effects due to Direct Mortality

Vehicle Collisions

The greatest concern for western toad populations during construction and operation will be direct mortality of adults and newly emerged terrestrial juveniles near roads and close to wetlands during the spring and late summer.

Both high- and low-traffic roads can cause mortality, particularly during breeding migrations (Lesbarrères, Lodé, and Merilä 2004) to and from breeding ponds from upland terrestrial habitat. Western toads will disperse more than 600 m from breeding sites (Rittenhouse and Semlitsch 2007). Suitable toad breeding habitat was identified along the TCAR; therefore, there is potential for toads and toadlets to be moving from breeding sites to upland areas and to access site roads.

Vegetation Clearing

Direct mortality could occur due to impacts from heavy machinery involved in Project-related construction or vehicles moving through the area. If construction is occurring during the breeding season, it may also affect toad breeding ponds due to sedimentation.

Residual Effects for Western Toads due to Direct Mortality

The effect of direct mortality is predicted to result in a residual effect on western toads. To mitigate potential direct mortality effects on toads, pre-clearing surveys will be conducted on any ponds that are identified as being affected by construction during the breeding (May) and emergence periods (mid-July to mid-August) to identify western toad breeding ponds. Use of machinery and associated construction activities (i.e., tree felling) would be avoided in identified breeding ponds during those periods. Appropriate protection for toads will be provided, which may include toad tunnels or other effective mitigation. Monitoring the effectiveness of mitigation will be part of the Wildlife Effects Monitoring Program (Section 26.21.3). Despite mitigation, residual effects are anticipated for western toads due to direct mortality.

18.7.5 Indirect Mortality

Indirect mortality, mortality due to increased access and hunting and range shifts due to disturbance are assessed for four wildlife VCs (moose, mountain goats, grizzly bears, and black bears), as described in Sections 18.7.5.1 to 18.7.5.4.

The effect of indirect mortality is not considered a potential affect for American marten, hoary marmot, bats, raptors, wetland birds, forest and alpine birds, or western toad. These seven VCs are not regularly hunted at a rate that can cause population-level effects in the RSA (Section 18.7.5).

The primary source of indirect mortality identified for wildlife VCs in association with Project development is increased hunting pressure on ungulates and bears—both legal and illegal—as a result of greater human access to the RSA.

Considerable research over the past 30 years has shown that the primary effect of new linear features (e.g., roads, transmission line clearings) on wildlife has been to increase access for recreation users and hunters (Andrews 1990; Gates 1992; Nellemann et al. 2003; Reed 2004). These effects are largest when a new road or other linear feature provides access to an otherwise inaccessible area. Effects are minimized when linear features traverse areas that are already accessible and disturbed through forestry and other development. The primary effect of increased access is increased hunting (Laurian et al. 2008).

Existing access roads occur along the Bell-Irving River and west of Highway 37 in the southeast of the RSA, where there are 62.76 m of road/km². With development of the Project, two new access corridors will be constructed: the TCAR and CCAR. The transmission line ROW will also create new access in small sections where it diverges from the TCAR alignment. These new corridors are assessed for their potential to increase access to high-quality moose, mountain goat, and bear habitat and thereby indirect mortality for the four evaluated VCs.

Hunting is regulated by the BC MFLNRO through a limited entry system. However, local population declines from hunting could occur in circumstances where new access is created, including:

- in high-quality habitat which functions as a spatial refugia for wildlife (grizzly bears and mountain goats);
- in high-quality habitat areas where environmental conditions force animals into a confined space during the winter (moose); and
- where the proposed Project would result in new access for unregulated hunters to high-quality moose habitat (as this may result in an increase of the total numbers of moose removed—including females—which has a greater effect on the population).

18.7.5.1 Mitigation for Indirect Mortality

Access management is one of the key issues identified in the Nass South SRMP and the Cassiar Iskut-Stikine LRMP. Specifically, the LRMP and SRMP both indicate strategies to minimize or avoid road construction in ungulate winter ranges (moose and mountain goat) and important grizzly bear habitat (e.g., avalanche chutes, high berry producing areas, salmon spawning

grounds). In order to minimize the need to build new roads and mitigate for potential effects to wildlife, the road location and alignment was designed to maximize the use of existing roads for access to the site. In addition, the ROW for the transmission line is designed to run parallel to the TCAR to minimize new access.

Measures to avoid effects on ungulates and bears during construction, operation, and closure will include restricting access to Project roads and only permitting traffic that is required for the Project. Access roads will be gated to prohibit the entry by non-authorized vehicles. Design of gates and security measures to control access will address the mobility of snow machines, all-terrain vehicles, and the ability of persons on foot to circumnavigate security structures. The TCAR gate will be located on the Bell-Irving River bridge crossing, eliminating the ability for hunters to circumnavigate the gate without a boat. At closure, all non-essential roads, including the CCAR, will be deactivated and traffic will be greatly reduced. The TCAR will remain open; however, access will be controlled by a manned gate through operation and closure, and access will remain controlled in perpetuity.

18.7.5.2 Potential for Residual Effects

All four wildlife VCs (moose, mountain goats, grizzly bears, and black bears) have the potential for residual effects due to indirect mortality, as described in the following sections (Table 18.7-13).

18.7.5.3 Ungulates (Moose and Mountain Goats): Potential Residual Effects due to Indirect Mortality

18.7.5.3.1 Moose

The potential source of indirect mortality identified for moose in association with Project development is an increase in hunting pressure resulting from greater accessibility to the Project area. Access management is a concern throughout the relevant land management plans (i.e., Nass South SRMP and Cassiar Iskut-Stikine LRMP).

The Project will increase access to some moose winter range habitats along the TCAR, into the high-quality moose habitat identified in the Treaty Creek Valley and moose UWR u-6-018. The CCAR will create access into moderately high-quality habitat along the Unuk River. The roads will also likely attract moose for easier movement (snow conditions) and forage production from the ROW, which will increase their vulnerability to harvest. The roads will also provide access into areas used during other seasons, including wetlands and higher elevation forage areas used in late summer/early fall. Road creation in high-quality moose habitat, particularly when roads are cleared in the winter, could also increase predator access into areas occupied by moose. This could, in turn, increase predator-induced mortality of moose.

Moose populations and hunting are regionally and provincially managed in BC by the BC MFLNRO through the quotas set for both non-Aboriginal resident trophy and subsistence hunters and through conservation enforcement.

Table 18.7-13. Potential Residual Effects on Wildlife and Wildlife Habitat Valued Components due to Indirect Mortality

Valued Component	Timing	Start	Project Area(s)	Project Component(s)	Description of Effect due to Project Component(s)	Type of Project Mitigation	Project Mitigation Description	Potential Residual Effect	Description of Residuals
Moose	Construction		PTMA and Mine Site	Treaty Creek access road and Coulter Creek access road	Increased accessibility in inaccessible landscape increasing hunting pressure on moose population	Management Practices, Monitoring and Adaptive Mangement	Controlled access (e.g., gated road); Project area designated as no hunting zone and no personal firearms permitted within project area; partial deactivation of Coulter Creek access road post-closure; agreement with First Nations on road closure.	Yes	The effect of indirect mortality is predicted to result in a residual effect on moose. The two new access roads could increase hunting pressure on moose in the study area; however, the road will be gated and controlled, reducing the possibility of unauthorized vehicle access into the area. Areas of previously inaccessible high quality moose habitat will, nevertheless, become accessible, particularly post-closure. Increased access cannot be completely avoided or mitigated, thus a potential adverse residual effect is predicted for moose during the post-closure phase.
Mountain Goat	Construction		PTMA and Mine Site	Treaty Creek access road and Coulter Creek access road, Kerr Pit, Sulphurets Pit, Mitchell Pit, helicopter traffic	Increased accessibility in pristine landscape increasing hunting pressure on mountain goat population, and indirect mortality due to consequences of shifting home range (e.g., competition, unfamiliarity)	Management Practices, Monitoring and Adaptive Mangement	Controlled access (e.g., gated road); Project area designated as no hunting zone and no personal firearms permitted within project area; partial deactivation of Coulter Creek access road post-closure. Monitoring of mountain goat distribution near the Mine Site.	Yes	The effect of indirect mortality is predicted to result in a residual effect on mountain goats. Mitigation measures to reduce the effect of increased access to mountain goats will include controlling access to Project roads. Displacement may occur due to shifts in range, potentially resulting in competition. The potential for indirect mortality as a consequence of increased hunting pressure post-closure and displacement from the mining area may still occur, thus a potential adverse residual effect is predicted for mountain goat.
Grizzly Bear	Construction		PTMA and Mine Site	Treaty Creek access road and Coulter Creek access road	Increased accessibility in pristine landscape increasing hunting pressure on grizzly bear population	Management Practices, Monitoring and Adaptive Mangement	Controlled access (e.g., gated road); Project area designated as no hunting zone and no personal firearms permitted within project area; deactivation of Coulter Creek access road post-closure	Yes	The effect of indirect mortality is predicted to result in a residual effect on grizzly bears. The two new access roads could increase hunting pressure on grizzly bears in the study area; however, the road will be gated and controlled, reducing the possibility of unauthorized vehicle access into the area. Areas of previously inaccessible high quality grizzly bear habitat will, nevertheless, become accessible, particularly post-closure. Increased access cannot be completely avoided or mitigated, thus a potential adverse residual effect is predicted for grizzly bears during the post-closure phase.
Black Bear	Construction		PTMA and Mine Site	Treaty Creek access road and Coulter Creek access road	Increased accessibility in pristine landscape increasing hunting pressure on black bear population	Management Practices, Monitoring and Adaptive Mangement	Controlled access (e.g., gated road); Project area designated as no hunting zone and no personal firearms permitted within project area; deactivation of Coulter Creek access road post-closure	Yes	The effect of indirect mortality is predicted to result in a residual effect on black bears. The two new access roads could increase hunting pressure on black bears in the study area; however, the road will be gated and controlled, reducing the possibility of unauthorized vehicle access into the area. Areas of previously inaccessible high quality black bear habitat will, nevertheless, become accessible, particularly post-closure. Increased access cannot be completely avoided or mitigated, thus a potential adverse residual effect is predicted for black bears during the post-closure phase.

A portion of the Project RSA overlaps the NWA at the southernmost point of the RSA. Nisga'a hunters in Nisga'a lands and the NWA are regulated by annual allocations set by a joint management committee composed of the Province, the Government of Canada, and Nisga'a Lisims Government. Despite the regulated nature of these hunts, an increase in access to high-quality moose habitats could increase unregulated moose hunting (illegal hunting and Aboriginal hunting) and negatively affect local moose populations, as moose populations are sensitive to unregulated harvest (Blood 2000a). Increases in access for unregulated hunting may also increase the hunting of female moose, which can have greater population consequences than regulated hunting of males during the fall.

Residual Effects for Moose due to Indirect Mortality

The effect of indirect mortality is predicted to result in a residual effect on moose. The CCAR and TCAR could increase hunting pressure on moose in the RSA; however, the road will be gated, staffed, and controlled, reducing the possibility of unauthorized vehicle access into the area. The TCAR gate will be located on the Bell-Irving River bridge crossing, preventing hunters from circumnavigating the gate without a boat. Project employees and contractors will be prohibited from bringing personal firearms and weapons to work (Wildlife Management and Monitoring Plan, Section 26.21). Areas of previously inaccessible high-quality moose habitat will, nevertheless, become accessible. Increased access cannot be completely avoided or mitigated, thus a potential adverse residual effect is predicted for moose.

18.7.5.3.2 Mountain Goat

The potential sources of indirect mortality identified for mountain goat in association with Project development is an increase in hunting pressure resulting from greater accessibility to the Project area.

Mountain goats are very sensitive to overharvest (Blood 2000b; Festa-Bianchet and Côté 2007). The two proposed access roads may provide new access to alpine areas (particularly BAFA BEC zone) for goat hunters. Alpine areas near Sulphurets and Treaty creeks contain highly suitable winter and summer habitat, including established UWR (#U-6-002), that are inhabited by a number of mountain goats ([Appendix 18A](#) and [18B](#)). The roads also put mountain goat habitat within a 1 km hike of hunters during all seasons.

Residual Effects for Mountain Goats due to Indirect Mortality

The effect of indirect mortality is predicted to result in a residual effect on mountain goats. Mitigation measures to reduce the effect of increased access to mountain goats will include controlling access to Project roads. Access roads will be gated and radio-controlled, reducing the possibility of unauthorized access into the area. Project employees and contractors will be prohibited from bringing personal firearms and weapons to work (Wildlife Management and Monitoring Plan, Section 26.21). The potential for indirect mortality as a consequence of increased hunting pressure may still occur due to creating access into BAFA habitat, thus a potential adverse residual effect is predicted for mountain goats.

18.7.5.4 Bears: Potential Residual Effects due to Indirect Mortality

The potential source of indirect mortality identified for grizzly and black bear in association with Project development is an increase in hunting pressure resulting from greater accessibility to the Project area. The RSA overlaps three grizzly bear population units. The western part of the RSA is within the Edziza-Lower Stikine, which in 2012 was estimated to contain 398 grizzly bears. The eastern portion of the RSA is within the Upper Skeena-Nass unit (755 grizzly bears), while the south and central RSA is within the Stewart unit (358 bears). All of these management units are listed as containing viable populations that are open to hunting (Hamilton, Heard, and Austin 2004; Hamilton 2012). Although hunting in this area appears to be sustainable, the TCAR and CCAR may open up an area that, to date, has been relatively inaccessible.

Indirect mortality of bears as a result of roads and increased hunting pressure is considered a greater concern than direct mortality from vehicle strikes (Ross 2002). Access allows for various human activities to be easily conducted further into formerly inaccessible habitats, bringing humans and bears into closer contact. Within the Central Rockies Ecosystem, for example, 90% of known human-caused grizzly bear mortalities in Alberta, and 56% in BC occurred within 500 m of a road or 200 m of a trail (Benn, Jevons, and Herrero 2005). During the course of the wildlife baseline studies (2008 to 2009), six grizzly bears were harvested within the RSA, all within 6 km of Highway 37 in the northeast of the RSA ([Appendix 18.C](#)). The road access created by industrial activities within interior BC grizzly bear habitat is considered a greater threat to the bears than direct habitat change caused by the industrial activities themselves (Ciarniello 2006).

The TCAR (including Wildlife Habitat Area WHA-6-282 for grizzly bears), and the CCAR will create new access to formerly inaccessible or difficult to access areas, including the Unuk River and along Treaty Creek. Increased access into high-quality bear habitat will increase hunting pressure by hunters travelling via truck, all-terrain vehicles, or snowmobile in late spring. Both grizzly and black bear will be attracted to the road, especially in spring when vegetation associated with the ROW will be most attractive. This increased access could have a negative effect on grizzly and black bear populations if hunter access is effectively increased or expanded to cover important areas for bear populations.

Regulated hunting is focused on male grizzly bears; however, females and males are difficult to differentiate, resulting in accidental kills of females by hunters. In addition, female grizzly bears are sometimes killed through unregulated hunting and through poaching. Grizzly bears are particularly prized by poachers and poaching continues to be an ongoing problem for this species in BC (Blood 2002). In addition, poaching black bears for their gall bladders, which are used in Chinese traditional medicines, is lucrative (Nowlan 1996) and represents 30 to 50% of the annual bear hunt in BC (Nowlan 1996, Northwest Wildlife Preservation Society).

More bears are killed each year when hunters defend a carcass during an ungulate hunt than are killed during permitted legal hunting. Out of a study population of 30 grizzly bears in central-eastern BC (Parsnip River) that were radio-tracked from 1998 to 2003, 10 grizzly bears died from human-caused mortality (Ciarniello 2006). Only 33% of these mortalities were legal permitted kills, the remaining 67% were either non-permitted or killed as problem wildlife. Five of the bears were killed by hunters defending themselves, their property, or a carcass of

another species. Four of the five non-permitted kills were also unreported despite compulsory inspection and reporting required by the BC MOE (2009). Hence, the real rate of bear mortality may be three times higher than the permitted hunting kills.

Residual Effects for Bears due to Indirect Mortality

The western portion of the RSA contains two-thirds of the 31 bears observed during baseline studies. This accounts for approximately 5% of the grizzly bear population in the Edziza-Lower Stikine management unit. The eastern RSA contains approximately 10 bears, which is 1.3% of the Upper Skeena-Nass management unit. Given that sustainable harvest can be carried out at 3% of the total population, virtually all of the bears in the RSA could be removed before a threshold was passed for these two management units.

However, for the grizzly population within the RSA, the effect of indirect mortality is predicted to result in a residual effect on grizzly and black bears. Areas of important habitat, including proposed grizzly bear WHAs (Section 18.1.10.2) and important salmon spawning reaches, were considered when developing roads, where practicable. The Nass South SRMP (BC MFLNRO 2012b) suggests a target buffer of 150 m between permanent roads and high-value grizzly bear habitat. The Project access roads will be gated and controlled, reducing the possibility of unauthorized access into the area, and some parts of the roads will be decommissioned upon closure. Project employees and contractors will be prohibited from bringing personal firearms and weapons to work (Wildlife Management and Monitoring Plan, Section 26.21). Mitigation cannot completely eliminate access and associated indirect mortality on bears, thus a potential adverse residual effect is expected from the combination of the potential increase in hunting, poaching, and incidental kills on grizzly and black bears.

18.7.6 Attractants

Features associated with development may act as attractants for nine VCs, including moose, mountain goats, grizzly bears, black bears, American martens, bats, raptors, wetland birds, and western toads, as described in Sections 18.7.6.3 to 18.7.6.8.

Attractants are not considered a potential effect on hoary marmots or forest and alpine birds. A review of the scientific and management literature indicated no significant risks of attractants to these species groups.

Features or materials associated with a mining project that interest or provide resources to wildlife are considered to be wildlife attractants. The Project contains both features and materials that have the potential to attract wildlife. These attractants include:

- odours and food sources associated with cooking, incinerators, garbage, or sewage;
- refuge, shelter, nesting, perching, or roosting habitat provided by Project structures;
- regenerating vegetation on road verges or other disturbed areas that creates desirable forage;
- travel corridors such as roads or cleared areas under transmission lines that facilitate movement through otherwise difficult terrain or vegetation;
- de-icing salts used on roads in winter; and

- ponds or ditches created by development that provide water and aquatic habitat.

Odours causing attractants can potentially affect bears and furbearers. Odours are particularly problematic for bears. The presence of odours poses indirect risks as they can draw animals to populated areas where they become habituated to people. Habituated wildlife can pose a threat to the safety of both humans and wildlife (i.e., attacks) and often necessitates wildlife relocation or destruction.

Structures (e.g., buildings, adits, towers) can act as attractants and can affect birds, furbearers, and bats. Animals that use Project infrastructure may be at risk of mortality since their presence can interfere with mechanical functions of equipment. Wetland birds can be attracted to tailing storage facilities. Use of these facilities can have potential health effects for birds.

Regenerating vegetation on road verges or in other disturbed areas that creates desirable forage can affect a number of species, including ungulates and bears. Attracting animals to roads and areas of development can potentially lead to increased incidents of wildlife/vehicle collisions and other interactions that put animals and humans at risk.

Travel corridors (e.g., roads or cleared areas under transmission lines) that enable wildlife movement through difficult terrain or dense vegetation can have potential effects on species such as moose and bears. Wildlife travel corridors can provide energetic benefits to wildlife but they can also pose potential risks to animals that may experience increased vulnerability to human-mediated mortality sources such as collisions with vehicles.

Salts from anthropogenic activities along access roads may attract wildlife, particularly ungulates, to roadsides (Fraser and Thomas 1982; Environment Canada and Health Canada 2001). The presence of this type of attractant along roadsides can increase the risk of mortality due to vehicle strikes (Grenier 1974; Silverberg, Pekins, and Robertson 2002).

Artificial ditches near roads can have a potential effect for western toads. Ephemeral pools that form in roadside ditches in spring can be attractive to western toads for breeding.

18.7.6.1 Mitigation for Attractants

Mitigation of attractants typically takes a two-tiered approach. First, positive behavioural stimuli are removed, such as limiting high-quality forage on road verges. Second, if wildlife are still attracted to the feature, then negative reinforcement is used to dissuade them from returning. A good example is garbage areas. It is easier and safer for staff and wildlife to remove the positive attractant of garbage than to attempt to repel wildlife once they have become habituated to this food source.

Mitigation strategies that are designed to reduce the effect of attractants on wildlife VCs will include, but are not limited to:

- managing waste to minimize attractants and rewards;
- planting less-attractive vegetation in roadside areas;

- limiting the amount of salt included in traction grit being used for winter road management;
- monitoring and adaptive management of the use of physical structures by wildlife for security habitat (refuge, shelter), daily activities (roosting, perching), or nesting purposes; and
- avoiding the creation of attractive roadside pools.

Detailed information regarding mitigation and management of attractants to wildlife VCs is described in detail in the Wildlife Management and Monitoring Plan (Section 26.21).

18.7.6.2 Potential for Residual Effects

Nine wildlife VCs were evaluated for potential effects of attractants in the following sections (Table 18.7-14). Two VCs (grizzly bears and black bears) have the potential for residual effects due to attractants.

18.7.6.3 Ungulates (Moose and Mountain Goats): Potential Residual Effects due to Attractants

Natural mineral licks are important habitat features for ungulates, as they provide dietary minerals (Klaus and Schmid 1998; Ayotte, Parker, and Gillingham 2008). Ungulates are attracted to sources of minerals and salt; therefore, road salts often attract moose and goats to roads where they can be at risk of vehicle-related mortality. Road salts are attractive during the winter and during summer when the salts have dissolved into downslope receiving environment (e.g., ponds or wetlands adjacent to the road; Fraser and Thomas 1982; Environment Canada and Health Canada 2001).

Moose primarily use mineral wallows in early spring (Couturier and Barrette 1988) and potentially in early winter (R.V. Rea, Hodder, and Child 2004), while mountain goats primarily use mineral licks in the summer after kidding (Ayotte, Parker, and Gillingham 2008). Animals may travel considerable distances to reach mineral licks, with records of moose travelling up to 7 km (Risenhoover and Peterson 1986) and mountain goats up to 17 km (Poole, Bachmann, and Teske 2010). The effect of road salts acting as an attractant along the TCAR and CCAR on moose and mountain goats is evaluated.

18.7.6.3.1 Moose

The use of road salts for winter road ice management is a concern for moose. Numerous studies have documented moose consuming de-icing salts from roadsides in the winter (R.V. Rea and Rea 2005) and drinking brackish water from roadside pools during the spring and summer (Grenier 1974; Silverberg, Pekins, and Robertson 2002; Leblond et al. 2007). This behaviour puts animals at elevated risk of vehicle strikes. For example, along roads in the Laurentides Wildlife Reserve, the presence of roadside salt pools increased the likelihood of a moose-vehicle incident by 80% (Grenier 1974). In addition, moose frequenting roadside salt pools appear to be less fearful of vehicles and human presence (Jones et al. 1992), which would increase the probability of moose encounters along roads.

Table 18.7-14. Potential Residual Effects on Wildlife and Wildlife Habitat Valued Components due to Attractants

Valued Component	Timing Start	Project Area(s)	Project Component(s)	Description of Effect due to Project Component(s)	Type of Project Mitigation	Project Mitigation Description	Potential Residual Effect	Description of Residuals
Moose	Construction	PTMA and Mine Site	Access roads	Attraction to roadsides due to road salting	Alternative	Minimize the use of roadside salts for winter road management; mitigation along KSM Project access roads will include creating breaks in snow banks along ploughed Project access roads.	No	After mitigation, no residual effect of attractants is expected.
Mountain Goat	Construction	PTMA and Mine Site	Access roads	Attraction to roadsides due to salting	Alternative	Minimize the use of roadside salts for winter road management.	No	After mitigation, no residual effect of attractants is expected.
Grizzly Bear	Construction	PTMA and Mine Site	Camps and processing facilities	Attraction to camps and processing facilities due to odours	Management Practices, Monitoring and Adaptive Mangement	Eliminate attractive odours by incinerating appropriate garbage items and properly storing items that cannot be incinerated, enforce proper waste disposal procedures for all employees and contractors.	Yes	Although waste management plans will reduce attraction to site, some bears may continue to be attracted to odours; therefore, a residual effect of attractants is predicted for grizzly bears.
Black Bear	Construction	PTMA and Mine Site	Camps and processing facilities	Attraction to camps and processing facilities due to odours	Management Practices, Monitoring and Adaptive Mangement	Eliminate attractive odours by incinerating appropriate garbage items and properly storing items that cannot be incinerated, enforce proper waste disposal procedures for all employees and contractors.	Yes	Although waste management plans will reduce attraction to site, some bears may continue to be attracted to odours; therefore, a residual effect of attractants is predicted for black bears.
American Marten	Construction	PTMA and Mine Site	Camps and processing facilities	Attraction to camps and processing facilities due to odours, attraction to structures for resting purposes	Management Practices, Monitoring and Adaptive Mangement	Eliminate attractive odours by incinerating appropriate garbage items and properly storing items that cannot be incinerated, enforce proper waste disposal procedures for all employees and contractors; Monitor use of structures by martens, recommend actions (e.g., building skirting) based on usage.	No	After mitigation, no residual effect of attractants is expected.
Bats	Construction	PTMA and Mine Site	Tunnel entrances and buildings	Attraction to tunnels and buildings for roosting purposes	Management Practices, Monitoring and Adaptive Mangement	Prevent bats from accessing tunnels. Monitor for use of tunnels and buildings by roosting bats, recommend actions based on species and location of roost.	No	After mitigation, no residual effect of attractants is expected.
Raptors	Construction	PTMA and Mine Site	Transmission line and pits	Attraction to tranmission lines or pits for perching and nesting purposes	Monitoring and Adaptive Mangement	Monitor use of tranmission line towers and pits by nesting raptors, recommend actions based on species and location of nest.	No	After mitigation, no residual effect of attractants is expected.
Wetland Birds	Construction	PTMA and Mine Site	TMF and water treatment facilities	Attraction to free-water collection area in proposed TMF	Management Practices, Monitoring and Adaptive Mangement	Monitor wetland bird use of the TMF and WSF; if wetland birds are attracted to the area and it is considered a potential hazard, then wetland bird species will be prevented from using any water collected within the proposed TMF and associated facilities.	No	After mitigation, no residual effect of attractants is expected.
Western Toad	Construction	PTMA and Mine Site	Treaty Creek access road and Coulter Creek access road	Attraction to roadside ditches filled with water for breeding purposes	Management Practices, Monitoring and Adaptive Mangement	Eliminate pools being formed in roadside ditches that may be attractive toad breeding areas by ensuring that ditches are free-draining; monitor roadside pools that are formed for toad breeding activities.	No	After mitigation, no residual effect of attractants is expected.

Closed roads or roads with little traffic are also frequently used as travel routes by ungulates. Moose are therefore likely to use the access roads to reach suitable habitats near Treaty Creek and Unuk River, particularly during winter, when the road is plowed and the snow pack hampers movement elsewhere. The attraction and use of roads by moose will increase the risk of vehicle/moose interactions. The Wildlife Management and Monitoring Plan (Section 26.21) will guide mitigating the potential for moose mortality along Project roads (Section 18.7.4.3).

Residual Effects for Moose due to Attractants

To mitigate the effects of salts acting as an attractant for moose, the amount of salt in the traction grit mix used on the roads will be minimized on winter roads. In addition, mitigation along Project roads will include creating breaks in snowbanks along plowed roads and following other mitigation practices to minimize indirect mortality (Section 18.7.3.1). After mitigation, no residual effect of attractants is expected for moose.

18.7.6.3.2 Mountain Goat

There is a limited amount of evidence for mountain goat attraction to road salts (e.g., Singer and Doherty 1985). Goats are sensitive to noise and visual disturbance and appear to be wary of roads (Côté 1996; Goldstein et al. 2005; BC MOE 2010a). Other mountain ungulates, however, are attracted to roadside salts (Bradford 1988; Jalkotzy, Ross, and Nasserden 1997; Environment Canada and Health Canada 2001). Mountain goats show a particular dependence on visiting natural salt licks (Ayotte, Parker, and Gillingham 2008); therefore, there is a potential for goats to be attracted to sources of sodium that are available, such as those that may form along roads if salts are used for winter road management. This behaviour would increase the risk of goat-vehicle encounters on Project roads in higher elevation terrain (Mitchell and Kerr Pit access roads).

Residual Effects for Mountain Goats due to Attractants

To mitigate the effects of salts acting as an attractant for mountain goat, the amount of salt used in traction grit will be minimized on winter roads. In addition, mountain goats avoid areas with human disturbance up to 2 km away. Therefore, mountain goats will likely avoid the area rather than be attracted to it. After mitigation and avoidance due to disturbance, no residual effect is expected for mountain goat.

18.7.6.4 Bears: Potential Residual Effects due to Attractants

Grizzly and black bears are often attracted to odours from human activity sites such as industry construction camps, community dumps, and provincial and backcountry camping areas (B. N. McLellan 1990; Blood 2001, 2002; COSEWIC 2002b). This behaviour is problematic as these bears are more likely to become acclimated to the presence of people. As both grizzly and black bear may be attracted to Project construction and operating camps, this effect is discussed together for both VCs.

Black bears appear to be more likely to become habituated to the presence of humans and food that is made available by humans (termed food-conditioned) than grizzly bears (Herrero 2003; Gore et al. 2006). However, once a bear becomes habituated to either humans or food, the probability of a negative human-bear interaction increases (Herrero 1985; Peine 2001). Conflicts often negatively affect the survival of bears. In Yellowstone National Park, bears that

came into conflict with humans had a higher probability of dying within a year of the conflict (Haroldson, Schwartz, and White 2005). If problem grizzly bears avoid conflict with humans for more than two years, their survival rate returns to that of bears with no known history of conflict with humans (Haroldson, Schwartz, and White 2005).

Problem bears pose a risk to human safety, which often requires their relocation or destruction (Gibeau and Herrero 1998). While relocation of habituated or food-conditioned bears reduces the chances of an immediate negative altercation, bears are moved into territories that are either occupied by other bears or have relatively less suitable habitat, leading to lower survival rates (Blanchard and Knight 1995; BC MOE 2001). In many cases, bears that are attracted to human activity centres and are perceived as a threat to life or property are destroyed. Approximately 588 of the 736 reported human-caused mortalities of grizzly bears (i.e., mortalities not associated with legal hunting) across BC from 1976 to 1999 were attributable to “defence of life and property” kills (COSEWIC 2002b). Recent statistics suggest up to 950 black bears and 50 grizzly bears are killed every year in BC as a consequence of conflicts with humans (BC MOE 2001; Blood 2001).

The Domestic and Industrial Waste Management Plan (Section 26.6) outlines mitigation to be implemented to reduce the attractiveness of Project infrastructure for bears and the consequent conflicts. This will include proper storage and removal of garbage and other wastes. All wastes will be stored inside buildings, bear-proof compounds, or in wildlife-proof containers, and all employees will receive training on safe disposal of wastes to avoid attraction (Section 26.6). In areas where mitigation measures are implemented, grizzly and black bears are able to maintain a high survival rate near human developments (Ciarniello 1997; H. Davis, Wellwood, and Ciarniello 2002).

Closed roads or roads with little traffic are also frequently used as travel routes by bears. In addition, bears are attracted to roads by edge vegetation and by vehicle-killed wildlife and waste discarded during construction and operation. These issues serve to increase the risk of bear-vehicle interactions. The Wildlife Management and Monitoring Plan (Section 26.21) outlines measures to reduce wildlife-vehicle interactions, such as low speed limits, road signs in wildlife habitats, removal of carrion along Project roads, and proper disposal of food wastes. Wildlife-vehicle and human-wildlife interactions will be reported and records compiled to help identify locations with high levels of wildlife conflicts, should they occur, to minimize the risk to bears.

Residual Effects for Bears due to Attractants

The effect of attractants is predicted to result in a residual effect on grizzly and black bears. To minimize the effects of attractants to bears, Project activities will adhere to the Domestic and Industrial Waste Management Plan (Section 26.6), which will include mitigation measures to store and remove all food wastes and wildlife attractants (e.g., liquid solvents, lubricants), erecting bear fences in appropriate areas, removing carrion from roads, and monitoring of the waste management plan. Mitigation measures such as site crew education in wildlife awareness and protocols in dealing with nuisance bears will also be implemented. However, despite similar mitigation measures at other remote mines in BC, bears have still been attracted to camps, kitchens, and storage areas. With mitigation, residual effects are still anticipated for bears from attractants.

18.7.6.5 American Marten: Potential Residual Effects due to Attractants

Like bears, marten and other furbearers may be attracted to Project features by odours, shelter, food, and prey (Ruggiero et al. 1994). Marten may be attracted to both human waste as well as small rodent populations within camp facilities. Marten may also seek out structures for resting (Hoylan, Jones, and Raphael 1998). These animals usually do not present a risk to human safety. However, like bears, animals that become habituated to human presence or foods may become more dangerous, or may become injured or ingest harmful materials.

Residual Effects for American Marten due to Attractants

To minimize the effects of attractants to marten, Project activities will adhere to the Domestic and Industrial Waste Management Plan (Section 26.6), which will include mitigation measures to store and remove all food wastes and wildlife attractants (e.g., liquid solvents, lubricants) and monitoring of the Waste Management Plan. The use of Project structures will be monitored and mitigated using exclusion measures such as building skirting to prevent access to on-site infrastructure. Mitigation measures such as site crew education in wildlife awareness will also be implemented. With mitigation, no residual effects are anticipated for American marten from attractants.

18.7.6.6 Bats: Potential Residual Effects due to Attractants

Inactive mine adits have been identified as roost sites or hibernacula for bats (Tuttle and Taylor 1998). Other man-made structures, such as buildings, tunnels, and crevices in the rocks produced by excavation, are also used as roosting sites by several species of bats (Nagorsen and Brigham 1995). Bats may be harmed if roosting in inactive Project facilities that are subsequently re-activated, effectively removing the habitat. Bats may be attracted to the tunnels as roosting sites during post-closure.

Residual Effects for Bats due to Attractants

Infrastructure and the tunnels will be monitored for bat roosting activity and adaptively managed. After monitoring and mitigation, no residual effects on bats are expected.

18.7.6.7 Birds: Potential Residual Effects due to Attractants

Potential sources of attractants for avian species include infrastructure acting as perching and nesting habitat for raptors, and the TMF water collection and the upstream tailing beach attracting wetland birds. The effects on raptors and wetland birds are discussed separately. No effect of attractants is expected for forest and alpine birds.

18.7.6.7.1 Raptors

In natural habitats, peregrine falcons, gyrfalcons, and rough-legged hawks nest on ledges and precipitous cliff faces. In landscapes with human-made structures, cliff-nesting birds nest on ledge-like features such as cairns, towers, bridges, and pit walls. The transmission line towers may also provide perches and nesting habitat for tree-nesting raptors (APLIC 2006). Red-tailed hawks are frequently seen perching on utility poles watching for prey (Preston and Beane 1993). Ospreys are known to use transmission line structures for nesting purposes more than any other North American raptor (APLIC 2006).

The Project transmission line will cross the Bell-Irving River at its eastern terminus and then parallel the TCAR to the PTMA. The transmission line and associated ROW for the most part travels beside the riparian zone of Treaty Creek. Therefore, attraction for perching and nesting purposes will be a concern for riparian nesting raptors, such as osprey and bald eagle. In addition, the transmission line will run along areas of Treaty Creek that support spawning salmon, increasing the attractiveness of perching on the transmission line. Effects of direct mortality due to electrocution and associated mitigation are listed in Section 18.7.4.8.

The walls of the open pits may also offer attractive nesting habitat for cliff-nesting species such as peregrine falcon and common raven. Common raven, while not a true raptor, is often described as a “functional raptor” as they select similar nesting habitat as cliff-nesting raptors. The Mitchell, Sulphurets, and Kerr pits will become progressively deeper through operation, and thus the open pit walls may begin to resemble steep-sided cliffs with attractive nesting ledges for cliff-nesting raptors. The use of open pits by nesting raptors (and/or common ravens) has the potential to affect operation, as the *Wildlife Act* (1996c) prevents the destruction of nests occupied by a bird or its eggs.

Residual Effects for Raptors due to Attractants

The use of the Project infrastructure by nesting raptor species will be monitored. The relevant government ministry will be contacted on a case-by-case basis in order to determine how to manage bird nests that are built on Project infrastructure, where required. The transmission line and pits will be monitored for nesting activity and managed adaptively if high-use areas are identified. With monitoring and mitigation, no residual effects are anticipated.

18.7.6.7.2 Wetland Birds

Natural waterbodies are important foraging, staging, and breeding habitat for wetland birds. Many species of wetland birds use sewage treatment ponds and other man-made waterbodies (Campbell et al. 1990a). This use may be accelerated when birds are tired, thirsty, and hungry (e.g., during migration or poor weather conditions), resulting in the use of potentially hazardous waterbodies in search of food and resting sites (Read 2001).

The TMF will replace a large swamp wetland area. This area was not identified as being important habitat for wetlands birds, as very few birds were observed in the TMF valley during baseline studies ([Appendix 18.A](#)). During the course of operation, a pond will be created in the centre of the proposed TMF that may be surrounded by a sandy shore. This area will likely be attractive to waterfowl and shorebirds because it will resemble wetlands used by these birds. The water quality of the collection pond in the proposed TMF is assessed for potential harmful effects in Section 18.8.8.2, Chemical Hazards.

Residual Effects for Wetland Birds due to Attractants

The effect of attractants is not anticipated to result in a residual effect on wetland birds. Monitoring of wetland bird use of the TMF will be conducted; if wetland birds are attracted to the area and it is considered a potential hazard, then wetland bird species will be prevented from using any water collected within the proposed TMF and associated facilities. After mitigation, no residual effect on wetland birds is anticipated due to attractants.

18.7.6.8 Western Toads: Potential Residual Effects due to Attractants

Western toads utilize a variety of natural wetland areas for breeding, including man-made structures such as ditches and road ruts (Gyug 1996; COSEWIC 2002a). These pools often have similar site characteristics to natural breeding ponds, including open forest canopy, warm water temperature, shallow water, and a gentle-sloped muddy bank ([Appendix 18-A](#)). The use of these types of temporary pools by toad is of concern for two reasons. Firstly, the water in roadside ditches or ruts may dry up before toads complete metamorphosing between tadpole and toadlet, which would result in complete mortality of tadpoles. Secondly, if the water does persist for long enough, emerging toadlets are in the vicinity of Project roads and are thus at risk of mortality from vehicle traffic.

Residual Effects for Western Toads due to Attractants

To avoid the creation of attractive roadside pools, the Project will construct drainage ditches that will promote free drainage. In the event that pools are inadvertently created and used by western toads during the summer, these areas will be monitored and adaptively managed. After mitigation and monitoring, no residual effects on western toad are expected.

18.7.7 Chemical Hazards

Exposure to chemical hazards was identified as a potential effect for the 11 wildlife VCs (Sections 18.7.7.3 to 18.7.7.9). For the purposes of this assessment, a chemical hazard is defined as a chemical that has the potential to cause an adverse health effect on wildlife VCs due to Project development during the construction, operation, closure, or post-closure phases.

In order to determine the potential effects of chemicals of potential concern (COPC) on wildlife VCs due to Project-related activities, the following three factors are necessary to result in an effect due to exposure to COPC, and are described in the following sections:

- a source of COPC and the presence of a wildlife VC receptor that can uptake the COPC;
- an exposure route for the COPC (method of uptake, e.g. ingestion); and
- the duration of chemical exposure and COPC toxicity.

This section evaluates the potential effects on wildlife VCs. Potential effects of COPC on fisheries and human health are evaluated separately in Sections 15 and 25, respectively.

Methodology of Assessment

Potential effects of COPC on wildlife VCs were evaluated through a three step process:

Step 1: Potential sources of COPC from the Project were evaluated to determine if COPC exceeded any relevant guidelines and these COPC were included for evaluation. COPC were also included if they are known to bioaccumulate in the food web.

Step 2: Wildlife VCs were then identified for assessment if they met three criteria:

1. The habitat of the wildlife VC overlaps with the source of an identified COPC.
2. The behaviour of the wildlife VC indicates that it might come in contact with the identified COPC.
3. The wildlife VC must be susceptible to adverse effects of the identified COPC.

Step 3: COPC and wildlife VCs that were identified in Steps 1 and 2 were then evaluated for the potential for residual effects. The concentration of the COPC, exposure route (method of uptake), and duration of exposure (either as a measure of time, or as a fraction of the home range of a species) were used to evaluate whether individual animals or the population as a whole would be evaluated for residual effects. In some cases, models were also used to predict the concentration of COPC in wildlife VCs.

Wildlife VCs were then evaluated at two hierarchical levels of effects; effects due to direct exposure to COPC and due to potential bioaccumulation of certain COPC:

1. The assessment of direct exposure to COPC used relevant guidelines, where guidelines exist (e.g., water-quality guidelines for the protection of wildlife). Therefore, a potential residual effect was determined if wildlife VCs are predicted to be exposed to environmental media that exceed these guidelines.
2. The assessment of bioaccumulation first evaluated which COPC have the potential to bioaccumulate in wildlife species using information from the scientific literature and calculated hazard ratios. Second, the locations where these COPC were evaluated was determined by comparing predicted concentrations of COPC against baseline (current) concentrations and comparing this distribution to that of wildlife VCs. Areas where concentrations of COPC are predicted to be above baseline conditions were included in the evaluation. In the Project area, baseline concentrations were often 50 to 100 times below water quality guidelines for the protection of wildlife. Therefore, using baseline concentrations as a standard to include areas in the evaluation produces a conservative assessment of potential effects. The majority of the areas evaluated are predicted to be far below wildlife water quality guidelines.

Potential Sources and Concentrations of Chemicals of Potential Concern and Wildlife Valued Component Receptors

This section evaluates the potential for direct effects of COPC on wildlife VCs. This evaluation is conducted by identifying: 1) potential sources of COPC due to the Project, and 2) which wildlife species may be exposed to these COPC by comparing the habitat and behaviour of each VC to the availability of COPC.

Wildlife VCs were evaluated for exposure to four Project-related sources of COPC, including those:

- available in water;
- associated with mine development and operation;

- available in metal leaching and acid rock drainage (ML/ARD) generated from exposed waste rock; and
- deposited in fugitive dust.

Wildlife exposed to elevated concentrations of COPC may be affected by these chemicals if they are taken up into their bodies from the environment and exceed effect thresholds. Rationale for inclusion and exclusion of individual COPC and wildlife VCs to these chemical hazards is outlined in the following sections and summarized in Table 18.7-15. In the case of water, sources of COPC were evaluated if the available concentrations exceeded provincial wildlife water quality guidelines.

Table 18.7-15. Sources of Chemicals of Potential Concern Evaluated for Valued Components

Valued Component	COPC in Water	COPC Associated with Mine Development and Operation	COPC in ML/ARD Exposed Rock	COPC in Fugitive Dust	Bioaccumulation of COPC in the Food Web
Moose	NA	NA	NA	NA	Yes
Mountain goats	NA	NA	Yes	Yes	Yes
Bears ¹	NA	Yes	NA	NA	NA
American marten	NA	Yes	NA	NA	NA
Hoary marmots	NA	NA	NA	Yes	Yes
Bats	NA	NA	NA	NA	Yes
Raptors	NA	NA	Yes	NA	Yes
Wetland birds	Yes	NA	NA	NA	Yes
Forest and alpine birds	NA	NA	NA	NA	Yes
Western toads	NA	NA	NA	NA	Yes

¹The assessment for bears includes both grizzly and black bears.
NA = Not assessed.

The potential for wildlife VCs to be exposed to COPC from various Project-related sources is evaluated in the following sections. If the range of a wildlife VC overlaps the potential distribution of a Project-related COPC, the interaction is then evaluated for the potential for residual effects on the VC in Section 18.7.7.2.

Chemicals of Potential Concern in Water

Water quality guidelines for the protection of wildlife (BC MOE 2010b) were used as the standard to evaluate the potential effects of COPC in water on wildlife VCs. Where there are no guidelines specific to wildlife (e.g., cadmium), water quality guidelines for the protection of aquatic life (BC MOE 2010b) were used. Hereafter, any reference to “water quality guidelines” refers to this combination of wildlife and aquatic guidelines, unless stated otherwise. These water quality guidelines are listed in Table 18.7-16. Where they exist, wildlife guidelines are generally higher or equal to those for the protection of aquatic life (with the exception of molybdenum, which is lower).

Table 18.7-16. Wildlife Guidelines for Water Quality

Element	Aquatic Life Guideline	Wildlife Guideline
Aluminum (Al)	-	5 mg/L
Antimony (Sb)	20 µg/L	-
Arsenic (As)	5 µg/L	25 ug/L
Barium (Ba)	1 mg/L	-
Beryllium (Be)	5.3 µg/L	-
Boron (B)	1.2 mg/L	5 mg/L
Cadmium (Cd)*	0.01 - 0.04 µg/L	-
Chromium (Cr)	1 µg/L	-
Cobalt (Co)	40 µg/L	-
Copper (Cu)*	1.5 - 3.0 µg/L	300 ug/L
Cyanide WAD	5 µg/L	50 mg/L
Iron (Fe)	1 mg/L	-
Lead (Pb)*	4.2 - 7.5 µg/L	100 ug/L
Lithium (Li)	96 µg/L	-
Manganese (Mn)*	2.2 - 6.1 µg/L	-
Mercury (Hg)	0.02 ug/L	0.02 ug/L
Molybdenum (Mo)	1 mg/L	0.05 mg/L
Nickel (Ni)*	65.5 - 113.2 µg/L	-
Selenium (Se)	2 ug/L	4.0 ug/L
Silver (Ag)*	0.05 - 1.5 µg/L	-
Thallium (Tl)	0.3 ug/L	-
Uranium (U)	300 ug/L	-
Vanadium (V)	6 ug/L	-
Zinc	7.5 ug/L	2 mg/L
Dissolved Aluminium (Al)	50 ug/L	-
Dissolved Iron (Fe)	350 ug/L	-

* Guideline range dependent on water hardness. See BC MOE (n.d.).

The four main Project areas evaluated for exposure of wildlife to COPC in water include:

- within the mine site, in the WSF;
- water discharged from the Mine Site;
- within the ponds of the TMF; and
- water discharged from the TMF.

The concentrations of candidate COPC were examined in each of these locations (at several stations for receiving environments) and during each Project phase in order to assess if the candidate COPC should be evaluated for potential effects on wildlife VCs. The results are listed in the following sections.

Mine Site WSF ponds: The WSF in the Mine Site will receive all contact water from the Mine Site (including the pits, waste rock, etc.) and will contain water with several COPC which are predicted to exceed wildlife water quality guidelines, including aluminum, arsenic, cadmium, cobalt, copper, lead, mercury, selenium, and zinc (see Chapter 14 Surface Water Quality, Section 14.7; [Appendix 14-H](#)). These COPC are predicted to exceed guidelines during all Project phases. Water quality monitoring at the WSF will be conducted as part of the Water Management Plan (Section 26.17).

Baseline studies ([Appendix 18-A](#)) reported that the Mine Site is relatively poor habitat for the majority of wildlife VCs, with a high proportion of exposed rock and little open water for wetland birds. Wildlife are anticipated to avoid the Mine Site and the WSF during all Project phases due to habitat loss and alteration (Section 18.7.1) and sensory disturbance (Section 18.7.3). However, wetland birds are known to use sources of open water, even those in industrial sites during spring and fall migrations (Read 2001). Therefore, wetland birds are evaluated for the potential for direct exposure to COPC in water within the WSF during all Project phases.

Discharged water from the Mine Site into Sulphurets Creek: Water from the WSF will be treated and discharged into Sulphurets Creek, which then flows into the Unuk River. Water in Sulphurets Creek is predicted to meet water quality guidelines for all COPC, with the exception of selenium, which is predicted to be approximately 15% above the guideline of 4 µg/L for wildlife (Table 18.7-17). At the confluence with the Unuk River (SC3), water is predicted to meet wildlife water quality guidelines for all COPC.

Baseline concentrations for many COPC are naturally elevated in Sulphurets Creek, and are approximately half the concentration of the current water quality guidelines for wildlife (Table 18.7-16). Water quality monitoring in the receiving environments will be conducted as part of the Aquatics Effects Monitoring Plan (Section 26.18.2).

Egg-laying vertebrates (birds and amphibians) are the only wildlife VCs sensitive to selenium (Janz et al. 2010). Baseline surveys identified Sulphurets Creek as poor habitat for both birds (unsuitable habitat) and western toad (no breeding ponds; [Appendix 18-A](#)). Thus, wildlife VCs (including raptors, wetland birds, forest and alpine birds, and western toad) were not evaluated for exposure to COPC in Sulphurets Creek.

Water will meet water quality guidelines for all COPC in the Unuk River and therefore, no direct effects due to COPC are evaluated in this area.

TMF ponds: The north, central, and south ponds in the TMF will contain process water from the mill and be contained within the dams of the TMF. Water in each of the TMF ponds is predicted to exceed water quality guidelines for several COPC, including arsenic, chromium, cobalt, mercury, molybdenum, selenium, and, vanadium during operation and closure (Chapter 14, Surface Water Quality, Section 14.7). At post-closure, the site will be reclaimed and water quality guidelines will be met for all COPC ([Appendix 14-H](#)).

Table 18.7-17. Predicted Water Concentrations of Selenium, Mercury, and Molybdenum within Project Facilities and Receiving Waters

		Selenium Wildlife Water Quality Guideline = 4.00E-03					Mercury Wildlife Water Quality Guideline = 2.00E-05					Molybdenum Wildlife Water Quality Guideline = 5.00E-02				
		Baseline	Operation	Closure	Post-Closure (10 years)	Post-Closure (> 10 years)	Baseline	Operation	Closure	Post-Closure (10 years)	Post-Closure (> 10 years)	Baseline	Operation	Closure	Post-Closure (10 years)	Post-Closure (> 10 years)
Project Facility																
WSF	Mine Site	1.04E-03	3.27E-02*	5.46E-02*	3.65E-02*	3.39E-02*	9.13E-06	2.05E-04*	2.75E-04*	1.87E-04*	1.81E-04*	2.60E-03	1.14E-01*	2.00E-01*	1.29E-01*	1.23E-01*
TMF North Cell	PTMA	7.00E-04	1.12E-02*	3.02E-04	3.71E-04	3.84E-04	5.94E-06	5.34E-05*	3.44E-06	4.04E-06	4.17E-06	4.00E-04	4.93E-02*	2.31E-04	2.47E-04	2.50E-04
TMF South Cell	PTMA	7.00E-04	2.75E-02*	9.28E-03*	3.15E-04	2.88E-04	5.94E-06	1.24E-04*	4.30E-05*	3.91E-06	3.85E-06	4.00E-04	1.23E-01*	4.09E-02*	3.43E-04	1.99E-04
TMF CIL Cell	PTMA	7.00E-04	2.55E-02*	1.42E-02*	3.51E-03	3.77E-04	5.94E-06	8.56E-06	8.82E-06	4.80E-06	3.67E-06	4.00E-04	9.96E-02*	5.54E-02*	1.32E-02	6.13E-04
Receiving Environment																
Sulphurets (SC2)	Mine Site	2.48E-03	4.57E-03*	4.77E-03*	4.50E-03*	4.31E-03*	1.36E-05	7.11E-06	7.35E-06	7.08E-06	7.09E-06	3.24E-03	3.59E-03	3.23E-03	3.47E-03	3.47E-03
Sulphurets (SC3)	Mine Site	2.07E-03	3.96E-03	4.10E-03*	3.90E-03	3.74E-03	1.13E-05	6.67E-06	6.84E-06	6.62E-06	6.67E-06	2.91E-03	3.25E-03	2.92E-03	3.14E-03	3.15E-03
Unuk River (UR1)	Mine Site	1.34E-03	2.00E-03	1.99E-03	1.97E-03	1.91E-03	1.77E-05	1.05E-05	1.08E-05	1.05E-05	1.05E-05	1.94E-03	1.95E-03	1.77E-03	1.90E-03	1.90E-03
Unuk River (UR2)	Mine Site	7.47E-04	1.09E-03	1.08E-03	1.08E-03	1.05E-03	2.78E-05*	1.54E-05	1.55E-05	1.54E-05	1.53E-05	2.25E-03	2.24E-03	2.17E-03	2.22E-03	2.22E-03
North Treaty (NTR2)	PTMA	7.00E-04	6.60E-04	7.14E-04	8.32E-04	6.37E-04	8.80E-06	6.70E-06	7.05E-06	6.61E-06	6.50E-06	5.10E-04	4.44E-04	4.82E-04	1.21E-03	4.67E-04
Treaty Creek (TRC2)	PTMA	1.20E-03	1.03E-03	9.90E-04	9.55E-04	9.37E-04	4.03E-05*	2.04E-05	2.05E-05	2.02E-05	2.03E-05	2.11E-03	1.95E-03	1.75E-03	1.60E-03	1.54E-03
South Teigen (STE3)	PTMA	7.00E-04	7.15E-04	6.45E-04	6.34E-04	6.34E-04	1.01E-05	9.32E-06	8.55E-06	9.33E-06	9.47E-06	4.00E-04	3.73E-04	3.48E-04	3.48E-04	3.49E-04
Teigen Creek (TEC2)	PTMA	5.00E-04	4.02E-04	3.98E-04	3.84E-04	3.82E-04	7.76E-06	5.09E-06	5.08E-06	5.08E-06	5.08E-06	3.20E-04	2.73E-04	2.71E-04	2.68E-04	2.67E-04

*Predicted water quality is averaged annually for each Project phase. For detailed water quality predictions see [Appendix 14-J](#)
*Water quality exceeding wildlife water quality guideline
Notes: Selenium will be above baseline conditions in south Teigen Creek during operation, but this is considered an artefact of the water quality modelling
All Guidelines and Concentrations are in mg/L

During operation and closure, wildlife are anticipated to avoid the TMF due to habitat loss and alteration (Section 18.7.1) and sensory disturbance (Section 18.7.3). However, wetland birds are known to use sources of open water during migrations (Read 2001). Therefore, wetland birds are evaluated for potential exposure to COPC in water within the TMF during operation and closure.

Cyanide, used as part of the gold recovery circuit process in the Treaty Process Plant, is regulated by the International Cyanide Management Code (ICMI 2005). Concentrations of cyanide in the TMF ponds are predicted to remain below 0.5 mg/L (Section 14.7.3), which is 100 times below the guideline of 50 mg/L weak acid dissociable (WAD) cyanide for the protection of wildlife (ICMI 2005). The proponent has committed to adhere to the International Cyanide Management Code, which provides guidelines for the transport, storage, use and treatment/destruction of cyanide (ICMI 2005). Since cyanide concentrations in all Project-related waters are predicted to remain below 0.5 mg/L (Section 14.7.3), effects due to cyanide are not considered further for wildlife VCs. As cyanide is not a bioaccumulative COPC, it is not considered under the assessment of bioaccumulation.

At post-closure, the TMF will be reclaimed to provide wildlife habitat (Section 27.7). At this time, water quality at the TMF is anticipated to meet the water quality guidelines for all COPC in the TMF ponds (Section 14.7.3). Water quality monitoring at the TMF will be conducted as part of the Water Management Plan (Section 26.17). Therefore, no wildlife VCs will be evaluated for potential exposure to COPC in water of the TMF during post-closure.

Water discharged from the TMF: Water discharged from the TMF during all Project phases will meet water quality guidelines. Therefore, this exposure pathway is not assessed for any wildlife VCs. Water quality monitoring in the receiving environments will be conducted as part of the Aquatics Effects Monitoring Plan (Section 26.18.2).

Chemicals of Potential Concern Associated with Mine Construction and Operation

Chemicals associated with mining activities include those used by the mine during construction, operation, or closure phases. Chemicals used on-site include materials such as fuel, oil and waste oil, hydraulic fluid, explosives, cyanide (discussed in the previous section), flocculants, chemical reagents and solvents, lead acid batteries, and oil filters, etc. These chemicals will be stored and handled according to safe handling and storage procedures (Chapter 4, Project Description; Section 26.7; and Section 26.8) and are not anticipated to be released into the environment. However, wildlife may be attracted to odours associated with camps and Project-related activities (Section 18.7.6).

There is a potential for residual effects resulting from COPC if wildlife are attracted to areas of Project operation and are able to access chemical storage areas. Baseline studies and Section 18.7.6 (Attractants) identified grizzly and black bears and American marten as three wildlife VCs that may be attracted to camps and Project facilities. Therefore, COPC associated with the construction, operation, and closure phases of the Project are assessed for these three VCs.

Chemicals of Potential Concern in Metal Leaching and Acid Rock Drainage Exposed Rock

The potential for wildlife exposure to COPC as a result of ML/ARD is assessed for all phases of the Project on the Mine Site. While ML/ARD processes are naturally occurring in the deposit

areas, excavation of rock for the development of the mine, including pit walls, waste rock, and ore stockpiles, may expose increased surface areas of un-weathered rock compared to current conditions. COPC in ML/ARD will likely contain similar constituents to those predicted for the WSF ponds.

Baseline studies and habitat suitability mapping identified two wildlife VCs which may use areas of exposed rock within the Mine Site pits at closure—mountain goats and raptors ([Appendices 18-A](#) and [18-B](#)). Therefore, COPC in ML/ARD exposed rock are assessed for these two VCs on the Mine Site, as they may use pit walls (e.g., raptor nesting) or waste rock (e.g., mountain goat escape terrain).

Chemicals of Potential Concern in Fugitive Dust

The Project will produce fugitive dust due to clearing, blasting, drilling, rock crushing, truck and conveyor transport activities, and from exposed rock during construction, operation, and closure phases.

This dust may have elevated, but variable, concentrations of COPC in excavated ore and rock. Dust generated from these activities will be dispersed from its place of origin with the prevailing southeast winds to settling areas and may accumulate on vegetation, which may be ingested by wildlife.

The air quality assessment (Section 7.8) used the proposed Project activities and observed climatic conditions in the area to map the likely deposition of fugitive dust. Peak dust deposition rates are predicted to be elevated 0.185% above baseline values in adjacent high elevation wildlife habitats on the Mine Site (Section 7.8; Figure 7.8-33).

Baseline studies and habitat suitability mapping identified two wildlife VCs which may use habitat within the area of likely deposition of fugitive dust - mountain goats and hoary marmots (Figure 18.7-22; [Appendices 18-A](#) and [18-B](#)). Both of these VCs are herbivores and may consume vegetation on which fugitive dust has been deposited. Therefore, exposure to COPC in fugitive dust is assessed for mountain goats and hoary marmots on the Mine Site. Raptors were included for exposure to COPC in ML/ARD, but excluded here because their food items (small mammals and birds) are unlikely to be sourced from the Mine Site due to habitat alteration.

After accounting for habitat loss and alteration due to the Project footprint (Section 18.7.1) and habitat that will be functionally lost due to sensory disturbance (Section 18.7.3), high-quality habitat for the other VCs is located outside of the zone of deposition for fugitive dust ([Appendix 18-B](#)). Thus, the effects of COPC in fugitive dust were not considered further for the remaining VCs (moose, grizzly bears, black bears, American marten, bats, wetland birds, forest and alpine birds, and western toads).

Dust generated through trucking along Project access roads and within the PTMA is expected to be low, due to the implementation of standard mitigation measures to suppress dust (Section 18.7.7.2). Therefore, exposure to COPC from road dust and dust at the PTMA was not assessed further for wildlife.

Bioaccumulation of Chemicals of Potential Concern in the Food Web

In addition to the potential effects of direct exposure (e.g., ingestion) of COPC from the Project, wildlife VCs were evaluated for the potential effects of bioaccumulating COPC and/or biomagnification up the food web. This was evaluated because in some cases wildlife species can accumulate high concentrations of persistent COPC, even when these concentrations are relatively low in environmental media such as water and soils, and when standards are met (Beatty and Russo 2012). The inclusion of bioaccumulation as a source of COPC for wildlife ensures a conservative assessment of the potential effects on wildlife VCs.

Sources of COPC include those in water, ML/ARD rock, and fugitive dust that may enter a food web when they are partitioned into soil, vegetation, and lower trophic organisms. These are fed upon by lower trophic level organisms such as insects or herbivorous mammals, which are in turn consumed by predators. Depending on the type of chemicals involved, COPC may bioaccumulate or biomagnify at one or all of these steps.

Chemicals of potential concern that have the potential to bioaccumulate in wildlife (despite being below water quality guidelines) were identified through calculating hazard ratios (Section 14.7.3.2 and Section 15.7.4.3), and include selenium, mercury, and molybdenum, which are discussed below. Mercury and selenium are unique among metals and metalloids in that their primary route of uptake is through the diet and are therefore assessed for potential effects due to bioaccumulation (Chapman et al 2009; Kidd and Batchelor 2012).

Selenium: The recommended water quality guideline for total selenium (Se) is 4 µg/L (Table 18.7-17). The concentration of selenium is predicted to be marginally above the water quality guideline directly within the TMF during operation and closure, directly within the WSF during all phases, and in the receiving waters of Sulphurets Creek during all phases. Wetland birds may use the TMF and WSF ponds during all phases and therefore these areas are included in the assessment.

Selenium is predicted to meet water quality guidelines in north Treaty Creek, and at the confluence with the Unuk River (5 to 40 times below guidelines; Table 18.7-17). Selenium is therefore evaluated for the potential for bioaccumulation in north Treaty Creek and the Unuk River because it can be bioaccumulated in the food web even when guidelines are met (Beatty and Russo 2012). All other rivers are predicted to have selenium concentrations at or below baseline concentrations (Treaty Creek and Teigen Creek). Note that Table 18.7-17 indicates that selenium will be above baseline conditions in south Teigen Creek during operation by 2%, but this is considered an artefact of the water quality modelling and not included for assessment.

Although selenium bioaccumulation is possible in most wildlife, elevated selenium concentrations in tissues of mammals did not indicate any negative impacts to these organisms (Janz et al. 2010). Egg-laying vertebrates (birds and amphibians) appear to be sensitive to selenium (Janz et al. 2010). Baseline studies indicated that Sulphurets Creek provides poor habitat for birds and toads ([Appendix 18-A](#)) and wildlife VCs are expected to avoid the WSF during all phases and the TMF during operation and closure due to habitat alteration and disturbance. However, wetland birds are known to use sources of open water, even those in industrial sites during spring and fall migrations (Read 2001).

Therefore, although selenium is an essential compound in wildlife at low levels, the potential for increased bioaccumulation of selenium is evaluated for birds and western toads directly within the TMF during post-closure, and north Treaty Creek and the Unuk River during operation, closure, and post-closure. The potential for bioaccumulation of selenium is also assessed for wetland birds directly within the WSF and TMF during all phases.

Mercury: Mercury bioaccumulated into vegetation and prey from Project water sources is assessed for wetland birds and bats, and mercury bioaccumulated into vegetation from dust deposition is assessed for mountain goats and hoary marmots.

The recommended water quality guideline for total mercury (THg) is 0.02 µg/L (Table 18.7-17). Mercury is predicted to be above water quality guidelines directly within the WSF during all phases and within some cells of the TMF during operation and closure, but will occur below baseline conditions in post-closure.

Wildlife, except wetland birds (during all phases) and bats (at closure at the TMF only), are anticipated to avoid the WSF during all phases, and the TMF during operation and closure. At post-closure when the TMF is reclaimed, mercury is predicted to meet water quality guidelines and be below baseline concentrations (Table 18.7-7). The potential for bioaccumulation of mercury into vegetation and prey from Project water sources is assessed for two VCs: 1) wetland birds in the WSF during all Project phases and in the TMF during operation and closure and 2) for bats in the TMF during closure.

Baseline concentrations of mercury in the Unuk River and Treaty Creek are above water quality guidelines, but are predicted to improve due to the Project ([Appendix 14-H](#)). Mercury is predicted to both meet water quality guidelines and be below baseline levels in all receiving environments (Sulphurets Creek, Unuk River, Teigen Creek and Treaty Creek); therefore, the potential for mercury to bioaccumulate in wildlife using the receiving waters downstream of the TMF or the WSF is not evaluated further.

Mercury is also assessed for the potential to accumulate in wildlife VCs that feed in areas of increased dust deposition (mountain goat and hoary marmot).

Molybdenum: The recommended water quality guideline for molybdenum (Mo) is 50 µg/L (Table 18.7-17). Molybdenum is predicted to be above water quality guidelines directly within the WSF ponds during all Project phases and within the TMF ponds during operation and closure (Table 18.7-17). Molybdenum is predicted to be well below water quality guidelines in all receiving environments but is predicted to be above baseline conditions in some areas, including Sulphurets Creek and north Treaty Creek. Bioaccumulation of molybdenum can occur, even when water quality guidelines are met, and these cases are therefore included in the evaluation.

Bioaccumulation of molybdenum can lead to molybdenosis, a condition in ungulates where they are unable to absorb copper, particularly where copper occurs at low concentrations (G. M. Ward 1994). Therefore, bioaccumulation of molybdenum is evaluated for moose and mountain goats.

Bioaccumulation of molybdenum in moose is assessed in the TMF at post-closure and within north Treaty Creek at post-closure ([Appendix 14-H](#)). Mountain goats are assessed for bioaccumulation of molybdenum due to dust deposition in habitats adjacent to the Mine Site during operation and post-closure.

Exposure Routes for Wildlife

For an exposure pathway to be complete, a potential contaminant must be taken up by the VC via one or more exposure routes, including:

- ingestion of water;
- ingestion of soil;
- ingestion of vegetation;
- ingestion of prey; and
- dermal absorption.

Inhalation of COPC is also an exposure route, but was not considered in this assessment because most of the COPC are non-volatile, and inhalation of airborne particles that may contain COPC is very low when compared to ingestion because the increase in dust deposition will be below 1%.

Duration of Chemical Exposure and COPC Toxicity

Duration of chemical exposure to wildlife is an important consideration for potential toxicity to COPC. The duration of exposure depends on how much time an animal spends where it is exposed to a source of COPC.

The potential effects of exposure to COPC also depend on the relative toxicity of the COPC. COPC with strong biological effects may cause acute toxicity over a short period of exposure, while those which are slow acting or require a higher exposure to the COPC may cause chronic effects. Chronic effects may include sub-lethal effects, such as decreased health, productivity, or fitness levels.

18.7.7.1 Mitigation for Chemical Hazards

To minimize the potential effects due to chemical hazards, the following mitigation measures will be carried out.

Mitigation of Water Quality

Mitigation for the degradation of water quality due to chemical hazards is detailed in Section 14.7.2 (Mitigation for Degradation of Water Quality). Mitigation includes measures to avoid, reduce, and monitor adverse effects to water quality. In addition, effluent quality monitoring will be conducted and designed to ensure regulatory compliance with permitted discharge criteria (Aquatic Effects Monitoring Plan, Section 26.18.2 and the Water Management Plan, Section 26.17).

Mitigation of Chemicals of Potential Concern Associated with Mine Development and Operation

Chemicals will be stored and transported according to BMPs and legislative requirements. All chemical storage and handling will meet the specifications identified and detailed in the following plans:

- Dangerous Goods and Hazardous Materials Management Plan (Section 26.7);
- Explosives Management Plan (Section 26.8);
- Domestic and Industrial Waste Management Plan (Section 26.6); and
- Spill Prevention and Emergency Response Plan (Section 26.10).

Mitigation of Metal Leaching and Acid Rock Drainage Exposed Rock

ML/ARD will be monitored during the construction, operation, closure, and post-closure phases of the Project to mitigate and adaptively manage the potential effects of ML/ARD on surface water quality, groundwater quality, fish and fish habitat, wildlife, and human health (Metal Leaching and Acid Rock Drainage Management Plan, Section 26.14). Mining contact water will be diverted, collected, and treated in a high-density sludge water treatment plant to remove metals. A selenium ion-exchange treatment plant will receive contact water from the mined out Sulphurets pit, which is backfilled with Kerr waste rock. Rock storage facilities will be engineered using bottom-up construction to carefully place waste rock to reduce the potential for infiltration of precipitation. Geochemical testing will be carried out prior to disturbance along access roads and tunnels.

Mitigation of Fugitive Dust

Mitigation measures will be implemented to limit the production and dispersal of fugitive dust. Mitigation for fugitive dust is addressed in the Fugitive Dust Emissions Management Plan (Section 26.11.2).

Dust will be mitigated along Project roads (Traffic and Access Management Plan; Section 26.25) and the PTMA. Mitigation for dust generated on roads includes road watering measures (Chapter 7, Section 7.7). Ore stockpiles at the PTMA will be enclosed so they are not subject to wind erosion, and ore crushers and grinders will be indoors where possible and equipped with baghouses to control dust (Chapter 7, Section 7.7.1.2).

Mitigation of Bioaccumulation in the Food Web

Uptake of COPC into the food web will be mitigated by implementing the management plans for COPC in water, ML/ARD rock, and fugitive dust (described above), as these plans will limit exposure of wildlife VCs to COPC bioaccumulated through the food web. In addition to the previously mentioned management and mitigation plans, the following contaminant prevention and monitoring plans will be implemented to monitor the uptake of COPC and elements in environmental media and biota:

- Soil Contamination Prevention Plan (e.g., monitoring COPC in soil; Section 26.13.3);
- Terrestrial Plant Tissue Metal Concentrations Monitoring Plan (e.g., monitoring COPC in vegetation; Section 26.20.4);
- Wetlands Management Plan (e.g., monitoring COPC in wetland vegetation; Section 26.19);

- Fish and Aquatic Habitat Effects Protection and Mitigation Plan (e.g., monitoring COPC in fish; Section 26.18.1); and
- Aquatic Effects Monitoring Plan (e.g., monitoring COPC in benthic invertebrates, water, and fish; Section 26.18.2).

Adaptive management and mitigation will be implemented where necessary. For detailed information on mitigation, see the Wildlife Management and Monitoring Plan (Section 26.21).

18.7.7.2 Potential for Residual Effects

All 11 wildlife VCs were evaluated for potential effects due to chemical hazards in the following sections. Of these, four VCs (moose, mountain goats, bats, and wetland birds) were determined to have the potential for residual effects (Table 18.7-18).

18.7.7.3 Ungulates: Potential Residual Effects due to Chemical Hazards

18.7.7.3.1 Moose

One potential pathway of exposure to COPC from Project-related activities was evaluated for moose: bioaccumulation of COPC in the food web. Moose have the potential to bioaccumulate COPC from forage when consuming vegetation with COPC, including directly within the TMF after reclamation during post-closure.

Bioaccumulation of Chemicals of Potential Concern in the Food Web

The potential for bioaccumulation in moose was assessed for molybdenum in the TMF during post-closure and in north Treaty Creek during operation. During post-closure, the TMF will be reclaimed and re-vegetated for wildlife use and moose are anticipated to use this area. The selection of COPC and locations to be evaluated is described in the introduction to bioaccumulation.

A food chain model was used to predict COPC concentrations, including molybdenum in moose tissues as part of the human health assessment (Chapter 25, [Appendix 25-C](#)). These models likely represent a conservative approach, as they overestimate the amount of time spent in or near the Project footprint. Predicted concentrations of all COPC in moose during all Project phases were well below toxicity reference values for cattle and those reported for elk and deer ([Appendix 25-C](#)).

In the absence of available toxicity data for moose, reference values are selected on the basis of phylogenetic similarity between the receptor species (moose) and the test species (cattle) with uncertainty factors applied to protect against species metabolic differences. While molybdenum concentrations in water directly within the TMF are predicted to be below the toxicity threshold values for moose during the post-closure phase, the results of the model indicates that concentrations of molybdenum are predicted to increase in moose tissue by 1.5% (Table A-7 in [Appendix 25-C](#)). These estimates are conservative as they were modeled with closure-phase water quality data, which was predicted to be higher than post-closure phase COPC concentrations and assumed availability of COPC uptake in plant tissue. Hence, operation and post-closure values are predicted to be lower in moose.

An assessment of the potential effects on human health due to consuming moose is presented separately in Section 25.

Residual Effects for Moose due to Chemical Hazards

Exposure of moose to chemical hazards is predicted to result in a residual effect on moose. No population-level effects are expected in moose after mitigation for chemical hazards, but some moose are predicted to have elevated concentrations of molybdenum which will likely remain below toxicity threshold values. At post-closure, water quality directly within the TMF is expected to improve and the magnitude of this effect is then expected to be reduced. Water quality monitoring (Section 26.17; and Section 27.10.2) and vegetation monitoring (Section 26.20.4) will be implemented in the TMF at post-closure, and compared to monitoring criteria established for the protection of wildlife, and adaptively managed if necessary. Despite mitigation, a residual effect of chemical hazards due to potential bioaccumulation on moose is predicted.

18.7.7.3.2 Mountain Goats

Three potential pathways of exposure to COPC from Project-related activities were evaluated for mountain goats, including:

- ingestion of COPC from ML/ARD exposed rock: mountain goats may be attracted to steep pit walls and rock storage facilities as escape terrain and may ingest COPC if these features are used as mineral licks;
- ingestion of COPC from fugitive dust: mountain goats may ingest COPC from dust on licks, and soils, as well as from the ingestion of vegetation where dust has deposited; and
- bioaccumulation of COPC in the food web: mountain goats may bioaccumulate COPC from forage when consuming vegetation growing in soils with elevated concentrations of COPC due to dust deposition during operation, closure, and post-closure.

Chemicals of Potential Concern in Metal Leaching and Acid Rock Drainage Exposed Rock

Mountain goats are expected to avoid the Project footprint during construction, operation, and closure phases of the Project due to habitat loss and alteration (Section 18.7.1.3) and sensory disturbance (Section 18.7.3.3). At post-closure, reclamation activities near the pits and the RSFs may be implemented to reclaim approximately 357 ha of winter habitat for mountain goats (Section 18.7.1.3). The pits will be decommissioned, and pit walls as well as rock storage facilities may act as an attractant to mountain goats seeking escape terrain.

Mineral licks are used by mountain goats and are important to the health of goat populations (Poole, Bachmann, and Teske 2010). Newly exposed rock including pit walls and RSFs will be salty and may act as an attractant to mountain goats for use as mineral licks. Mountain goats using pit walls and RSFs as escape terrain may be exposed to elevated concentrations of COPC if they use the pit walls and exposed rock as mineral licks.

Table 18.7-18. Potential Residual Effects on Wildlife and Wildlife Habitat Valued Components due to Chemical Hazards

Valued Component	Timing	Start	Project Area(s)	Project Component(s)	Description of Effect due to Project Component(s)	Type of Project Mitigation	Project Mitigation Description	Potential Residual Effect	Description of Residuals
Moose	Post-closure		PTMA	TMF, receiving waters of North Treaty Creek	Elevated concentrations of COPCs due to COPC bioaccumulation up the food chain	Management Practices, Monitoring, and Adaptive Management	Mitigation for the degradation of water quality is addressed in the Water Quality Chapter (Section 14.7.2). Effluent water quality monitoring will be conducted and designed to ensure regulatory compliance with permitted discharge criteria outlined in the Aquatic Effects Monitoring Plan (Section 26.18.2). In the event that COPC concentrations are observed to approach the monitoring criteria, adaptive management will be initiated to minimize the risk of COPC uptake to moose. Water quality in the TMF will be monitored as per the Water Management Plan (Section 26.17). If water quality does not meet guidelines, wildlife will be prevented from accessing the TMF until guidelines are met.	Yes	The effect of chemical hazards is predicted to result in a residual effect on moose. There is potential for individual moose to bioaccumulate molybdenum from the TMF at post-closure. Molybdenum concentrations in moose are anticipated to be below toxicity thresholds for effects in moose. Despite mitigation, a residual effect of chemical hazards due to potential bioaccumulation in moose is predicted.
Mountain goat	Construction		Mine Site	Pits, RSFs, tunnel excavation	Elevated concentrations of COPCs due to ingestion of COPCs in ML/ARD exposed rock, COPC-dusted vegetation, and COPC bioaccumulation up the food chain	Monitoring and Adaptive Management	Mitigation and management of ML/ARD will be addressed in the Metal Leaching and Acid Rock Drainage Management Plan (Section 26.14). If goats are found using the pit walls or RSF prior to reclamation, adaptive management may be implemented to prevent them from accessing these areas. Mitigation and management of fugitive dust is addressed in the Fugitive Dust Emissions Management Plan (Section 26.11.2). Vegetation growing in dusted areas will be monitored as per the Terrestrial Plant Tissue Metal Concentrations Monitoring Plan (Section 26.20.4). In the event that COPC concentrations are found to approach the monitoring criteria, adaptive management may be initiated to minimize the risk of COPC uptake to mountain goats.	Yes	The effect of chemical hazards is predicted to result in a residual effect on mountain goats due to direct ingestion of fugitive dust deposited on vegetation and bioaccumulation of molybdenum and mercury up the food web. Since it may not be possible to prevent all individuals from accessing areas with elevated concentrations of COPCs, a residual effect is predicted for mountain goats.
Bears (grizzly and black bear)	Construction		PTMA and Mine Site	Camps	Toxicity due to direct ingestion of COPCs associated with mine development and operation	Management Practices, Monitoring, and Adaptive Management	All chemical storage and handling will meet the specifications identified in the Dangerous Goods and Hazardous Materials Management Plan (Section 26.7), the Explosives Manufacture, Storage, and Handling Management Plan (Section 26.8), the Domestic and Industrial Waste Management Plan (Section 26.6), and the Spill Prevention and Emergency Response Plan (Section 26.10).	No	After mitigation, the effects of Project-related chemical hazards on grizzly and black bears are not anticipated to result in a residual effect. Mitigation measures are anticipated to effectively decrease the likelihood of exposure to COPCs associated with mine development and operation. Thus, a residual effect due to COPCs is not predicted for bears.
American marten	Construction		PTMA and Mine Site	Camps	Toxicity due to direct ingestion of COPCs associated with mine development and operation	Management Practices, Monitoring, and Adaptive Management	All chemical storage and handling will meet the specifications identified in the Dangerous Goods and Hazardous Materials Management Plan (Section 26.7), the Explosives Manufacture, Storage, and Handling Management Plan (Section 26.8), the Domestic and Industrial Waste Management Plan (Section 26.6), and the Spill Prevention and Emergency Response Plan (Section 26.10).	No	After mitigation, the effects of Project-related chemical hazards on American marten is not anticipated to have a residual effect. Mitigation measures are anticipated to effectively decrease the likelihood of exposure to COPCs associated with mine development and operation. Thus, exposure to COPCs is anticipated to be low.
Hoary marmot	Construction		Mine Site	Pits and tunnel excavation	Ingestion of COPCs in fugitive dust and COPC bioaccumulation up the food web	Monitoring and Adaptive Management	Mitigation and management of fugitive dust is addressed in the Fugitive Dust Emissions Management Plan (Section 26.11.2). Vegetation growing in dusted areas will be monitored as per the Terrestrial Plant Tissue Metal Concentrations Monitoring Plan (Section 26.20.4). In the event that COPC concentrations are found to approach the monitoring criteria, adaptive management may be initiated to minimize the risk of COPC uptake to hoary marmots.	No	After mitigation, the effect of chemical hazards is not anticipated to have a residual effect on hoary marmot. After accounting for habitat is lost due to Project activities, areas where there will be a small increase in dust which may contain COPCs account for only a relatively small percentage (4.6 - 10%) of hoary marmot high quality habitat in the RSA
Bats	Closure		PTMA	TMF	Bioaccumulation of mercury up the food chain and resulting toxicity	Monitoring and Adaptive Management	Mitigation for the degradation of water quality is addressed in the Water Quality Chapter (Section 14.7.2). Water quality in the TMF will be monitored as per the Water Management Plan (Section 26.17). Wildlife will be prevented from accessing the TMF until water quality meets guidelines.	Yes	The effect of chemical hazards is predicted to result in a residual effect on bats due to potential bioaccumulation of mercury up the food web in the TMF during post-closure. Bats will be attracted to the TMF, as these areas will include shallow pools with vegetation that may be desirable for insect breeding. In bats, exposure to mercury is anticipated to be a result of bioaccumulation through the ingestion of insect prey with elevated concentrations of mercury. Despite mitigation measures, a residual effect of chemical hazards on bats is predicted.
Raptors	Construction		PTMA and Mine Site	Pits, TMF, receiving waters of Sulphurets Creek and Unuk River	Exposure to COPCs in ML/ARD exposed rock, and selenium bioaccumulation through the food web	Monitoring and Adaptive Management	Mitigation and management of ML/ARD on wildlife will be addressed in the Metal Leaching and Acid Rock Drainage Management Plan (Section 26.14). If raptors are found using the pit walls or RSF prior to reclamation, adaptive management may be implemented. Water quality will be monitored in the receiving environment downstream of Sulphurets Creek (Section 26.18.2). Vegetation COPC monitoring (Section 26.20.4) and benthic invertebrate COPC monitoring (Section 26.18.2) will be conducted in the receiving environment downstream of Sulphurets Creek during all Project phases. In the event that COPC concentrations are found to approach the monitoring criteria, adaptive management may be initiated to minimize the risk of COPC uptake to raptors.	No	After mitigation, the effect of chemical hazards is not anticipated to have a residual effect on raptors. While raptors may use pit walls at post-closure for nesting, the number of raptors using pit walls is expected to be few, and ingestion of COPCs from pit walls is expected to be minimal. Raptors have large home ranges and their prey is diverse. Thus, exposure of raptors to selenium through bioaccumulation processes is anticipated to be low and well below concentrations that may elicit effects.
Wetland birds	Operation		PTMA and Mine Site	TMF, WSF, receiving waters (Unuk Creek and North Treaty Creek)	Elevated concentrations of COPCs in water, and selenium and mercury bioaccumulation up the food chain	Management Practices, Monitoring, and Adaptive Management	Mitigation for the degradation of water quality is addressed in the Water Quality Chapter (Section 14.7.2). Water quality monitoring will be conducted in the TMF and WSF during all Project phases (Section 26.17). Wildlife will be prevented from accessing the TMF and the WSF until water meets water quality guidelines for all COPCs. Effluent water quality monitoring will be conducted to ensure regulatory compliance with permitted discharge criteria outlined in the Aquatic Effects Monitoring Plan (Section 26.18.2). In addition, benthic invertebrate monitoring outlined in the Aquatic Effects Monitoring Plan (Section 26.18.2) and vegetation monitoring outlined in the Terrestrial Plant Tissue Metal Concentrations Monitoring Plan (Section 26.20.4) will be conducted in the TMF at post-closure (Section 27.10) and in the receiving waters of North Treaty Creek at closure and post-closure and Unuk River during all Project phases. In the event that COPC concentrations are observed to approach the monitoring criteria, adaptive management may be initiated to minimize the risk of COPC uptake to wetland birds.	Yes	The effect of chemical hazards is predicted to result in a residual effect on wetland birds due to direct exposure to COPCs in water and bioaccumulation up the food web. Exposure to COPCs through ingestion of water is expected to be minimal. In addition, duration of exposure is expected to be minimal for wetland birds using areas such as the TMF and WSF for staging during migration. However, there is some potential for wetland birds breeding in areas downstream of discharge sites and in the TMF at post-closure to bioaccumulate selenium through the food web. Despite mitigation, a residual effect is anticipated for wetland birds.

(continued)

Table 18.7-18. Potential Residual Effects on Wildlife and Wildlife Habitat Valued Components due to Chemical Hazards (completed)

Valued Component	Timing	Start	Project Area(s)	Project Component(s)	Description of Effect due to Project Component(s)	Type of Project Mitigation	Project Mitigation Description	Potential Residual Effect	Description of Residuals
Forest and alpine breeding birds	Construction		PTMA and Mine Site	TMF, receiving waters (North Treaty Creek and Unuk River)	Toxicity due to bioaccumulation of selenium through the food chain	Management Practices, Monitoring, and Adaptive Management	Mitigation for the degradation of water quality is addressed in the Water Quality Chapter (Section 14.7.2). Water quality will be monitored in the TMF during all Project phases (Section 26.17). Forest and alpine birds will be prevented from accessing the TMF when water quality guidelines are not met. Effluent water quality monitoring will be conducted to ensure regulatory compliance with permitted discharge criteria outlined in the Aquatic Effects Monitoring Plan (Section 26.18.2). In addition, benthic invertebrate monitoring outlined in the Aquatic Effects Monitoring Plan (Section 26.18.2) and vegetation monitoring outlined in the Terrestrial Plant Tissue Metal Concentrations Monitoring Plan (Section 26.20.4) will be conducted in the TMF at post-closure (Section 27.10) and in the receiving waters of North Treaty Creek and Unuk River. In the event that selenium and mercury concentrations are observed to approach the monitoring criteria, adaptive management may be initiated to minimize the risk of COPC uptake to forest and alpine birds.	No	After mitigation, the effect of chemical hazards is not anticipated to have a residual effect due to bioaccumulation of selenium on forest and alpine birds. Insects and vegetation with elevated concentrations of selenium are anticipated to constitute only a minor amount of food resources for forest and alpine birds relative to forage in other areas as their diet is mainly terrestrial. Thus, exposure to COPCs in forest and alpine birds is anticipated to be low and below concentrations that may elicit effects.
Western toad	Operation		PTMA	TMF, Receiving waters of North Treaty Creek and Unuk River	bioaccumulation of selenium up the food chain and resulting toxicity	Management Practices, Monitoring, and Adaptive Management	Mitigation for the degradation of water quality is addressed in the Water Quality Chapter (Section 14.7.2). Water quality in the TMF will be monitored as per the Water Management Plan (Section 26.17). If water quality guidelines are not met, toads will be prevented from accessing the TMF until guidelines are met. Effluent water quality monitoring will be conducted and designed to ensure regulatory compliance with permitted discharge criteria outlined in the Aquatic Effects Monitoring Plan (Section 26.18.2). In addition, benthic invertebrate monitoring outlined in the Aquatic Effects Monitoring Plan (Section 26.18.2) will be conducted in the TMF at post-closure (Section 27.10) and in the receiving waters of North Treaty Creek during closure and post-closure, and Unuk River during all Project phases. In the event that COPC concentrations are observed to approach the monitoring criteria, adaptive management may be initiated to minimize the risk of COPC uptake to western toad.	No	After mitigation, the effect of chemical hazards is not predicted to have a residual effect on western toads because toads, toad breeding sites, and surrounding living habitats are not expected to come into contact with water that contains concentrations of COPCs such as selenium above baseline concentrations. Thus, exposure to these COPCs in western toad is anticipated to be low and below concentrations that may elicit effects.

Chemicals of Potential Concern in Fugitive Dust

Mountain goats were included as a sensitive receptor for fugitive dust modelling as part of the air quality assessment (Figure 7.8-33 in Section 7.9.3). At the Mine Site, a 0.186% increase in fugitive dust was predicted during construction and operation phases of the Project at four of the mountain goat receptors included in the model. These areas were generally located in high elevation habitat north west of dust generating Project activities. After accounting for habitat loss and alteration due to the Project footprint (Section 18.7.1.3), and the area functionally lost due to sensory disturbance (Section 18.7.3.3), approximately 1,332 hectares (2%) of the remaining high-quality habitat for mountain goats are predicted to fall within the area with the highest dust deposition (greater than 1.3415 mg/dm²/day) which is 0.186% above baseline. Approximately 6,196 ha (8%) of the remaining high-quality habitat will receive dust deposition with a detectable increase in dust relative to baseline conditions (1.3405 mg/dm²/day; Figure 18.7-22). In these areas, dust will settle on soil and vegetation. Mountain goats ingesting this vegetation and soil may be exposed to COPC in dust.

Bioaccumulation of Chemicals of Potential Concern in the Food Web

Mountain goats are evaluated for the potential to bioaccumulate mercury and molybdenum in areas of increased fugitive dust deposition adjacent to the Mine Site. The selection of COPC and locations to be evaluated is described in the introduction to bioaccumulation. Vegetation in mountain goat forage areas with the greatest dust deposition (Section 26.20.4) and in the RSF after reclamation (Section 27.10) will be monitored for concentrations of COPC as part of the Terrestrial Plant Tissue Metal Concentrations Monitoring Plan (Section 26.20.4).

The potential for bioaccumulation was assessed by evaluating the increase in dust deposition and the area of a goat home range where this would occur. The increase in dust deposition will be very small (0.186% above baseline). Mountain goat home ranges can range from 300 to 9,000 ha. The area receiving fugitive dust (greater than 1.3415 mg/dm²/d) within occupied mountain goat habitat identified in baseline studies ([Appendix 18-A](#), [18-B](#), [18-D](#)) is 1,332 ha. Thus, the amount of vegetation with potential to accumulate COPC consumed by mountain goats consists of a small area relative to a goat's home range (14.8%) and is therefore anticipated to make up a small amount of the overall diet of a limited number of goats (Figure 18.7-22).

Residual Effects for Mountain Goats due to All Chemical Hazards

Chemical hazards are predicted to result in a residual effect on mountain goats on the Mine Site due to direct ingestion of fugitive dust deposited on vegetation and bioaccumulation of COPC up the food web. Monitoring of vegetation (Section 26.20.4) growing in dust deposition areas and in the RSFs at post-closure may be initiated, and adaptive mitigation implemented if necessary. Mitigation measures to further reduce fugitive dust may be examined. Since it may not be possible to prevent all individuals from accessing areas with elevated concentrations of COPC, a residual effect is predicted for mountain goats.

18.7.7.4 Bears: Potential Residual Effects due to Chemical Hazards

One potential pathways of exposure to COPC from Project-related activities was evaluated for bears including: ingestion of COPC associated with mine development and operation: bears may be exposed to COPC if they enter the Project footprint and are able to access and ingest chemicals stored in these areas.

18.7.7.4.1 Chemicals of Potential Concern Associated with Mine Development and Operation

Camps associated with the construction and operation phases of the Project will be located in areas that overlap with high-quality grizzly and black bear habitat. Bears are expected to largely avoid these areas during these Project phases due to habitat loss and alteration (Section 18.7.1.4) and sensory disturbance (Section 18.7.3.4). However, bears are attracted to odours from human activity such as construction camps and dumps (B. N. McLellan 1990; Blood 2002; COSEWIC 2002b). Bears have been observed to ingest anthropogenic substances that are odourous and petroleum products such as oil and grease (BC MOE 2001).

Management and mitigation measures such as proper handling and storage of chemicals (Section 26.7) and spill prevention and response measures (Section 26.10) are anticipated to effectively decrease the likelihood of chemical exposure to bears. In the event that mitigation measures do not entirely prevent bears from being exposed to chemicals used in mining and camp activities, adaptive mitigation will be implemented.

Residual Effects for Bears due to Chemical Hazards

After mitigation, the effects of Project-related chemical hazards on grizzly and black bears are not anticipated to result in a residual effect.

18.7.7.5 American Martens: Potential Residual Effects due to Chemical Hazards

One potential pathways of exposure to COPC from Project-related activities were evaluated for American martens, including: ingestion of COPC associated with mine development and operation: American marten may be exposed to COPC if they enter the Project site and are able to access and ingest these chemicals.

Chemicals of Potential Concern Associated with Mine Development and Operation

Camps associated with the construction and operation phases of the Project will be located in areas that overlap with high-quality American marten habitat. American marten may be attracted to both human waste as well as small rodent populations within camp facilities (Ruggiero et al. 1994).

Management and mitigation measures such as proper handling and storage of chemicals (Section 26.7) and spill prevention and response measures (Section 26.10) are expected to effectively decrease the likelihood of chemical exposure to American martens. In the event that mitigation measures do not entirely prevent American marten from being exposed to COPC used in mining and camp activities, adaptive mitigation will be implemented. These management and mitigation measures effectively decrease the likelihood of chemical exposure to marten.

Residual Effects for American Martens due to Chemical Hazards

After mitigation, the effects of Project-related chemical hazards on American marten are not expected to result in a residual effect.

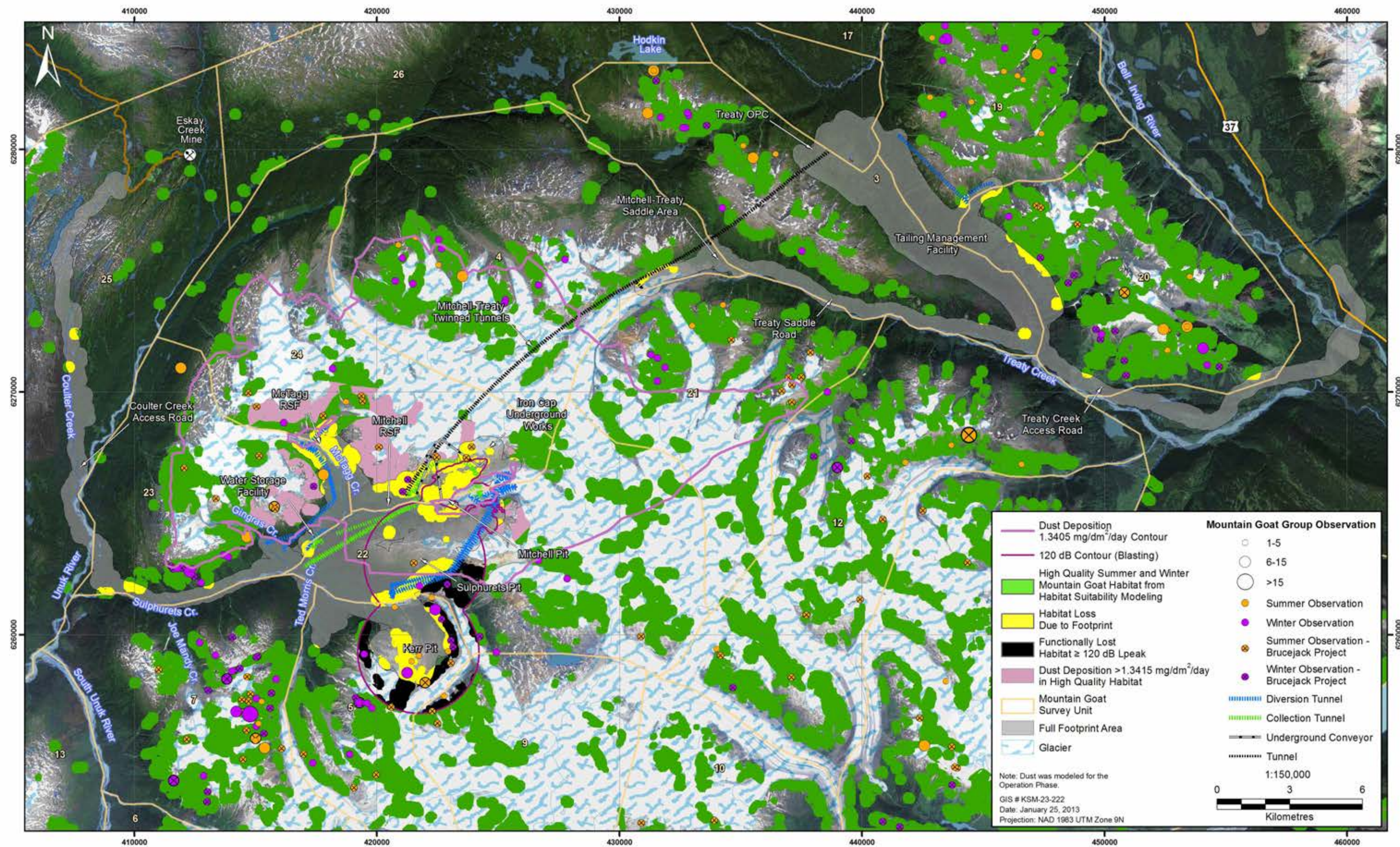


Figure 18.7-22

18.7.7.6 Hoary Marmots: Potential Residual Effects due to Chemical Hazards

Two potential pathways of exposure to COPC from Project-related activities were evaluated for hoary marmots, including:

- ingestion of COPC in fugitive dust: hoary marmots may ingest COPC from dust deposited on forage plants; and
- bioaccumulation of COPC in the food web: hoary marmots may bioaccumulate COPC when consuming vegetation with elevated COPC in areas with increased dust deposition during operation, closure, and post-closure.

Chemicals of Potential Concern in Fugitive Dust

Habitat Suitability Modelling for marmot was conducted as part of baseline studies ([Appendix 18-A](#)) and areas identified as high-quality habitat overlap with some areas where fugitive dust is predicted to be deposited (Section 7.9). An increase in fugitive dust deposition of 0.186% from Project-related activities (range of dust deposition from 1.3405 to greater than 1.3415 mg/dm²/day) is predicted in 4.6 to 10% of areas considered high-quality habitat for hoary marmots after accounting for habitat loss and alteration due to the Project (Section 18.7.1.6).

These identified areas support high-quality habitat, but were not surveyed for marmot habitats, although it is assumed that marmot colonies occur in these areas ([Appendix 18-B](#)).

Bioaccumulation of Chemicals of Potential Concern in the Food Web

Bioaccumulation of mercury was evaluated for hoary marmot in areas with predicted dust deposition during operation, closure, and post-closure.

Hoary marmots are mainly herbivorous, occupying areas of high elevation, and feed on leaves and blossoms of a variety of lush alpine grasses and forbs in spring and early summer (Gray 1975) and seeds later in the summer (D. S. Lee and Funderburg 1982). Hoary marmots have relatively small home ranges and generally feed within 100 m of their den sites (Holmes 1984b).

Hoary marmots are anticipated to avoid the Project footprint and surrounding areas during all Project phases due to habitat loss and alteration (Section 18.7.1.6). Thus, the only areas where hoary marmot may forage on vegetation with accumulated COPC due to Project activities are in dust deposition areas. These areas are expected to receive a small increase in dust deposition (0.186%) and occupy only a relatively small percentage (4.6 to 10%) of hoary marmot high-quality habitat in the LSA ([Appendix 18-B](#)).

Residual Effects for Hoary Marmots due to Chemical Hazards

After mitigation, the effects of Project-related chemical hazards on hoary marmots are not expected to result in a residual effect on the hoary marmot population. Vegetation growing in areas with predicted dust deposition high-quality habitat for hoary marmot will be monitored (Section 26.20.4) and compared to monitoring criteria established for the protection of wildlife, and adaptive management implemented where necessary.

18.7.7.7 Bats: Potential Residual Effects due to Chemical Hazards

One potential pathway of exposure to COPC from Project-related activities was evaluated for bats: bioaccumulation of COPC in the food web. Bats are evaluated for the potential to bioaccumulate COPC when foraging on insects that are emerging from waterbodies that contain COPC above baseline concentrations (but below water quality guidelines).

Bioaccumulation of Chemicals of Potential Concern in the Food Web

Bioaccumulation of mercury within the TMF at closure was assessed in bats because it can accumulate and biomagnify through the food chain (Eisler 1987) (reviewed in O'Shea, Clark, and Boyle 2000).

Bats are considered a main predator of night-flying insects (Whitaker 1996). Bats will largely avoid the Project footprint during construction and operation phases due to habitat loss and alteration (Section 18.7.1.7) and sensory disturbance (Section 18.7.3.5). At closure, bats may use the TMF.

A small amount of forested habitat will remain near the TMF and bats may use these areas for roosting. Bats may be attracted to the waters of the TMF, as these areas may become suitable habitat for insects. Thus, it is possible that bats will bioaccumulate COPC if they consume insect prey in the TMF.

Some bat species forage over water and on emergent aquatic insects (O'Shea, Clark, and Boyle 2000). The Northern long-eared myotis (*Myotis septentrionalis*) and the little brown myotis (*Myotis lucifugus*) are two species of conservation concern that have been documented in the RSA ([Appendix 18-A](#)). The Northern long-eared myotis forages at least occasionally over water and on emergent aquatic insects, while the little brown myotis regularly forages over water and on emergent aquatic insects (O'Shea, Clark, and Boyle 2000).

Residual Effects for Bats due to Chemical Hazards

Chemical hazards are predicted to result in a residual effect on bats due to potential bioaccumulation of mercury up the food web in the TMF at closure. Despite mitigation, a residual effect of chemical hazards on bats is predicted.

18.7.7.8 Birds: Potential Residual Effects due to Chemical Hazards

Three bird VCs were evaluated for potential effects to COPC: raptors, wetland birds, and forest and alpine birds.

18.7.7.8.1 Raptors

Two potential pathways of exposure to COPC from Project-related activities were evaluated for raptors, including:

- ingestion of COPC in ML/ARD exposed rock: raptors may ingest COPC when using pit walls for building nests; and
- bioaccumulation of COPC through the food web: raptors may ingest COPC from prey such as fish, small mammals, birds, and bird eggs with elevated concentrations of COPC.

Chemicals of Potential Concern in Metal Leaching and Acid Rock Drainage Exposed Rock

Raptors are expected to avoid the Project footprint during construction, operation, and closure phases of the project due to habitat loss and alteration (Section 18.7.1.8) and sensory disturbance (Section 18.7.3.6). At post-closure, the pits will be decommissioned and pit walls may act as an attractant to raptors for nesting. Raptors using pit walls for nesting may be exposed to elevated concentrations of COPC if they ingest soil, rock, and vegetation from the pit walls while building nests. However, the number of raptors using these areas is expected to be minimal, and exposure to COPC is expected to be negligible relative to exposure through the food web. Thus, uptake of COPC in ML/ARD exposed rock is not considered further for raptors.

Bioaccumulation of Chemicals of Potential Concern in the Food Web

Birds of prey occupy the top of the food chain and can bioaccumulate persistent COPC to high levels through the food chain. Some raptor species, particularly young birds, may be sensitive to COPC if they ingest sufficient quantities.

Selenium bioaccumulation was considered for raptors because studies demonstrate that it can bioaccumulate and cause effects in these species (Weimeyer and Hoffman 1996; Santolo et al. 1999). While raptors will largely avoid the Project footprint due to habitat loss and alteration (Section 18.7.1.8) and sensory disturbance (Section 18.7.3.6) during operation, they may forage in areas along the Unuk River and directly within the TMF at post-closure after reclamation. Raptors may be exposed to selenium if they forage on prey with elevated concentrations of this COPC in these areas.

Four interrelating factors reduce the potential for bioaccumulation of COPC in raptors. First, concentrations of selenium are predicted to meet water quality guidelines in the TMF post-closure and in all receiving environments during all phases with the exception of Sulphurets Creek. Despite this, bioaccumulation can occur where selenium occurs in environmental media below guidelines.

Second, wetland and forest ecosystems that support small mammal communities are generally supplied with water from upslope streams (Section 16, Wetlands), rather than from the Unuk River and/or north Treaty Creek, which reduces the chance that any COPC in the rivers may enter the food chain through small mammals.

Third, raptors have large home ranges, which are 20 to 30 km² for golden eagles (Kochert et al. 2002) and their prey species are diverse, thus, COPC exposure to raptors is expected to be low, and any bioaccumulation from ingestion of vegetation, soils, and prey will likely result in concentrations of COPC that are well below the threshold exposure for effects.

Fourth, some fish-eating raptors such as bald eagles will prey on salmon spawning in the Unuk River ([Appendix 18-A](#)). Salmon returning to spawn are not expected to uptake selenium from the spawning creeks and are instead expected to be in equilibrium with the ocean concentrations of these chemicals (Section 15, Fish and Aquatic Habitat).

Residual Effects for Raptors due to Chemical Hazards

The effects of Project-related chemical hazards on raptors are not anticipated to result in a residual effect. However, monitoring of water quality (Section 26.17; and Section 26.18.2), and COPCs in vegetation (Section 26.20), and in benthic invertebrate tissue (Section 26.18.2) within the TMF at post-closure (Section 27.10), in the Unuk River during all Project phases and in north Treaty Creek during closure and post-closure will be implemented and compared to monitoring criteria established for the protection of wildlife. Adaptive management may be implemented if necessary.

18.7.7.8.2 Wetland Birds

Two potential pathways of exposure to COPC from Project-related activities were evaluated for wetland birds, including:

- ingestion of COPC in water: wetland birds may ingest COPC from water directly when drinking and indirectly when foraging; and
- bioaccumulation of COPC in the food web: wetland birds may bioaccumulate COPC (selenium and mercury) when consuming vegetation and prey with elevated COPC.

Chemicals of Potential Concern in Water

Chemicals of Potential concern in water are evaluated for two groups of wetland birds—transient migratory birds, which may only spend one or two days in waterbodies in the RSA during spring and fall migration, and resident wetland birds which will spend several months in the RSA during the breeding season.

Migratory wetland birds using the ponds in the WSF (all phases) and TMF (operation and closure) for staging are evaluated for exposure to a variety of COPC. Migratory birds may be spending short periods of time in these waters if they use them, which will reduce any potential effects. Birds may also avoid these ponds due to habitat alteration and disturbance, particularly during operation. Water quality monitoring will be conducted in these ponds as part of the Water Management Plan (Section 26.17). If COPC are above water quality guidelines, and monitoring indicates that birds are using the TMF and/or the WSF, adaptive management will be conducted to prevent birds from accessing these areas. Thus, exposure to water with elevated concentrations of COPC in these Project facilities is anticipated to be minimal.

All receiving waters discharged from the TMF or the WSF are predicted to meet water quality guidelines with the exception of selenium discharged to Sulphurets Creek. Selenium concentrations are predicted to be below the threshold value of 6.8 µg Se/L; which is reported to protect 90% of avian species exposed to selenium (Adams et al. 1998) in most areas, with the exception of the WSF and Sulphurets Creek where concentrations are predicted to be 7.5 µg Se/L. However, Sulphurets Creek does not support wetland bird communities ([Appendix 18-A](#)) and by the time discharge waters reach the confluence at the Unuk River, where some wetland birds may be found, selenium concentrations are predicted to be approximately 3.4 µg Se/L, which is below the threshold for effects in birds and meets the BC MOE selenium water quality guidelines for wildlife. Thus, exposure to water with elevated concentrations of COPC in these areas is expected to be minimal.

Spring and fall staging habitat has been identified at Unuk Lake in Border Lake Provincial Park and this area supports large groups of migratory birds ([Appendix 18A](#)). Unuk Lake is not fed by the Unuk River and therefore this important migratory area will not be exposed to any selenium (or other COPC) due to the Project.

Under the conditions described above and with mitigation, neither transient migratory birds using the RSA as a staging area, nor resident wetland birds using the RSA for breeding, are expected to be directly exposed to COPC in water that are above water quality guidelines.

Bioaccumulation of Chemicals of Potential Concern in the Food Web

Migratory and resident wetland birds were evaluated for the potential effects of bioaccumulation of selenium in the TMF ponds (operation, closure, and post-closure) and in north Treaty Creek and Unuk River (operation, closure, post-closure). Mercury is assessed for its potential to bioaccumulate in wetland birds in the TMF ponds (operation and closure).

Water quality monitoring will be conducted in the TMF ponds as part of the Water Management Plan (Section 26.17). If COPC exceed wildlife guidelines, adaptive management will be conducted to prevent birds from accessing these areas. Thus, exposure to water with elevated concentrations of COPC in the ponds of the TMF (operation and closure) is anticipated to be minimal.

Bioaccumulation of selenium and effects of selenium and selenium compounds in wildlife depend largely on the length and type of food-chain pathway, which in turn will be dependent on the physical, biological, and chemical characteristics of the water body (Ohlendorf 2003; Chapman et al. 2009). Birds inhabiting lentic water bodies that are low flow, such as lakes and wetlands, are more at risk from the inputs of selenium than those inhabiting lotic systems with flowing water (Ohlendorf 2003; Chapman et al. 2009). Thus, wetland birds inhabiting areas of the Unuk are at a lower risk of bioaccumulating concentrations of selenium to effect threshold concentrations. In addition, bioaccumulation of selenium in North Treaty is not anticipated to result in concentrations of selenium that exceed effect thresholds for toxicity as selenium water concentrations in this area are predicted to be elevated above baseline condition by only 10 to 20%, which is within the uncertainty limits of the model (Section 14.7.3).

The TMF at post-closure was evaluated for potential bioaccumulation of selenium for resident birds that spend several months in the area and are therefore most likely to bioaccumulate COPC. During the first 10 years of post-closure, selenium is predicted to be below water quality guidelines, but above baseline (current) conditions and will fall below baseline conditions after that. The re-vegetation process will take more than 10 years, making the TMF relatively poor habitat during the period when selenium is predicted to occur above baseline conditions. Water quality monitoring will be conducted in these ponds as part of the Water Management Plan (Section 26.17). If COPC exceed wildlife guidelines, adaptive management will be conducted to prevent birds from accessing these areas. Hence, bioaccumulation of selenium in the TMF is anticipated to be minimal.

Residual Effects for Wetland Birds due to Chemical Hazards

Chemical hazards are predicted to result in a residual effect on wetland birds due to bioaccumulation of COPC in the food web. Monitoring of water quality (Section 26.17 and

Section 26.18), vegetation (Section 26.20.4), and benthic invertebrate tissue (Section 26.18.2) will be implemented in the TMF at post-closure, in north Treaty Creek during closure and post-closure phases, and in the Unuk River during all Project phases. In addition, water quality monitoring (Section 26.17) will be conducted in the WSF, where COPC in water, vegetation and benthic invertebrate tissue will be compared to monitoring criteria established for the protection of wildlife. If wetland birds are observed to be using the TMF or WSF, adaptive management will be initiated to prevent wetland birds from accessing these facilities.

18.7.7.8.3 Forest and Alpine Birds

One potential pathway of exposure to COPC from Project-related activities was evaluated for forest and alpine birds: bioaccumulation of COPC in the food web. Forest and alpine birds may ingest COPC when consuming prey with elevated concentrations of COPC.

Bioaccumulation of Chemicals of Potential Concern in the Food Web

Bioaccumulation of selenium was evaluated for the potential to bioaccumulate in forest and alpine birds in the TMF at post-closure and selenium was evaluated in north Treaty Creek and the Unuk River during operation, closure, and post-closure.

Concentrations of selenium are predicted to meet water quality guidelines upon discharge to north Treaty Creek and at the confluence of the Unuk River but are evaluated for potential bioaccumulation. Both of these rivers are fast flowing, lotic environments, which reduces the potential for bioaccumulation. Moreover, neither river flows directly into a wetland where there may be uptake and accumulation of selenium.

As with wetland birds, the potential for bioaccumulation of selenium was assessed in the TMF post-closure. Selenium concentrations in water will only be above baseline conditions (but below guidelines) during the first 10 years, before re-vegetation activities will provide habitat for forest birds.

Residual Effects for Forest and Alpine Birds due to Chemical Hazards

The effects of Project-related chemical hazards on forest and alpine birds are not anticipated to result in residual effects. Monitoring of water quality (Section 26.17; and Section 26.18), vegetation (Section 26.20.4), and benthic invertebrate tissue (Section 26.18.2) will be implemented and adaptive management will be implemented as necessary.

18.7.7.9 Western Toads: Potential Residual Effects due to Chemical Hazards

One potential pathway of exposure to COPC from Project-related activities was evaluated for western toads: bioaccumulation of COPC in the food web.

Bioaccumulation of Chemicals of Potential Concern in the Food Web

Bioaccumulation of selenium was evaluated for the potential to bioaccumulate in western toads in the TMF at post-closure and in north Treaty Creek and the Unuk River during operation, closure, and post-closure.

Baseline studies indicated that neither north Treaty Creek nor the Unuk River flow into ponds or habitats that may be used by toads for breeding, or into wetlands where selenium may bioaccumulate in western toads. However, western toads were still assessed for bioaccumulation as a conservative approach, because they are listed on Schedule 1 of SARA.

The ponds of the TMF were evaluated during post-closure for bioaccumulation of selenium. These ponds will occur at an elevation of nearly 1,100 m at closure. Baseline studies at the KSM Project identified breeding ponds (and therefore habitat) up to a maximum of 900 m ([Appendix 18-A](#)), which was higher than other surrounding baseline studies, where the maximum elevation of toad ponds was recorded at 600 m. Hence, toads are unlikely to use the TMF as breeding or living habitat at post-closure due to the effects of high elevation, high snowfall, etc. and no effect is predicted.

Residual Effects for Western Toads due to Chemical Hazards

Chemical hazards are not predicted to result in a residual effect on western toads because toads, toad breeding sites, and surrounding living habitats are not expected to come into contact with water that contains concentrations of selenium above baseline conditions. Monitoring of water quality (Section 26), vegetation (Section 26.20.4), and benthic invertebrate tissues (Section 26.18.2) will be implemented in and compared to monitoring criteria established for the protection of wildlife. Adaptive management may be implemented if necessary.

18.8 Significance of Residual Effects for Wildlife and Wildlife Habitat

The 11 wildlife VCs, (moose, mountain goats, grizzly bears, black bears, American martens, hoary marmots, bats, raptors, wetlands birds, forest and alpine birds, and western toads) may experience residual effects, as described in the following sections.

Cumulative effects of the Project and additional surrounding industrial projects, forestry, and other land use activities is presented in Section 18.9.

18.8.1 Residual Effect Descriptors for Wildlife and Wildlife Habitat

The following sections (18.8.2 to 18.8.9) assess the potential Project-related effects and significance on each VC. The assessment considered results of wildlife baseline studies ([Appendix 18-A](#) to [18-D](#)), regional planning documents, and scientific literature. The duration and frequency of each potential effect was considered when determining the potential effects of greatest concern. For example, an effect that occurs continuously beyond the life of the Project is likely to be of greater concern than a short-term effect that is confined to a discrete time period (Table 18.8-1). Each section is subdivided according to the issues deemed to be of concern for that VC. Within each section, the extent and significance of both positive and adverse potential effects of the Project on wildlife VCs are predicted and discussed. A detailed description of the effects assessment methodology, logic, variables, and descriptors are in Chapter 5.

In some cases, population-level effects could result from the combined effects of habitat loss, disruption of movement, sensory disturbance, mortality (direct and indirect), attractants, and/or chemical hazards, even when each of these residual effects are independently rated as not

significant residual effects. Multiple residual effects may combine to produce a greater effect, as one effect may weaken the resilience of a VC to a subsequent or concurrent effect. This predicted “overall effect” on each VC is assessed within each section when there are two or more residual effects on a wildlife VC. If there is only one residual effect on a VC, no overall effect is assessed.

18.8.2 Residual Effects Assessment for Moose

The residual effects assessment for moose is summarized in Table 18.8-2.

18.8.2.1 Residual Habitat Loss and Alteration

High-quality winter habitat for moose that will be removed or altered during the life of the Project consists of riparian, wetland, and forested habitats. This total loss or alteration of 2,765 ha of combined early and late winter habitat was deemed to result in an adverse residual effect for moose and is evaluated here for significance.

This loss represents a small percentage (6.8%) of the available high-quality moose habitat in the RSA and is therefore considered to have a low magnitude. The extent of the effect is local, as it is limited to the Project footprint and the 300-m buffer. The duration is far future, because the habitat will be lost for more than 70 years. The frequency of the event leading to habitat loss (i.e., vegetation clearing) is sporadic; the majority of habitat will be lost during construction (2,584 ha), but an additional 181 ha will be lost during the operation phase. The effect is irreversible, as the majority (72%) will not be suitable for reclamation post-closure. The moose population in the NWA and Bell-Irving corridor (including part of the eastern extent of the RSA) is currently declining (M. W. Demarchi 2011); therefore, the context of the moose population is considered to be high (i.e., the population has a low resilience to imposed stresses and will not easily adapt to the effect due to existing stressors). The probability of the effect occurring is high, and the confidence in the significance rating is medium.

For this residual effect, the magnitude rating had a strong influence on the significance rating. The magnitude was rated as low due to a relatively small habitat loss of 6.8% of the high-quality habitat in the RSA. The definition for low magnitude in the assessment is: “differs from the average value for baseline conditions to a small degree (e.g., within the range of natural variation of the local population and well below a guideline or threshold value).” Due to this low rating for the magnitude of habitat removal, the effect of habitat loss for moose is assessed as **not significant (minor)**.

18.8.2.2 Residual Disruption of Movement

The distribution of infrastructure along Treaty Creek (the TCAR and Saddle Area), the TMF valley (the PTMA), and increased traffic along the TCAR may impede movement of moose between valley systems, beginning during the construction phase. The TMF valley will not be a movement corridor to moose during operation, but this function may return upon closure and reclamation. The Saddle Area is assumed to be a movement corridor and design mitigation in the Saddle Area will facilitate movement through this area, as the twinned tunnels will remain underground across the valley. The moose populations in the Unuk and Bell-Irving valleys will remain connected via the Teigen Valley.

Table 18.8-1. Definitions of Significance Criteria for Wildlife and Wildlife Habitat Residual Effects

Timing What phase of the Project is the effect associated with?	Magnitude (negligible, low, medium, high)	Geographic Extent (local, landscape, regional, beyond regional)	Duration (short-term, medium-term, long-term, far future)	Frequency (once, sporadic, regular, continuous)	Reversibility (reversible short-term, reversible long-term, or irreversible)	Context (ecological resilience and/or unique attributes) (low, neutral, high)	Probability (low, medium, high)	Confidence (low, medium, high)	Significance (Not Significant: minor, moderate; Significant: major)	Follow-Up Monitoring (Not required, required)
Construction	Negligible. There is no detectable change from baseline conditions.	Local. The effect is limited to the project footprint (e.g., within a 300 m buffer) and/or to individuals within the buffer.	Short term. The effect lasts approximately 1 year or less.	Once. The effect occurs once during any phase of the project.	Reversible short-term: An effect that can be reversed relatively quickly.	Low. The valued component is considered to have little to no unique attributes and/or there is high resilience to imposed stresses.	Low. An effect is unlikely but could occur.	Low (< 50% confidence). The cause-effect relationship between the project and its interaction with the environment is poorly understood; data for the project area may be incomplete; uncertainty associated with synergistic and/or additive interactions between environmental effects may exist. High degree of uncertainty.	Not Significant (minor). Residual effects have no or low magnitude, local geographical extent, short or medium-term duration, and occur intermittently, if at all. There is a high level of confidence in the conclusions. The effects on the VC (at a population or species level) are indistinguishable from background conditions (i.e., occur within the range of natural variation as influenced by physical, chemical, and biological processes). Land use management objectives will be met. Follow-up monitoring is optional.	Not required
Operation	Low. The magnitude of effect differs from the average value for baseline conditions, but is within the range of natural variation of the local population and well below a guideline or threshold value.	Landscape. An effect extends beyond the project footprint to a broader watershed area, but remains tied to the footprint and/or to individuals within that watershed.	Medium term. The effect lasts from 1 – 11 years.	Sporadic. The effect occurs at sporadic or intermittent, intervals during any phase of the project.	Reversible long-term: An effect that can be reversed after many years.	Neutral. The valued component is considered to have some unique attributes, and/or there is neutral (moderate) resilience to imposed stresses.	Medium. An effect is likely but may not occur.	Medium. (50 – 80% confidence): The cause-effect relationship between the project and its interaction with the environment is not fully understood, or data for the project area is incomplete: moderate degree of uncertainty.	Not Significant (moderate). Residual effects have medium magnitude, local, landscape or regional geographic extent, are short-term to chronic (i.e., may persist into the far future), and occur at all frequencies. Residual effects on VCs are distinguishable at the population, community, and/or ecosystem level. Ability of meeting land use management objectives may be impaired. Confidence in the conclusions is medium or low. The probability of the effect occurring is low or medium. Follow-up monitoring of these effects may be required.	Required
Closure	Medium. The magnitude of effect differs from the average value for baseline conditions and approaches the limits of natural variation of the local population, but below or equal to a guideline or threshold value.	Regional. The effect extends across the Regional Study Area and/or the population.	Long term. The effect lasts between 12 and 70 years.	Regular. The effect occurs on a regular basis during, any phase of the project.	Irreversible. The effect cannot be reversed.	High. The valued component is considered to be unique, and/or there is low resilience to imposed stresses.	High. An effect is highly likely to occur.	High. There is greater than 80% confidence in understanding the cause-effect relationship between the project and its interaction with the environment, and all necessary data is available for the project area. There is a low degree of uncertainty.	Significant (Major). Residual effects have high magnitude, regional or beyond regional geographic extent, are chronic (i.e., persist into the far future), and occur at all frequencies. Residual effects on VCs are consequential (i.e., structural and functional changes in populations, communities and ecosystems are predicted). Ability to meet land use management objectives is impaired. Probability of the effect occurring is medium or high. Confidence in the conclusions can be high, medium, or low. Follow-up monitoring is required.	
Post-Closure	High. The magnitude of effect is predicted to differ from baseline conditions and exceed guideline or threshold values so that there will be a detectable change beyond the range of natural variation of the local population (i.e., change of state from baseline conditions).	Beyond Regional: The effect extends possibly across or beyond the province and/or the population.	Far Future: The effect lasts more than 70 years.	Continuous. An effect occurs constantly during any phase of the Project.						

Table 18.8-2. Summary of Residual Effects on Moose

Description of Residual Effect	Project Component(s)	Timing of Effect	Magnitude	Extent	Duration	Frequency	Reversibility	Context	Likelihood of Effects		Significance Determination	Follow-up Monitoring
									Probability	Confidence Level		
Habitat Loss	All	Construction	Low	Local	Far future	Sporadic	Irreversible	High	High	Medium	Not Significant (Minor)	Required
Disruption of Movement	TMF, TCAR	Construction	Low	Landscape	Far future	Sporadic	Reversible long-term	High	Medium	Low	Not Significant (Minor)	Required
Direct Mortality	TCAR, CCAR	Construction	Low	Landscape	Far future	Sporadic	Reversible long-term	High	Medium	Medium	Not Significant (Minor)	Required
Indirect Mortality	TCAR, CCAR	Construction	Low	Landscape	Far future	Sporadic	Reversible long-term	High	Low	Low	Not Significant (Minor)	Required
Chemical Hazard	TMF	Post-closure	Low	Local	Far future	Regular	Reversible long-term	High	Medium	Medium	Not Significant (Minor)	Required
Overall Residual Effect	All	Construction	Medium	Landscape	Far future	Sporadic	Reversible long-term	High	Medium	Medium	Not Significant (Moderate)	Required

After mitigation, the residual effect of disruption of moose movements is expected to have a low magnitude. The extent of this effect will be at the landscape scale because movement may be disrupted to individuals within the watershed, not just the footprint. The duration will be far-future because, although the TMF and the CCAR will be partially reclaimed and traffic volumes will decrease post-closure, some structures (TCAR and the Saddle Area) will remain in perpetuity. The frequency will be sporadic, as the moose movement will likely only be disrupted when moose are travelling through the footprint. The effect will be partially reversible long term because of post-closure mitigation in the TMF. The context of the moose population is high and the probability of disruption of movement occurring is medium. Confidence of this analysis is low because it has been assumed that these valleys are movement corridors, but no movement data has been gathered in the field. The effect of disruption of moose movement is assessed as **not significant (minor)**.

18.8.2.3 Residual Direct Mortality

Direct mortality due to vehicle collisions is assessed as a residual effect for moose because of traffic during the construction and operation phases of the Project. With mitigation and monitoring, the residual effects of direct mortality on moose will have a low magnitude (estimate of 1.3 vehicle-moose collisions per year along the access roads and Highway 37 within the RSA), as it will likely remain within the natural variation of the local population. The extent of this effect will be landscape because it will remain tied to the Project. The duration will be far-future because traffic will continue post-closure. The frequency will be sporadic. The effect will be reversible long term because the risk of collision will decline when traffic volumes decline at closure. Because of the status of the moose population in the area (i.e., declining in the NWA and Highway 37 corridor) and the high-value habitat along Treaty Creek and near Highway 37 in the RSA, the context of the population is high, confidence is medium, and the probability of direct mortality occurring is medium. Direct mortality is not expected to affect the viability of the local moose population (magnitude low), and thus this effect is considered to be **not significant (minor)**.

A population viability analysis was conducted for the Highway 37 and 37A corridors to evaluate the effect of the KSM Project and cumulative traffic from multiple projects. The results of this analysis are presented in the cumulative effects section for moose (Section 18.9 and Appendix D of [Appendix 22-C](#)).

18.8.2.4 Residual Indirect Mortality

The Project roads were evaluated for the potential to increase hunting pressure as a result of increased access. The Project roads will be gated and controlled for the life of the Project and into the post-closure phase, limiting unauthorized entry. Increased access may not be completely avoided or mitigated, thus a potential adverse residual effect of low magnitude is predicted for moose. The extent of this effect will be landscape because it remains tied to the access roads. The duration will be far-future because the area may be accessible to some degree post-closure. The frequency will be sporadic. The effect will be reversible with planned road closure of the CCAR and adaptive mitigation. Because of the status of the moose population in the NWA and Highway 37 corridor (i.e., declining) and the high value habitat along the access roads, the context of the population is high. The probability of increased hunting is low given the

mitigation planned as it is unlikely but could occur. The assessment is of low confidence because the actual number of hunters who could use these areas and the associated effect on the local moose population is uncertain. The effect of indirect mortality on moose was assessed as **not significant (minor)**.

18.8.2.5 Residual Chemical Hazards

Chemical hazards were predicted to result in a residual effect on moose (Table 18.8-2) because of the potential for moose to bioaccumulate COPC (molybdenum and mercury) when consuming aquatic vegetation in the TMF at post-closure. The results of a food chain model indicate that residual effects of chemical hazards on moose will have a low magnitude, because COPC concentrations are expected to be below the threshold for effects for all COPC.

The extent of this effect will be local, because the effect is anticipated to be limited to the TMF. The duration of the effect will be far future during post-closure in the TMF. The frequency of the effect will be regular. The effect will be reversible long-term as concentrations of COPC will decrease in the TMF over time, thus, exposure to moose will decrease as well. The context of the moose population is considered to be high, and the probability of chemical hazards occurring is anticipated to be medium. Confidence of this analysis is medium, because the model assumed that moose will forage the majority of the time in the TMF, but moose are likely to forage over a greater area – yielding a model which predicts conservatively high values. The effect of chemical hazards on moose is assessed as **not significant (minor)** because COPC in the water that supports aquatic vegetation will meet guidelines and because the food chain model predicted that concentrations of COPC would occur below the threshold for effects in moose.

18.8.2.6 Overall Effect on Moose

Project-related residual effects (habitat loss, disruption of movement, direct mortality, indirect mortality, and chemical hazards) were predicted for moose. Although these effects were individually rated as not significant, these effects may interact, and are evaluated for the potential to create additive or synergistic effects that have a different magnitude or extent for the local moose population within the RSA.

Several factors have been considered to evaluate the overall effects on moose which may result in an increased magnitude rating. First, interactions among habitat loss due to the Project, functional loss of habitat due to noise disturbance, and activities in the RSA (i.e., forestry, roads, and hunting) have been considered. Second, several assumptions have been made about the efficacy of mitigation measures (e.g., retention of the Saddle Area as a movement corridor and success of the reclamation activities to provide habitat and a movement corridor in the TMF). Third, several of the effects ratings have low certainty (e.g., efficacy of road closures to exclude hunters). Taken together, these factors suggest that a cautionary approach should be taken to predict the outcome of these effects on moose and a rating of medium magnitude is predicted for the moose population within the RSA. The extent will be landscape and the duration will be far future (i.e., continue post-closure). The frequency will be sporadic. The effect will be reversible long-term because the level of effects will decline at closure. Because of the status of the moose population in the nearby NWA and Highway 37 corridor area (i.e., declining) and the high-value habitat within the LSA, the context of the population is high. The probability of an overall

residual effect is medium, as it is likely but may not occur. The assessment is of medium confidence because there is a moderate degree of uncertainty. The overall residual effect of habitat loss, disruption of movement, direct mortality, indirect mortality, and chemical hazards acting synergistically on moose is assessed as **not significant (moderate)**.

18.8.3 Residual Effects Assessment for Mountain Goats

The residual effects assessment for mountain goats is summarized in Table 18.8-3.

18.8.3.1 Residual Habitat Loss and Alteration

High-quality mountain goat habitat and established UWR that will be removed or altered during the life of the Project will occur in the Mine Site near the pits and RSFs. This loss or alteration of 1,150 ha of winter habitat is 2% of winter habitat in the RSA, and was rated as a potential adverse residual effect for mountain goat. The Project will also result in the removal or alteration of 547 ha or 4% of the provincially designated mountain goat UWR u-02-006 within the RSA. Hence, this effect is considered to have a medium magnitude.

The extent of the effect is local (i.e., tied to the footprint), the duration is far future, the frequency is sporadic (i.e., the event of removing habitat will begin during construction but will increase at sporadic intervals through operation), and the effect is irreversible, as the habitat will not be reclaimed, although it should be noted that areas that are altered may return to baseline conditions when disturbances due to noise, dust, etc., cease. The context of the mountain goat population is considered to be neutral because although they are sensitive to loss of habitat and are particularly limited by winter habitat, the goat population may be able to adapt. The probability of the effect occurring is high and the confidence in the analysis is high. The footprint overlaps habitat for a relatively small (2%) proportion of goats in the RSA, but overlaps an area of established UWR, and is therefore assessed as **not significant (moderate)**.

18.8.3.2 Residual Disturbance to Movement

Disruption of movement may result from development of infrastructure (e.g., pits, RSFs, and Project roads) at high elevation and due to sensory disturbance (Section 18.8.3.3) where goats avoid areas that allow for habitat connectivity. After mitigation, the residual effect of disruption of mountain goat movements is considered to be of low magnitude because complex of mountains, ridges, and ice fields that surround the Mine Site will not be physically altered and can still function as movement corridors. The extent of this effect will be local because movement will likely be disrupted due to Project infrastructure and within and across the Project footprint. The duration will be long-term because some mine infrastructure will be partially reclaimed and the majority of disturbances (e.g., noise) will be removed post-closure. The frequency will be sporadic. The reversibility will be reversible long-term. The context of mountain goats is neutral and the probability of goat movement being disrupted is medium. The confidence is low because predicting mountain goat movement patterns cannot be done with high confidence. The effect of disruption of mountain goat movement is assessed as **not significant (minor)**.

Table 18.8-3. Summary of Residual Effects on Mountain Goat

Description of Residual Effect	Project Component(s)	Timing of Effect	Magnitude	Extent	Duration	Frequency	Reversibility	Context	Likelihood of Effects		Significance Determination	Follow-up Monitoring
									Probability	Confidence Level		
Habitat Loss	Mine Site	Construction	Medium	Local	Far future	Sporadic	Irreversible	Neutral	High	High	Not Significant (Moderate)	Required
Disruption of Movement	Mine Site	Construction	Low	Local	Long	Sporadic	Reversible long-term	Neutral	Medium	Low	Not Significant (Minor)	Required
Sensory Disturbance	Mine Site	Construction	Medium	Landscape	Long	Regular	Reversible short-term	Neutral	Medium	Low	Not Significant (Moderate)	Required
Direct Mortality	Controlled avalanche	Construction	Negligible	Landscape	Long	Sporadic	Reversible long-term	Neutral	Low	Low	Not Significant (Minor)	Required
Indirect Mortality	Project Roads	Closure	Low	Landscape	Far future	Sporadic	Reversible long-term	Neutral	Low	Low	Not Significant (Minor)	Required
Chemical Hazards	Mine Site	Construction	Low	Landscape	Far future	Continuous	Reversible long-term	Neutral	Medium	Low	Not Significant (Minor)	Required
Overall Residual Effect	All	Construction	Medium	Landscape	Far future	Sporadic	Reversible long-term	Neutral	Medium	Medium	Not Significant (Moderate)	Required

18.8.3.3 Residual Sensory Disturbance

Auditory and visual disturbance to mountain goats surrounding the Mine Site may result in the displacement of these goats from adjacent habitats. The population of goats may be affected as they move away from the Mine Site through density-dependent effects and via some increase in the probability of mortality or reduced reproduction for individuals unfamiliar with predation risks and foraging opportunities in the new range. Noise disturbance from helicopters during construction and pit blasting during operation are rated to result in a medium magnitude effect on mountain goats, as up to 13% of the winter population within the RSA (19% of the massif winter subpopulation) are modelled to be exposed to noise levels that are reported to cause disturbance.

The extent of the effect is landscape, as the noise disturbance extends beyond the Project footprint. The duration will be long-term, as the noise disturbance will be removed at the end of operation. The frequency is regular, as blasting will occur daily. The effect of sensory disturbance is reversible short-term, as the sound from blasts ends relatively quickly. The context of the mountain goat population is neutral and the probability of the effect occurring is medium (i.e., it is likely, but may not occur). The confidence in this assessment is low, as the response of mountain goats to sensory disturbance is relatively well known in the scientific literature, but can vary depending on habitat quality. The effect of sensory disturbance for mountain goats is assessed as **not significant (moderate)**.

18.8.3.4 Residual Direct Mortality

Avalanche control (i.e., avalanche blasting) may result in incidental mortality of mountain goats. Monitoring of the mountain goat population in the RSA will form an important component of the Wildlife Management and Monitoring Plan (Section 26.21). Direct mortality is unlikely to affect the regional mountain goat population because it will not exceed direct mortality that would likely occur under natural avalanche conditions to which they are already exposed (Section 18.7.4); therefore the residual effects are considered to be negligible in magnitude. The extent is landscape because avalanche control will occur outside of the 300-m footprint buffer. The duration will be long term because avalanche control will occur throughout the life of the Project. The frequency will be sporadic. The effect will be reversible long term, because individuals lost will be replaced in the population after many years. The context of the mountain goat population is considered to be neutral. The probability of the effect is low and the confidence is low. The effect of direct mortality due to avalanche control on mountain goats is assessed as **not significant (minor)**.

18.8.3.5 Residual Indirect Mortality

The potential source of indirect mortality identified for mountain goats in association with Project development is an increase in hunting pressure resulting from greater accessibility to the Project area. Project roads may facilitate access to the alpine areas (BAFA BEC zone) near Sulphurets Creek and the Snowslide Range that contain high-quality winter and summer habitat, including established UWR (u-6-002), and are occupied by a number of mountain goats. Mitigation measures were conducted during the design stage to limit the number of roads built to, or within mountain goat habitat (including UWR). During construction, operation, and closure, mitigation will include actively controlling access on Project roads to minimize unauthorized entry. A potential adverse residual effect of low magnitude is predicted for

mountain goats because mortality from hunting is likely to be minor with mitigation, and hence within the limits of natural variation.

The geographic extent of the effect will be landscape, as it will extend beyond the footprint. The duration will be far-future as although some roads will be close, the TCAR will remain in perpetuity. The frequency will be sporadic. The effect is reversible long term with ongoing adaptive mitigation. The context of the mountain goat population is considered to be neutral. Because of mitigation, the probability of indirect mortality occurring is low and the confidence is low. The effect of indirect mortality of mountain goats due to increased hunting pressure is assessed as **not significant (minor)**.

18.8.3.6 Residual Chemical Hazards

Chemical hazards were predicted to result in a residual effect on mountain goats (Table 18.8-3) because of the potential for mountain goats to bioaccumulate COPC when consuming vegetation adjacent to the mine site in areas of dust deposition. The timing of the effect is anticipated to commence at construction when blasting and drilling will begin, with the majority of fugitive dust created during the operation phase.

With monitoring and mitigation, the residual effect of chemical hazards on mountain goats is predicted to have a low magnitude, because the increase in dust that may contain COPC is low (0.186%) and any resulting bioaccumulation is expected to be below the threshold for effects for all COPC. The extent of this effect will be landscape, because the effect is anticipated to extend to areas outside of the Project footprint but will not extend throughout the RSA. The duration of the effect will be far future, as the effect is expected to last beyond 70 years, and the frequency will be continuous, as the effect will occur constantly during construction, operation, and closure phases of the Project. The effect will continue until vegetation growing in the affected areas returns to or below baseline concentrations of COPC. The effect will be reversible long-term as concentrations of COPC will decrease in vegetation, thus will decrease in mountain goats over time after cessation of Project activities. The context of mountain goats is neutral, and the probability of bioaccumulation of COPC occurring in mountain goats is anticipated to be medium. Confidence in this analysis is low, because it was assumed that goats will forage for a substantial amount of time in dusted areas; however, they may forage over a larger area. Thus, the effect of chemical hazards on mountain goats is assessed as **not significant (minor)**.

18.8.3.7 Overall Effect on Mountain Goats

The residual effects for mountain goats are habitat loss, including UWR, disruption of movement, sensory disturbance, direct mortality, indirect mortality, and chemical hazards. These six effects may interact, creating additive or synergistic effects that have a different extent for the local mountain goat population as a whole.

Considering these potential effects on mountain goats in combination with the amount of suitable habitat and UWR in the RSA, and mitigation to minimize effects, the overall potential Project-related residual effect on local mountain goat populations is rated as medium magnitude. This assessment is largely driven by the relatively large area of noise disturbance north of the Mine Site and the removal and alteration of area within an established UWR.

The extent will be landscape and the duration will be far future (i.e., continue post-closure). The frequency will be sporadic. The effect will be reversible long-term because the level of effects will decline at closure. The context of the population is considered neutral. The probability of an overall residual effect is medium, as it is likely but may not occur. The assessment is of medium confidence because there is a moderate degree of uncertainty. The overall residual effect of habitat loss, disruption of movement, sensory disturbance, direct mortality, indirect mortality, and chemical hazards acting synergistically on mountain goats is assessed as **not significant (moderate)**.

18.8.4 Residual Effects Assessment for Grizzly Bears and Black Bears

The residual effects assessments for grizzly bears and black bears are summarized in Tables 18.8-4 and 18.8-5, respectively.

18.8.4.1 Residual Habitat Loss and Alteration

The overall loss or alteration of 10,886 ha (6.3% of habitat in the RSA) of high-quality grizzly bear habitat is roughly equivalent to the loss or alteration of 58% of the home range of a single male grizzly bear in the interior of BC, or up to two female coastal grizzly bear home ranges. Based on the estimated superpopulation of grizzly bears in the RSA (58 bears; [Appendix 18-C](#)), 188 ha of high-quality habitat (10,886 ha) per bear will be lost or altered.

Important habitat for grizzly bears in the RSA includes the proposed grizzly bear WHA in the TMF valley and the salmon-foraging streams along the Unuk and Bell-Irving rivers. Approximately 3.8% (1,807 ha) of the proposed WHA will be lost or altered as a result of development of the PTMA and TCAR. Two-thirds of the grizzly bears found in the RSA were located along the Unuk River, indicating that salmon resources are important to the maintenance of the grizzly population. The Project design has provisions to minimize any effects to the salmon resources in the Unuk River and Teigen Creek (Chapter 15). Timing of construction work would adhere to appropriate fisheries operating windows for fish-bearing streams (Fish and Aquatic Habitat, Chapter 15). With no significant effects predicted for the salmon resource, and hence on this food resource for bears, the only habitat-related effects predicted are in the removal and alteration of vegetation resources, particularly where Project infrastructure is located in valley bottoms.

Removal or alteration of existing black bear habitat is rated to result in a residual effect. The overall loss of 11,132 ha of high-quality habitat represents 6.4% of the available high-quality habitat in the RSA, and 39.5% of the LSA.

The habitat loss represents a small percentage of both the grizzly bears' and black bears' range within the RSA and is therefore considered to be an effect of a low magnitude, as it will not approach the threshold level where greater than 25% of the habitat is modified (Hargis and Bissonnette 1997; Hargis, Bissonnette, and Turner 1999; Potvin, Courtois, and Belanger 1999; Poole et al. 2004). The definition of a low-magnitude effect is that it "differs from the average value for baseline conditions to a small degree (e.g., within the range of natural variation of the local population and well below a guideline or threshold value)."

Table 18.8-4. Summary of Residual Effects on Grizzly Bear

Description of Residual Effect	Project Component(s)	Timing of Effect	Magnitude	Extent	Duration	Frequency	Reversibility	Context	Likelihood of Effects		Significance Determination	Follow-up Monitoring
									Probability	Confidence Level		
Habitat Loss	All	Construction	Low	Local	Far future	Sporadic	Irreversible	Neutral	High	Medium	Not Significant (Minor)	Required
Disruption of Movement	All	Construction	Low	Landscape	Far future	Sporadic	Reversible long-term	Neutral	Medium	Low	Not Significant (Minor)	Required
Direct Mortality	TCAR, CCAR	Construction	Low	Landscape	Long	Sporadic	Reversible long-term	Neutral	Medium	Medium	Not Significant (Minor)	Required
Indirect Mortality	TCAR, CCAR	Construction	Low	Landscape	Far future	Sporadic	Reversible long-term	Neutral	Medium	Medium	Not Significant (Minor)	Required
Attractants	Camps, Project roads	Construction	Low	Local	Far future	Sporadic	Reversible long-term	Neutral	High	Medium	Not Significant (Minor)	Required
Overall Residual Effect	All	Construction	Medium	Landscape	Far future	Sporadic	Reversible long-term	Neutral	Medium	Medium	Not Significant (Moderate)	Required

Table 18.8-5. Summary of Residual Effects on Black Bear

Description of Residual Effect	Project Component(s)	Timing of Effect	Magnitude	Extent	Duration	Frequency	Reversibility	Context	Likelihood of Effects		Significance Determination	Follow-up Monitoring
									Probability	Confidence Level		
Habitat Loss	All	Construction	Low	Local	Far future	Sporadic	Irreversible	Low	High	Medium	Not Significant (Minor)	Required
Disruption of Movement	All	Construction	Low	Landscape	Far future	Sporadic	Reversible long-term	Low	Medium	Low	Not Significant (Minor)	Not Required
Direct Mortality	TCAR, CCAR	Construction	Low	Landscape	Long	Sporadic	Reversible long-term	Low	Medium	Medium	Not Significant (Minor)	Required
Indirect Mortality	TCAR, CCAR	Construction	Low	Landscape	Far future	Sporadic	Reversible long-term	Low	Medium	Medium	Not Significant (Minor)	Required
Attractants	Camps, Project roads	Construction	Low	Local	Far future	Sporadic	Reversible long-term	Low	High	Medium	Not Significant (Minor)	Required
Overall Residual Effect	All	Construction	Medium	Landscape	Far future	Sporadic	Reversible long-term	Low	Medium	Medium	Not Significant (Minor)	Not Required

The extent of the effect is local (i.e., within 300 m of the Project footprint), the duration is far future, the frequency is sporadic, and the effect is irreversible, as not all areas will not return to existing baseline conditions although areas of the 300-m buffer may return to baseline conditions. The context of the grizzly bears is considered to be neutral as grizzly bears may be able to adapt their habitat use to accommodate the lost area, while the context of black bears is considered low, as black bears can respond well to human activities and adapt to changes in habitat. The probability of the effect occurring is high and the confidence of the area and proportion removed is medium. The effect of habitat loss for both grizzly and black bears is assessed as **not significant (minor)**.

18.8.4.2 Residual Disruption of Movement

Roads and infrastructure may act as barriers to grizzly and black bear movements, reducing connectivity between seasonal habitats. Grizzly bears frequently alter their behaviour and avoid areas with human activity (such as high-use roads), helicopter disturbance, and periods when humans are most active (Mueller 2001), whereas black bears are more tolerant of human presence. Because grizzly and black bears have very large home ranges, and due to the mitigation actions taken, particularly to design features so as not to create barriers to movement (e.g., minimizing infrastructure at the bridge over the Unuk River and the infrastructure in the Saddle Area) the residual effect of disruption of bear movements is considered to be low magnitude.

The extent of this effect will be landscape because disruption of movement will be tied to Project infrastructure. The duration will be far-future because the majority of mine features (e.g., pits, dams) will remain and will not return to baseline conditions. The frequency will be sporadic. The effect will be reversible long term once the Project ends. The context is neutral for grizzly bears and low for black bears, because the bear populations are considered healthy in this region and suitable habitat in the RSA is abundant. Bears may temporarily avoid habitats where there is a barrier to their movement, but are expected to re-occupy the habitat once the disturbance is removed. The probability of the effect occurring is medium and the confidence is low because predicting bear movement patterns cannot be done with high confidence. The effect of disruption of both grizzly and black bear movement is assessed as **not significant (minor)**.

18.8.4.3 Residual Direct Mortality

Direct grizzly bear and black bear mortality due to vehicle collisions is a potential residual effect because of traffic during the construction and operation phases of the Project along Project roads (access, service, and haul roads) and Highway 37. Potential Project-related vehicle interactions with bears will be mitigated through adhering to speed limits, road and traffic signs, cutting vegetation low at locations where bears tend to cross roads to ensure visibility of animals, and removal of carrion that may attract bears to the Project roads.

Direct mortality from tree felling is a potential effect on black bears, because denning may occur within low elevation forests in the Project area. To minimize potential mortality from tree felling, felling will be conducted outside of the denning season. If felling is required during the denning season (primarily for soil stability reasons), pre-clearing surveys to identify and avoid active black bear dens will be conducted within high-quality bear denning habitat.

With mitigation and monitoring, the residual effects of direct mortality on both grizzly bears and black bears are predicted to have a low magnitude. The extent of this effect will be landscape because it extends to the watershed but remains tied to the Project footprint. The duration will be long term because traffic volumes will be reduced post-closure. The frequency will be sporadic. The effect will be reversible long term when traffic is reduced at closure. The probability of direct mortality occurring is medium and confidence is medium. Direct mortality is not expected to affect the viability of the local grizzly bear (neutral context) or black bear (low context) populations, and thus this effect is considered to be **not significant (minor)**.

18.8.4.4 Residual Indirect Mortality

The potential source of indirect mortality identified for grizzly bears in association with Project development is an increase in hunting pressure and human activity resulting from greater accessibility. Mortality for grizzly bears can increase through a combination of unregulated hunting, incidental mortality when hunters defend their catches, poachers, and increased numbers of problem bears caused by increased bear-human contact. This potential effect is rated as a negative residual effect of low magnitude for grizzly bears, and low magnitude for black bears. Mitigation will include access control on all Project access roads for the life of the Project and into post-closure.

For both species, the geographic extent will be landscape, as it will extend outside the footprint, and occur sporadically. Increased access will extend beyond the life of the Project and is therefore far-future in duration and reversible in the long term through adaptive mitigation. Grizzly bear and black bear populations in the area are relatively healthy (Hamilton 2012); therefore, grizzly bears will have a neutral context, and black bears a low context to increased hunting. Because bears have large home range sizes and are broad habitat generalists, access may increase opportunities for hunting but not to the extent where the viability of local grizzly bear or black bear populations would be affected. The probability of this effect is rated as medium, with medium confidence, because predicting the behaviour of hunters and their potential effect on the local bear populations is uncertain. With mitigation and monitoring, the residual effect of indirect mortality on grizzly bears and black bears is assessed as **not significant (minor)**.

18.8.4.5 Residual Attractants

Grizzly and black bears will be attracted to the odours from human activity within the Project footprint, such as camps, waste, or carrion along roads. To minimize the effects of attractants to bears, mitigation measures will be implemented, including storing and removing all food wastes and wildlife attractants (e.g., liquid solvents, lubricants), erecting bear fences in appropriate areas, removing carrion from roads, educating employees and contractors in wildlife awareness, and monitoring waste management.

With mitigation, the magnitude of the effect is rated as low, the geographic extent is local, as it remains within the 300-m buffer of the Project footprint, and duration is far future, as the effect will remain as long as the camps are being used. The frequency of bears being attracted to Project infrastructure will be sporadic and will be reversible in the long term. The context of grizzly bears is neutral and black bears have a low context. The probability of the effect occurring is high, and

confidence is medium, as bears are known to be attracted to mining camps. The effect of attractants on both grizzly and black bears is assessed as **not significant (minor)**.

18.8.4.6 Overall Effect on Bears

The residual effects for bears are habitat loss and alteration, disruption of movement, direct mortality, indirect mortality, and attractants. These individual effects are assessed for their potential to interact, creating additive or synergistic effects that would have a different nature or extent for local grizzly bear and black bear populations as a whole. Several factors were considered when evaluating the overall magnitude of the potential effect on bears, including: 1) the amount of high-quality habitat in the RSA that is predicted to be lost or altered is relatively low, 2) salmon food sources on the Unuk River are not predicted to be affected, 3) existing human disturbance and activity (i.e., forestry, roads, and hunting) in the area, 4) the large home-range size and habitat generalist preference of bears, and 5) mitigation to prevent residual effects. The overall potential Project-related residual effect on local grizzly and black bear populations may cause a shift from baseline conditions that may or may not be detectable but do not cross a significant threshold or adversely affect the viability of the local populations. Therefore, the magnitude of the potential for overall effects is rated as medium for both species.

The extent will be landscape and the duration will be far future (i.e., continue post-closure). The frequency will be sporadic. The effect will be reversible long-term because the level of effects will decline at closure. The context of grizzly bears is neutral and black bears have a low context. The probability of an overall residual effect is medium, as it is likely but may not occur. The assessment is of medium confidence because there is a moderate degree of uncertainty. The overall residual effect of habitat loss, disruption of movement, sensory disturbance, direct mortality, and indirect mortality acting synergistically on black bears is assessed as **not significant (minor)**. Because the grizzly bear context is neutral, the overall effect on grizzly bears is assessed as **not significant (moderate)**.

18.8.5 Residual Effects Assessment for American Marten

The residual effects assessment for American marten is summarized in Table 18.8-6.

18.8.5.1 Residual Habitat Loss and Alteration

High-quality American marten winter habitat that will be removed or altered during the life of the Project will occur in the low elevation mature forest. This loss or alteration of 6,317 ha (7.4% of the available American marten habitat mapped in the RSA) will result in a potential residual effect for marten. This effect is considered to have a low magnitude, as development of the Project will not approach the threshold level where greater than 25% of the habitat is modified (Hargis and Bissonnette 1997; Hargis, Bissonnette, and Turner 1999; Potvin, Courtois, and Belanger 1999; Poole et al. 2004), remaining within the range of natural variation on a landscape scale. The extent of the effect is local, and the duration is far future, as the habitat will be lost throughout life of the Project and beyond. The frequency is sporadic, and the effect is irreversible, as the habitat will not be returned to baseline conditions (old-growth forest) at closure. The context of the American marten population is considered to be neutral. The probability of the effect occurring is high and the confidence is medium. The effect of habitat loss for American martens is assessed as **not significant (minor)**.

Table 18.8-6. Summary of Residual Effects on American Marten

Description of Residual Effect	Project Component(s)	Timing of Effect	Magnitude	Extent	Duration	Frequency	Reversibility	Context	Likelihood of Effects		Significance Determination	Follow-up Monitoring
									Probability	Confidence Level		
Habitat Loss	All	Construction	Low	Local	Far future	Sporadic	Irreversible	Neutral	High	Medium	Not Significant (Minor)	Not Required
Direct Mortality	TCAR, CCAR, PTMA	Construction	Low	Local	Long	Sporadic	Reversible long-term	Neutral	Medium	Medium	Not Significant (Minor)	Required
Overall Residual Effect	All	Construction	Low	Local	Far future	Sporadic	Reversible long-term	Neutral	Medium	Medium	Not Significant (Minor)	Not Required

18.8.5.2 Residual Direct Mortality

Direct mortality of American marten could occur as a result of tree felling and vehicle interactions during construction and operation. Project infrastructure and access road preparation activities such as felling old-growth trees (e.g., large cottonwoods and/or spruce trees) and removing coarse woody debris could cause incidental mortality of female martens or females and their offspring if these activities are scheduled during the birthing and rearing periods. The exposure of American marten to vehicular collisions is anticipated to be relatively low along Project roads because marten tend to avoid roads and areas that lack overhead cover. With mitigation of cutting outside of denning seasons or pre-clearing surveys if cutting is required, residual effects are still predicted. However, the magnitude of the effect is anticipated to be low, as Project-related mortality is not anticipated to contribute to detectable population level effects on marten. The extent will be local, as it will remain tied to the footprint. The duration will be long term, as it will last throughout the life of the mine. The frequency will be sporadic and the effects of mortality will be reversible in the long term. Marten have a neutral context as they may be able to adapt to changes in the environment. The probability of the effect occurring is medium and the confidence is medium. The overall effect of direct mortality on American marten is assessed as **not significant (minor)**.

18.8.5.3 Overall Effect on American Marten

The residual effects for American marten are habitat loss and direct mortality. These two effects may interact, creating additive or synergistic effects that would have a different extent for local American marten populations as a whole. Several factors were considered when evaluating the magnitude of the potential effect on marten, including: 1) the relatively small amount of high-quality habitat removed or altered in the RSA, 2) existing human disturbance and activity (i.e., forestry, roads, and hunting) in the area, and 3) mitigation to prevent residual effects.

The overall potential Project-related residual effect on local American marten populations is not predicted to affect the viability of the local populations (low magnitude). The geographic extent of the overall effect will remain local (tied to the footprint and 300 m buffer), and the duration will be far future. The frequency of the two effects is sporadic, but overall, will be reversible in the long-term. The removal of habitat will not be reversible, but road-based effects will largely be reversible at closure when traffic drops to low levels. The context of the American marten population is neutral, the probability of habitat loss and direct mortality acting synergistically on the marten population is medium, and the confidence is medium. The overall effect on American marten is assessed as **not significant (minor)**.

18.8.6 Residual Effects Assessment for Hoary Marmot

The residual effects assessment for hoary marmots is summarized in Table 18.8-7.

Table 18.8-7. Summary of Residual Effects on Hoary Marmot

Description of Residual Effect	Project Component(s)	Timing of Effect	Magnitude	Extent	Duration	Frequency	Reversibility	Context	Likelihood of Effects		Significance Determination	Follow-up Monitoring
									Probability	Confidence Level		
Habitat Loss	Mine Site	Construction	Low	Local	Far future	Sporadic	Irreversible	Low	High	Medium	Not Significant (Minor)	Not Required
Direct Mortality	Mine Site	Construction	Low	Local	Long	Sporadic	Irreversible	Low	Medium	Medium	Not Significant (Minor)	Required
Overall Residual Effect	Mine Site	Construction	Low	Local	Far future	Sporadic	Irreversible	Low	Medium	Medium	Not Significant (Minor)	Not Required

18.8.6.1 Residual Habitat Loss and Alteration

The majority of high-quality marmot habitat that will be removed or altered during the life of the Project will occur in the Mine Site near the pits and RSFs. This loss or alteration of 3,845 ha (29.6% of available habitat mapped in the LSA) will result in a potential residual effect for marmots. This effect is considered to have a low magnitude, as nine known colonies (of 49 observed in the LSA; 18%) overlap with the footprint or 300-m buffer, two of which directly overlap the Mine Site footprint, resulting in a minor effect on the population within the LSA. The extent of the effect is local, and the duration is far future, as pits will not be reclaimed. The frequency is sporadic, and the effect is irreversible, as the habitat will not be returned to baseline conditions. The context of the hoary marmot population is considered to be low as they may respond and adapt to the effect within the 300-m buffer area; the loss of or disturbance to several colonies will not impact the overall health of the population in the LSA, and is considered minor in the context of the RSA. The probability of the effect occurring is high and the confidence is medium. The effect of habitat loss for hoary marmot is assessed as **not significant (minor)**.

18.8.6.2 Residual Direct Mortality

There are two predicted avenues of direct mortality of hoary marmot during construction and operation: destruction of marmot burrows during Project road construction and pit excavations, and vehicle collisions with marmots along roads in high elevation areas of the Mine Site. Development of the Kerr, Mitchell, and Sulphurets pits and the construction of haul roads from these pits will remove two marmot colonies and their inhabitants. Although some colonies will be affected, population-level effects are not anticipated. The magnitude of the effect is expected to be low, and local in extent, because mortality due to pit development and vehicle collisions along haul roads would be limited to the footprint. This effect would occur throughout the life of the mine (long term) and mortality events will likely be sporadic. The removal of two colonies will be irreversible. The context of hoary marmots is considered low as they may be able to respond and adapt to the effect, as the loss of a low number of colonies will not impact the overall health of the population. The probability of the effect is medium, and confidence is medium. The effect of direct mortality on hoary marmots is assessed as **not significant (minor)**.

18.8.6.3 Overall Effect on Hoary Marmots

The residual effects for hoary marmots are habitat loss and direct mortality. Considering the two residual effects on marmots, the amount of high-quality habitat in the LSA and mitigation to prevent residual effects, the overall potential Project-related residual effect on local hoary marmot populations is not predicted to affect the viability of the local populations (low magnitude). The geographic extent of the overall effect will remain local (tied to the footprint and 300-m buffer), and the duration will be far future. The frequency of the two effects is sporadic, and removal of the two colonies will be irreversible. The context of the hoary marmot population is low, the probability of habitat loss and direct mortality acting synergistically on the marmot population is medium, and the confidence is medium. The overall effect on hoary marmots is assessed as **not significant (minor)**.

18.8.7 Residual Effects Assessment for Bats

The residual effects assessment for bats is summarized in Table 18.8-8.

Table 18.8-8. Summary of Residual Effects on Bats

Description of Residual Effect	Project Component(s)	Timing of Effect	Magnitude	Extent	Duration	Frequency	Reversibility	Context	Likelihood of Effects		Significance Determination	Follow-up Monitoring
									Probability	Confidence Level		
Chemical Hazard	TMF	Closure	Negligible	Local	Far future	Regular	Reversible long-term	High	Medium	Medium	Not Significant (Minor)	Required

18.8.7.1 Residual Chemical Hazards

Chemical hazards were predicted to result in a residual effect on bats (Table 18.8-8) because of the potential for bats to bioaccumulate COPC (mercury) when consuming aquatic insects in the TMF at closure. All Project areas that could support aquatic insects are expected to meet aquatic guidelines, but the TMF is predicted to contain mercury at levels lower than baseline (current) concentrations during post-closure when insects are expected to inhabit the TMF. With monitoring and mitigation, the residual effects of chemical hazards on bats will be negligible.

The extent of this effect will be local, within the TMF only. The duration of the effect will be far future, during the post-closure phase, and the frequency regular. The effect will continue until concentrations of COPC in aquatic insects return to or are below baseline concentrations and half-lives of COPC in bats are reached. The context of bats in British Columbia is considered high, because bats are long lived and one of the species likely to occur (little brown myotis) is listed as Endangered by COSEWIC. The probability of bioaccumulation of COPC occurring in bats is anticipated to be medium. It is assumed that bats will forage in the TMF at post-closure, but this may not occur. Confidence in this analysis is medium. The effect of chemical hazards on bats is assessed as **not significant (minor)**.

18.8.8 Residual Effects Assessment for Birds

The residual effects assessment for raptors, wetland birds, and forest and alpine birds are summarized in Tables 18.8-9, 18.8-10, and 18.8-11, respectively. Two residual effects were assessed for their significance on wetland birds: habitat loss and chemical hazards. Habitat loss is the only residual effect that was assessed for significance on raptors and forest and alpine birds.

18.8.8.1 Residual Habitat Loss and Alteration

The effect of habitat loss on raptors, wetland birds, and forest and alpine birds was assessed for significance. For raptors (including the SARA Schedule 1-listed northern goshawk *laingi* subspecies), suitable nesting habitat was identified as mature and old-growth forests. The area of suitable nesting habitat lost within the Project footprint was compared to the total area available within the RSA. A total of 6,341 ha will be altered for Project development, representing 7.4% of the available raptor nesting habitat in the RSA.

For wetland birds, the area and number of wetlands lost within the Project footprint were compared to the total area and number of wetlands available within the RSA. A total of 311 ha of wetland habitat will be removed or altered, representing 3.9% of the wetland area in the RSA. With regards to loss or alteration of cavity-nesting waterfowl habitat, a total of 4,435 ha of mature forest within 1 km of suitable wetland habitat will be lost or altered, which represents 8% of available mature forest present within the RSA (56,153 ha total). The amount of riverine habitat (for harlequin ducks) that will be lost or altered is 5% (144 km of streams) of the available riverine habitat in the RSA (2,896 km).

Table 18.8-9. Summary of Residual Effects on Raptors

Description of Residual Effect	Project Component(s)	Timing of Effect	Magnitude	Extent	Duration	Frequency	Reversibility	Context	Likelihood of Effects		Significance Determination	Follow-up Monitoring
									Probability	Confidence Level		
Habitat Loss	All	Construction	Low	Local	Far future	Sporadic	Irreversible	Neutral	High	Medium	Not Significant (Minor)	Not Required

Table 18.8-10. Summary of Residual Effects on Wetland Birds

Description of Residual Effect	Project Component(s)	Timing of Effect	Magnitude	Extent	Duration	Frequency	Reversibility	Context	Likelihood of Effects		Significance Determination	Follow-up Monitoring
									Probability	Confidence Level		
Habitat Loss	All	Construction	Low	Local	Far future	Sporadic	Irreversible	Neutral	High	Medium	Not Significant (Minor)	Not Required
Chemical Hazards	TMF, WSF, receiving waters of Unuk River & North Treaty Creek	Operations	Medium	Landscape	Far future	Continuous	Reversible long-term	Neutral	Medium	Low	Not Significant (Moderate)	Required
Overall Residual Effect	All	Construction	Low	Landscape	Far future	Sporadic	Reversible long-term	Neutral	Medium	Low	Not Significant (Minor)	Not Required

Table 18.8-11. Summary of Residual Effects on Forest and Alpine Birds

Description of Residual Effect	Project Component(s)	Timing of Effect	Magnitude	Extent	Duration	Frequency	Reversibility	Context	Likelihood of Effects		Significance Determination	Follow-up Monitoring
									Probability	Confidence Level		
Habitat Loss	All	Construction	Low	Local	Far future	Sporadic	Irreversible	Neutral	High	Medium	Not Significant (Minor)	Not Required

Finally, for forest and alpine birds, including the three SARA Schedule 1 species—olive-sided flycatcher, rusty blackbird, and common nighthawk—habitat loss and alteration will occur wherever forest stands are cleared or where roads and/or infrastructure replace open spaces. The area of suitable forest and alpine bird habitat lost or altered within the Project footprint and 300-m buffer was compared to the total area available within the RSA. Overall, construction and operation will result in the removal or alteration of 4,046 ha of habitat, the majority of which (1,513 ha) is within the MHmm2 BEC zone, which is a loss or alteration of 4% of the available MHmm2 in the RSA.

The magnitude of the effect of habitat loss and alteration on all birds is classified as low because the area affected is relatively low within the RSA. The effect of habitat loss will be local because wetlands and forest stands will only be lost or altered within the Project footprint and 300-m buffer. The duration will be far future because reclamation will not occur until post-closure. The frequency will be sporadic as the habitat loss will begin during the construction phase and additional loss will sporadically occur through operation. The effect will be irreversible long-term, as habitat loss will not return to baseline conditions. The context is neutral because some populations of birds are increasing (i.e., high resilience) while others (e.g., Schedule 1 species) are or may be declining (i.e., low resilience). However, since this VC group contains species with both high and low resilience, the context was classified as neutral. The probability that this effect will occur is high and the confidence is medium. The effect of habitat loss is assessed as **not significant (minor)** for all bird groups, including northern goshawk, olive-sided flycatcher, rusty blackbird, and common nighthawk.

18.8.8.2 Residual Chemical Hazards

One bird VC (wetland birds) was predicted to have a residual effect due to chemical hazards (Table 18.8-10). This residual effect was predicted for wetland birds because of the potential for wetland birds to bioaccumulate COPC when consuming vegetation and aquatic insects in the Unuk River and in north Treaty, and the TMF at post-closure. With mitigation and monitoring, the residual effects of chemical hazards on wetland birds will have a medium magnitude, as it is anticipated to differ from the average value for baseline conditions.

The timing of the effect is anticipated to commence at operation when the TMF and WSF will be formed and water will be discharged to the receiving environment. The extent of this effect will be landscape in the PTMA (directly within the TMF and within north Treaty Creek but not beyond), and on the Mine Site, as the effect will extend beyond the Project footprint to a broader watershed area, but remain tied to the footprint. The duration of the effect will be far future, as the effect is expected to last beyond 70 years. The frequency of the availability of the COPC will be continuous but the actual timing of when and how often wetland birds will use these areas is unknown. The effect will continue until concentrations of COPC in aquatic insects and vegetation return to or are below baseline concentrations and half-lives of COPC in wetland birds are reached. Overall, the context is rated as neutral. The probability of bioaccumulation of COPC occurring in wetland birds is anticipated to be medium. Confidence in this analysis is low, because it was assumed that wetland birds will forage for a substantial amount of time on insects and vegetation with elevated concentrations of COPC. However, much of the breeding habitat for wetland birds occurs in areas that are not predicted to be elevated in COPC, and wetland birds will likely forage on insects and vegetation in areas that are not affected by COPC in

addition to those in areas that are. Thus, the effect of chemical hazards on wetland birds is assessed as **not significant (moderate)**.

18.8.8.3 Overall Effect on Wetland Birds

Wetland birds are the only avian VC that may experience more than one residual effect, and are therefore the only avian VC to be assessed for an overall effect. The residual effects predicted for wetland birds are habitat loss and alteration, and chemical hazards. Considering the two residual effects on wetland birds, an overall potential residual effect is not predicted to affect the larger wetland bird population, and the magnitude is predicted to be low (Table 18.8-10). The geographic extent of the overall effect is landscape, the duration will be far-future, the frequency of the two effects is sporadic, and will be reversible in the long-term. The context of the wetland bird population is neutral, and the probability of an overall effect on wetland birds is medium, with a medium confidence. The overall cumulative effect on wetland birds is assessed as **not significant (minor)**.

18.8.9 Residual Effects Assessment for Western Toads

The residual effects assessment for western toads is summarized in Table 18.8-12.

18.8.9.1 Residual Direct Mortality

The effect of direct mortality is predicted to result in a residual effect on western toads. To mitigate potential direct mortality effects on toads, pre-clearing surveys would be conducted on any ponds that would be affected by construction during the breeding (May) and emergence periods (mid-July to mid-August) to identify western toad breeding ponds. Use of machinery and associated construction activities (i.e., tree felling) would be avoided in identified breeding ponds during those periods. Appropriate protection for toads will be provided, which may include toad tunnels or other effective mitigation to minimize the risk of vehicle collisions. Project access roads are constructed. The magnitude of the effect of direct mortality on western toads is predicted to be low. Ponds were identified in the Project footprint, but none of the surveyed ponds in the area supported toad breeding during 2008 or 2009.

The extent is evaluated as local, as direct mortality would be tied to Project infrastructure, or within the 300 m buffer. The duration will be long term, as the effect will end after the life of the Project, and direct mortality may occur sporadically. The effect will be reversible long term with adaptive mitigation. The context of western toads is considered high, because they are listed on Schedule 1 of SARA. The probability of direct mortality occurring is medium, as some mortality is likely to occur, but it may not, and the confidence is medium. After mitigation and monitoring, the effect of direct mortality is assessed as **not significant (minor)** for western toads.

18.9 Potential Cumulative Effects for Wildlife and Wildlife Habitat

The cumulative effects assessment (CEA) considers the effects on wildlife and wildlife habitat that are likely to result from the residual environmental effects of the KSM Project in combination with the effects of other projects and activities that have been or are likely to be carried out in the same area as the Project. The CEA methodology is based on the framework outlined by the *Canadian Environmental Assessment Act* (1992) guidelines (Hegmann et al. 1999) with additional guidance provided in the AIR. The following steps are taken in this CEA:

Table 18.8-12. Summary of Residual Effects on Western Toad

Description of Residual Effect	Project Component(s)	Timing of Effect	Magnitude	Extent	Duration	Frequency	Reversibility	Context	Likelihood of Effects		Significance Determination	Follow-up Monitoring
									Probability	Confidence Level		
Direct Mortality	PTMA, CCAR, TCAR	Construction	Low	Local	Long	Sporadic	Reversible long-term	High	Medium	Medium	Not Significant (Minor)	Required

1. Identify residual environmental effects of the Project on the 11 wildlife VCs assessed in the Application/EIS (Summarized in Table 18.9-1).
2. Identify the spatial and temporal boundaries appropriate for assessing cumulative effects for each wildlife VC.
3. Identify existing conditions within the spatial boundary by collating regional data.
4. Identify past, present, and future projects and activities that have, or are likely to have, residual environmental effects that may act cumulatively (i.e., additively or synergistically) with those of the Project (Chapter 5).
5. Characterize the potential interactions between residual environmental effects of the KSM Project and the likely residual effects of other projects and activities.
6. Assess the contribution of the KSM Project to the cumulative effect.
7. Identify any additional mitigation and/or management measures to avoid and/or reduce identified cumulative environmental effects.
8. Characterize the residual cumulative environmental effects and determine the significance of effects by comparing effects against thresholds and/or land use objectives.

Table 18.9-1. Residual Effects Predicted from the Wildlife Application/EIS

Effect ⇨	Habitat Loss/ Alteration	Disruption of Movement	Sensory Disturbance	Direct Mortality	Indirect Mortality	Attractants	Chemical Hazards
VC ⇩							
Moose	Y	Y	N	Y	Y	N	Y
Mountain goat	Y	Y	Y	Y	Y	N	Y
Grizzly bear	Y	Y	N	Y	Y	Y	N
Black bear	Y	Y	N	Y	Y	Y	N
American marten	Y	N	N	Y	N	N	N
Hoary marmot	Y	N	N	Y	N	N	N
Bats	N	N	N	N	N	N	Y
Raptors	Y	N	N	N	N	N	N
Wetland birds	Y	N	N	N	N	N	Y
Forest and alpine birds	Y	N	N	N	N	N	N
Western toad	N	N	N	Y	N	N	Y

Note: All effects identified begin during the construction phase and continue into post-closure. The presence of a residual effect is marked with a “Y” while those effects not expected to result in a residual are marked with an “N”. All residual effects (marked with a “Y”) are considered in this CEA.

The CEA considers the potential for cumulative effects on the same 11 VCs as identified in the Application/EIS. The CEA is organized by VC, as each VC is influenced by different projects, over different spatial and temporal scales. Wherever possible, this CEA uses quantitative information and thresholds/land use objectives; however, in cases where quantitative assessment is not possible due to insufficient regional information, or where thresholds or land use objectives have not been developed for the species, a qualitative assessment is used.

For each of the 11 wildlife VCs considered in the Application/EIS (Section 18.7), at least one residual effect was predicted. All potential residual effects are listed in Tables 18.7-1, 18.7-8

to 18.7-9, and 18.7-13 to 18.7-15 by VC and effect, and are summarized in Table 18.9-1. The residual effects marked with a “Y” in Table 18.9-1 were carried forward into the CEA, where other projects that may interact with these effects for VCs on a larger spatial scale are considered. Detailed descriptions of the nature and extent of each residual effect for the KSM Project is provided in Section 18.8.

18.9.1 Scoping of Cumulative Effects

18.9.1.1 Spatial Linkages with Other Projects and Human Actions

Spatial boundaries were chosen to evaluate the effects on 1) individual animals and 2) populations of animals. The effects on individual animals of wide-ranging species (moose, mountain goat, grizzly bear, and black bear) were examined by calculating a Movement Area, defined as the distance away from the KSM Project that an average animal of a particular species may travel in a year (maximum home range size). The assessment within the Movement Areas then looked at the other projects that an individual animal could foreseeably interact with.

Effects on populations of VCs were evaluated over a larger area than for an individual animal, using WMUs or natural boundaries. Four main spatial scales were selected to evaluate effects on wildlife populations for use in the CEA:

1. The grizzly bear population unit (GBPU) boundaries (the outer periphery of the three GBPUs that converge at the KSM Project; used for grizzly bears and black bears).
2. The wildlife management area (WMA), used for moose and mountain goat, which consisted of two wildlife management units that converge at the KSM Project (WMUs 6-21 and 6-17).
3. The adjusted RSA based on the RSA used in the wildlife effects assessment, with species-specific adjustments to the RSA boundary based on home range size (used for American marten and western toad, which can move slightly farther than the original RSA boundary).
4. The RSA (used for all remaining VCs whose movement from the Project should not extend beyond the RSA boundary).

Further information on the rationale for the spatial boundaries and maximum range size calculations for each wildlife VC are outlined in Table 18.9-2. Figures 18.9-1 to 18.9-6 display the Movement Areas used for examining effects on individual animals (moose, mountain goat, grizzly bear, and black bear) and the CEA Area, used for examining effects on populations.

After identifying the CEA and Movement Areas for wildlife VCs, these areas were used to narrow the focus of the CEA. This was conducted in two ways: first, the projects and project components that fall outside of the CEA Area for each VC were scoped out of the CEA. Second, the elevations of all projects within the CEA Area for each VC were considered against the elevation ranges of each VC; projects within the CEA Area for each VC, but outside of their capable elevation range, were also eliminated. Projects eliminated because they are outside of the elevation range of the VC are shown in Table 18.9-3.

Table 18.9-2. CEA Area and Movement Area Rationale for Each Wildlife Valued Component

CEA Area	Used For	CEA Area (used to evaluate effects on VC populations)	Movement Area (home range; used to evaluate effects on individual animals)	Figure
1. Wildlife Management Area	Moose	The WMA Boundary (which includes two WMUs: 6-21 and 6-17) was used to consider cumulative impacts on moose populations, which require connectivity across large landscapes for gene flow and access to capable winter range. The WMU is used for regional management of moose, making it a logical assessment area to aid regulatory agencies in tracking and managing cumulative impacts on these VCs.	Migratory moose in the Nass area have a mean multiannual home range of 218 km ² while non-migratory moose have a mean multiannual home range of 42 km ² (M. W. Demarchi 2000, 2003). For the purposes of the CEA, all moose were assumed to be migratory, as this assumption resulted in a precautionary assessment. The square root of the migratory home range was taken (= 15 km), and a movement area boundary for moose was placed 15 km from the KSM Project. For the purposes of this assessment, this represents the maximum number of projects that a moose could interact with, while still interacting with the KSM Project.	18.9-1
	Mountain Goat	The WMA boundary was used to consider cumulative impacts on mountain goat populations, which require connectivity across large landscapes to promote gene flow and population rescue following local extirpations in limited capable habitat (Ortego et al. 2011). The WMU is also used for regional management of mountain goats, making it a logical assessment area.	Typically, the largest distances travelled by mountain goats are made from their winter range to mineral licks. In a study in north-central BC, radio-collared goats travelled 3.6 to 10.6 km from their winter range to mineral licks (Corbould et al. 2010). One male travelled up to 60 km, but this appeared to be anomalous in the literature. In another study of goat movement in southeastern BC, Poole, Bachmann, and Teske (2010) recorded a maximum movement distance of 17.3 km by radio-collared mountain goats; this also falls within the upper range of distances observed by Hebert and Cowan (1971) . A movement area boundary for mountain goat was therefore placed 17.3 km from the Project, representing the maximum number of projects that a goat could interact with, while also interacting with the KSM Project. As mountain goats require escape terrain, this area was fitted to the edge of capable habitat when it extended into non- capable habitat.	18.9-2

(continued)

**Table 18.9-2. CEA Area and Movement Area Rationale for Each Wildlife Valued Component
(continued)**

CEA Area	Used For	CEA Area (used to evaluate effects on VC populations)	Movement Area (home range; used to evaluate effects on individual animals)	Figure
2. Grizzly Population Unit Boundary	Grizzly bear and black bear	The current range of grizzly bears in BC has been partitioned into grizzly bear population units (GBPU) for conservation and management purposes. In northern and coastal BC, GBPU boundaries follow natural and ecological boundaries or transition areas (primarily height of land between watersheds) as there are few actual barriers to grizzly bear movement. Three GBPU boundaries converge at the KSM Project: The Edziza-Lower Stikine GBPU to the north, the Stewart GBPU to the south and the Upper Skeena-Nass GBPU to the east. These three boundaries were combined into a CEA Area and were used to consider cumulative impacts on grizzly bears and black bears.	The maximum grizzly bear movement recorded during the Project baseline was a 70 km straight line distance by a male grizzly bear moving between hair snag stations (Appendix 18-C). In nearby areas, coastal grizzly bear ranges were estimated at 5,200 ha (52 km²; 7.2 x 7.2 km) for females and 13,700 ha (137 km²; 11.7 x 11.7 km) for males (Khutzeymateen; MacHutchon, Himmer, and Bryden 1993). Interior grizzly bear ranges were estimated at 10,300 ha (103 km²; 10.1 x 10.1 km) for females and 18,700 ha (187 km²; 13.6 x 13.6 km) for males (Ciarniello 2006). Thus, a linear distance of 70 km is used as a local maximum for the grizzly bears, and the movement area boundary was delineated 70 km from edge of the Project. This area represents the maximum number of projects that a grizzly bear could interact with, while also interacting with the KSM Project. As black bears move similarly long distances, the same movement area was used for both species.	18.9-3
3. Adjusted RSA	American marten	The CEA Area used for American marten is based on the RSA, but expands in some areas to account for the likely movement distances of American marten. American marten in south-central Alaska were reported to repeatedly travel 11 to 14 km between two areas of home range focal activity (Buskirk 1983). Slough (1994) reported that the mean final distances that American marten travelled from release sites were 13.4 km for males and 8.6 km for females. Therefore, a movement area for American marten of 14 km from the KSM Project was added to the RSA boundary. This area represents the maximum number of projects that an individual American marten could interact with, while also interacting with the KSM Project. This area is the CEA Area used for American marten.	Not applicable to American marten. Only a CEA Area is used for the cumulative effects assessment for American marten.	18.9.4

(continued)

Table 18.9-2. CEA Area and Movement Area Rationale for Each Wildlife Valued Component (completed)

CEA Area	Used For	CEA Area (used to evaluate effects on VC populations)	Movement Area (home range; used to evaluate effects on individual animals)	Figure
3. Adjusted RSA (<i>cont'd</i>)	Western toad	The CEA Area used for western toad is based on the RSA, but expands in some sections due to maximum movement distances of western toad. The longest distance recorded for western toad movement is 7.2 km (Wind and Dupuis 2002). Therefore, an area for western toad was placed at a distance of 7.2 km from the Project footprint, representing the maximum number of projects that a western toad could interact with, while interacting with the KSM Project.	Not applicable to western toads. Only a CEA Area is used for the cumulative effects assessment for western toads.	18.9.5
4. Regional Study Area (RSA)	Hoary marmot	Impacts on hoary marmots are expected to occur as a result of impacts to burrowing habitat. Since distances moved by marmots (median distance of 5 m and a maximum distance of 115 m from the talus; Karels, Koppel, and Hik 2004) are relatively low, the RSA was used with no adjustments to this as the CEA Area.	Not applicable to hoary marmots. Only a CEA Area is used for the cumulative effects assessment for hoary marmots.	18.9.6
	Bats and birds	Impacts to all bat and bird VCs are expected to occur in relation to impacts to nesting, and roosting habitat, respectively. Since distances moved during the breeding season are relatively low for these VCs, the RSA was used with no adjustments as the CEA Area.	Not applicable to bats and birds. Only a CEA Area is used for the cumulative effects assessment for bats and birds.	

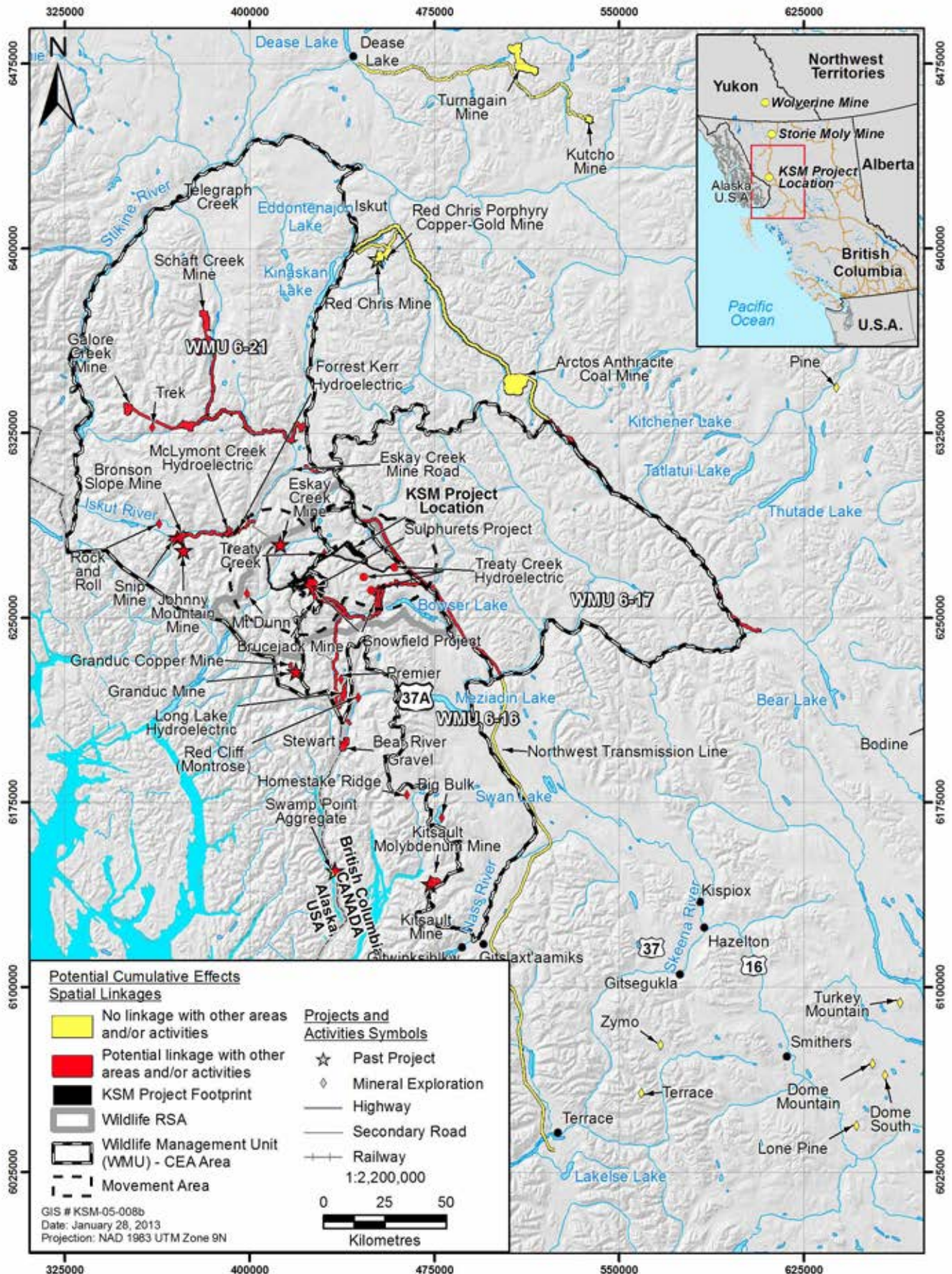
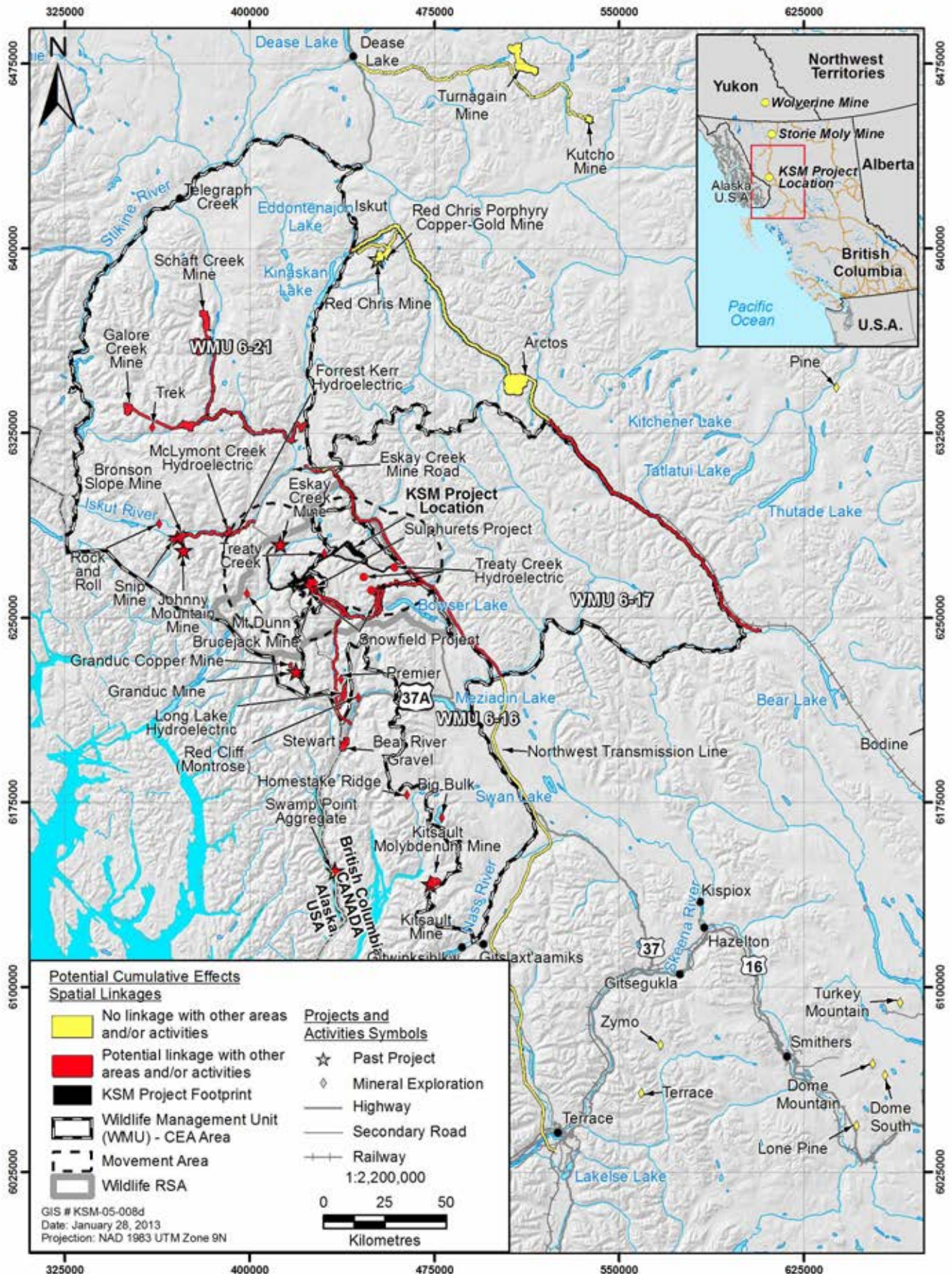


Figure 18.9-1



**Mountain Goat CEA Area
and Movement Area**

Figure 18.9-2

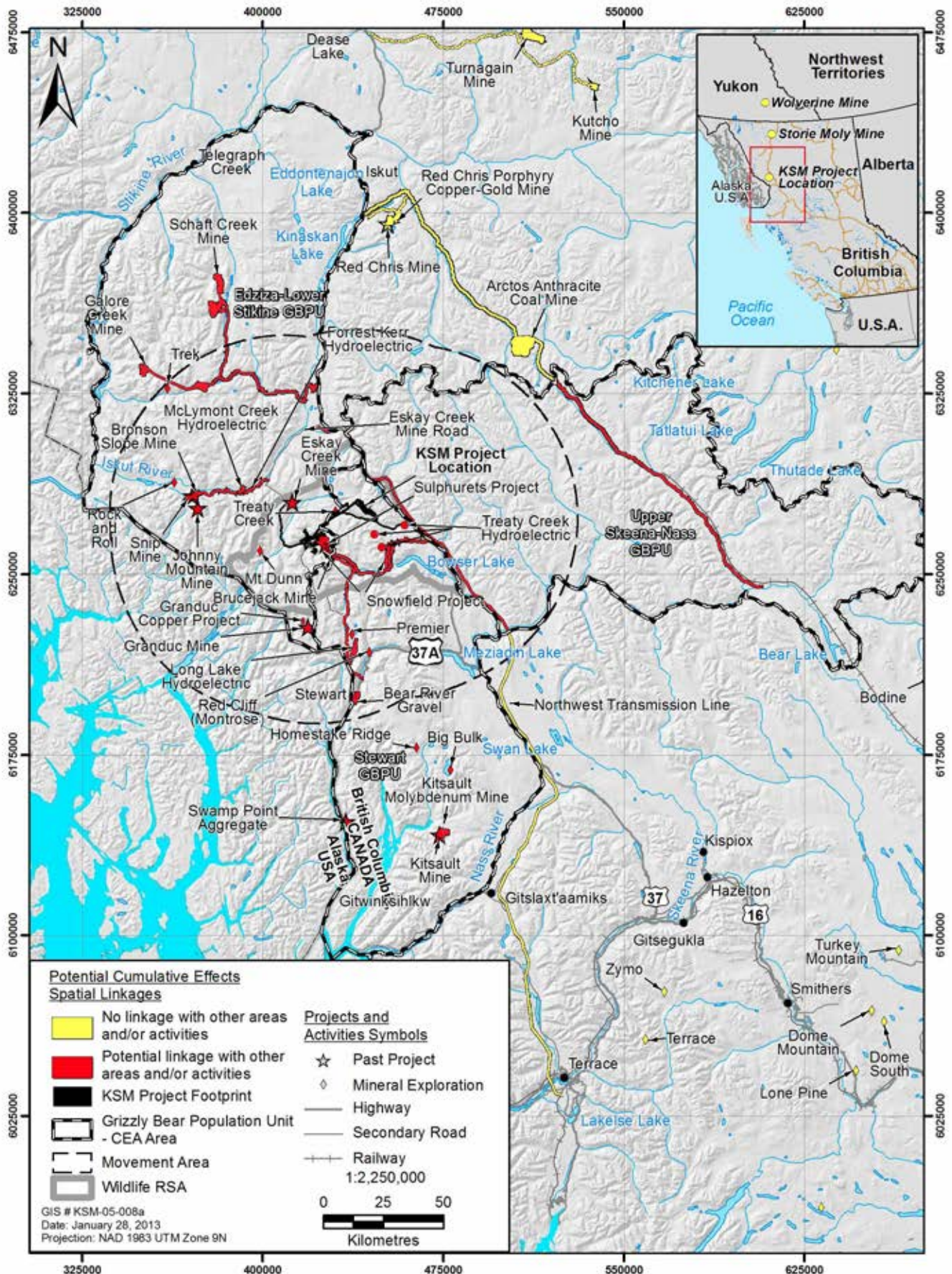


Figure 18.9-3

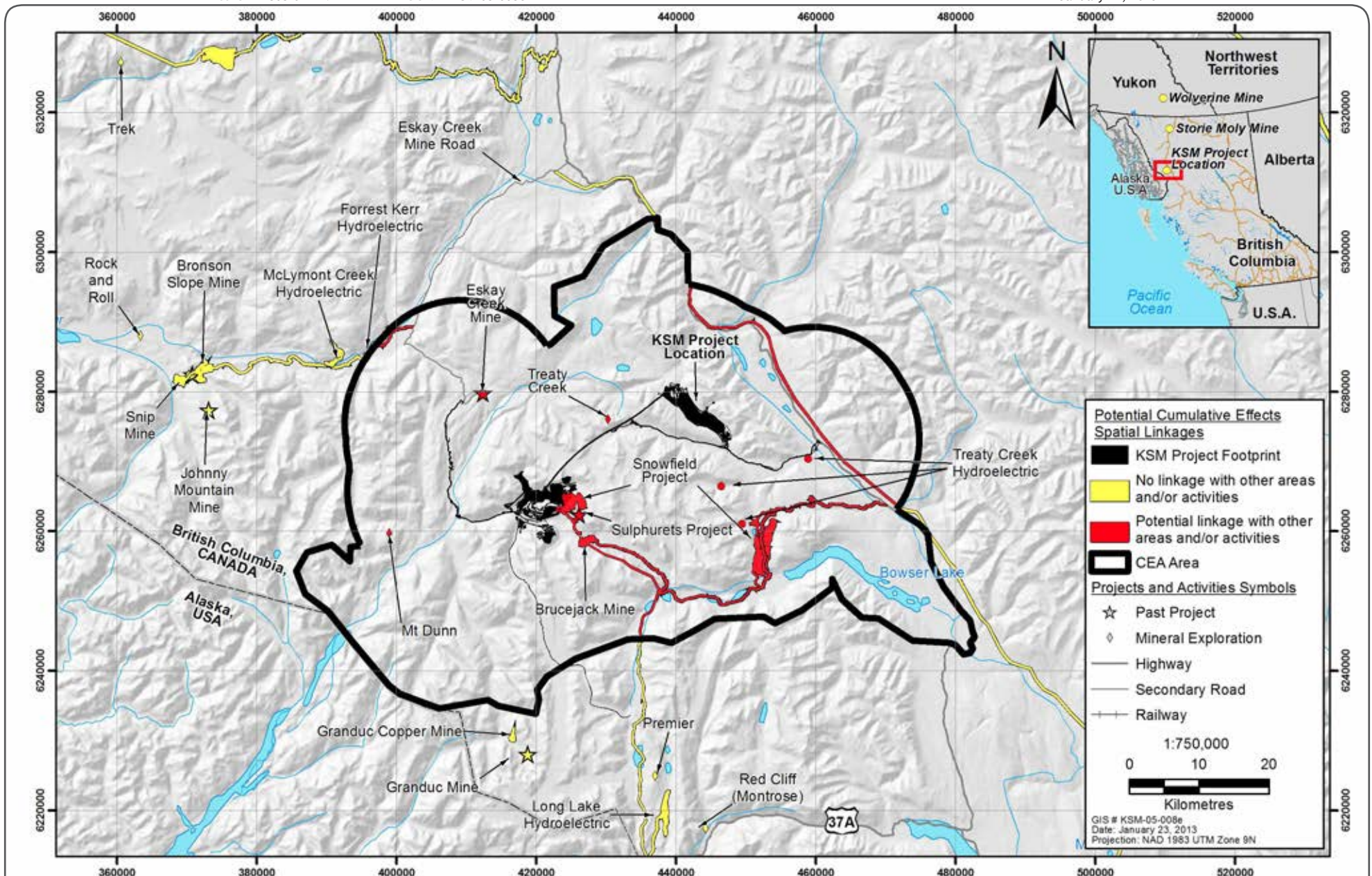


Figure 18.9-4

SEABRIDGE GOLD
KSM PROJECT

American Marten CEA Area

Figure 18.9-4

Rescan
Engineers & Scientists

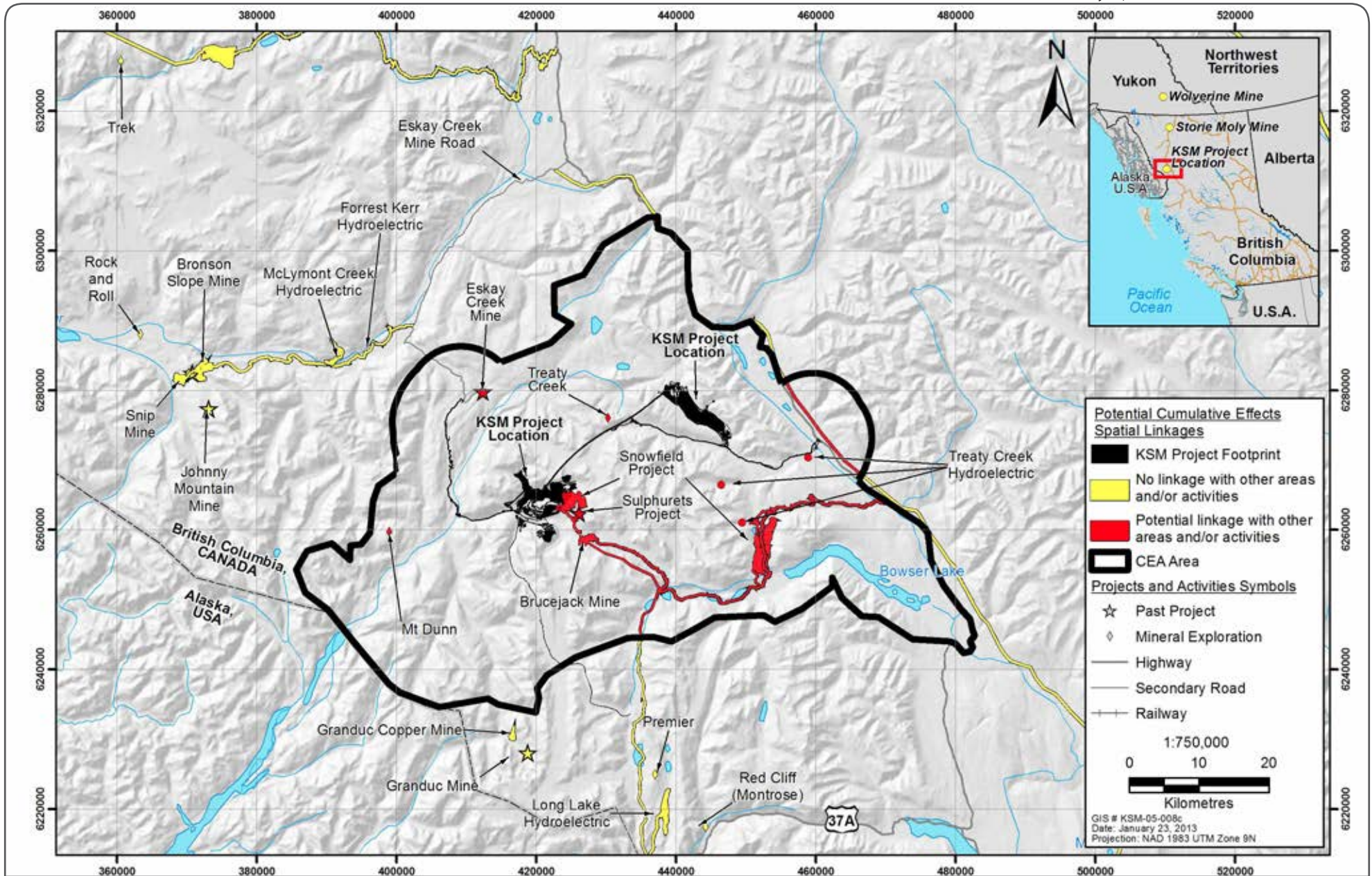


Figure 18.9-5

SEABRIDGE GOLD
KSM PROJECT

Western Toad CEA Area

Figure 18.9-5

Rescan
Engineers & Scientists

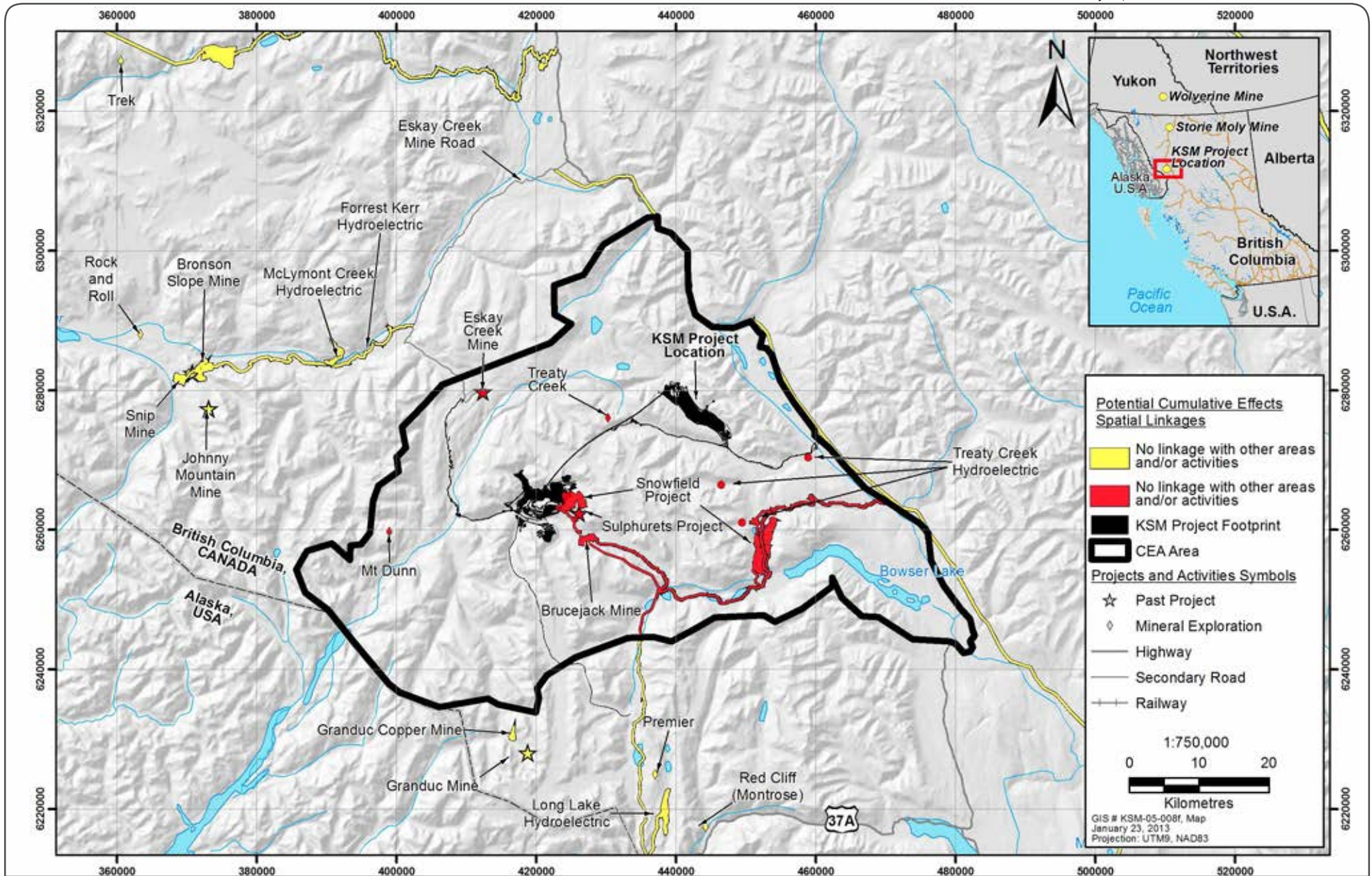


Figure 18.9-6

Figure 18.9-6

Table 18.9-3. Projects Scoped Out from the Cumulative Effects Assessment Because Their Elevation Falls Outside of the Capable Range of the Species

VC	Project/Project Component Excluded	Reason for Exclusion from within CEA Area
Moose	Of the potential spatial linkages (Figure 18.9-1), seven fall outside the elevational range of moose: • Johnny Mountain mine (1,250 masl) • Trek exploration (1,465 masl) • Sulphurets Project (1,680 masl) • Mt Dunn exploration (1,355 masl) • Premier exploration (1,615 masl) • Big Bulk exploration (1,340 masl) • Treaty Creek exploration (1,500 masl)	Above elevation range of moose. These projects did not/will not create any new access points, and hence will not contribute to indirect mortality of this VC.
Mountain goat	None	No projects within the CEA Area were scoped out, due to the wide elevation range used by this VC. In addition, sensory impacts have to be considered due to the prediction of a residual sensory effect of the KSM Project on this VC. Sensory disturbances are not limited to a project site and elevation; sensory effects may occur due to activities such as helicopters flying alongside mountain goat habitat on their way to access a site.
Grizzly bear and black bear	Of the potential spatial linkages (Figure 18.9-3), four fall outside the elevational range of bears: • Sulphurets Project (1,680 masl) • Treaty Creek exploration (1,500 masl) • Trek exploration (1,465 masl) • Premier exploration (1,615 masl)	Above vegetation line (above alpine vegetation) in non-capable habitat.
American marten	Of the potential spatial linkages (Figure 18.9-4), three fall outside of the elevational range of American marten: • Sulphurets Project (1,680 masl) • Mt Dunn exploration (1,355 masl) • Treaty Creek mineral exploration (1,500 masl)	Above the treeline in open habitat; this is unsuitable habitat for marten. These projects did not/will not create new access points, and hence will not contribute to indirect mortality effects.
Hoary marmot	Of the potential spatial linkages (Figure 18.9-6), one falls outside of the elevational range of hoary marmots: • Treaty Creek Hydroelectric (Northern Site; 520 masl)	Below the elevation range of this VC.
Bats	Of the potential spatial linkages (Figure 18.9-6), three fall outside of the elevational range of bats: • Sulphurets Project (1,680 masl) • Mt. Dunn exploration (1,355 masl) • Treaty Creek exploration (1,500 masl)	Above treeline and too far from potential roost sites for this VC.
Raptors	Of the potential spatial linkages (Figure 18.9-6), one falls outside of the elevational range of raptors: • Sulphurets Project (1,680 masl)	Above vegetation line (above alpine vegetation) in non-capable habitat for this VC.

(continued)

Table 18.9-3. Projects Scoped Out from the Cumulative Effects Assessment Because Their Elevation Falls Outside of the Capable Range of the Species (completed)

VC	Project/Project Component Excluded	Reason for Exclusion from within CEA Area
Wetland birds	Of the potential spatial linkages (Figure 18.9-6), one falls outside of the elevational range of wetland birds: • Sulphurets Project (1,680 masl)	Above vegetation line (above alpine vegetation) in non-capable habitat for this VC.
Forest and alpine birds	Of the potential spatial linkages (Figure 18.9-6), one falls outside of the elevational range of forest and alpine birds: • Sulphurets Project (1,680 masl)	Above vegetation line (above alpine vegetation) in non-capable habitat for this VC.
Western toad	None	No projects within the CEA Area were scoped out, due to the wide elevation range used by this VC.

Tables 18.9-4 to 18.9-10 list the potential spatial interactions between residual effects of the KSM Project and all remaining past, present, and future projects, including the temporal linkages between past, present, and future projects with the past, present, and future conditions of each VC. See Temporal Linkages in Section 18.9.1.2 for details on the rationale for the temporal linkages identified within the following tables:

- moose (Table 18.9-4);
- mountain goats (Table 18.9-5);
- grizzly bears and black bears (Table 18.9-6);
- American marten (Table 18.9-7);
- hoary marmots (Table 18.9-8);
- bats, raptors, wetland birds, and forest and alpine birds (Table 18.9-9); and
- Western toads (Table 18.9-10).

18.9.1.2 Temporal Linkages with Other Projects and Human Activities

The projects that were linked spatially with the KSM Project for each VC were also assessed for temporal linkages in Tables 18.9-4 to 18.9-10. The following time spans were used to define past, present, and future effects:

- **Past:** 1964 to 2008; coinciding with the development of the Granduc Copper-Gold Mine, which influenced the growth of the community of Stewart and other human activities in the area (StewartBC.com 2004);
- **Present:** 2008 to 2013 from the start of KSM Project baseline studies to the completion of the environmental effects assessment; and
- **Future:** 2013 to 2165; the time period over which all wildlife VCs may recover to baseline conditions following the completion of the 51.5 year mine life of the KSM Project.

Table 18.9-4. Summary of Potential Linkages between the KSM Project and Other Human Actions in Regards to Moose

Action/Project		Past	Present	Future
Past Projects	Eskay Creek Mine	X; This closed mine (and the use of Eskay Creek Road) is within the home range of an individual moose that could also interact with the KSM Project (Movement Area), and within the CEA Area used to assess cumulative effects on moose populations (Figure 18.9-1). This project has the potential to affect the past condition of this VC.	X; Since this project closed 8 years ago (2004) and moose live for 15 to 20 years, effects of this project are potentially still affecting the present condition of this VC.	X; Since this project closed in 2004 and moose live for 15 to 20 years, past effects of this project may affect the future condition of this VC.
	Granduc Mine	X; This project is within the CEA Area used to assess cumulative effects on moose populations, but outside of the home range of an individual moose that could also interact with the KSM Project. This project potentially affected the past condition of this VC.	X; The access road developed for this mine remained after closure, providing a permanent access route for hunters, guide outfitters, recreationalists, and mining and exploration activities in the area. Therefore, this project may affect the present condition of this VC.	X; The access road developed for this mine remained after closure, providing a permanent access route for hunters, guide outfitters, recreationalists, and mining and exploration activities in the area. Therefore, this project may affect the future condition of this VC.
	Johnny Mountain Mine	X; This project is within the CEA Area used to assess cumulative effects on moose populations, but outside of the home range of an individual moose that could also interact with the KSM Project. This project potentially affected the past condition of this VC.	X; The closure of this project occurred in 1990. The tailing impoundment and other project implements remain at site, and the site offers continuing exploration potential. Therefore, this project may affect the present condition of this VC.	X; The closure of this project occurred in 1990. The tailing impoundment and other project implements remain at site, and the site offers continuing exploration potential; therefore this project may affect the future condition of this VC.
	Kitsault Mine (Closed)	NL	NL	NL
	Snip Mine	X; This project is within the CEA Area used to assess cumulative effects on moose populations, but outside of the home range of an individual moose that could also interact with the KSM Project. This project potentially affected the past condition of this VC.	X; This site was closed and reclaimed in 1999, within the potential lifespan of moose that may also interact with the KSM Project. Therefore, this project may affect the present condition of this VC.	X; This site was closed and reclaimed in 1999, within the potential lifespan of moose that may also interact with the KSM Project. Therefore, this project may affect the future condition of this VC.
	Sulphurets Project	NL	NL	NL
	Swamp Point Aggregate Mine	NL	NL	NL

(continued)

Table 18.9-4. Summary of Potential Linkages between the KSM Project and Other Human Actions in Regards to Moose (continued)

Action/Project		Past	Present	Future
Present Projects	Forrest Kerr Hydroelectric	NL	X; This project is within the CEA Area used to assess cumulative effects on moose populations, but outside of the home range of an individual moose that could also interact with the KSM Project. Construction began in 2011, so it has the potential to affect the present condition of this VC.	X; As this project will become operational in 2014 for a 60 year operational life, it has the potential to affect the future condition of this VC.
	Red Chris Mine	NL	NL	NL
	Northwest Transmission Line (NTL)	NL	X; This project is within the home range of an individual moose that could also interact with the KSM Project (Movement Area), and within the CEA Area used to assess cumulative effects on moose populations. Construction of this project, as well as use of highway 37, began in 2012, so it has the potential to affect the present condition of this VC.	X; This transmission line is expected to be operational by 2014, and the presence of a cleared corridor will remain indefinitely. The use of highway 37 and helicopters for repairs and maintenance will also continue, and has the potential to affect the future condition of this VC.
	Long Lake Hydroelectric Project	NL	X; This project is within the CEA Area used to assess cumulative effects on moose populations, but outside of the home range of an individual moose that could also interact with the KSM Project. Construction began in 2010, so it has the potential to affect the present condition of this VC.	X; This project is expected to be operational by the end of 2012, and it will have a project life of 80 years. Therefore, it will have the potential to affect the future condition of this VC.
	Wolverine Mine	NL	NL	NL
Reasonably Foreseeable Future Projects	Bear River Gravel	NL	NL	NL
	Bronson Slope Mine	NL	NL	X; This project is within the CEA Area used to assess cumulative effects on moose populations, but outside of the home range of an individual moose that could also interact with the KSM Project. It is expected that construction of this project will begin in 2018 and the project will operate for 20 years. Therefore, it will have the potential to affect the future condition of this VC.

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Table 18.9-4. Summary of Potential Linkages between the KSM Project and Other Human Actions in Regards to Moose (continued)

Action/Project		Past	Present	Future
Reasonably Foreseeable Future Projects	Brucejack Mine	NL	NL	X; This project is within the home range of an individual moose that could also interact with the KSM Project (Movement Area), and within the CEA Area used to assess cumulative effects on moose populations.
	Galore Creek Mine	X; This project is within the CEA Area used to assess cumulative effects on moose populations, but outside of the home range of an individual moose that could also interact with the KSM Project. The original construction of 48 km of the access road was completed in 2007 before the project was halted. Thus, this could have potentially affected the past condition of this VC.	X; The original construction of 48 km of the access road was completed in 2007 before the project was halted for financial reasons. These construction activities, along with activities between 2007 and the present could have potentially affected the present condition of this VC.	X; The construction of the mine and the remainder of the access road is expected to occur in 2018, and the project will operate for 18 years. Therefore, it will have the potential to affect the future condition of this VC.
	Granduc Copper Mine	NL	NL	NL
	Kitsault Mine	NL	NL	NL
	Kutcho Mine	NL	NL	NL
	McLymont Creek Hydroelectric	NL	X; This project is within the CEA Area used to assess cumulative effects on moose populations, but outside of the home range of an individual moose that could also interact with the KSM Project. Construction was expected to begin in 2012 and last for three years, so it has the potential to affect the present condition of this VC.	X; As this project is expected to become operational in 2015 for a 40 year operational life, it has the potential to affect the future condition of this VC.
	Arctos Anthracite Coal Project	NL	NL	X; The ROW to be used for the Arctos Anthracite Coal Project abuts the eastern edge of the CEA Area used to assess cumulative effects on moose populations, but is outside of the home range of an individual moose (Movement Area) that could also interact with the KSM Project. Project construction is expected to begin in 2015, and operation, including shipping through the GBPU, will occur from 2017 and continue for 20 years. Therefore, it will have the potential to affect the future condition of this VC.

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Table 18.9-4. Summary of Potential Linkages between the KSM Project and Other Human Actions in Regards to Moose (continued)

Action/Project		Past	Present	Future
Reasonably Foreseeable Future Projects	Schaft Creek Mine	NL	X; This project is within the CEA Area used to assess cumulative effects on moose populations, but outside of the home range of an individual moose that could also interact with the KSM Project. Road building was scheduled to begin in 2012, and thus could affect the present condition of this VC.	X; The construction of this mine is expected to begin in 2014 until 2017, and the project will operate for 15 years. Therefore, it will have the potential to affect the future condition of this VC.
	Snowfield Project	NL	NL	X; This project is within the home range of an individual moose that could also interact with the KSM Project (Movement Area), and within the CEA Area used to assess cumulative effects on moose populations.
	Storie Moly Mine	NL	NL	NL
	Treaty Creek Hydroelectric	NL	NL	X; This project is within the home range of an individual moose that could also interact with the KSM Project (Movement Area), and within the CEA Area used to assess cumulative effects on moose populations. This project is in the early planning phases, but it is expected that it has the potential to affect the future condition of this VC when construction and operation begin.
	Turnagain Mine	NL	NL	NL
Land Use Activities	Agricultural Resources	NL	NL	NL
	Fishing	X; Fishing has occurred in the past along the Stikine, the Upper Bell Irving River and its tributaries, and in other bodies of water within the CEA.	X; Fishing occurs along the Stikine, the Upper Bell Irving River and its tributaries, and in other bodies of water within the CEA.	X; Fishing is expected to continue along the Stikine, the Upper Bell Irving River and its tributaries, and in other bodies of water within the CEA.
	Guide Outfitting	X; Moose hunting has occurred in the past within the CEA Area and Movement Area.	X; Moose hunting continues within the region. Five guide outfitting tenures exist within close proximity to the Project and all target moose.	X; Moose hunting, is expected to continue within the region.

(continued)

Table 18.9-4. Summary of Potential Linkages between the KSM Project and Other Human Actions in Regards to Moose (completed)

Action/Project		Past	Present	Future
Land Use Activities	Resident and Aboriginal Harvest	X; Hunting for moose has traditionally been undertaken by residents of nearby communities and at least five aboriginal groups within the CEA Area.	X; Hunting for moose now occurs within the CEA Area.	X; Hunting is expected to continue within the CEA Area.
	Mineral and Energy Resource Exploration	X; Multiple exploration activities have occurred in the past throughout the CEA Area. Five properties (Trek 1,465 masl), Mt. Dunn (1,355 masl), Premier (1,615 masl), Big Bulk (1,340 masl) and Treaty Creek (1,500 masl) are not included due being above the elevation range of moose.	X; Multiple mineral exploration endeavors are ongoing throughout the CEA boundaries. Five properties (Trek, Mt. Dunn, Premier, Big Bulk and Treaty Creek) are not included due being above the elevation range of moose.	X; Mineral exploration is expected to continue into the future throughout the CEA boundaries, particularly as new roads increase access and the NTL makes energy resources more available. Five properties (Trek, Mt. Dunn, Premier, Big Bulk and Treaty Creek) are not included due being above the elevation range of moose.
	Recreation and Tourism	X; Past recreation activities within the CEA Area have included ATVing, snowmobiling, wildlife viewing, river travel, multi-day hiking, river and lake paddling, fly-fishing, heli-skiing, and horse trips in the remote backcountry.	X; Current recreation activities within the CEA Area include ATVing, snowmobiling, wildlife viewing, river travel, multi-day hiking, river and lake paddling, fly-fishing, heli-skiing, and horse trips in the remote backcountry.	X; Future recreation activities within the CEA Area are likely to include ATVing, snowmobiling, river travel, multi-day hiking, river and lake paddling, fly-fishing, and horse trips in the remote backcountry.
	Timber Harvesting	X; The KSM Project is within 10 km of the north-western part of the Nass Timber Supply Area (TSA), parts of which have been historically clear-cut.	X; There has been no recent logging activity within two registered forest tenures in the vicinity of the Project, but some forest harvesting may be ongoing within the greater CEA Area.	X; Plans for future timber harvest exists within the two registered forest tenures in the vicinity of the Project. Other forest harvesting is expected to occur within the CEA Area.
	Traffic and Roads	X; Use of roads by vehicles, particularly along Hwy. 37, and Eskay Creek Mine road, as well as along small access roads within the CEA Area may have impacted moose in the past.	X; Use of roads by vehicles along Hwy. 37, Eskay Creek Mine road, within the CEA Area could presently impact moose.	X; Use of roads by vehicles along Hwy. 37, Eskay Creek Mine road, and other roads developed for the proposed projects within the CEA Area could impact moose in the future.

NL = No Linkage (no spatial and temporal overlap, or potential effects do not act in combination)

X = Potential spatial and temporal linkage with project or action

Table 18.9-5. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to Mountain Goats

Action/Project		Past	Present	Future
Past Projects	Eskay Creek Mine	X; This closed mine (and the use of Eskay Creek Mine road) is within the home range of an individual mountain goat (Movement Area) that could also interact with the KSM Project, and within the CEA Area used to assess cumulative effects on mountain goat populations (Figure 18.9-2). This project has the potential to affect the past condition of this VC.	X; Since this project closed in 2004, within the potential lifespan of mountain goats (13 to 17 years; Festa-Bianchet and Côté 2007), effects of this project are potentially still affecting the present condition of this VC.	X; Since this project closed in 2004 and mountain goat live for 13 to 17 years, past effects of this project may affect the future condition of this VC.
	Granduc Mine	X; This project is within the CEA Area used to assess cumulative effects on mountain goat populations, but outside of the home range of an individual mountain goat that could also interact with the KSM Project. This project has the potential to affect the past condition of this VC.	X; The access road developed for this mine remained after closure, providing a permanent access route for hunters, guide outfitters, recreationalists, and mining and exploration activities in the area. Therefore, this project may affect the present condition of this VC.	X; The access road developed for this mine remained after closure, providing a permanent access route for hunters, guide outfitters, recreationalists, and mining and exploration activities in the area. Therefore, this project may affect the future condition of this VC.
	Johnny Mountain Mine	X; This project is within the CEA Area used to assess cumulative effects on mountain goat populations, but outside of the home range of an individual mountain goat that could also interact with the KSM Project. This project potentially affected the past condition of this VC.	X; The tailing impoundment and other project implements remain at site, and the site offers continuing exploration potential. Therefore, this site may affect the condition of this VC.	X; The tailing impoundment and other project implements remain at site, and the site offers continuing exploration potential; therefore this site may affect the future condition of this VC.
	Kitsault Mine (Closed)	NL	NL	NL
	Snip Mine	X; This project is within the CEA Area used to assess cumulative effects on mountain goat populations, but outside of the home range of an individual mountain goat that could also interact with the KSM Project. This project has the potential to affect the past condition of this VC.	X; This site was closed and reclaimed in 1999, within the potential lifespan of mountain goat that may also interact with the KSM Project. This project potentially affected the present condition of this VC.	X; This site was closed and reclaimed in 1999, within the potential lifespan of mountain goat that may also interact with the KSM Project. This project potentially affected the future condition of this VC.

(continued)

Table 18.9-5. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to Mountain Goats (continued)

Action/Project		Past	Present	Future
Past Projects	Sulphurets Project	X; This project is within the CEA Area used to assess cumulative effects on mountain goat populations, but outside of the home range of an individual mountain goat that could also interact with the KSM Project. This site was reclaimed in 1998, and may have affected the past condition of this VC.	X; This closed mine was reclaimed in 1998, and goats that were alive near the end of the operation and closure phase of this mine may still be alive at present.	X; This closed mine was reclaimed in 1998, and goats that were alive near the end of the operation and closure phase of this mine may still be alive in the future.
	Swamp Point Aggregate Mine	NL	NL	NL
Present Projects	Forrest Kerr Hydroelectric	NL	X; This project is within the CEA Area used to assess cumulative effects on mountain goat populations, but outside of the home range of an individual mountain goat that could also interact with the KSM Project. Construction began in 2011, and so it has the potential to affect the present condition of this VC.	X; As this project will become operational in 2014 for a 60 year operational life, it has the potential to affect the future condition of this VC.
	Red Chris Mine	NL	NL	NL
	NTL	NL	X; This project is within the home range of an individual mountain goat (Movement Area) that could also interact with the KSM Project, and within the CEA Area used to assess cumulative effects on mountain goat populations. Construction of NTL including the use of Highway 37 began in January, 2012 so it has the potential to affect the present condition of this VC.	X; This transmission line is expected to be operational by 2014, and the presence of a cleared corridor will remain indefinitely. The use of Highway 37 and helicopters for repairs and maintenance will also continue, and have the potential to affect the future condition of this VC.
	Long Lake Hydroelectric Project	NL	X; This project is within the CEA Area used to assess cumulative effects on mountain goat populations, but outside of the home range of an individual mountain goat that could also interact with the KSM Project. Construction began in 2010, so it has the potential to affect the present condition of this VC.	X; This project is expected to be operational by the end of 2012, and it will have a project life of 80 years. Therefore, it will have the potential to affect the future condition of this VC.
	Wolverine Mine	NL	NL	NL

(continued)

Table 18.9-5. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to Mountain Goats (continued)

Action/Project		Past	Present	Future
Reasonably Foreseeable Future Projects	Bear River Gravel	NL	NL	NL
	Bronson Slope Mine	NL	NL	X; Within the CEA boundaries used to assess cumulative effects on mountain goat, but outside of the home range of goat that could also interact with the KSM Project. It is expected that construction of this project will begin in 2018 and the project will operate for 20 years. Therefore, it will have the potential to affect the future condition of this VC.
	Brucejack Mine	NL	NL	X; This project is within the home range of an individual mountain goat (Movement Area) that could also interact with the KSM Project, and within the CEA Area used to assess cumulative effects on mountain goat populations.
	Galore Creek Mine	X; This project is within the home range of an individual mountain goat (Movement Area) that could also interact with the KSM Project, and within the CEA Area used to assess cumulative effects on mountain goat populations. The original construction of 48 km of the access road was completed in 2007 before the project was halted. Thus, this could have potentially affected the past condition of this VC.	X; The original construction of 48 km of the access road was completed in 2007 before the project was halted for financial reasons. These construction activities, along with activities between 2007 and present, have the potential to affect the present condition of this VC.	X; The construction of the mine and the remainder of the access road is expected to occur in 2018, and the project will operate for 18 years. Therefore, it will have the potential to affect the future condition of this VC.
	Granduc Copper Mine	NL	NL	NL
	Kitsault Mine	NL	NL	NL
	Kutcho Mine	NL	NL	NL
	McLymont Creek Hydroelectric	NL	X; This project is within the CEA Area used to assess cumulative effects on mountain goat populations, but outside of the home range of an individual mountain goat that could also interact with the KSM Project. Construction was expected to begin in 2012 and last for three years, so it has the potential to affect the present condition of this VC.	X; As this project is expected to become operational in 2015 for a 40 year operational life, it has the potential to affect the future condition of this VC.

(continued)

Table 18.9-5. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to Mountain Goats (continued)

Action/Project		Past	Present	Future
Reasonably Foreseeable Future Projects	Arctos Anthracite Coal Project	NL	NL	X; The ROW to be used for the Arctos Anthracite Coal Project abuts the eastern edge of the CEA Area used to assess cumulative effects on mountain goat populations, but is outside of the home range of an individual goat (Movement Area) that could also interact with the KSM Project. Project construction is expected to begin in 2015, and operation will occur for 20 years starting in 2017. Therefore, it will have the potential to affect the future condition of this VC.
	Schaft Creek Mine	NL	X; This project is within the CEA Area used to assess cumulative effects on mountain goat populations, but outside of the home range of an individual mountain goat that could also interact with the KSM Project. Road building was scheduled to begin in 2012, and thus could affect the present condition of this VC.	X; The construction of this mine is expected to extend from 2014 until 2017, and the project will operate for 15 years. Therefore, it will have the potential to affect the future condition of this VC.
	Snowfield Project	NL	NL	X; This project is within the home range of an individual mountain goat (Movement Area) that could also interact with the KSM Project, and within the CEA Area used to assess cumulative effects on mountain goat populations.
	Storie Moly Mine	NL	NL	NL
	Treaty Creek Hydroelectric	NL	NL	X; This project is within the home range of an individual mountain goat that could interact with the KSM Project, and within the CEA Area used to assess goat populations. This project is in the early planning phases, but it is expected that it has the potential to affect the future condition of this VC when construction and operation begin.
	Turnagain Mine	NL	NL	NL

(continued)

Table 18.9-5. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to Mountain Goats (completed)

Action/Project		Past	Present	Future
Land Use Activities	Agricultural Resources	NL	NL	NL
	Fishing	NL	NL	NL
	Guide Outfitting	X; Mountain goat hunting has occurred in the past within the CEA Area.	X; Mountain goat hunting continues within the CEA Area.	X; Mountain goat hunting will likely continue within the CEA Area.
	Resident and Aboriginal Harvest	X; Mountain goat hunting has traditionally been undertaken by residents of nearby communities and at least five aboriginal groups within the CEA Area.	X; Mountain goat hunting now occurs within the CEA Area, primarily by aboriginal groups and residents of nearby communities.	X; Mountain goat hunting is expected to continue within the CEA Area, primarily by aboriginal groups and residents of nearby communities.
	Mineral and Energy Resource Exploration	X; Multiple exploration activities have occurred in the past throughout the CEA Area.	X; Multiple mineral exploration endeavors are ongoing throughout the CEA Area.	X; Mineral exploration is expected to continue into the future throughout the CEA Area, particularly as new roads increase access and the NTL makes energy resources more available.
	Recreation and Tourism	X; Past recreation activities within the CEA Area have included ATVing, snowmobiling, wildlife viewing, river travel, multi-day hiking, river and lake paddling, fly-fishing, heli-skiing, and horse trips in the remote backcountry, and may have affected goat populations in the past.	X; Current recreation activities within the CEA Area include ATVing, snowmobiling, wildlife viewing, river travel, multi-day hiking, river and lake paddling, fly-fishing, heli-skiing, and horse trips in the remote backcountry, and may affect current goat populations.	X; Future recreation activities within the CEA Area are likely to include ATVing, snowmobiling, river travel, multi-day hiking, river and lake paddling, fly-fishing, and horse trips in the remote backcountry, and have the potential to affect future goat populations.
	Timber Harvesting	X; The KSM Project falls within 10 km of the north-western part of Nass Timber Supply Area (TSA), parts of which have been historically clear-cut.	X; There has been no recent logging activity within two registered forest tenures in the vicinity of the Project, but some forest harvesting may be ongoing within the greater CEA Area.	X; Plans for future timber harvest exists within the two registered forest tenures in the vicinity of the Project. Other forest harvesting is expected to occur within the CEA Area.
	Traffic and Roads	X; Use of the roads by vehicles along roads at higher elevations within the CEA Area may have impacted mountain goat populations in the past.	X; Use of the roads by vehicles along roads at higher elevations within the CEA Area could presently impact mountain goat populations.	X; Use of the roads by vehicles along roads at higher elevations within the CEA Area could impact mountain goat populations in the future.

NL = No Linkage (no spatial and temporal overlap, or potential effects do not act in combination)

X = Potential spatial and temporal linkage with project or action

Table 18.9-6. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to Grizzly Bears and Black Bears

Action/Project		Past	Present	Future
Past Projects	Eskay Creek Mine	X; This project is within the home range of an individual bear (Movement Area) that could also interact with the KSM Project, and within the CEA Area used to assess cumulative effects on bear populations (Figure 18.9-3). This project has the potential to affect the past condition of grizzly and black bears.	X; Since this project closed 8 years ago (2004) and bears live for 25-35 years, effects of this project are likely still affecting the present condition of bears.	X; Since this project closed in 2004 and bears live for 25-35 years, past effects of this project may affect the future condition of bears.
	Granduc Mine	X; This project is within the home range of an individual bear (Movement Area) that could also interact with the KSM Project, and within the CEA Area used to assess cumulative effects on bear populations. This project potentially affected the past condition of bears.	X; Although the project closed 28 years ago (1984), the long lifespan of bears, and the strong role of social learning of cubs from their mothers (e.g., with regard to how to identify food, respond to potential danger) means that the mine may affect the present condition of bears. For example, bears that have previously been taught to approach camps to look for human food items may still be in the area and may approach attractants.	X; Although the project closed 28 years ago (1984), the long lifespan of bears, and the strong role of social learning of cubs from their mothers (e.g., with regard to how to identify food, respond to potential danger) means that the mine may affect the future condition of bears.
	Johnny Mountain Mine	X; This project is within the home range of an individual bear (Movement Area) that could also interact with the KSM Project, and within the CEA Area used to assess cumulative effects on bear populations. This project has the potential to affect the past condition of grizzly and black bears.	X; Due to the closure of this project in 1990, which falls within the long lifespan of bears, and certain project footprint components remain (such as the tailing impoundment), the effects of this project may affect the present condition of bears.	X; Due to the closure of this project in 1990, the long lifespan of bears, and the fact that this site has ongoing exploration potential, and certain project footprint components remain (such as the tailing impoundment), this project may affect the future condition of bears.
	Kitsault Mine (Closed)	X; This project is within the home range of an individual bear (Movement Area) that could also interact with the KSM Project, and within the CEA Area used to assess cumulative effects on bear populations. This project has the potential to affect the past condition of grizzly and black bears.	X; This mine has the potential to link past effects of this mine to the present condition of bears. A small mining village also remains.	X; Due to the recent closure and reclamation of this project in the past 6 years, the long lifespan of bears has the potential to affect the future condition of bears. A small mining village also remains.

(continued)

Table 18.9-6. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to Grizzly Bears and Black Bears (continued)

Action/Project		Past	Present	Future
Past Projects	Snip Mine	X; This project is within the home range of an individual bear (Movement Area) that could also interact with the KSM Project, and within the CEA Area used to assess cumulative effects on bear populations. This project has the potential to affect the past condition of grizzly and black bears.	X; Given the long life span of bears, this mine has the potential to affect the present condition of bears.	X; Given the long life span of bears, this mine has the potential to affect the future condition of bears.
	Sulphurets Project	NL	NL	NL
	Swamp Point Aggregate Mine	X; This project is within the home range of an individual bear (Movement Area) that could also interact with the KSM Project, and within the CEA Area used to assess cumulative effects on bear populations. This project has the potential to affect the past condition of grizzly and black bears.	X; This recently closed mine has the potential to affect the present condition of bears.	X; Due to the recent closure of this project in the past year (2011) and the long lifespan of bears, this project has the potential to affect the future condition of bears.
Present Projects	Forrest Kerr Hydroelectric	NL	X; This hydroelectric power project is within the home range of an individual bear (Movement Area) that could also interact with the KSM Project, and within the CEA Area used to assess cumulative effects on bear populations. Construction began in 2011, and so it has the potential to affect the present condition of these VCs.	X; As this project will become operational in 2014 for a 60 year operational life, it has the potential to affect the future condition of these VCs.
	Red Chris Mine	NL	NL	NL
	NTL	NL	X; This transmission line runs north-south across the eastern section of the home range of an individual bear (Movement Area) that could also interact with the KSM Project, and within the CEA Area used to assess cumulative effects on bear populations. Use of Highway 37, which runs adjacent to the NTL also falls within this zone. Construction of this project began in 2012, and so it has the potential to affect the present condition of these VCs.	X; This transmission line is expected to be operational by 2014, and the presence of a cleared corridor will remain indefinitely. The use of Highway 37 and helicopters for repairs and maintenance will also continue, and have the potential to affect the future condition of bears.

(continued)

Table 18.9-6. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to Grizzly Bears and Black Bears (continued)

Action/Project		Past	Present	Future
Present Projects	Long Lake Hydroelectric Project	NL	X; This hydroelectric power project is within the home range of an individual bear (Movement Area) that could also interact with the KSM Project, and within the CEA Area. Construction began in 2010, and so this project will potentially affect the present condition of bears.	X; This project is expected to be operational by the end of 2012, and it will have a project life of 80 years. Therefore, the footprint and operation activities will potentially affect the future condition of bears
	Wolverine Mine	NL	NL	NL
Reasonably Foreseeable Future Projects	Bear River Gravel	NL	NL	X; This project is within the home range of an individual bear (Movement Area) that could also interact with the KSM Project, and within the CEA Area used to assess cumulative effects on bear populations. Construction of the project is assumed to begin in 2018 and the project will operate for 25 years. Therefore, it will have the potential to affect the future condition of these VCs.
	Bronson Slope Mine	NL	NL	X; This project is within the home range of an individual bear (Movement Area) that could also interact with the KSM Project, and within the CEA Area used to assess cumulative effects on bear populations. It is expected that construction of this project will begin in 2018 and the project will operate for 20 years. Therefore, it will have the potential to affect the future condition of these VCs.
	Brucejack Mine	NL	NL	X; This project is within the home range of an individual bear (Movement Area) that could also interact with the KSM Project, and within the CEA Area used to assess cumulative effects on bear populations. The construction of this project is expected to begin in 2014 and the project will operate for 24 years. Therefore, it will have the potential to affect the future condition of these VCs.

(continued)

Table 18.9-6. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to Grizzly Bears and Black Bears (continued)

Action/Project		Past	Present	Future
Reasonably Foreseeable Future Projects	Galore Creek Mine	X; This project is within the CEA Area used to assess cumulative effects on bear populations, but outside of the home range of an individual bear (Movement Area) that could also interact with the KSM Project. The original construction of 48 km of the access road was completed in 2007 before the project was halted for financial reasons. Thus, this project could have potentially affected the past condition of these two VCs.	X; The original construction of 48 km of the access road was completed in 2007 before the project was halted for financial reasons. These construction activities, along with activities between 2007 and present, have potentially affect the present condition of these VCs.	X; The construction of the mine and the remainder of the access road is expected to occur in 2018, and the project will operate for 18 years. Therefore, it will have the potential to affect the future condition of these VCs.
	Granduc Copper Mine	NL	NL	NL
	Kitsault Mine	NL	NL	X; This project is within the CEA Area used to assess cumulative effects on bear populations, but outside of the home range of an individual bear (Movement Area) that could also interact with the KSM Project. The construction of the project will begin in 2013 and the project will operate for 15 to 16 years. Therefore, it will have the potential to affect the future condition of these VCs.
	Kutcho Mine	NL	NL	NL
	McLymont Creek Hydroelectric	NL	X; This project is within the CEA Area used to assess cumulative effects on bear populations, and within the home range of an individual bear (Movement Area) that could also interact with the KSM Project. Construction was expected to begin in 2012 and last for three years, so it has the potential to affect the present condition of this VC.	X; As this project is expected to become operational in 2015 for a 40 year operational life, it has the potential to affect the future condition of this VC.

(continued)

Table 18.9-6. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to Grizzly Bears and Black Bears (continued)

Action/Project		Past	Present	Future
Reasonably Foreseeable Future Projects	Arctos Anthracite Coal Project	NL	NL	X; The ROW to be used for the Arctos Anthracite Coal Project shipping route bisects the CEA. This project is within the CEA Area used to assess cumulative effects on bear populations, but outside of the home range of an individual bear (Movement Area) that could also interact with the KSM Project. Project construction is expected to begin in 2015, and operation, including shipping through the CEA, will begin in 2017, and continue for 20 years. Therefore, it will have the potential to affect the future condition of these VCs.
	Schaft Creek Mine	NL	X; This project is within the home range of an individual bear (Movement Area) that could also interact with the KSM Project, and within the CEA Area used to assess cumulative effects on bear populations. Road building was scheduled to begin in 2012, and thus could affect the present condition of these VCs.	X; The construction of this mine is expected to extend from 2014 until 2017, and the project will operate for 15 years. Therefore, it will have the potential to affect the future condition of these VCs.
	Snowfield Project	NL	NL	X; This project is within the home range of an individual bear (Movement Area) that could also interact with the KSM Project, and within the CEA Area used to assess cumulative effects on bear populations and is expected to occur starting in 2018, with an operation period of 27 years. Therefore, it will have the potential to affect the future condition of these VCs.
	Storie Moly Mine	NL	NL	NL

(continued)

Table 18.9-6. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to Grizzly Bears and Black Bears (continued)

Action/Project		Past	Present	Future
Reasonably Foreseeable Future Projects	Treaty Creek Hydroelectric	NL	NL	X; This project and the use of Treaty Creek access road and Highway 37 are within the home range of an individual bear (Movement Area) that could also interact with the KSM Project, and within the CEA Area used to assess cumulative effects on bear populations. This project is in the early planning phases, but it is expected that it has the potential to affect the future condition of these VCs when construction and operation begin.
	Turnagain Mine	NL	NL	NL
Land Use Activities	Agricultural Resources	NL	NL	NL
	Fishing	X; Fishing has occurred in the past along the Stikine, the Upper Bell Irving River and its tributaries, and in other bodies of water within the home range of an individual bear (Movement Area) that could also interact with the KSM Project, and within the CEA Area used to assess cumulative effects on bear populations. The home range of a bear that could also interact with the KSM Project and/or within the CEA boundary used to assess cumulative effects on bears.	X; Fishing occurs along the Stikine, the Upper Bell Irving River and its tributaries, and in other bodies of water within the home range of a bear that could also interact with the KSM Project and/or within the CEA boundary used to assess cumulative effects on bears.	X; Fishing is expected to continue along the Stikine, the Upper Bell Irving River and its tributaries, and in other bodies of water within the home range of a bear that could also interact with the KSM Project and/or within the CEA boundary used to assess cumulative effects on bears.
	Guide Outfitting	X; Big game hunting has occurred in the past within the Cassiar region, and species targeted have included grizzly bear and black bear.	X; Big game hunting continues within the Cassiar region. Five guide outfitting tenures exist within close proximity to the Project. Species targeted include grizzly bear and black bear.	X; Big game hunting, including bear hunting, is expected to continue within the Cassiar region. Ease of the hunt, and hunting success may increase due to increased access to backcountry areas due to construction of roads for mine, exploration, and hydroelectric projects.

(continued)

Table 18.9-6. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to Grizzly Bears and Black Bears (continued)

Action/Project		Past	Present	Future
Land Use Activities	Resident and Aboriginal Harvest	X; Hunting has traditionally been undertaken by residents of nearby communities and at least five aboriginal groups within the home range of an individual bear (Movement Area) that could also interact with the KSM Project, and within the CEA Area used to assess cumulative effects on bear populations. the home range of a bear that could also interact with the KSM Project and within the CEA boundary used to assess cumulative effects on bears	X; Hunting now occurs within the home range of a bear that could also interact with the KSM Project, and within the CEA boundary used to assess cumulative effects on bears.	X; Hunting is expected to continue within the home range of a bear that could also interact with the KSM Project, and within the CEA boundary used to assess cumulative effects on bears. Hunting interest and success rates may increase with increased road access into the area
	Mineral and Energy Resource Exploration	X; Multiple exploration activities have occurred in the past throughout the CEA Boundary. Three projects (Treaty Creek (15,00 masl), Trek (1,465 masl), and Premier (1,615 masl)) are eliminated due to their high elevations, above the vegetation line.	X; Multiple mineral exploration endeavors are ongoing throughout the CEA boundary. Three projects (Treaty Creek, Trek, and Premier) are eliminated due to their high elevations, above the vegetation line.	X; Mineral exploration is expected to continue into the future throughout the CEA boundary, particularly as new roads increase access and the NTL makes energy resources more available. Three projects (Treaty Creek, Trek, and Premier) are eliminated due to their high elevations, above the vegetation line.
	Recreation and Tourism	X; Past recreation activities within the CEA boundary have included ATVing, snowmobiling, wildlife viewing, river travel, multi-day hiking, river and lake paddling, mountain biking, fly-fishing, heli-skiing, and horse trips in the remote backcountry.	X; Current recreation activities within the CEA boundaries include ATVing, snowmobiling, wildlife viewing, river travel, multi-day hiking, river and lake paddling, mountain biking, fly-fishing, heli-skiing, and horse trips in the remote backcountry.	X; Future recreation activities within the CEA boundaries are likely to include ATVing, snowmobiling, river travel, multi-day hiking, river and lake paddling, mountain biking, fly-fishing, and horse trips in the remote backcountry.
	Timber Harvesting	X; The KSM Project falls within 10 km of the north-western part of Nass Timber Supply Area (TSA), parts of which have been historically clear-cut. Most forestry activities in the past have been largely restricted to the Bob Quinn area or south of Bell II.	X; There has been no recent logging activity within two registered forest tenures in the vicinity of the Project, but some forest harvesting may be ongoing within the greater CEA boundary used to assess cumulative effects on bears.	X; Plans for future timber harvest exists within the two registered forest tenures in the vicinity of the Project. Other forest harvesting is expected to occur within the CEA boundary used to assess cumulative effects on bears.

(continued)

Table 18.9-6. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to Grizzly Bears and Black Bears (completed)

Action/Project		Past	Present	Future
Land Use Activities	Traffic and Roads	X; Use of the roads by vehicles, particularly along Hwy. 37, and Eskay Creek Mine road fall within the home range of an individual bear (Movement Area) that could also interact with the KSM Project, and within the CEA Area used to assess cumulative effects on bear populations. the home range of a bear that could also interact with the KSM Project, and within the CEA boundary used to assess cumulative effects on bears	X; Use of the roads by vehicles along Hwy. 37, Eskay Creek Mine road, and other roads developed for various proposed projects fall within the home range of a bear that could also interact with the KSM Project, and/or within the CEA boundary used to assess cumulative effects on bear.	X; Use of the roads by vehicles along Hwy. 37, Eskay Creek Mine road, and other roads developed to various proposed projects fall within the home range of a bear that could also interact with the KSM Project, and/or within the CEA boundary used to assess cumulative effects on bears.

NL = No Linkage (no spatial and temporal overlap, or potential effects do not act in combination)

X = Potential spatial and temporal linkage with project or action

Table 18.9-7. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to American Marten

Action/Project		Past	Present	Future
Past Projects	Eskay Creek Mine	X; This now closed mine, and use of Eskay Creek Road is within the home range of American marten that could also interact with the KSM Project, and within the CEA (VA-WSA; Figure 18.9-4) boundary used to assess cumulative effects on American marten. This project closed 8 years ago in 2004, but since American marten can live up to 14.5 years (Bull and Heater 2001), it potentially affected the past condition of this VC.	X; This project closed in 2004, but since American marten can live up to 14.5 years in the wild (Bull and Heater 2001), it could potentially affect the present condition of this VC.	X; This project closed in 2004, but since American marten can live up to 14.5 years, it could potentially affect the future condition of this VC.
	Granduc Mine	NL	NL	NL
	Johnny Mountain Mine	NL	NL	NL
	Kitsault Mine (Closed)	NL	NL	NL
	Snip Mine	NL	NL	NL
	Sulphurets Project	NL	NL	NL
	Swamp Point Aggregate Mine	NL	NL	NL

(continued)

Table 18.9-7. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to American Marten (continued)

Action/Project		Past	Present	Future
Present Projects	Forrest Kerr Hydroelectric	NL	X; This project is within the northern extend of home ranges of the CEA boundary used to assess cumulative effects on American marten. Construction began in 2011, and so it has the potential to affect the present condition of this VC.	X; As this project will become operational in 2014 for a 60 year operational life, it has the potential to affect the future condition of this VC.
	Red Chris Mine	NL	NL	NL
	NTL	NL	X; This project intersects the CEA boundaries used to assess cumulative effects on American marten. Construction of NTL including the use of Highway 37 began in January, 2012 and so it has the potential to affect the present condition of this VC.	X; This transmission line is expected to be operational by 2014, and the presence of a cleared corridor will remain indefinitely. The use of Highway 37 and helicopters for repairs and maintenance will also continue, and have the potential to affect the future condition of this VC.
	Long Lake Hydroelectric Project	NL	NL	NL
	Wolverine Mine	NL	NL	NL
Reasonably Foreseeable Future Projects	Bear River Gravel	NL	NL	NL
	Bronson Slope Mine	NL	NL	NL
	Brucejack Mine	NL	NL	X; This project is within the CEA boundary used to assess cumulative effects on American marten. This project has the potential to affect the future condition of this VC.
	Galore Creek Mine	NL	NL	NL
	Granduc Copper Mine	NL	NL	NL
	Kitsault Mine	NL	NL	NL
	Kutcho Mine	NL	NL	NL
	McLymont Creek Hydroelectric	NL	NL	NL
	Arctos Anthracite Coal Project	NL	NL	NL

(continued)

Table 18.9-7. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to American Marten (continued)

Action/Project		Past	Present	Future
Reasonably Foreseeable Future Projects	Schaft Creek Mine	NL	NL	NL
	Snowfield Project	NL	NL	X; This project will fall within the CEA boundaries used to assess cumulative effects on American marten. The construction of this mine is expected to occur for this project starting in 2018, with an operation period of 27 years. Therefore, it will have the potential to affect the future condition of this VC.
	Storie Moly Mine	NL	NL	NL
	Treaty Creek Hydroelectric	NL	NL	X; This project will use Treaty Creek access road and Hwy. 37, and is within the CEA boundaries used to assess American marten. This project is in the early planning phases, but it is expected that it has the potential to affect the future condition of this VC if construction and operation begin.
	Turnagain Mine	NL	NL	NL
Land Use Activities	Agricultural Resources	NL	NL	NL
	Fishing	NL	NL	NL
	Guide Outfitting	NL	NL	NL
	Resident and Aboriginal Harvest (Trapping)	X; Trapping of American marten has traditionally been undertaken by residents of nearby communities and at least five aboriginal groups within the CEA boundaries used to assess cumulative effects on American marten.	X; Trapping for American marten continues within the CEA boundary used to assess cumulative effects on American marten.	X; Trapping of American marten is expected to continue within the CEA boundary.

(continued)

Table 18.9-7. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to American Marten (completed)

Action/Project		Past	Present	Future
Land Use Activities	Mineral and Energy Resource Exploration	X; Multiple exploration activities have occurred within the CEA boundaries for American marten. Two projects are not considered as interacting with this VC due to their elevation being above capable habitat: Mt Dunn exploration (1,355 masl), and Treaty Creek exploration (1,500 masl)	X; Exploration activities (Mt. Dunn and Treaty Creek) are occurring within the CEA boundaries for American marten. Two projects are not considered as interacting with this VC due to their elevation being above capable habitat: Mt Dunn exploration (1,355 masl), and Treaty Creek exploration (1,500 masl)	X; Increasing exploration activities are expected in the future within the CEA boundaries for American marten, due to increased accessibility and the NTL. Two projects are not considered as interacting with this VC due to their elevation being above capable habitat: Mt Dunn exploration (1,355 masl), and Treaty Creek exploration (1,500 masl)
	Recreation and Tourism	NL	NL	NL
	Timber Harvesting	X; The CEA boundaries for American marten include the north-western part of Nass Timber Supply Area (TSA), parts of which have been historically clear-cut.	X; There has been no recent logging activity within two registered forest tenures in the vicinity of the Project, but some forest harvesting may be ongoing within the greater CEA boundaries for American marten.	X; Plans for future timber harvest exist within the two registered forest tenures in the vicinity of the Project. Other forest harvesting is expected to occur within the CEA boundary.
	Traffic and Roads	X; Use of the roads by vehicles, particularly along Hwy. 37, and Eskay Creek Mine road, as well as small access roads within the VA- WSA boundaries may have impacted American marten in the past	X; Use of the roads by vehicles along Hwy. 37, Eskay Creek Mine road, within the CEA boundaries could presently impact American marten.	X; Use of the roads by vehicles along Hwy. 37, Eskay Creek Mine road, and added traffic to other roads proposed projects within the CEA boundaries could impact American marten in the future.

NL = No Linkage (no spatial and temporal overlap, or potential effects do not act in combination)

X = Potential spatial and temporal linkage with project or action

Table 18.9-8. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to Hoary Marmots

Action/Project		Past	Present	Future
Past Projects	Eskay Creek Mine	NL	NL	NL
	Granduc Mine	NL	NL	NL
	Johnny Mountain Mine	NL	NL	NL
	Kitsault Mine (Closed)	NL	NL	NL
	Snip Mine	NL	NL	NL

(continued)

Table 18.9-8. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to Hoary Marmots (continued)

Action/Project		Past	Present	Future
Past Projects	Sulphurets Project	X; This closed mine (reclaimed in 1998) is within the CEA Area; Figure 18.9-6) used to assess cumulative effects on this VC. This project potentially affected the past condition of this VC.	NL	NL
	Swamp Point Aggregate Mine	NL	NL	NL
Present Projects	Forrest Kerr Hydroelectric	NL	NL	NL
	Red Chris Mine	NL	NL	NL
	NTL	NL	X; This project intersects the CEA boundary used to assess cumulative effects on Hoary marmot. Construction of NTL including the use of highway 37 began in January, 2012 and so the portions of it that run through high elevation areas just below and above the treeline have the potential to affect the present condition of this VC.	X; This transmission line is expected to be operational by 2014, and the presence of a cleared corridor will remain indefinitely. The use of highway 37 and helicopters for repairs and maintenance will also continue, and have the potential to affect the future condition of this VC.
	Long Lake Hydroelectric Project	NL	NL	NL
	Wolverine Mine	NL	NL	NL
Reasonably Foreseeable Future Projects	Bear River Gravel	NL	NL	NL
	Bronson Slope Mine	NL	NL	NL
	Brucejack Mine	NL	NL	NL
	Galore Creek Mine	NL	NL	NL
	Granduc Copper Mine	NL	NL	NL
	Kitsault Mine	NL	NL	NL
	Kutcho Mine	NL	NL	NL
	McLymont Creek Hydroelectric	NL	NL	NL

(continued)

Table 18.9-8. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to Hoary Marmots (continued)

Action/Project		Past	Present	Future
Reasonably Foreseeable Future Projects	Arctos Anthracite Coal Project	NL	NL	NL
	Schaft Creek Mine	NL	NL	NL
	Snowfield Project	NL	NL	X; This project will fall within the CEA boundaries used to assess cumulative effects on Hoary marmots. The construction of this mine is expected to occur for this project starting in 2018, with an operation period of 27 years. Therefore, it will have the potential to affect the future condition of this VC.
	Storie Moly Mine	NL	NL	NL
	Treaty Creek Hydroelectric	NL	NL	X; This project will use Hwy. 37, and is within the CEA boundaries used to assess Hoary marmot. This project is in the early planning phases, but it is expected that it has the potential to affect the future condition of this VC if construction and operation begin. The northern-most of the three sites comprising the Treaty Creek hydroelectric project is not expected to interact with this VC, as the elevation of this site (520 masl) is below the elevation range of this VC.
	Turnagain Mine	NL	NL	NL
Land Use Activities	Agricultural Resources	NL	NL	NL
	Fishing	NL	NL	NL
	Guide Outfitting	NL	NL	NL
	Resident and Aboriginal Harvest (Trapping)	X; Trapping/hunting of Hoary Marmot has traditionally been undertaken by residents of nearby communities and at least five aboriginal groups within the CEA boundary used to assess cumulative effects on these VCs.	X; Trapping/hunting of Hoary marmot (groundhog) continues in the area, primarily within the CEA boundary used to assess cumulative effects on these VCs.	X; Trapping/hunting is expected to continue into the future.

(continued)

Table 18.9-8. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to Hoary Marmots (completed)

Action/Project		Past	Present	Future
Land Use Activities	Mineral and Energy Resource Exploration	X; Multiple exploration activities have occurred within the CEA boundary used to assess cumulative effects on this VCs.	X; Exploration activities are currently identified within the CEA boundary used to assess cumulative effects on this VC.	X; More exploration expected in the future within the CEA boundary used to assess cumulative effects on this VC.
	Recreation and Tourism	NL	NL	NL
	Timber Harvesting	X; The CEA includes the northwestern part of Nass Timber Supply Area (TSA), parts of which have been historically clear-cut.	X; There has been no recent logging activity within two registered forest tenures in the vicinity of the Project, but some forest harvesting may be ongoing within the greater CEA boundary used to assess cumulative effects on this VC.	X; Plans for future timber harvest exists within the two registered forest tenures in the vicinity of the Project. Other forest harvesting is expected to occur within the CEA boundary used to assess cumulative effects on this VC.
	Traffic and Roads	X; Use of the roads near and above the treeline within the VA- CEA boundaries may have impacted this VC in the past.	X; Use of the roads near and above the treeline within the CEA boundaries could presently impact this VC.	X; Use of the high elevation roads by vehicles and added traffic to other roads by proposed projects within the CEA boundaries could impact this VC in the future.

NL = No Linkage (no spatial and temporal overlap, or potential effects do not act in combination)

X = Potential spatial and temporal linkage with project or action

Table 18.9-9. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to Bats, Raptors, Wetland Birds, and Forest and Alpine Birds

Action/Project		Past	Present	Future
Past Projects	Eskay Creek Mine	X; This now closed mine, and Eskay Creek Mine road are within the CEA Area boundary used to assess cumulative effects on these bats and three avian VCs (raptors, wetland birds, and forest and alpine birds). This project potentially affected the past conditions of these VCs.	X; This now closed mine, and Eskay Creek Mine road are within the CEA Area boundary used to assess cumulative effects on these bats and three avian VCs (raptors, wetland birds, and forest and alpine birds). This project potentially affected the past conditions of these VCs.	X; This now closed mine, and Eskay Creek Mine road are within the CEA Area boundary used to assess cumulative effects on these bats and three avian VCs (raptors, wetland birds, and forest and alpine birds). This project potentially affected the past conditions of these VCs.
	Granduc Mine	NL	NL	NL
	Johnny Mountain Mine	NL	NL	NL
	Kitsault Mine (Closed)	NL	NL	NL
	Snip Mine	NL	NL	NL

(continued)

Table 18.9-9. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to Bats, Raptors, Wetland Birds, and Forest and Alpine Birds (continued)

Action/Project		Past	Present	Future
Past Projects	Sulphurets Project	NL	NL	NL
	Swamp Point Aggregate Mine	NL	NL	NL
Present Projects	Forrest Kerr Hydroelectric	NL	NL	NL
	Red Chris Mine	NL	NL	NL
	NTL	NL	X; This project intersects the CEA boundaries used to assess cumulative effects on bats, raptors, wetland birds, and alpine and forest birds. Construction of NTL including the use of Hwy 37 began in January, 2012 and so it has the potential to affect the present condition of these VCs.	X; This transmission line is expected to be operational by 2014, and the presence of a cleared corridor that will remain indefinitely as the transmission line ROW, as well as the use of Hwy 37 and helicopters for repairs and maintenance, as well as the presence of the transmission line towers and lines, have the potential to affect the future condition of these VCs.
	Long Lake Hydroelectric Project	NL	NL	NL
	Wolverine Mine	NL	NL	NL
Reasonably Foreseeable Future Projects	Bear River Gravel	NL	NL	NL
	Bronson Slope Mine	NL	NL	NL
	Brucejack Mine	NL	NL	X; This project is within the CEA boundary used to assess cumulative effects on bats and avian VCs. This project has the potential to affect the future condition of these VCs.
	Galore Creek Mine	NL	NL	NL
	Granduc Copper Mine	NL	NL	NL
	Kitsault Mine	NL	NL	NL
	Kutcho Mine	NL	NL	NL
	McLymont Creek Hydroelectric	NL	NL	NL

(continued)

Table 18.9-9. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to Bats, Raptors, Wetland Birds, and Forest and Alpine Birds (continued)

Action/Project		Past	Present	Future
Reasonably Foreseeable Future Projects	Arctos Anthracite Coal Project	NL	NL	NL
	Schaft Creek Mine	NL	NL	NL
	Snowfield Project	NL	NL	X; This project will fall within the CEA boundaries used to assess cumulative effects on the bat and avian VCs. The construction of this mine is expected to occur for this project starting in 2018, with an operation period of 27 years. Therefore, it will have the potential to affect the future condition of these VCs.
	Storie Moly Mine	NL	NL	NL
	Treaty Creek Hydroelectric	NL	NL	X; This project will use Hwy 37, and is within the CEA boundaries used to assess these VCs. This project is in the early planning phases, but it is expected that it has the potential to affect the future condition of these VCs when construction and operation begin.
	Turnagain Mine	NL	NL	NL
Land Use Activities	Agricultural Resources	NL	NL	NL
	Fishing	NL	NL	NL
	Guide Outfitting	NL	NL	NL
	Resident and Aboriginal Harvest (Trapping)	X; Harvest of certain birds, such as ptarmigan, grouse, eagle and waterfowl, has traditionally been undertaken by residents of nearby communities and at least five aboriginal groups within the CEA boundary used to assess cumulative effects on these VCs.	X; Harvest of birds continues in the area, primarily within the CEA boundary used to assess cumulative effects on these VCs.	X; Harvest occurring in the past and present, within the CEA boundary used to assess cumulative effects on these VCs, is expected to continue into the future.
	Mineral and Energy Resource Exploration	X; Multiple exploration activities have occurred in the past within the CEA boundary used to assess cumulative effects on these VCs.	X; Exploration activities currently occur within the CEA boundary used to assess cumulative effects on these VCs.	X; More exploration is expected in the future within the CEA boundary used to assess cumulative effects on these VCs.

(continued)

Table 18.9-9. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to Bats, Raptors, Wetland Birds, and Forest and Alpine Birds (continued)

Action/Project		Past	Present	Future
Land Use Activities	Recreation and Tourism	NL	NL	NL
	Timber Harvesting	X; The CEA includes the north-western part of Nass Timber Supply Area (TSA), parts of which have been historically clear-cut.	X; There has been no recent logging activity within two registered forest tenures in the vicinity of the Project, but some forest harvesting may be ongoing within the greater CEA boundary used to assess cumulative effects on these VCs.	X; Plans for future timber harvest exists within the two registered forest tenures in the vicinity of the Project. Other forest harvesting is expected to occur within the CEA boundary used to assess cumulative effects on these VCs.
	Traffic and Roads	X; Use of the roads by vehicles, particularly along Hwy. 37, and Eskay Creek Mine road, as well as along small access roads within the CEA boundaries may have impacted these VCs in the past.	X; Use of the roads by vehicles along Hwy. 37, Eskay Creek Mine road, within the CEA boundaries could presently impact these VCs.	X; Use of the roads by vehicles along Hwy. 37, Eskay Creek Mine road, and added traffic to other roads proposed projects within the CEA boundaries could impact these VCs in the future.

NL = No Linkage (no spatial and temporal overlap, or potential effects do not act in combination)

X = Potential spatial and temporal linkage with project or action

Table 18.9-10. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to Western Toads

Action/Project		Past	Present	Future
Past Projects	Eskay Creek Mine	X; This now closed mine, and the Eskay Creek Mine road, are within the CEA (Figure 18.9-5) boundary used to assess cumulative effects on Western toad. This project potentially affected the past condition of this VC.	X; This project closed in 2004, but since western toad can live up to 12 years in the wild (Loeffler 2001), it could potentially affect the present condition of this VC.	X; Since Western toad can live up to 12 years in the wild (Loeffler 2001), it could potentially affect the future condition of this VC.
	Granduc Mine	NL	NL	NL
	Johnny Mountain Mine	NL	NL	NL
	Kitsault Mine (Closed)	NL	NL	NL
	Snip Mine	NL	NL	NL
	Sulphurets Project	X; This closed mine is within the CEA boundaries used to assess cumulative effects on Western toad. This project potentially affected the past condition of this VC.	X; The access road for this mine remained after closure, providing a permanent access route.	X; This closed mine was reclaimed in 1998, but the access road for this mine remained.
	Swamp Point Aggregate Mine	NL	NL	NL

(continued)

Table 18.9-10. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to Western Toads (continued)

Action/Project		Past	Present	Future
Present Projects	Forrest Kerr Hydroelectric	NL	NL	NL
	Red Chris Mine	NL	NL	NL
	NTL	NL	X; This project intersects the CEA boundaries used to assess cumulative effects on Western toad. Construction of the NTL including the use of Hwy. 37 began in January, 2012 and so it has the potential to affect the present condition of this VC.	X; This transmission line is expected to be operational by 2014, and the presence of a cleared corridor will remain indefinitely. The use of Hwy. 37 and helicopters for repairs and maintenance will also continue, and has the potential to affect the future condition of this VC.
	Long Lake Hydroelectric Project	NL	NL	NL
	Wolverine Mine	NL	NL	NL
Reasonably Foreseeable Future Projects	Bear River Gravel	NL	NL	NL
	Bronson Slope Mine	NL	NL	NL
	Brucejack Mine	NL	NL	X; This project is within the CEA boundary used to assess cumulative effects on western toads. This project has the potential to affect the future condition of this VC.
	Galore Creek Mine	NL	NL	NL
	Granduc Copper Mine	NL	NL	NL
	Kitsault Mine	NL	NL	NL
	Kutcho Mine	NL	NL	NL
	McLymont Creek Hydroelectric	NL	NL	NL
	Arctos Anthracite Coal Project	NL	NL	NL
	Schaft Creek Mine	NL	NL	NL

(continued)

Table 18.9-10. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to Western Toads (continued)

Action/Project		Past	Present	Future
Reasonably Foreseeable Future Projects	Snowfield Project	NL	NL	X; This project will falls within the CEA boundaries used to assess cumulative effects on western toads. The construction of this mine is expected to occur for this project starting in 2018, with an operation period of 27 years. Therefore, it will have the potential to affect the future condition of this VC.
	Storie Moly Mine	NL	NL	NL
	Treaty Creek Hydroelectric	NL	NL	X; This project will use Hwy. 37, and is within the CEA boundaries used to assess Western toad. This project is in the early planning phases, but it is expected that it has the potential to affect the future condition of this VC if construction and operation begin.
	Turnagain Mine	NL	NL	NL
Land Use Activities	Agricultural Resources	NL	NL	NL
	Fishing	NL	NL	NL
	Guide Outfitting	NL	NL	NL
	Resident and Aboriginal Harvest (Trapping)	NL	NL	NL
	Mineral and Energy Resource Exploration	X; Multiple exploration activities have occurred within the CEA boundaries for Western toad.	X; Exploration activities are presently identified within the CEA boundaries for Western toad.	X; Increasing exploration activities are expected in the future within the CEA boundaries for Western toad, due to increased accessibility and the NTL.
	Recreation and Tourism	NL	NL	NL
	Timber Harvesting	X; The CEA boundaries for Western toad include the north-western part of Nass Timber Supply Area (TSA), parts of which have been historically clear-cut.	X; There has been no recent logging activity within two registered forest tenures in the vicinity of the Project, but some forest harvesting may be ongoing within the greater CEA boundaries for Western toad.	X; Plans for future timber harvest exists within the two registered forest tenures in the vicinity of the Project. Other forest harvesting is expected to occur within the CEA boundary.

(continued)

Table 18.9-10. Summary of Potential Linkages between the KSM Project and Other Human Actions in regards to Western Toads (completed)

Action/Project		Past	Present	Future
Land Use Activities	Traffic and Roads	X; Use of Hwy. 37, and Eskay Creek Mine road, as well as along small access roads within the VA- WSA boundaries may have impacted Western toad in the past. There has been a significant amount of traffic associated with this activity, which can affect Western toad if this species attempts to cross the road in a large group during seasonal migration from breeding to overwintering areas.	X; Use of Hwy. 37, and Eskay Creek Mine road, pass within the CEA boundaries and could presently impact Western toad. There is presently a significant amount of traffic associated with this activity, which can affect Western toad if this species attempts to cross the road in a large group during seasonal migration from breeding to overwintering areas.	X; Use of Hwy. 37, Eskay Creek Mine road, and added traffic to other new roads proposed projects within the CEA boundaries could impact Western toad in the future. Traffic density is expected to increase in the future, which can affect Western toad if this species attempts to cross the road in a large group during seasonal migration from breeding to overwintering areas.

NL = No Linkage (no spatial and temporal overlap, or potential effects do not act in combination)

X = Potential spatial and temporal linkage with project or action

All spatially linked projects that clearly overlap the construction and operation phases of the KSM Project were considered to be temporally linked in the CEA; see Figure 5.3-3 for more details on temporal overlap of projects. Some past projects were still considered to be linked to the present (and sometimes future) conditions of certain VCs due to remaining infrastructure (e.g., roads), learned responses from wildlife (e.g., food attractants), or permanent/long lasting habitat alterations (e.g., cleared areas). Brief explanations for temporal linkages among projects are provided in Tables 18.9-4 to 18.9-10 for each VC.

A brief description of all projects with at least one spatial and temporal linkage for the VCs considered is provided in Table 18.9-11. More detailed descriptions of these projects are found in Chapter 5.

For assessments involving traffic volumes, Yukon Zinc's Wolverine Mine is included after requests made at Working Group meetings to include traffic from this mine. This additional project falls outside of the CEA Areas, but is included because it adds vehicles to major thoroughfares (i.e., Highway 37 and 37A) that pass through CEA Areas (see Chapter 5 for projects included in traffic calculations).

18.9.1.3 Cumulative Effects Analyses for Wildlife

The initial step in the wildlife CEA included determining what projects were spatially or temporally linked for each VC (Tables 18.9-4 to 18.9-10). This exercise was used to focus the assessment on the interactions resulting in cumulative effects between projects and the residual effects predicted for the KSM Project.

Past and present projects and activities that are spatially and temporally linked for each VC were considered in the CEA if they met the following four requirements for determining cumulative effects, as per Hegmann et al. (1999):

Table 18.9-11. Summary Descriptions of Each Project with at Least One Spatial Linkage to at Least One Wildlife Valued Component

Project Name and Elevation	Existing Project Descriptions (Summarized from Chapter 5)
Eskay Creek Mine (780 masl)	The Eskay Creek Mine was an underground gold-silver mine 18 km from the proposed KSM Project and is at 780 masl. Eskay Creek Mine operated from 1998 to 2004, when 27 ha of land were cleared, 9 ha of which were reclaimed by 2004. This mine required construction of the Eskay Creek Mine road, which will be extended and used by the KSM Project, and this extension (Coulter Creek access road) will link the areas disturbed by the Eskay Creek Mine. The road remaining from this project also provides access the Forest Kerr Hydroelectric project.
Granduc Mine (closed; 1,195 masl)	The Granduc Mine is a closed, underground copper mine 40 km south of the KSM Project at 1,195 masl. Much of the town of Stewart was built for the development of the Granduc Mine. Construction of the Granduc Mine began in 1964 and was completed in 1970. The mine operated until 1978. It was re-opened in 1980 and closed in 1984. The proposed Temporary Frank Mackie Glacier access route will start from near the former Granduc mill site, about 30 km from the proposed KSM Project. The Granduc Copper Mine property has been acquired by Castle Resources, which is seeking to explore and redevelop the mine as the Granduc Copper Mine (see future projects). There is a 50 km access road from the Port of Stewart that is closed during the winter season, but is used as an access route for continued exploration in the area.
Johnny Mountain Mine (1,250 masl)	The Johnny Mountain Mine is a closed, underground mine located in the Iskut River watershed about 50 km northwest of the Eskay Creek Mine road, and about 70 km northeast from the proposed KSM Project. The project site is at an elevation of 1,250 masl. The Johnny Mountain Mine began operation in 1988 and closed in 1990. Skyline Gold re-opened the mine for a limited, 2-month production run in 1993. The property still offers exploration potential. There is no road access to this site, as it was fly-in, fly-out only; however, a road connects this site to the Bronson airstrip at the Snip Mine as an alternative access route.
Kitsault Mine (Past producing; 605 masl)	The Kitsault Mine is a closed, open-pit mine located about 135 km south of the proposed KSM Project. The footprint of this mine spans an elevation range from 435 to 935 masl. Between January 1968 and April 1972, approximately 9.3 million tonnes of ore were produced with about 22.9 million pounds of molybdenum recovered. Reclamation of the mine was completed in 2006. The access road built for this project is open to the public during the summer, but is not currently plowed during the winter. The mine is in the permitting process in 2012/2013 to re-open the mine (see future projects). The existing access road will be used for re-opening of the mine, as existing roads to the project do not require significant upgrades.
Snip Mine (305 masl)	The Snip Mine is a closed, underground mine located in the Iskut River watershed about 50 km northwest of the Eskay Creek Mine, at 305 masl in elevation. The Snip Mine operated between January 1991 and June 1999, first by Cominco Ltd. and then, beginning in 1996, by Homestake Canada Inc. The mine was successfully closed and reclaimed in 1999. Like the Johnny Mountain Mine, it is located in the Bronson Slope area and the property still offers exploration potential. There is no road access to this site, as it was fly-in, fly-out only.

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Table 18.9-11. Summary Descriptions of Each Project with at Least One Spatial Linkage to at Least One Wildlife VC (continued)

Project Name and Elevation	Existing Project Descriptions (Summarized from Chapter 5)
Sulphurets Project (1,680 masl)	The Sulphurets Project is a closed, advanced, underground mining exploration project near Brucejack Lake. It was located approximately 30 km to the southwest of the proposed KSM Project, at an elevation of 1,615 masl. Newhawk Gold Mines Ltd. excavated the underground workings between 1986 and 1990 as part of an advanced exploration and bulk sampling program. Construction of the underground workings generated approximately 124,000 tonnes of waste rock. The waste rock was placed as a shallow pad along the southern boundary of Brucejack Creek and was used as the foundation for the camp and other facilities. The operation never went into production and in 1996 the Sulphurets Project property was placed on care and maintenance. Development plans for the mine were indefinitely suspended and Newhawk Gold Mines Ltd. decided to fully reclaim the property in 1998. The project did require the development of an access road, but this original access route to this mine is no longer used. Instead, Pretium Resources Inc. (proponent of the Brucejack Mine) is rehabilitating an old access road along the Bowser River and up the Knipple Glacier, and are building a new access road along Scott Creek from Highway 37.
Swamp Point Aggregate Mine (60 masl)	The Swamp Point Aggregate Mine was an aggregate (sand and gravel) pit and ship-loading facility on the Portland Canal at an elevation of 60 masl. The project was approximately 50 km south of Stewart, BC, and 115 km southeast of the proposed KSM Project. Ascot Resources Ltd. began site development in 2006, with plans to export sand and gravel to west coast North American markets by ships and barges. The first shipment began in April 2007, while construction continued. The project was planned to run for 18 years, with a maximum production capacity of 3.3 million tonnes per year. In 2008, Ascot Resources Ltd. suspended construction due to the economic downturn. The project was closed in 2011, and most infrastructure removed. There was no road access created to this site.
Forest Kerr Hydroelectric (245-340 masl)	The Forrest Kerr Hydroelectric Power Project comprises a proposed 195 MW run-of-river hydroelectric power facility and 188 km transmission line located on the Iskut River near the confluence of Forrest Kerr Creek, approximately 30 km northwest of the proposed KSM Project. The project elevation ranges from 245 to 340 masl. Project construction began in 2011 and the project is expected to become operational in 2014. The project life will be 60 years. Approximately 29 ha of land will be cleared to accommodate a plant site and project facilities. A 37.3 km transmission line, with a right-of-way clearance of 68 m, will run from the plant site, along the new 8-km access road and the Eskay Creek Mine road to Highway 37 at Bob Quinn.
NTL (305-1,070 masl)	The NTL will be a 344 km, 287 kV power transmission line. The line will follow Highway 37 between the Skeena Substation at Terrace and a new substation near Bob Quinn Lake and thus will pass near the junction of Treaty Creek access road with Highway 37. The NTL will span a range of elevations, from 305 masl to 1,070 masl. Construction began in January 2012 and the transmission line is expected to be operational in 2014, which will potentially make mining, power, and other projects in the region surrounding Bob Quinn (including the KSM Project) more economically feasible.
Long Lake Hydroelectric Project (45-1,075 masl)	Long Lake comprises a 31 MW hydroelectric power project and 10 km transmission line located on Cascade Creek, approximately 17 km north of Stewart, BC. This project includes the re-development of a 20-m high rockfill dam at the head of Long Lake, and a new 10 km, 138 kV transmission line. The project will span a range of elevations from 45 to 1,075 masl. Construction of this project began in the spring of 2010 and is expected to be operational by the end of 2012, with a project lifespan of 80 years.

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Table 18.9-11. Summary Descriptions of Each Project with at Least One Spatial Linkage to at Least One Wildlife VC (continued)

Project Name and Elevation	Existing Project Descriptions (Summarized from Chapter 5)
Bear River Gravel Project (60-395 masl)	Bear River Gravel is a gravel extraction project located in Stewart, BC, at the mouth of the salmon-bearing Bear River, 65 km from the KSM Project. The project spans an elevation range of 60 to 395 masl. Extraction of 2 million tonnes per year of gravel from the lower Bear River is expected in the first year of Project operation, with the potential to extract 3.8 million tonnes per year for the first five years. Two years of initial construction, anticipated to begin in 2018, will precede production. Construction will continue through the first few years of operation, until the project reaches full production capacity. During operation, predicted to run for 25 years, the project will ship material from the deep sea Port of Stewart to Pacific Rim markets.
Bronson Slope Project (120-855 masl), and road (120-520 masl)	The Bronson Slope gold deposit is located approximately 30 km west of the Eskay Creek Mine road. The project footprint spans from 120 to 855 masl, while the access road spans 120 to 520 masl. The proposed project includes an open pit mine, concentrator plant, tailing storage locations, an access road, and a transmission line that connects to the BC grid. The expected project lifespan is 20 years. Given that the project is still early in the planning process, it is assumed that its construction will not begin until the KSM Project is operational in 2018. It is also assumed that traffic from Bronson Slope Mine will be travelling to Stewart along the Eskay Creek Mine road, Highway 37, and Highway 37A.
Brucejack Mine (420-840 masl) and road (400-1,020 masl)	The Brucejack Mine is located immediately east of the KSM Project Mine Site. This project will begin construction in 2014 and will be operational by 2016. The project footprint spans 420 to 840 masl, while the road spans 400 to 1,020 masl. The mine lifespan is expected to be 24 years. The project includes underground mining operations at two deposits, two process plants, a tailing storage facility, and a 70 km road extending along the Bowser River and up the Knipple Glacier. A new access road from Highway 37 is also being constructed along Scott Creek, and the road works are expected to be completed in late 2012.
Granduc Copper Project (future project; 835-1,675 masl)	In 2011, Castle Resources rehabilitated the 17-km long tunnel from the previous Granduc Mine and plans to rehabilitate specific levels of the underground mine to establish underground drill stations for exploration. Castle Resources plans to initiate construction in 2015, provided that they receive an EA Certificate. For the purposes of the CEA, it is expected that construction will take two years and that the mine would be operational for 10 years.
Galore Creek Project (640-2,180 masl) and road (430-1,190 masl)	The Galore Creek Project is a copper-gold-silver open-pit mine 90 km northwest of the proposed KSM Project. The project footprint spans 640 to 2,180 masl, while the road spans 430 to 1,190 masl. The project received an EA Certificate in 2007 and construction of an access road from Highway 37 to the Galore Creek mill site began in mid-2007. Approximately 48 km of the road was completed when the project was halted later in 2007. In 2011, studies on construction and production costs were completed. The project was redesigned, decreasing the footprint in the Galore Creek Valley and increasing the footprint in the More Valley, which increased production to a 95,000 tpd capacity. The new project description has mining and waste rock facilities in the Galore Creek Valley, and plant and tailing facilities in the adjacent West More Valley. A 13.6 km tunnel would be used for conveying ore and equipment between the two facilities. A 71 km pipeline would transfer concentrate from the proposed mill site in the West More Valley to a filter plant and concentrate truck-loading facility near Highway 37. From the filter plant, the concentrate would be transported by truck to a port facility in Stewart.

(continued)

Table 18.9-11. Summary Descriptions of Each Project with at Least One Spatial Linkage to at Least One Wildlife VC (continued)

Project Name and Elevation	Existing Project Descriptions (Summarized from Chapter 5)
Kitsault Project (435-935 masl)	Re-opening of the past-producing Kitsault open pit molybdenum mine, located about 135 km south of the KSM Project, is proposed by Avanti Kitsault Mining Inc. The elevation of the project footprint is 605 masl. Avanti submitted an Application for an Environmental Assessment Certificate on April 30, 2012, which is currently under review. The project will be an open pit operation that will utilize existing access roads and power lines, as well as an existing and permitted barge docking facility, to bring in materials and equipment during construction. Molybdenum concentrates will be trucked to the Port of Vancouver. For this assessment it is assumed that Avanti will begin the 25-month construction phase in 2013, with commissioning of the project in 2015.
Arctos Anthracite Coal Project (640-1,280 masl; Coal Transport Route)	The Arctos Anthracite Coal Project (formerly Mt. Klappan Coal Project) is a proposed open pit anthracite coal mine. Only the rail, trucking, and shipping options from the Arctos Anthracite Coal Project overlap with the CEA Area for grizzly and black bears. The project entered the EA process in 2004 for an anticipated production of up to 1.5 million tonnes of clean coal per year. Plans included trucking coal and haul product to the Port of Stewart along a proposed new access route. In 2010, Fortune Minerals announced the development of a railway transportation option for hauling product from the mine site to the Ridley Coal Terminal in Prince Rupert and completed updates to a technical study that proposed the project capacity was increased to 3 million tonnes per year. For the purposes of the CEA, it is assumed that the project will have a two-year construction phase beginning in 2015.
Schaft Creek Mine (795-1,770 masl) and road (730-1,040 masl)	The proposed Schaft Creek Mine is located 80 km southwest of Telegraph Creek and approximately 76 km west of Highway 37. The mineral claims of interest are situated near upper Schaft Creek, a tributary of Mess Creek, which flows into the Stikine River downstream of the community of Telegraph Creek. The project footprint spans from 795 to 1,770 masl, while the road spans 730 to 1,040 masl. The project is in the pre-application stage of the BC Environmental Assessment Office process that was launched in 2006. It is assumed that power will be supplied by the provincial electrical grid through a transmission line from Highway 37 near Bob Quinn, along the selected access route. Copper Fox expects to complete the EA process by the end of 2013. For the purposes of the KSM Project CEA, it is assumed that the three-year construction phase will begin in mid-2014 and finish in 2017, and that the project will operate for 15 years.
Snowfield Project (1,140-2,020 masl) and road (400-1,460 masl)	The Snowfield Project property is adjacent to the KSM Project such that it may be influenced by KSM Project access plans. The Snowfield Project footprint spans 1,140 to 2,020 masl, with the road spanning between 400 and 1,460 masl. This project has not yet entered the BC Environmental Assessment Office process, but is included in the CEA because of its proximity and likely temporal overlap with the KSM Project. While the Snowfield Project is still in the very early planning stages, it is anticipated that construction will not begin until the KSM Project is operational in 2018, with an expected project lifespan of 27 years. The project footprint includes a pit and crusher, and a conveyor that will transport ore through a tunnel to a processing plant and tailing facility in the Scott Creek watershed. A separate access road from Highway 37 to the process plant is proposed.
Treaty Creek Hydroelectric (520 masl: Northern, 820 masl: Middle, 960 masl: Southern)	The Treaty Creek Hydroelectric Project is proposed to the immediate southwest of the proposed KSM Project TMF. The three sites comprising the Treaty Creek Hydroelectric Project range from 520 to 960 masl. The project is expected to be small-scale and will involve the use of run-of-river technology. Treaty Creek Hydroelectric is still in the very early planning stages and is considered in the CEA because of its proximity and likely temporal overlap with the KSM Project.

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Table 18.9-11. Summary Descriptions of Each Project with at Least One Spatial Linkage to at Least One Wildlife VC (completed)

Project Name and Elevation	Existing Project Descriptions (Summarized from Chapter 5)
Land Use Activities	The following land use activities occur within the grizzly bear population unit boundaries (CEA Area): • mineral and energy exploration: - Big Bulk (1,340 masl), - Premier (1,615 masl), - Mount Dunn (1,355 masl), - Rock and Roll (120 masl), - Trek (1,465 masl), - Treaty Creek (1,500 masl), - Red Cliff (260 masl), - Homestake Ridge (765 masl) • fishing; • guide outfitting; • resident and Aboriginal hunting; • recreation and tourism; • timber harvest; and • traffic and roads. Details on these activities are described in Chapter 5 and in the Land Use Environmental Setting (Section 23.1).

- There must be a residual environmental effect of the Project being assessed (all residual effects of the KSM Project are shown in Table 18.9-1).
- Residual environmental effect from the KSM Project must operate cumulatively with the residual environmental effects from other projects and activities.
- Other projects or activities must have been, are being, or are likely to be, carried out (i.e., not hypothetical).
- The cumulative environmental effect must be likely to occur.

The significance of each residual cumulative effect was determined based on effects criteria (see Chapter 5) and existing threshold or land use objectives for each wildlife VC. Theoretically, if the combined effects of all actions within a region do not exceed a certain threshold, the cumulative effects are considered acceptable (not significant). A CEA-adjusted significance rating is generated, and CEA-related adjustments to existing mitigation methods, if required, are suggested.

Thresholds are generally defined as “points where even small changes in environmental conditions will lead to large changes in system state variables” (Hobbs and Suding 2009). Ecological thresholds and/or performance standards are associated with:

- provincial and federal recovery goals identified in recovery plans and management strategies;
- landscape unit objectives (i.e., WHA/UWR targets and thresholds); and/or
- other scientific research.

For some VCs, the CEA may be hindered by a lack of such thresholds or key indicators (FSB 2011). In the absence of defined thresholds, one of the following was done:

1. An appropriate threshold or limit of acceptable change or of concern was suggested.
2. If it is acknowledged that there is no established threshold, the residual effect and its significance is reported based on a qualitative assessment.

In most cases, option 1 was used in this wildlife CEA where an appropriate, defensible threshold exists and option 2 is used in all other cases.

The significance determination also includes a discussion of the confidence in the predictions, which is based on three factors: 1) effects assessment certainty, 2) mitigation effectiveness certainty, and 3) professional judgment based on relevant past experience. Of these three factors, effects assessment certainty is the most important in the assessment of significance. This factor reflects the scientific data available in estimating the effect, typically in the quantification of the effect considering the quality and quantity of data (i.e., are the data appropriate and sufficient?), and the understanding of the effects mechanisms (i.e., is the ecological production system sufficiently understood to allow confident assessment). Significance is evaluated qualitatively by the level of confidence in these three factors. The criteria used to determine significance and confidence in the CEA are provided in Chapter 5.

18.9.1.4 Identification of Mitigation Measures for Cumulative Effects

Mitigation measures to minimize cumulative effects are not necessarily the same as those that are designed to minimize Project effects (Hegmann et al. 1999). Mitigating a local effect as much as possible is the best way to reduce Project residual effects, which in turn reduces cumulative effects. Measures specifically designed to reduce identified cumulative effects require coordination with regional stakeholders led by the government to implement initiatives that involve mitigation of developments unrelated to the Project and Proponent (FSB 2011). Such regionally based mitigation initiatives are beyond the scope of this CEA; however, where possible, measures are suggested for mitigating cumulative effects.

The Proponent will consider participating in regional monitoring programs by contributing to regionally based monitoring initiatives where those monitoring initiatives replace proposed KSM Project-specific monitoring (Section 26.21.3), and these monitoring activities are approved by relevant provincial authorities and stakeholders. It is an assumption of this CEA that the BC government will play a coordinating and managing role in the ongoing meta-analysis of monitoring data from multiple proponents over time, and that they will act in accordance with those data to trigger adaptive management to protect these VCs at larger regional scales when cumulative effects approach threshold levels (e.g., thresholds that, when reached, trigger the potential for a population to decline).

18.9.2 Cumulative Effects Assessment for Moose

The provincial population estimate for moose in 2000 was approximately 170,000 animals, 70% of which live in northern BC (Blood 2000a). Moose populations in BC are apparently secure and not susceptible to extirpation or extinction under present conditions (BC CDC 2012).

However, maintaining stable numbers of local moose is important to the culture and economy of local communities, First Nations, and Nisga'a Nation, as moose are culturally significant and are highly valued as a hunted animal in the CEA and Movement Areas (Figure 18.9-1). Moose are identified as an important species requiring management consideration by the Nass South SRMP (BC MFLNRO 2012b) and Cassiar Iskut-Stikine LRMP (BC ILMB 2000).

The Nass moose population to the south of the CEA Area has been declining since the early 2000s (M. W. Demarchi 2011). Approximately 71% of moose in the NWA are migratory, with bulls and cows moving considerable distances (approximately 15 km) between seasonal ranges, compared to distances of approximately 6 km moved by non-migratory moose (M. W. Demarchi 2000). Migratory behaviour is learned, and migratory networks are maintained (Bowyer, Ballenberghe, and Kie 2003).

Table 18.9-12 summarizes the projects and activities that have the potential to have residual cumulative effects on moose due to spatial and temporal overlap with the KSM Project.

18.9.2.1 Project-specific Residual Effects on Moose that Are Not Likely to Result in Cumulative Effects

The effect of chemical hazards on moose is the only residual effect identified for moose due to the KSM Project that will not result in cumulative effects. This effect is considered in the moose Movement Area (Figure 18.9-1). The two projects that have a possible interaction with the KSM Project for chemical hazards are Eskay Creek Mine and Brucejack Mine (Table 18.9-12). Water quality from the Brucejack Mine will not exceed guidelines (Rescan 2013) and is therefore not considered to interact with the KSM Project. The Eskay Creek Mine is considered in the baseline water quality data used for the KSM Project due to its proximity to the Project and spatial overlap with discharge into the Unuk River; therefore, the effects from Eskay Creek Mine are considered in Section 18.7.7 and are not further assessed in the CEA.

At least one project or activity will interact with the remaining four residual effects on moose identified for the KSM Project. Therefore, the cumulative effects assessment is conducted for the following four potential cumulative effects on moose:

1. habitat loss and alteration;
2. disruption to movement;
3. direct mortality; and
4. indirect mortality.

18.9.2.2 Cumulative Effect of Habitat Loss and Alteration on Moose

The KSM Project Application/EIS predicted a low-magnitude residual effect of habitat loss and alteration on moose that was not significant (minor) with mitigation (Section 18.8.2.1). Approximately 6.8% of the high-quality moose habitat within the RSA boundary was estimated to be lost or altered as a result of the TMF, Treaty Process Plant, and TCAR. This residual effect is brought forward into the CEA, which considers all sources of likely residual habitat loss due to relevant projects (Table 18.9-12) that could impact moose populations within and surrounding the KSM Project (Figure 18.9-1). As winter habitat limits the carrying capacity for moose (Cederlund and Okarma 1988), loss of winter habitat is the focus of this section of the CEA.

Table 18.9-12. Summary of Projects and Activities with Potential to Interact Cumulatively with Expected Project-specific Residual Effects on Moose

[illegible][illegible][illegible]

To determine the potential impacts of habitat loss on moose, all relevant past, present, and future projects for this VC (Table 18.9-12) were quantified within the CEA and Movement Areas. Following the precautionary principle, the calculated loss and alteration represent a worst-case scenario that assumes that all projects will occur (which is unlikely) and that all habitat loss due to projects is incurred simultaneously. Information that could not be obtained included the amounts of habitat altered or lost due to past projects, future mineral and hydroelectric exploration projects, and due to the majority of new roads. Therefore, linear road density (km/km²) was used as a proxy for habitat loss due to roads.

Due to some overlaps between project footprints, overlapping areas were counted only once. The total habitat loss values were calculated by sector (i.e., forestry, mining, hydroelectric) and by BEC unit where possible. Both the moose CEA and Movement Areas were examined for overlap with any proposed UWRs for moose. Habitat loss and alteration due to the KSM Project is presented both separately to allow for the comparison to the overall cumulative habitat loss and alteration from all projects, and within the total for mining projects.

Within the CEA and Movement Areas, not all of the area is suitable for moose. To evaluate the loss of moose habitat, the areas of relevant projects were summarized by BEC unit. This approach was used because formal habitat suitability mapping does not exist for the entire CEA and Movement Areas. Winter surveys for moose and habitat suitability modelling indicate that most moose use ICH vc, CWH wm, MH un, and ESSF wv BEC zones during the critical winter season ([Appendix 18-A](#) and [18-B](#)); Therefore, the amount of habitat lost or altered for moose is reported for these four BEC units.

The moose CEA Area is 3,404,146 ha; of this area, 1,262,570 ha are within high-quality moose winter habitat (i.e., ICH vc, CWH wm, MH un, and ESSF wv BEC zones). Within the CEA Area, 34,475 ha of high-quality moose winter habitat (1% of the entire CEA Area; 2.7% of available high-quality habitat in the CEA Area) are expected to be lost or altered with all projects considered, including the KSM Project. Of the high-quality habitat lost in the CEA Area, most is due to forest harvesting (71.6%), followed by mining (24.8%) and hydroelectricity projects (3.6%; Table 18.9-13).

Within the smaller Movement Area (maximum home range of a single moose), there are 330,439 ha of habitat available, 163,703 ha of which are considered high-quality winter habitat for moose (i.e., ICH vc, CWH wm, MH un, and ESSF wv BEC zones). Within the Movement Area, 17,302 ha of high-quality moose winter habitat (5% of the entire Movement Area; 11% of available high-quality habitat in the Movement Area) will be lost or altered (Table 18.9-13). Of the high-quality habitat lost in the Movement Area, most is due to forest harvesting (70%), followed by mining (28%), and hydroelectricity projects (2%).

While forest harvesting contributes to most of the habitat loss at both scales, this may not be permanent if forestry rotation allows for no net reduction in important habitat (i.e., early or late winter habitat) over time. Thus, this area lost due to forestry may be temporary. Excluding forestry from the calculations, 0.8% (9,799 ha) of the CEA Area and 3.2% (5,243 ha) of the Movement Area will be lost or altered.

Table 18.9-13. Summary of Moose Winter Habitat Loss and Alteration¹ due to all Projects in the CEA Area and Movement Area

Sector	CEA Area High-quality Moose Habitat (1,262,570 ha) ²			Movement Area High-quality Moose Habitat (163,703) ²		
	Habitat Lost/Altered (ha)	Habitat Lost/Altered (% of Habitat in CEA Area)	Habitat Lost/Altered (% of Lost Habitat due to each Sector)	Habitat Lost/Altered (ha)	Habitat Lost/Altered (% of Habitat in CEA Area)	Habitat Lost/Altered (% of Lost Habitat due to each Sector)
Mining Projects ³	8,570	0.7	24.8	4,842	3.0	28
Hydroelectric Projects	1,229	0.1	3.6	401	0.2	2
Forestry	24,677	1.9	71.6	12,058	7.4	70
KSM Project	2,765	0.2	8.0	2,765	1.7	16
Total	34,476	2.7		17,302	10.6	

¹Only suitable habitat in the ICH vc, CWH wm, MH un, and ESSF vv BEC zones are considered in calculations for habitat loss and alteration for moose.

²This is the amount of available high-quality habitat in the CEA and Movement Areas; see text for definition of high-quality habitat.

³Includes KSM Project in calculations.

In summary, when habitat loss and alteration from the high-quality winter habitat BEC units only are considered, 2.7% (0.8% excluding forestry) and 10.6% (3.2% excluding forestry) of available winter habitat BEC units from the CEA and Movement Areas, respectively, were estimated to be lost or altered. The KSM Project will contribute 2,765 ha of the total lost or altered habitat (see Section 18.7.1.3), accounting for 0.2% of the habitat within the CEA Area and 1.7% of the habitat within the Movement Area.

Road density can also result in alteration of habitat use by moose. A road density value of 0.6 km/km² has been suggested as a threshold, above which populations of many large vertebrate species are affected (Forman et al. 2007). Therefore, this threshold was applied to evaluating the impact of increasing road density on habitat. An increase in road density of 10.9% (from 0.07 km/km² at present to 0.089 km/km² in the future) was predicted in the CEA Area, remaining below the threshold value of 0.6 km/km². An increase in road density of 65.2% (from 0.02 to 0.095 km/km²) was predicted in the Movement Area, also remaining below the threshold value of 0.6 km/km². The KSM Project will create 68 km of new road in two sections: the CCAR (35 km) and TCAR (33 km). Despite increases in road density, density values are well below the threshold value. The potential effects of roads are considered in greater detail in the disruption of movement (Section 18.9.2.3), direct mortality (Section 18.9.2.4), and indirect mortality (Section 18.9.2.5) sections.

18.9.2.2.1 Other Project/Activity Mitigations to Address Habitat Loss and Alteration

The Proponent will consider participating in regional monitoring programs by contributing to regionally based monitoring initiatives where those monitoring initiatives replace proposed KSM Project-specific monitoring (Section 26.21.3), and these monitoring activities are approved by relevant provincial authorities and stakeholders (see Section 18.9.1.4).

Other projects contributing to habitat loss and alteration for moose are expected to follow relevant Best Management Practices (BMPs), and legislative requirements, and to avoid high-quality moose winter habitat, especially proposed UWR, wherever possible. Avoidance of mineral licks, rutting areas, and wetland foraging sites is also expected to occur wherever possible. In the case that any legally designated moose UWR is removed, compensation to offset the loss is expected. Other proponents are expected to design projects such that they attempt to meet the objectives of the Cassiar Iskut-Stikine LRMP and the Nass South SRMP.

Forest harvesting on the regional scale is expected to follow general provincial forest harvesting principles to maintain functional habitat, including designing and locating cutblocks to provide connectivity of appropriate seral stage forests, and linking moose habitats at the landscape, subregional, and regional scales.

18.9.2.2.2 *Determination of Potential for Residual Cumulative Effect and Significance*

Table 18.9-14 characterizes the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance. The cumulative effect of habitat loss for moose is considered to have a low magnitude, as a relatively low overall proportion of high-quality winter habitat will be lost from the CEA (2.7%) and Movement (10.6%) Areas. The extent of the effect is regional and the duration is far-future, as the habitat will be lost throughout life of the Project and longer. The frequency is sporadic, and the effect is irreversible, as much of the habitat will not be returned to baseline conditions at closure. The context of the population is high, since the moose population is currently declining (M. W. Demarchi 2011). There is a medium probability of the effect occurring and confidence is medium. The cumulative effect of habitat loss for moose is assessed as **not significant (moderate)**.

18.9.2.3 *Cumulative Effect of Disruption of Movement on Moose*

The KSM Project Application/EIS (Section 18.8) predicted a low-magnitude residual effect of disruption of movement for moose that was not significant (minor) with mitigation. The KSM Project will require infrastructure along Treaty Creek (the TCAR), the TMF valley (the PTMA), and increased traffic along the TCAR and existing roads (e.g., Highway 37 and 37A). These roads were evaluated for the potential to act as a barrier to movement for moose. To determine the potential cumulative effects of disruption of movement for moose, projects potentially causing disruption of moose movement (Table 18.9-12) were considered within the CEA and Movement Areas (Figure 18.9-1).

Roads and road traffic are the most likely aspects of industrial activity that could influence movement of moose in the CEA Area. 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 (greater than 416 VPH) are impermeable to most species. These traffic rates were used as thresholds to evaluate impacts of cumulative vehicle traffic on moose.

All of Highway 37 and 37A within the CEA and Movement Areas were estimated to have hourly vehicular traffic rates below the traffic value of 42 VPH (see Table 18.9-21), 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 south of the TCAR (see Table 18.9-21; Figure 18.9-7). 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. Other roads that will be used for the KSM Project (CCAR, TCAR, and Eskay Creek Mine road) are predicted to be below this threshold, and will not cause disruption to movement of moose.

Moose may also avoid moving through habitat abutting project footprints due to noise or other disturbances (Johnson et al. 2005; Laurian et al. 2008; Stankowich 2008). Movement of moose may also be reduced or impeded where snowbanks and/or earthberms have been created along road edges or within clearings that minimize crossing potential. Earth berms and snowbank heights of 60 to 90 cm along road verges may inhibit road crossing, or the ability of moose to clear the road to get out of the way of oncoming traffic (Peek et al. 1982).

18.9.2.3.1 Other Project/Activity Mitigations to Address Disruption of Movement for Moose

The Proponent will consider participating in regional monitoring programs by contributing to regionally based monitoring initiatives where those monitoring initiatives replace proposed KSM Project-specific monitoring (Section 26.21.3), and these monitoring activities are approved by relevant provincial authorities and stakeholders (see Section 18.9.1.4).

It is expected that other proponents will try to minimize their traffic volumes and will follow all relevant acts, regulations, and BMPs for the activities that they carry out. It is also expected that proponents will avoid placing infrastructure across or within moose travel networks where this can be avoided. Where winter use of roads is required and snow clearing activity is going to occur, it is assumed that gaps in snowbanks will be created at frequent intervals to allow moose to cross and clear roads. Other proponents are also expected to attempt to design projects such that they meet the objectives of the Cassiar Iskut-Stikine LRMP and the Nass South SRMP.

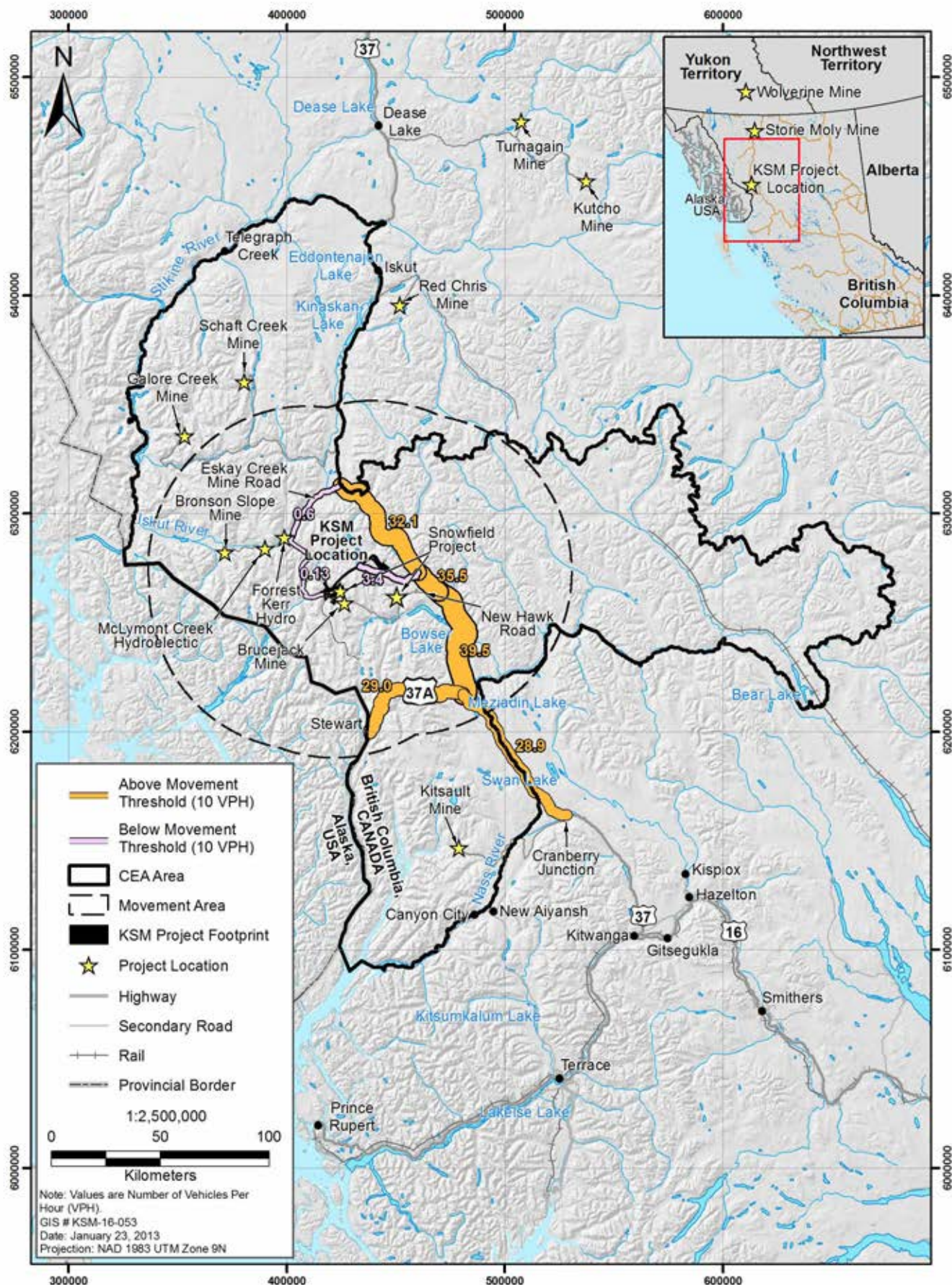
18.9.2.3.2 Determination of Potential for Residual Cumulative Effect and Significance

Table 18.9-14 characterizes the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance for the effect of disruption of movement on moose. Moose movement is not expected to be disrupted due to traffic rates predicted in this assessment, and effects due to snowbanks and roadside berms can be mitigated. This effect is considered to have a low magnitude. The extent of the effect is regional, and the duration is expected to extend into the far future, as traffic will be added during the life of the Project and longer. The frequency is sporadic, and the effect is reversible, as traffic rates could decrease at closure or through traffic restrictions. The context of the moose population is considered to be high. The probability of the effect is medium and the confidence is medium. The cumulative effect of disruption of movement for moose is assessed as **not significant (minor)**.

Table 18.9-14. Summary of Cumulative Residual Effects on Moose

Description of Residual Effect	Project Component(s)	Timing of Effect	Magnitude	Magnitude Adjusted for CE	Extent	Extent Adjusted for CE	Duration	Duration Adjusted for CE	Frequency	Frequency Adjusted for CE	Reversibility	Reversibility Adjusted for CE	Context	Context Adjusted for CE	Likelihood of Effects				Significance	Significance Adjusted for CE	Follow up Monitoring	Follow up Monitoring Adjusted by CE
															Probability	Probability Adjusted by CE	Confidence Level	Confidence Adjusted by CE				
Habitat Loss	All	Construction	Low	Low	Local	Regional	Far future	Far future	Sporadic	Sporadic	Irreversible	Irreversible	High	High	High	Medium	High	Medium	Not Significant (Minor)	Not Significant (Moderate)	Required	Not Required
Disruption of Movement	TMF, TCAR	Construction	Low	Low	Landscape	Regional	Far future	Far future	Sporadic	Sporadic	Reversible long-term	Reversible long-term	High	High	Medium	Medium	Low	Medium	Not Significant (Minor)	Not Significant (Minor)	Required	Not Required
Direct Mortality	TCAR, CCAR	Construction	Low	Medium	Landscape	Regional	Far future	Far future	Sporadic	Sporadic	Reversible long-term	Reversible long-term	High	High	Medium	Medium	Low	Medium	Not Significant (Minor)	Not Significant (Moderate)	Required	Not Required
Indirect Mortality	TCAR, CCAR	Construction	Low	Low	Landscape	Regional	Far future	Far future	Sporadic	Sporadic	Reversible long-term	Reversible long-term	High	High	Medium	Medium	Low	Medium	Not Significant (Minor)	Not Significant (Minor)	Required	Not Required
Chemical Hazards	TMF	Post-closure	Low	N/A	Local	N/A	Far future	N/A	Regular	N/A	Reversible long-term	N/A	High	N/A	Medium	N/A	Medium	N/A	Not Significant (Minor)	N/A	Required	N/A
Overall Effect - Likely Development Scenario	All	Construction	Medium	Medium	Landscape	Regional	Far future	Far future	Sporadic	Regular	Reversible long-term	Reversible long-term	High	High	Medium	Medium	Medium	Medium	Not Significant (Moderate)	Not Significant (Moderate)	Not Required	Not Required
Overall Effect - Unlikely Development Scenario	All	Construction	N/A	Medium	N/A	Regional	N/A	Far future	N/A	Regular	N/A	Reversible long-term	N/A	High	N/A	Low	N/A	Low	N/A	Significant (Major)	N/A	Not Required

CE = Cumulative Effect



Summary of Projected Traffic Rates (vehicles/hour) by Road and Sections Predicted to Impede Grizzly Bear Movement

Figure 18.9-7

18.9.2.4 Cumulative Effect of Direct Mortality on Moose

The KSM Project Application/EIS (Section 18.8.2.3), predicted a low-magnitude effect and was predicted to be not significant (minor) with mitigation. Direct mortality was still considered a potential residual effect to be carried forward into the CEA.

In most areas of North America, the largest source of direct mortality of moose is moose/vehicle collisions (MVCs). Increased traffic in the moose CEA Area was evaluated for the potential to increase MVCs and thereby direct moose mortality. MVCs occur throughout the species range and are highlighted as an issue from both wildlife management and traffic safety perspectives (Sielecki 2004; R. V. Rea et al. 2006). Along highways in the Bulkley-Stikine District (District 10, which includes highways 16, 35, 37, 37A, and 118, and is approximately 201,700 km² in size), moose were the most commonly recorded road accident between 1988 and 2007 (1,022 moose collisions), representing 38% of all wildlife collisions, and an average of 51 moose/year (Sielecki 2010).

MVCs in northern BC are more frequent in winter (December and January), coinciding with times of highest snowfall. Moose often select roads as travel corridors during periods of high snowfall, as they provide ease of movement (Sielecki 2004, 2010). Moose that hear vehicles approaching may run along the road until the snowbank is sufficiently shallow (less than 90 cm; Peek et al. 1982) to exit the road. Running for extended periods may leave moose exhausted, susceptible to predation, and/or contribute to a loss in body fat that is crucial to winter survival.

Due to the social, cultural, and economic importance of moose in the region, their sensitivity to MVCs, 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 CEA analysis was conducted using data from the area south of the CEA Area boundary and applied to the entire CEA Area, as moose population data were only available for the 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 Highway 37 and 37A road corridor (Appendix D in [Appendix 22-C](#)). The moose population in the NWA is declining, potentially due to overharvesting (Appendix D in [Appendix 22-C](#)), as there were an estimated 1,595 animals in 2001, 638 animals in 2004, and 517 animals in 2011 (M. W. Demarchi 2011). Although the majority of this area is south of the CEA Area boundary, the PVA is used for this cumulative effects assessment to represent the cumulative effects of traffic on moose in the CEA Area.

The Traffic Study (See [Appendix 20-C](#)) examined the current MVC risk, as well as the risk when the KSM Project is added, for moose along Highway 37 and 37A. This report relied heavily on data from the BC Wildlife Accident Reporting System (WARS; Sielecki 2010), coupled with historical traffic data collected from 1985 to 2001 along these highways. As part of the Traffic Study, a PVA was conducted to quantitatively evaluate the potential effects of the KSM Project traffic and all other proposed projects that will add traffic to Highway 37 and 37A, on the moose population in the NWA (Appendix D in [Appendix 22-C](#)).

The PVA predicted that the increased traffic from the KSM Project would not cause a decline in the Nass moose population (Appendix D in [Appendix 22-C](#)). However, results suggested that an additional increase in mortality of as little as 1% more than the increase predicted due to the KSM Project from MVCs could cause the population to decline. Hence, assuming conditions remain constant (much-reduced moose population, current hunting rates, etc.), if all projects in the moose CEA Area were to operate simultaneously, the PVA predicted that MVCs from these projects may be sufficient to have an effect on the moose population in the NWA. The density of moose in the KSM Project RSA is higher (0.55 moose/km² in the interior area of the RSA; [Appendix 18-A](#)) than the density of moose in the NWA (0.14 moose/km²; M. W. Demarchi 2011); therefore, it is predicted that there will be less of an effect of traffic on moose to the north of the NWA.

18.9.2.4.1 *Other Project/Activity Mitigations to Address Direct Mortality of Moose*

The Proponent will consider participating in regional monitoring programs by contributing to regionally based monitoring initiatives where those monitoring initiatives replace proposed KSM Project-specific monitoring (Section 26.21.3), and these monitoring activities are approved by relevant provincial authorities and stakeholders (see Section 18.9.1.4).

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, in particular related to heavy industrial traffic, 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 address all proximal causes contributing to the predicted decline in the moose population. The proponent is willing to participate in a regional initiative with other stakeholders as described.

18.9.2.4.2 *Determination of Potential Residual Cumulative Effect and Significance*

Table 18.9-14 characterizes the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance for the effect for moose. The effect of direct mortality on moose is considered to have a medium magnitude, as cumulative annual rates of mortality could drive moose populations down below levels of natural variation. This is expected to have a high-magnitude effect on the Nass population in the southern portion of the CEA Area; however, because the moose population in the northern portion of the CEA and Movement Areas (north of the declining population boundary) is predicted to be larger in size (density of 0.55 moose/km² in the KSM Project RSA compared to 0.14 moose/km² in the NWA), the overall predicted effect of direct mortality due to MVCs in the CEA Area is expected to have a medium magnitude effect. The extent of the effect is regional. The duration of the effect is expected to extend into the far-future, and the frequency is sporadic. The effect is reversible long-term. The context of the moose population is considered to be high. The probability of the effect occurring is medium and the confidence is medium. The cumulative effect of direct mortality on moose is assessed as **not significant (moderate)** if all projects go through, due to the status of the moose population in the southern portion of the CEA Area.

18.9.2.5 Cumulative Effect of Indirect Mortality on Moose

The KSM Project Application/EIS (Section 18.8) predicted a low-magnitude residual effect of indirect mortality of moose, which was not significant (minor) with mitigation. The potential residual effect for indirect mortality is expected to result from increased access and human use of the area. Any new roads for the KSM Project will be gated and controlled for the life of the Project and through the post-closure phase. Increased access may not be completely avoided or mitigated and is a potential adverse residual effect. This section assesses the overall effect of indirect mortality on moose within the CEA and Movement Areas for moose (Figure 18.9-1).

Increased mortality rates often occur as an unintended consequence of increased access routes into an area. This well-documented phenomenon is due to mortality as a result of increased access to hunters and increased vulnerability of moose due to reduced cover (Timmerman and Gollat 1982; Girard and Joyal 1984; Eason 1989). Road creation in high-quality moose habitat, particularly when roads are cleared in the winter, could also increase predator access into areas occupied by moose. This could, in turn, increase predator-induced mortality of moose.

18.9.2.5.1 Other Project/Activity Mitigations to Address Indirect Mortality

The Proponent will consider participating in regional monitoring programs by contributing to regionally based monitoring initiatives where those monitoring initiatives replace proposed KSM Project-specific monitoring (Section 26.21.3), and these monitoring activities are approved by relevant provincial authorities and stakeholders (see Section 18.9.1.4).

It is expected that all other industrial projects will include similar mitigation measures as adopted by the KSM Project to minimize the impacts of new road creation on indirect mortality rates for moose, and that each project will follow relevant acts, regulations, and BMPs for the activities that they carry out. It is expected that all industry roads would have controlled access, and that only forestry roads would potentially result in increased access.

18.9.2.5.2 Determination of Potential for Residual Cumulative Effect and Significance

Table 18.9-14 characterizes the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance for the effect for moose. This cumulative effect of indirect mortality on moose is considered to have a low magnitude, as the combined effect of increased hunting pressure and increased predator access is predicted to affect moose populations to a greater extent than natural variation, but it is assumed that all industry roads will have controlled access, reducing the effect of increased hunting. The extent of the effect is regional. The duration of the effect is expected to extend into the far-future, the frequency is sporadic, and the effect is reversible long-term. The context of the moose population is considered to be high. The probability of the effect occurring is medium and the confidence is medium. The cumulative effect of indirect mortality on moose is assessed as **not significant (minor)** if all projects go through.

18.9.2.6 Overall Cumulative Effect on Moose

The overall effect on moose is rated based on the knowledge that these individual effects may interact and create additive or synergistic effects that would have a different nature or greater

impact on local populations as a whole, potentially impacting the survival rates and reproductive success of individual animals.

The level of future industrial development along the Highway 37 corridor is uncertain. It is unlikely that all currently proposed mine projects will be developed at the same time. Therefore, two possible future scenarios were evaluated for potential overall cumulative effects on moose, primarily driven by increased mortality from traffic accidents: 1) a “likely development” scenario, with one to three mining projects being concurrently in production, and 2) an “unlikely development” scenario where all or most projects go ahead as planned. The overall cumulative effect under both scenarios is considered to have a medium magnitude, to extend into the far-future, to be regular in frequency, and (largely, but not wholly) reversible in the long-term. The context of the population is high, as moose in the area are declining.

The **likely development scenario** has a medium probability of occurring and a medium confidence, as it is more likely that one to three projects occur, rather than all projects considered in the cumulative effects assessment. The overall cumulative effect on moose under the likely development scenario is **not significant (moderate)**.

The **unlikely development scenario**, in contrast, has a low probability of occurring, as it is unlikely that all projects will occur simultaneously, and the confidence is low due to the difficulty in knowing how many proposed projects will go forward and the precise timing of each project. The overall cumulative effect on the moose population under the unlikely scenario of high development is predicted to result in a **significant (major)** effect due to increased mortality due to traffic accidents. However, this assessment has relatively low certainty because the likelihood of all proposed projects occurring simultaneously is low and the model structure is posited to cause it to be overly sensitive to small reductions in survival.

18.9.3 Cumulative Effects Assessment for Mountain Goats

The total number of mountain goats in BC was estimated at 50,000 individuals in 2000 (Blood 2000b; Côté and Festa-Bianchet 2003), of which 16,000 to 35,000 occur within the Skeena Region (BC MFLNRO 2012b). Mountain goats are apparently secure in BC, due to their abundance and large range of habitat occupancy, but are considered Regionally Important Wildlife under the provincial *Wildlife Act* (1996c), whereby harvest activities are only permitted with hunting licences.

Mountain goats maintain separate seasonal habitats and move between and within these habitats, which are typically infrequent and short in distance (Côté and Festa-Bianchet 2003). Longer movements do occur, however, when mountain goats move between isolated patches of suitable habitat or travel to mineral licks (Côté and Festa-Bianchet 2003). Summer habitats tend to be vegetated areas near escape terrain and above the treeline on south- and west-facing slopes. Winter habitats tend to be similar, but downslope and below the treeline. The winter season is the most important for survival of mountain goats as they are exposed to harsh conditions, nutrition deprivation, and reduced locomotion due to deep snow.

Mountain goats have several life history characteristics that make their populations more susceptible to small demographic changes than other ungulates. They have a low propensity for

dispersal, tend to exist as small, isolated populations, are sensitive to sensory disturbances, and have a limited ability for density dependent responses in reproductive and survival to compensate for population reductions (Toweill et al. 2004).

Table 18.9-15 summarizes the projects and activities that have the potential to have residual cumulative effects on mountain goats due to spatial and temporal overlap with the KSM Project.

18.9.3.1 Project-specific Residual Effects on Mountain Goats that Are Not Likely to Result in Cumulative Effects

The effect of chemical hazards on mountain goats is the only residual effect identified for goats due to the KSM Project that will not result in cumulative effects. This effect is considered in the mountain goat Movement Area (Figure 18.9-2). The one project that has a potential spatial linkage with the KSM Project for chemical hazards is Brucejack Mine (Table 18.9-15), due to dust deposition. However, it is assumed the dust will be deposited north toward the KSM Project Mine Site, already considered in Section 18.7.7; therefore, the effects from Brucejack Mine are considered in Section 18.7.7 and are not further assessed in the CEA.

At least one Project or Activity will interact with the remaining five residual effects on mountain goats identified for the KSM Project. Therefore, the cumulative effects assessment is conducted for the following five potential cumulative effects on goats:

1. habitat loss and alteration;
2. disruption to movement;
3. sensory disturbance;
4. direct mortality; and
5. indirect mortality.

18.9.3.2 Cumulative Effect of Habitat Loss and Alteration on Mountain Goat

The KSM Project Application/EIS (Section 18.8) predicted a medium magnitude residual effect of habitat loss and alteration on mountain goat that was not significant (minor) with mitigation. Approximately 2% (1,703 ha) of the available winter and summer habitat within the RSA will be lost or altered, some of which (238 ha) is within mountain goat UWR u-6-002. This residual effect was brought forward into the CEA, which considers all sources of likely residual habitat loss due to relevant projects (Table 18.9-15) that could impact mountain goat populations within and surrounding the KSM Project (Figure 18.9-2).

To determine the potential effects of habitat loss and alteration due to project footprints on mountain goats, permanent and transient (e.g., forest harvesting) habitat loss due to all relevant projects for this VC were quantified within the mountain goat CEA and Movement Areas (Table 18.9-15; Figure 18.9-2). The calculated loss and alteration represent a worst-case scenario that assumes that the habitat loss and alteration due to all projects is incurred simultaneously. Information that could not be obtained included the amounts of permanent habitat loss and alteration due to past projects, future mineral and hydroelectric exploration projects, and due to a majority of new roads. Therefore, linear road density (km/km^2) was used as a proxy for habitat loss due to roads.

Table 18.9-15. Summary of Projects and Activities with Potential to Interact Cumulatively with Expected Project-specific Residual Effects on Mountain Goats

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities		
	Eskay Creek Mine	Granduc Mine	Johnny Mountain Mine
<i>Habitat Loss</i>	Possible Interaction	Possible Interaction	Possible Interaction
<i>Movement</i>	Possible Interaction	Possible Interaction	No Interaction
<i>Sensory</i>	No Interaction	No Interaction	No Interaction
<i>Direct Mortality</i>	Possible Interaction	Possible Interaction	No Interaction
<i>Indirect Mortality</i>	Possible Interaction	Possible Interaction	No Interaction
<i>Chemical</i>	No Interaction	No Interaction	No Interaction

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities		
	Snip Mine	Sulphurets Project	Forest Kerr Mine
<i>Habitat Loss</i>	Possible Interaction	Possible Interaction	Possible Interaction
<i>Movement</i>	No Interaction	No Interaction	Possible Interaction
<i>Sensory</i>	No Interaction	No Interaction	Possible Interaction
<i>Direct Mortality</i>	No Interaction	No Interaction	Possible Interaction
<i>Indirect Mortality</i>	No Interaction	No Interaction	Possible Interaction
<i>Chemical</i>	No Interaction	No Interaction	No Interaction

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities		
	NTL	Long Lake Hydroelectric	Bronson Slope Mine
<i>Habitat Loss</i>	Possible Interaction	Possible Interaction	Possible Interaction
<i>Movement</i>	Possible Interaction	Possible Interaction	Possible Interaction
<i>Sensory</i>	Possible Interaction	Possible Interaction	Possible Interaction
<i>Direct Mortality</i>	Possible Interaction	Possible Interaction	Possible Interaction
<i>Indirect Mortality</i>	Possible Interaction	Possible Interaction	Possible Interaction
<i>Chemical</i>	No Interaction	No Interaction	No Interaction

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities		
	Brucejack Mine	Galore Creek Mine	Arctos Antrocite Coal Transport
<i>Habitat Loss</i>	Possible Interaction	Possible Interaction	Possible Interaction
<i>Movement</i>	Possible Interaction	Possible Interaction	Possible Interaction
<i>Sensory</i>	Possible Interaction	Possible Interaction	Possible Interaction
<i>Direct Mortality</i>	Possible Interaction	Possible Interaction	Possible Interaction
<i>Indirect Mortality</i>	Possible Interaction	Possible Interaction	Possible Interaction
<i>Chemical</i>	Possible Interaction	No Interaction	No Interaction

(continued)

Table 18.9-15. Summary of Projects and Activities with Potential to Interact Cumulatively with Expected Project-specific Residual Effects on Mountain Goats (completed)

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities		
	Schaft Creek Mine	Snowfield Project	Treaty Creek Hydroelectric Project
<i>Habitat Loss</i>	Possible Interaction	Possible Interaction	Possible Interaction
<i>Movement</i>	Possible Interaction	Possible Interaction	Possible Interaction
<i>Sensory</i>	Possible Interaction	Possible Interaction	Possible Interaction
<i>Direct Mortality</i>	Possible Interaction	Possible Interaction	Possible Interaction
<i>Indirect Mortality</i>	Possible Interaction	Possible Interaction	Possible Interaction
<i>Chemical</i>	No Interaction	No Interaction	No Interaction

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities		
	McLymont Creek Hydroelectric	Residential and Aboriginal Harvest	Mineral and Energy Exploration
<i>Habitat Loss</i>	Possible Interaction	No Interaction	Possible Interaction
<i>Movement</i>	Possible Interaction	Possible Interaction	Possible Interaction
<i>Sensory</i>	Possible Interaction	Possible Interaction	Possible Interaction
<i>Direct Mortality</i>	Possible Interaction	Possible Interaction	Possible Interaction
<i>Indirect Mortality</i>	Possible Interaction	No Interaction	Possible Interaction
<i>Chemical</i>	No Interaction	No Interaction	No Interaction

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities		
	Fishing	Recreation and Tourism	Timber Harvest
<i>Habitat Loss</i>	No Interaction	No Interaction	Possible Interaction
<i>Movement</i>	No Interaction	Possible Interaction	Possible Interaction
<i>Sensory</i>	No Interaction	Possible Interaction	Possible Interaction
<i>Direct Mortality</i>	No Interaction	No Interaction	No Interaction
<i>Indirect Mortality</i>	No Interaction	No Interaction	Possible Interaction
<i>Chemical</i>	No Interaction	No Interaction	No Interaction

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities	
	Traffic and Roads	Guide Outfitting
<i>Habitat Loss</i>	Possible Interaction	No Interaction
<i>Movement</i>	Possible Interaction	Possible Interaction
<i>Sensory</i>	Possible Interaction	Possible Interaction
<i>Direct Mortality</i>	Possible Interaction	Possible Interaction
<i>Indirect Mortality</i>	Possible Interaction	No Interaction
<i>Chemical</i>	No Interaction	No Interaction

Due to overlaps between certain project footprints, overlapping areas were counted only once. The total habitat loss and alteration values were calculated by sector and by BEC unit where possible. Overlaps with UWR for mountain goats were also totalled. Habitat loss and alteration due to the KSM Project was calculated separately to allow for the comparison relative to overall cumulative habitat loss.

Formal habitat mapping has not been conducted for the entire CEA Area. To evaluate the loss of mountain goat habitat, the areas of relevant projects were summarized by BEC unit. Specific values of each BEC unit are difficult to rate without knowledge and analysis of multiple attributes of the terrain, which is beyond the scope of this CEA. For this assessment, it is assumed that higher elevation BEC units are considered to be high-quality habitat for mountain goats, as the geomorphology at higher elevations is more likely to support escape terrain. Therefore, loss and alteration to BAFA and ESSF BEC zones are considered for mountain goats within the CEA and Movement Areas.

Within the mountain goat CEA Area (3,404,146 ha), 1,976,973 ha are within mountain goat high-quality winter and summer habitat (i.e., BAFA and ESSF BEC zones). Of the available high-quality mountain goat habitat, 30,387 ha (0.9% of the entire CEA Area; 1.5% of available high-quality habitat in the CEA Area) is expected to be lost or altered with all projects considered, including the KSM Project. Of this area lost or altered, most is due to forest harvesting (80.1%), followed by mining (19.7%), and hydroelectric power projects (0.2%; Table 18.9-16).

Table 18.9-16. Summary of Mountain Goat Winter and Summer Habitat Loss and Alteration¹ due to all Projects in the CEA Area and Movement Area

Sector	CEA Area (1,976,973 ha) ²			Movement Area (219,625) ²		
	Habitat Lost/Altered (ha)	Habitat Lost/Altered (% of Habitat in CEA Area)	Habitat Lost/Altered (% of Lost Habitat due to each Sector)	Habitat Lost/Altered (ha)	Habitat Lost/Altered (% of Habitat in CEA Area)	Habitat Lost/Altered (% of Lost Habitat due to each Sector)
Mining Projects ³	5,973	0.3	19.7	2,323	1.0	21
Hydroelectric Projects	57	0.0	0.2	0	0	0
Forestry	24,356	1.2	80.1	8,964	4.1	79
KSM	1,703	0.09	5.6	1,703	0.8	15
Total	30,387	1.5		11,288	5.1	

¹Only suitable habitat in the BAFA and ESSF BEC zones are considered in calculations for habitat loss and alteration for mountain goats.

²This is the amount of available high-quality habitat in the CEA and Movement Areas; see text for definition of high-quality habitat.

³Includes KSM Project in calculations.

Within the smaller Movement Area (maximum home range of a single mountain goat, 386,297 ha in size), there are 219,626 ha of high-quality mountain goat habitat (i.e., BAFA and ESSF BEC zones). Of the available high-quality habitat, 11,288 ha (3% of the entire Movement

Area; 5% of available high-quality habitat in the Movement Area) are predicted to be lost or altered with all projects considered, including the KSM Project. Of this area lost or altered, most is due to forest harvesting (79%), followed by mining (21%; Table 18.9-16). No habitat is expected to be lost or altered due to hydroelectric projects in the Movement Area.

While forest harvesting contributes to most of the habitat loss at both scales, this may not be permanent if forestry rotation allows for no net reduction in important habitat over time. Thus, this area lost due to forestry may be temporary. Excluding forestry from the calculations, 0.3% (6,031 ha) of the CEA Area and 1% (2,323 ha) of the Movement Area will be lost or altered.

In summary, when only habitat loss and alteration from the high-quality mountain goat habitat BEC zones are considered, 1.5% (0.3% excluding forestry) and 5% (1% excluding forestry) of available high-quality habitat from the CEA and Movement Areas, respectively, were estimated to be lost or altered. The KSM Project will contribute 1,703 ha of the total lost or altered habitat (see Section 18.7.1.3), accounting for 0.09% of the habitat within the CEA Area and 0.8% of the habitat within the Movement Area.

Road density will increase by 10.9% in the mountain goat CEA Area (from 0.07 km/km² to 0.089 km/km²) and by 65.2% in the Movement Area (from 0.02 to 0.095 km/km²). Road density will not exceed the threshold value of 0.6 km/km², above which population of many large vertebrate species decline (Forman et al. 2007).

18.9.3.2.1 Other Project/Activity Mitigations to Address Habitat Loss and Alteration

The Proponent will consider participating in regional monitoring programs by contributing to regionally based monitoring initiatives where those monitoring initiatives replace proposed KSM Project-specific monitoring (Section 26.21.3), and these monitoring activities are approved by relevant provincial authorities and stakeholders (see Section 18.9.1.4).

Other projects contributing to habitat loss and alteration for mountain goat are expected to follow relevant BMPs and legislative requirements, and to avoid high-quality habitat (e.g., UWRs) where possible. Avoidance of mineral licks is also expected wherever possible. It is assumed that proponents will be expected to design projects such that they attempt to meet the objectives of the Cassiar Iskut-Stikine LRMP and the Nass South SRMP and follow the General Wildlife Measures under the *Forest Range and Practices Act* (2002a) for approved mountain goat UWRs.

18.9.3.2.2 Determination of Potential for Residual Cumulative Effect and Significance

Table 18.9-17 characterizes the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance. The cumulative effect of habitat loss and alteration on mountain goat is considered to have a medium magnitude, as a relatively low overall proportion of high-quality habitat will be lost from the CEA (1.5%) and Movement (5%) Areas. The extent is regional, the duration is far-future, and the effect is irreversible. The context is neutral, since the mountain goat population in the area is currently healthy. There is a high probability of the effect occurring and a medium confidence. The cumulative effect of habitat loss for mountain goat is assessed as **not significant (moderate)** if all projects go forward.

Table 18.9-17. Summary of Cumulative Residual Effects on Mountain Goats

Description of Residual Effect	Project Component(s)	Timing of Effect	Magnitude	Magnitude Adjusted for CE	Extent	Extent Adjusted for CE	Duration	Duration Adjusted for CE	Frequency	Frequency Adjusted for CE	Reversibility	Reversibility Adjusted for CE	Context	Context Adjusted for CE	Likelihood of Effects				Significance	Significance Adjusted for CE	Follow up Monitoring	Follow up Monitoring Adjusted by CE
															Probability	Probability Adjusted by CE	Confidence Level	Confidence Adjusted by CE				
Habitat Loss	Mine Site	Construction	Medium	Medium	Local	Regional	Far future	Far future	Sporadic	Sporadic	Irreversible	Irreversible	Neutral	Neutral	High	High	High	Medium	Not Significant (Moderate)	Not Significant (Moderate)	Required	Not Required
Disruption of Movement	Mine Site	Construction	Low	Low	Local	Regional	Far future	Far future	Sporadic	Sporadic	Reversible long-term	Reversible long-term	Neutral	Neutral	Medium	Medium	Low	Medium	Not Significant (Minor)	Not Significant (Minor)	Required	Not Required
Sensory Disturbance	Mine Site	Construction	Medium	Medium	Landscape	Regional	Long	Long	Regular	Regular	Reversible long-term	Reversible long-term	Neutral	Neutral	Medium	Medium	Low	Medium	Not Significant (Moderate)	Not Significant (Moderate)	Required	Not Required
Direct Mortality	Controlled avalanche	Construction	Negligible	Low	Landscape	Regional	Far future	Far future	Sporadic	Sporadic	Reversible long-term	Reversible long-term	Neutral	Neutral	Medium	Medium	Low	Medium	Not Significant (Minor)	Not Significant (Minor)	Required	Not Required
Indirect Mortality	Project Roads	Closure	Low	Low	Landscape	Regional	Far future	Far future	Sporadic	Sporadic	Reversible long-term	Reversible long-term	Neutral	Neutral	Low	Medium	Low	Medium	Not Significant (Minor)	Not Significant (Minor)	Required	Not Required
Chemical Hazards	Mine Site	Construction	Low	N/A	Landscape	N/A	Far future	N/A	Continuous	N/A	Reversible long-term	N/A	Neutral	N/A	Medium	N/A	Low	N/A	Not Significant (Minor)	N/A	Required	N/A
Overall Effect	All	Construction	Medium	Medium	Landscape	Regional	Far future	Far future	Sporadic	Regular	Reversible long-term	Reversible long-term	Neutral	High	Medium	Medium	Medium	Medium	Not Significant (Moderate)	Not Significant (Moderate)	Not Required	Not Required

CE = Cumulative Effect

18.9.3.3 Cumulative Effect of Disruption of Movement on Mountain Goats

The KSM Project Application/EIS (Section 18.8) predicted a low-magnitude residual effect of disruption of movements for mountain goat that was not significant (minor) with mitigation. Disruption of movement may result from development of infrastructure (e.g., pits, RSFs, and Project roads) at high elevation and due to sensory disturbance (Section 18.8.3.3). This residual effect was brought forward into the CEA, which considers all sources of likely residual effects on movement (Table 18.9-15) due to past, present, and future developments that could affect mountain goat populations within and surrounding the KSM Project (Figure 18.9-2). The overall combined effect of disruption of movement on mountain goats was therefore assessed.

Mountain goats do not move long distances compared to other ungulates, such as moose. Goats make relatively short-distance movements between seasonal habitats along ridge lines and traditional trails (Wilson 2005). Typically, the largest distances travelled by mountain goats are made from their winter range to mineral licks. In northcentral BC, radio-collared goats travelled 3.6 to 10.6 km from their winter range to mineral licks (Corbould et al. 2010), while one male travelled up to 60 km. In southeastern BC, Poole, Bachmann, and Teske (2010) reported movement of 17.3 km by radio-collared mountain goats.

Disruption of movement may result from development of infrastructure (e.g., pits and site roads) at high elevation. Since mountain goats tend to travel along ridge tops, low elevation roads are unlikely to affect movements. Mining, hydroelectric, and exploration projects are planned within the CEA Area that are at sufficiently high elevation that they have the potential to interrupt mountain goat movement (Figure 18.9-2; Table 18.9-11).

18.9.3.3.1 Other Project/Activity Mitigations to Address Disruption of Movement

The Proponent will consider participating in regional monitoring programs by contributing to regionally based monitoring initiatives where those monitoring initiatives replace proposed KSM Project-specific monitoring (Section 26.21.3), and these monitoring activities are approved by relevant provincial authorities and stakeholders (see Section 18.9.1.4).

Other projects contributing to the disruption of movements for mountain goat are expected to follow relevant BMPs and legislative requirements. Other proponents are expected to design projects such that they attempt to meet the objectives of the Cassiar Iskut-Stikine LRMP and the Nass South SRMP.

18.9.3.3.2 Determination of Potential for Residual Cumulative Effect and Significance

Table 18.9-17 characterizes the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance. The cumulative effect of disruption of movement on mountain goats is considered to have a low magnitude, due to the fact that mountain goats largely move above elevations that experience high road and traffic densities. The extent of the effect is regional, the duration is far-future, frequency is sporadic, and the effect is reversible long-term. The context is neutral, since the mountain goat population in the area is currently healthy. There is a medium probability of the effect occurring and a medium confidence. The cumulative effect of disruption of movement on mountain goats is assessed as **not significant (minor)**.

18.9.3.4 Cumulative Effect of Sensory Disturbance on Mountain Goat

The KSM Project Application/EIS (Section 18.8) predicted a medium magnitude residual effect of sensory disturbance for mountain goats that was not significant (moderate) with mitigation. Disturbance from blasting noise was predicted to result in the potential displacement of mountain goats from adjacent habitats and resulting density-dependent population effects. This residual effect was brought forward into the CEA, which considers all sources of likely residual sensory disturbance (Table 18.9-15) that could affect mountain goat populations within the mountain goat CEA Area (Figure 18.9-2).

Mountain goats are considered to be more susceptible to disturbances from noise, helicopters, vehicles, and other industrial activity than other ungulate species (Côté 1996; Goldstein et al. 2005; Festa-Bianchet and Côté 2007). As a consequence, helicopters in BC are required to remain greater than 2,000-m away from habitats containing goats (Management Plan for the Mountain Goat in British Columbia; BC MOE 2010a).

Mining, hydroelectric, and exploration projects that may disturb goats through blasting, human presence, and other activities were assessed in the CEA and Movement Areas for mountain goats (Figure 18.9-2). The area of disturbance from applicable projects was calculated using a 500-m buffer (Table 18.9-15). This is the distance from goat habitat where ground-based activities are restricted by the General Wildlife Measures under the FRPA (2002a). Future roads are included and buffered as part of the individual footprints of each project with one exception: Eskay Creek Mine road is included on its own as multiple projects use this road segment. These calculations represent a worst-case scenario where all projects go forward and are operating or being constructed simultaneously.

Within high-quality mountain goat habitat (i.e., BAFA and ESSF BEC zones) in the CEA Area, a total of 49,501 ha (2.5% of the high-quality habitat in the CEA Area) is within the 500-m buffer, and is therefore estimated to be disturbed for mountain goats by industrial activities. However, this includes the area already considered lost or altered (30,387 ha) in Section 18.9.3.2, Habitat Loss and Alteration. When this area already considered lost is removed from the calculations, 19,114 ha of habitat may be disturbed due to sensory disturbance. Within the Movement Area, 16,739 ha (7.6% of the high-quality habitat in the Movement Area) is within the 500-m buffer, and is therefore estimated to be disturbed for mountain goats. This includes the area already considered lost or altered (11,288 ha) in Section 18.9.3.3 (Habitat Loss and Alteration); therefore, when this area already considered lost is removed from the calculations, 5,451 ha of habitat may be disturbed due to sensory disturbance. Disturbance within UWRs (i.e., development within 500 m of a UWR) is estimated to affect 1,532 ha (1.1%) in the CEA Area and 1,217 ha (8.8%) in the Movement Area.

18.9.3.4.1 Other Project/Activity Mitigations to Address Sensory Disturbance

The Proponent will consider participating in regional monitoring programs by contributing to regionally based monitoring initiatives where those monitoring initiatives replace proposed KSM Project-specific monitoring (Section 26.21.3), and these monitoring activities are approved by relevant provincial authorities and stakeholders (see Section 18.9.1.4).

Other projects contributing to sensory disturbance for mountain goats are expected to follow relevant BMPs and legislative requirements, and to avoid high-quality habitat, UWR, and mineral licks. Projects operating within 500 m of a UWR or occupied goat range are expected to mitigate their development activities seasonally, following the General Wildlife Measures under the FRPA (2002a). Helicopters flying over UWR or occupied mountain goat habitat are expected to adhere to setbacks of 2,000 m horizontal distance and 400 m vertical distance, as set out in the Management Plan for Mountain Goats in BC (BC MOE 2010a).

18.9.3.4.2 *Determination of Potential for Residual Cumulative Effect and Significance*

Table 18.9-17 characterizes the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance. The cumulative effect of sensory disturbance for mountain goat is considered to be medium magnitude. The extent of the effect is regional, the duration is long, the frequency is regular, and the effect is reversible long-term. The context is neutral, since the mountain goat population in the area is currently healthy. There is a medium probability of the effect occurring and a medium confidence. The cumulative residual effect of sensory disturbance for mountain goat is assessed as **not significant (moderate)**.

18.9.3.5 *Cumulative Effect of Direct Mortality on Mountain Goat*

The KSM Project Application/EIS (Section 18.8) predicted a residual effect of direct mortality of mountain goat, which was not significant (minor) with mitigation. To determine the potential cumulative effects of direct mortality on mountain goat, relevant projects potentially contributing to this effect (Table 18.9-15) were considered within the CEA and Movement Areas (Figure 18.9-2). All sources of direct mortality (e.g., due to avalanche blasting and vehicle strikes) that could increase are discussed in this section.

Other projects within the CEA and Movement Areas have the potential to increase direct mortality of mountain goats due to avalanche control methods. During winter, mountain goats occupy habitat in or below areas prone to avalanches, including alpine areas. There are recorded accounts of mountain goats being killed in avalanches, although it is not considered a frequent cause of mortality (e.g., Macgregor 1977; Chadwick 1983). The number of goats involved in this type of mortality cannot be predicted; however, it is expected that these events will be infrequent. Such a risk may be controllable; pre-blasting surveys can be used to locate any mountain goats, and blasting activities can be delayed until goats leave the area.

Virtually no mountain goats are killed by vehicle collisions within BC (Sielecki 2004) because there are very few roads supporting high velocity vehicles within their natural range at high elevations. Some high-elevation roads will be created for projects within the CEA and Movement Areas, which will host traffic at low density and travelling at slower speeds that could cause vehicle collision risks to goats; however, this risk will be minor.

18.9.3.5.1 *Other Project/Activity Mitigations to Address Direct Mortality*

The Proponent will consider participating in regional monitoring programs by contributing to regionally based monitoring initiatives where those monitoring initiatives replace proposed KSM Project-specific monitoring (Section 26.21.3), and these monitoring activities are approved by relevant provincial authorities and stakeholders (see Section 18.9.1.4).

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. Projects operating within 500 m of UWR or occupied goat range will be managed through *General Wildlife Measures* under the FRPA (2002a), which imposes restrictions on activities around these areas. Where specific habitat protections are not afforded but mountain goats are suspected to occasionally use an area in the winter, adaptive mitigation such as mitigation of avalanche blasting is expected. To effectively address cumulative effects of direct mortality on mountain goats, the proponent is willing to participate in a regional initiative with other stakeholders, assuming the initiative is coordinated and managed by the appropriate government agency.

18.9.3.5.2 *Determination of Potential for Residual Cumulative Effect and Significance*

Table 18.9-17 characterizes the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance. The cumulative effect of direct mortality on mountain goats is considered to be of low magnitude. The extent of the effect is regional, the duration is far-future, and the frequency is sporadic, as mortality events would only be expected to happen occasionally. The effect is reversible long-term. The context of the population is neutral, since the mountain goat population in the area is currently healthy. There is a medium probability of the effect occurring and a medium confidence. The cumulative residual effect of direct mortality on mountain goats is assessed as **not significant (minor)**.

18.9.3.6 *Cumulative Effect of Indirect Mortality on Mountain Goat*

The KSM Project Application/EIS (Section 18.8.3.5) predicted a residual effect of indirect mortality on mountain goats. This effect was of low magnitude and not significant (minor) with mitigation. To determine the potential cumulative effects of indirect mortality on mountain goats, relevant projects potentially contributing to increased access to the area (Table 18.9-15) were considered within the CEA and Movement Areas (Figure 18.9-2).

Increased access into previously inaccessible mountain goat habitat can increase indirect mortality of mountain goats due to increased hunting. Mountain goat populations are sensitive to adult female mortality because of comparatively late age at first reproduction (four to five years old). In addition, mountain goats have low production and low survival of kids (Hamel et al. 2006; Festa-Bianchet and Côté 2007), as a large proportion of mountain goats die within their first or second year of life (Smith 1986). Road creation in high elevation areas, particularly when roads are cleared in the winter, could increase predator access into areas occupied by goats. This could, in turn, increase predator-induced mortality of young goats. However, very few access roads are built into high-elevation mountain goat habitat. If roads are constructed within goat habitat, they would likely be industrial roads, and therefore access would likely be controlled, preventing increased hunting.

18.9.3.6.1 *Other Project/Activity Mitigations to Address Indirect Mortality*

The Proponent will consider participating in regional monitoring programs by contributing to regionally based monitoring initiatives where those monitoring initiatives replace proposed KSM Project-specific monitoring (Section 26.21.3), and these monitoring activities are approved by relevant provincial authorities and stakeholders (see Section 18.9.1.4).

It is expected that all other industrial projects will include similar mitigation measures as adopted by the KSM Project to minimize the impacts of new road creation in affecting indirect mortality rates for mountain goat, and will follow all relevant acts, regulations, and BMPs for the activities that they carry out.

18.9.3.6.2 *Determination of Potential for Residual Cumulative Effect and Significance*

Table 18.9-17 characterizes the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance. It is assumed that any new Project access roads will be controlled, as with the KSM Project. In addition, very few access roads are built into mountain goat habitat at high elevations. The cumulative effect of indirect mortality for mountain goat is therefore considered to be of low magnitude. The extent of the effect is regional, the duration is far-future, and the frequency is sporadic, as indirect mortality events would be expected to happen occasionally. The effect is reversible long-term. The context of the population is neutral, since the mountain goat population in the area is currently healthy. There is a medium probability of the effect occurring and a medium confidence. The cumulative residual effect of indirect mortality is rated as **not significant (minor)**.

18.9.3.7 Overall Cumulative Effect on Mountain Goat

The overall cumulative effect on mountain goats is rated based on the knowledge that individual effects may interact and create additive or synergistic effects that would have a different nature or greater impact on local populations as a whole, potentially impacting the survival rates and reproductive success of individual animals. The overall cumulative effect is considered to have a medium magnitude, to extend into the far-future, to be regular in frequency, and (largely) reversible in the long-term. The context of the population is high, as mountain goat will not be as resilient to a combination of effects occurring together as they are to individual effects. The effect has a medium probability of occurring and a medium confidence due to the difficulty in knowing how many proposed projects will go forward and the precise timing of each project (Table 18.9-17). The cumulative overall effect on mountain goats is assessed as **not significant (moderate)** if all other projects go through.

18.9.4 Cumulative Effects Assessment for Grizzly Bears

The grizzly bear population in BC is estimated as 13,800 (Gyug, Hamilton, and Austin 2004). Grizzly bears are considered a species of special concern by COSEWIC and are blue-listed in BC (COSEWIC 2002b; BC CDC 2010a). Grizzly bears require large areas that are relatively undisturbed, with a low risk of mortality or displacement, and with access to differing seasonal habitats. The range of grizzly bears is divided into GBPU's in BC for conservation and management purposes. The KSM Project overlaps three of these GBPU's and the outer boundary of these GBPU's is used as the boundary of the CEA Area for grizzly bears (Figure 18.9-3).

The GBPU's comprising the CEA Area consist of the Edziza-Lower Stikine GBPU to the north, the Stewart GBPU to the south, and the Upper Skeena-Nass to the east (Figure 18.9-3). The estimated grizzly bear numbers within these GBPU's are 398 in the Edziza-Lower Stikine, 358 in the Stewart, and 755 in the Upper Skeena-Nass (BC MFLNRO 2012a). The estimated grizzly bear densities for these respective GBPU's are 20 to 30, 30 to 40, and 40 to 50 bears per 1,000 km² (BC MFLNRO 2012a). Therefore, a total of 1,511 grizzlies are estimated within the

CEA Area (4,584,222 ha), and 833 grizzlies are estimated to occur within the Movement Area (Figure 18.9-3; 2,527,154 ha). Some areas within these GBPU have been proposed as candidate WHAs under the FRPA (2002a), but have yet to be officially approved.

Table 18.9-18 summarizes the projects and activities that have the potential to have residual cumulative effects on grizzly bears due to spatial and temporal overlap with the KSM Project.

18.9.4.1 Project-specific Residual Effects on Grizzly Bears that Are Not Likely to Result in Cumulative Effects

All five residual effects on grizzly bears identified for the KSM Project will interact with at least one project or activity. Therefore, there are no residual effects on grizzly bears that are not likely to result in cumulative effects.

The cumulative effects assessment is conducted for the following potential cumulative effects on grizzly bears:

1. habitat loss and alteration;
2. disruption to movement;
3. direct mortality;
4. indirect mortality; and
5. attractants.

18.9.4.2 Cumulative Effect of Habitat Loss and Alteration on Grizzly Bears

The assessment of effects of habitat loss and alteration due to the KSM Project (Section 18.8.4.1) predicted a low-magnitude residual effect on grizzly bears that was not significant (minor) with mitigation. Approximately 6.3% of high-quality habitat within the RSA was estimated to be lost as a result of development. Habitat loss due to the KSM Project alone was roughly equivalent to the loss of 58% of the home range of a single male grizzly bear in the interior of BC, or up to two home ranges of female coastal grizzly bears. This residual effect was brought forward into the CEA, which considers all sources of likely residual habitat loss due to relevant projects (Table 18.9-18) that could impact the grizzly bears within and surrounding the KSM Project footprint (Figure 18.9-3).

Grizzly bears are omnivorous and require different seasonal habitats throughout the year. A single grizzly bear often requires a home range between 50 and 100 km², with some ranging over thousands of square kilometres (MacHutchon 2007). During the spring, grizzly bears are often found at low elevation sites, such as within riparian areas, where vegetation is first emerging after the snowpack melts (Ash 1985). Grizzly bears may migrate to higher elevations in the summer, following the emergence of new vegetation and berries. During fall, grizzly bears often descend to lower elevations again, where in some areas of BC they feed on spawning salmon and ultimately prepare to hibernate from mid-October to May and have their cubs (Gyug, Hamilton, and Austin 2004).

Table 18.9-18. Summary of Projects and Activities with Potential to Interact Cumulatively with Expected Project-specific Residual Effects on Grizzly Bears

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities					
	Eskay Creek Mine	Granduc Mine	Johnny Mountain Mine	Kitsault Mine (Closed)	Snip Mine	Swamp Point Aggregate Mine
<i>Habitat Loss</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
<i>Movement</i>	Possible Interaction	Possible Interaction	No Interaction	Possible Interaction	No Interaction	No Interaction
<i>Direct Mortality</i>	Possible Interaction	Possible Interaction	No Interaction	Possible Interaction	No Interaction	No Interaction
<i>Indirect Mortality</i>	Possible Interaction	Possible Interaction	No Interaction	Possible Interaction	No Interaction	No Interaction
<i>Attractants</i>	No Interaction	No Interaction	No Interaction	Possible Interaction	No Interaction	No Interaction

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities					
	Forest Kerr Mine	NTL	Long Lake Hydroelectric	Bear River Gravel	Bronson Slope Mine	Brucejack Mine
<i>Habitat Loss</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
<i>Movement</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
<i>Direct Mortality</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
<i>Indirect Mortality</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
<i>Attractants</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities					
	Galore Creek Mine	Kitsault Mine	Arctos Anthracite Coal Mine	Schaft Creek Mine	Snowfield Project	Treaty Creek Hydroelectric
<i>Habitat Loss</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
<i>Movement</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
<i>Direct Mortality</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
<i>Indirect Mortality</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
<i>Attractants</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities					
	Fishing	Guide Outfitting	Residential and Aboriginal Harvest	Mineral and Energy Exploration	Recreation and Tourism	Timber Harvest
<i>Habitat Loss</i>	No Interaction	No Interaction	No Interaction	Possible Interaction	No Interaction	Possible Interaction
<i>Movement</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
<i>Direct Mortality</i>	No Interaction	No Interaction	Possible Interaction	Possible Interaction	No Interaction	No Interaction
<i>Indirect Mortality</i>	No Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
<i>Attractants</i>	Possible Interaction	No Interaction	No Interaction	Possible Interaction	Possible Interaction	Possible Interaction

Description of KSM Residual Effect	Projects and Activities	
	Traffic and Roads	McLymont Creek Hydroelectric
<i>Habitat Loss</i>	Possible Interaction	Possible Interaction
<i>Movement</i>	Possible Interaction	Possible Interaction
<i>Direct Mortality</i>	Possible Interaction	Possible Interaction
<i>Indirect Mortality</i>	Possible Interaction	Possible Interaction
<i>Attractants</i>	Possible Interaction	Possible Interaction

To determine the potential impacts of habitat loss and alteration on grizzly bears, permanent and transient (e.g., forest harvesting) habitat loss due to all relevant projects (Table 18.9-18) were quantified within the CEA Area and Movement Area. Calculated numbers represent a worst case scenario, as they assume habitat loss due to all projects is incurred simultaneously. Information that could not be obtained included permanent habitat loss due to past projects and future mineral and hydroelectric exploration projects, as well as new roads, due to a lack of information on road widths. Therefore, linear road density (km/km²) was used as a proxy for habitat loss (Gibeau et al. 2002).

Due to overlaps between some project footprints, all overlapping habitat loss and alteration were counted only once, and were calculated by sector and BEC area where possible. Calculations were also conducted for habitat alteration within proposed WHAs. Habitat loss and alteration due to the KSM Project was calculated separately to allow for comparison within the CEA and Movement Areas.

Grizzly bears use all BEC zones throughout the year during different seasons. Therefore, calculations of lost and altered habitat are presented as a proportion of all BEC zones altered in the entire CEA Area. The grizzly bear CEA Area is 4,584,222 ha; of this area, 68,562 ha (1.5%) is expected to be lost or altered due to a combination of all projects, including the KSM Project (Table 18.9-19). The KSM Project will contribute 10,886 ha of the total lost or altered habitat (see Section 18.7.1.4), accounting for 0.2% of the CEA Area. Of the habitat altered, most is due to forest harvesting (75%), followed by mining (23%) and hydroelectric power projects (2%).

Table 18.9-19. Summary of Grizzly Bear Habitat Loss and Alteration¹ due to all Projects in the CEA Area and Movement Area

Sector	CEA Area (4,584,222 ha) ²			Movement Area (2,527,154 ha) ²		
	Habitat Lost/Altered (ha)	% Habitat Lost/Altered (% of Habitat in CEA Area)	% Habitat Lost/Altered (% of Lost Habitat due to each Sector)	Habitat Lost/Altered (ha)	% Habitat Lost/Altered (% of Habitat in CEA Area)	% Habitat Lost/Altered (% of Lost Habitat due to each Sector)
Mining Projects ³	15,519	0.3	23	9,180	0.36	26
Hydroelectric Projects	1,451	0.03	2	1,452	0.06	4
Forestry	51,592	1.1	75	25,279	1.0	70
KSM Project	10,886	0.2	16	10,886	0.4	30
Total	68,563	1.5		35,910	1.4	

¹Suitable habitat occurs in all BEC zones; therefore, the entire area is considered in calculations for habitat loss and alteration for grizzly bears.

²This is the size of the entire CEA Area, as grizzly bears use all BEC zones; see text for more information.

³Includes KSM Project in calculations.

Within the Movement Area of an individual bear (2,527,154 ha), 35,910 ha (1.4%) will be lost or altered (Table 18.9-19). Similarly, most of the area impacted within the Movement Area will be due to forest harvesting (70%), followed by mining (26%), and hydroelectricity projects (4%). The KSM Project will contribute 10,886 ha of the total lost or altered habitat (see Section 18.7.1.4), accounting for 0.4% of the Movement Area.

While forest harvesting contributes to most of the habitat loss at both scales, this may not be permanent if forestry rotation allows for no net reduction in important habitat (i.e., early or late winter habitat) over time. Thus, this area lost due to forestry may be temporary. Excluding forestry from the calculations, 0.4% (16,971 ha) of the CEA Area and 0.4% (10,631 ha) of the Movement Area will be lost or altered.

Two thresholds were identified from the literature to evaluate whether the loss of grizzly bear habitat is significant for a bear population: the length of roads per area and the proportion of habitat lost. The density of roads in an area can cause habitat avoidance by grizzly bears, which renders the surrounding habitat as “functionally lost” (B. N. McLellan and Shackleton 1988; Aune 1994). A conservative threshold of 0.6 km/km² of roads has been suggested to protect high-quality grizzly bear habitat (NCGBRT 2004); this threshold of 0.6 km/km² was used for this assessment. For habitat loss, threshold levels are predicted to occur when habitat loss or modification is greater than 25% (Hargis and Bissonnette 1997; Hargis, Bissonnette, and Turner 1999; Potvin, Courtois, and Belanger 1999; Poole et al. 2004); below this value, available habitat is assumed to exist within the range of natural variation.

In the CEA Area and Movement Areas, a 14% increase in road density (from 0.073 km/km² to 0.085 km/km²), and a 31.5% increase (from 0.05 to 0.073 km/km²), respectively, is predicted due to road-building from all identified projects in the future. The total estimated road densities will fall well below the threshold of 0.6 km/km²; therefore, roads are not expected to contribute to avoidance-based habitat loss.

In summary, 1.5% (0.4% excluding forestry) and 1.4% (0.4% excluding forestry) of available grizzly bear habitat from the CEA and Movement Areas, respectively, were estimated to be lost or altered. The total habitat loss and alteration due to all past, present, and future projects (including the KSM Project) will not exceed the threshold value of 25% loss or alteration of habitat.

18.9.4.2.1 Other Project/Activity Mitigations to Address Habitat Loss and Alteration

The Proponent will consider participating in regional monitoring programs by contributing to regionally based monitoring initiatives where those monitoring initiatives replace proposed KSM Project-specific monitoring (Section 26.21.3), and these monitoring activities are approved by relevant provincial authorities and stakeholders (see Section 18.9.1.4).

Other projects are expected to avoid high-quality grizzly bear habitat wherever possible, and follow all relevant legislation, regulations, and BMPs for the activities that they carry out. Other proponents are also expected to design projects with careful consideration of the objectives of the Cassiar Iskut-Stikine LRMP and the Nass South SRMP.

The CEA highlights the potential for the majority of habitat loss and alteration for grizzly bears to occur in the ESSF and ICH BEC units (largely by forestry), which are important for grizzly bears. Management of forest practices and other industrial activities must be coordinated on a regional scale to maintain a diverse habitat matrix distributed across a large elevational gradient to ensure persistence of grizzly bears.

18.9.4.2.2 *Determination of Potential for Residual Cumulative Effect and Significance*

Table 18.9-20 characterizes the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance. The effect of habitat loss on grizzly bears is considered to have a low magnitude because cumulative habitat loss and alteration will not approach the threshold level where greater than 25% of the habitat is modified (Hargis and Bissonnette 1997; Hargis, Bissonnette, and Turner 1999; Potvin, Courtois, and Belanger 1999; Poole et al. 2004), and available habitat will remain within the range of natural variation (less than 2% of available habitat).

The extent of the effect is regional, and the duration is far-future, as the habitat will be lost throughout life of the Project and longer. The frequency is sporadic, and the effect is irreversible, as much of the habitat will not be returned to baseline conditions at closure or within a time frame relevant to large-scale grizzly bear population dynamics. The context of the grizzly bear population is considered to be neutral—grizzly bears have a relatively lower reproductive output than black bears, with females typically producing their first cubs between 4.5 to 8.5 years of age, and have litters of one to four cubs every two to seven years (Craighead, Hornocker, and Craighead 1969). The probability of the effect is medium and the confidence is medium. The significance of cumulative habitat loss on grizzly bears is assessed as **not significant (minor)**.

18.9.4.3 *Cumulative Effect of Disruption of Movement on Grizzly Bears*

The KSM Project Application/EIS (Section 18.8.4.2) predicted a low-magnitude residual effect of disruption to movement of grizzly bears, which was not significant (minor) with mitigation. Grizzly bears were predicted to avoid areas when there is noise associated with the development and operation of the Project (Sensory Disturbance, Section 18.7.3.4). However, because grizzly bears have very large home ranges, and due to the mitigation actions taken, the residual effect of disruption to movements was not predicted to be significant. This residual effect was brought forward into the CEA, which considers all sources of likely residual movement disruptors due to relevant projects and human land use activities (Table 18.9-18) that could affect grizzly bears within and surrounding the KSM Project (Figure 18.9-3).

Roads and road traffic are the most likely industrial features that could 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 on primary roads within the CEA and Movement Areas, because industrial driving occurs throughout a 24-hour period. Background traffic data was 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 2011a).

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 vehicles per hour (VPH) was added to all sections of Highway 37 and 37A (Table 18.9-21).

Table 18.9-20 Summary of Cumulative Residual Effects on Grizzly Bears

Description of Residual Effect	Project Component(s)	Timing of Effect	Magnitude	Magnitude Adjusted for CE	Extent	Extent Adjusted for CE	Duration	Duration Adjusted for CE	Frequency	Frequency Adjusted for CE	Reversibility	Reversibility Adjusted for CE	Context	Context Adjusted for CE	Likelihood of Effects				Significance	Significance Adjusted for CE	Follow-up Monitoring	Follow-up Monitoring Adjusted by CE
															Probability	Probability Adjusted by CE	Confidence Level	Confidence Adjusted by CE				
Habitat Loss	All	Construction	Low	Low	Local	Regional	Far Future	Far future	Sporadic	Sporadic	Irreversible	Irreversible	Neutral	Neutral	High	Medium	High	Medium	Not Significant (Minor)	Not Significant (Minor)	Required	Not Required
Disruption of Movement	All	Construction	Low	Medium	Landscape	Regional	Far Future	Far future	Sporadic	Regular	Reversible long Term	Reversible long-term	Neutral	Neutral	Medium	High	Low	Medium	Not Significant (Minor)	Not Significant (Moderate)	Required	Not Required
Direct Mortality	TCAR, CCAR	Construction	Negligible	Low	Landscape	Regional	Far Future	Far future	Sporadic	Sporadic	Reversible long Term	Reversible long-term	Neutral	Neutral	Medium	Medium	Low	Medium	Not Significant (Minor)	Not Significant (Minor)	Required	Not Required
Indirect Mortality	TCAR, CCAR	Construction	Low	Low	Landscape	Regional	Far Future	Far future	Sporadic	Sporadic	Reversible long Term	Reversible long-term	Neutral	Neutral	Medium	Medium	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Required	Not Required
Attractants	Camps, Project roads	Construction	Low	Low	Local	Regional	Far Future	Far Future	Sporadic	Sporadic	Reversible long-term	Reversible long-term	Neutral	Neutral	High	High	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Required	Not Required
Overall Effect	All	Contruction	Low	Medium	Local	Regional	Far Future	Far Future	Sporadic	Sporadic	Reversible long-term	Reversible long-term	Neutral	High	Medium	Medium	Medium	Medium	Not Significant (Moderate)	Not Significant (Moderate)	Not Required	Not Required

CE = Cumulative Effect

Table 18.9-21. Estimated Traffic Rates (Vehicles per Hour) of all CEA 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 CEA (including KSM)	# of Vehicles from KSM per Day (VPH and % of total)
CCAR	0.13 Projected Traffic 0 Background Traffic	0.13	3 (0.125 VPH; 100%)
TCAR	3.4 Projected Traffic 0 Background Traffic	3.4	82 (3.4 VPH; 100%)
Eskay Creek Mine road	0.6 Projected Traffic 0 Background Traffic	0.6	3 (0.1 VPH; 21.6%)
*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.

The background traffic levels on Highway 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 Highway 37 and 37A (Table 18.9.21). Traffic on the KSM Project access roads is expected to remain below the threshold of 10 VPH and is therefore not expected to cause a barrier to grizzly bear movement (Figure 18.9-7). 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 Highway 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.

18.9.4.3.1 *Other Project/Activity Mitigations to Address Disruption of Movement*

The Proponent will consider participating in regional monitoring programs by contributing to regionally based monitoring initiatives where those monitoring initiatives replace proposed KSM Project-specific monitoring (Section 26.21.3), and these monitoring activities are approved by relevant provincial authorities and stakeholders (see Section 18.9.1.4).

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.

18.9.4.3.2 *Determination of Potential Residual Cumulative Effect and Significance*

Table 18.9-20 characterizes the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance. The effect of disruption of movement on grizzly bears is considered to be of medium magnitude because the threshold value of 10 VPH has been exceeded along Highway 37 and 37A—although this threshold level is already exceeded at current existing baseline traffic volumes. The extent of the effect is regional, throughout the CEA Area. The duration of the effect is expected to extend into the far-future. The frequency is expected to be regular, as traffic will likely be present at levels exceeding the threshold during all days comprising the non-hibernation seasons. The effect is predicted to be reversible, as movements would likely resume if traffic rates decreased to below threshold levels. The context of the grizzly bear population is considered to be neutral. The probability of the effect occurring is considered high and the confidence is medium. The cumulative effect of disruption to movements for grizzly bears is assessed as **not significant (moderate)** if all other projects go through.

While this CEA identifies a not significant (moderate) cumulative effect on movement of grizzly bears, it is important to emphasize that background traffic rates (based on a 12-hour driving day) along Highway 37 are already likely disrupting the movement of grizzly bears across this road, as the background traffic rate of 18.7 VPH is above the 10 VPH threshold prior to the KSM Project and all other potential projects. Therefore, this cumulative effects assessment identifies this effect as already occurring.

18.9.4.4 *Cumulative Effect of Direct Mortality on Grizzly Bears*

The KSM Project Application/EIS (Section 18.8.4.3) predicted a negligible magnitude residual effect on direct mortality of grizzly bears, which was not significant (minor) with mitigation. The potential residual effect for direct mortality of grizzly bears predicted for the KSM Project was due to vehicle collisions, since vehicles will be used during the construction and operation phases of the Project along Project roads (access, service, and haul roads) and Highway 37 and 37A. This residual effect was brought forward into the CEA, which considers all residual sources of direct mortality due to all relevant projects and human uses of the area (Table 18.9-18) that could impact the grizzly bear populations within and surrounding the KSM Project (Figure 18.9-3).

Government records (Compulsory Inspection Database) over the past three decades in BC show that, on average, 339 of a total of approximately 15,900 grizzly bears in BC are killed each year by humans (Rockwell 2012). The vast majority of human-induced mortalities are due to legal harvest (87%). Other causes, in order of decreasing importance, include the destruction of problem bears (7%), illegal kills (3%), vehicular collisions (1.6%), and rail kills (1%). Sources of direct mortality that could be affected by increased human development in the CEA and Movement Areas include motor vehicle and rail collisions and avalanche control. Hunting (documented and undocumented) is considered in the Indirect Mortality section (Section 18.9.4.5). Destruction of problem bears is considered in the Attractants section (Section 18.9.4.6).

Vehicle strikes could increase in some parts of the CEA and Movement Areas due to increased road densities and traffic from multiple projects (Figure 18.9-7). There are four LKI segments along Highway 37 that overlap with the CEA Area from Gitwagak (Kitwanga) and north to Burrage (LKI segments 3710, 3720, 3730, and 3740). 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 2011b). The majority (68.5%) of bear collisions occurred in July (N = 1), August (N = 24), and September (N = 29).

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 18.9.4.3), which may act to curb any increases in traffic mortality. For instance, vehicle strikes in areas with higher traffic rates than those expected on Highway 37 account for a relatively small percentage (less than 3%) of human-induced bear mortalities (Rockwell 2012). Rail strikes (due to the coal transport rail line) may also increase with increased use of rail transport in the CEA Area; however, rail strikes also account for a very small percentage of recorded mortalities in the provincial records.

Increased avalanche control in the bear CEA Area may also increase grizzly bear mortality if an avalanche covers their den. Bears may also emerge from hibernation if blasting is sufficiently close. The risk of this occurring is also considered low due to relatively few projects occurring within habitat selected by grizzly bears for denning (e.g., MH un).

18.9.4.4.1 *Other Project/Activity Mitigations to Address Direct Mortality*

The Proponent will consider participating in regional monitoring programs by contributing to regionally based monitoring initiatives where those monitoring initiatives replace proposed KSM Project-specific monitoring (Section 26.21.3), and these monitoring activities are approved by relevant provincial authorities and stakeholders (see Section 18.9.1.4).

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.

18.9.4.4.2 *Determination of Potential Residual Cumulative Effect and Significance*

Table 18.9-20 characterizes the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance. The residual cumulative effects of direct

mortality on grizzly bears will have a negligible magnitude, as it will remain within the natural variation of the local population. Increases in vehicle mortalities are expected to be partly offset by a decreased willingness of bears to cross Highway 37 and 37A with increased traffic (Section 18.9.4.3). The extent of the effect is regional, will extend into the far-future, is sporadic in frequency, and is reversible in the long-term. The context of the population is neutral, with a medium probability of the effect occurring and a medium confidence. The cumulative effect of direct mortality on grizzly bears is assessed as **not significant (minor)**.

18.9.4.5 Cumulative Effect of Indirect Mortality on Grizzly Bears

The KSM Project Application/EIS (Section 18.8.4.4) predicted a low-magnitude residual effect of indirect mortality of grizzly bears, due to increased hunting pressure resulting from increased access, which was not significant (minor) with mitigation. This residual effect was brought forward into the CEA, which considers all residual sources of indirect mortality due to relevant projects and human use of the area (Table 18.9-18), which could affect the grizzly bear populations in the grizzly bear CEA Area (Figure 18.9-3).

Grizzly bears experience increases in legal and illegal/unreported harvest as a consequence of increased road access by hunters (Schallenberger 1980; Zager 1980; B. N. McLellan and Mace 1985; Aune and Kasworm 1989). A disproportionate number of human-caused grizzly bear mortalities are known to occur near roads (B. N. McLellan and Mace 1985). For example, 63% of bear mortalities occurred within 1 km of a road in the Rocky Mountains (Aune and Kasworm 1989). This well documented phenomenon is due to increased access to hunters and increased “defence of life,” property kills, and illegal kills (Titus and Beier 1991; Schoen et al. 1994).

Road density (km/km^2) acts as a proxy for predicting indirect mortality of grizzly bears. In the CEA and Movement Areas, respectively, a 14% increase in road density (from $0.073 \text{ km}/\text{km}^2$ to $0.085 \text{ km}/\text{km}^2$) and a 31.5% increase (from 0.05 to $0.073 \text{ km}/\text{km}^2$) is predicted if all projects occur. Increases in indirect mortality rates are expected to mirror those increases. The KSM Project will create 68 km of new road in two sections: CCAR (35 km) and TCAR (33 km). New roads due to the KSM Project represent 2.05 and 3.69% of new roads in the CEA and Movement Areas, respectively. Where these roads are for mining, they will be access controlled, which will reduce the effect of increased hunting to low levels. Where new roads are not access controlled—such as forestry roads—this effect may increase.

18.9.4.5.1 Other Project/Activity Mitigations to Address Indirect Mortality

The Proponent will consider participating in regional monitoring programs by contributing to regionally based monitoring initiatives where those monitoring initiatives replace proposed KSM Project-specific monitoring (Section 26.21.3), and these monitoring activities are approved by relevant provincial authorities and stakeholders (see Section 18.9.1.4).

It is expected that all other industrial projects will include similar mitigation measures as adopted by the KSM Project (e.g., controlled access to new roads) to minimize the impacts of new road creation on indirect mortality rates for grizzly bear, and will follow all relevant acts, regulations, and BMPs for the activities that they carry out.

18.9.4.5.2 *Determination of Potential for Residual Cumulative Effect and Significance*

Table 18.9-20 characterizes the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance. The cumulative effect of indirect mortality on grizzly bears is considered to have a negligible magnitude, as the access in the CEA Area, although expected to increase, is still relatively low in terms of road density (below 0.6 km/km²). The extent of the effect is regional, will extend into the far-future, is sporadic in frequency, and is reversible in the long-term. The context of the population is neutral, with a medium probability of the effect occurring and medium confidence due to the difficulty in knowing current or future rates of largely illegal and undocumented activity. The cumulative effect on indirect mortality for grizzly bears is assessed as **not significant (minor)** if all other projects go through.

18.9.4.6 *Cumulative Effect of Attractants on Grizzly Bears*

The KSM Project Application/EIS (Section 18.8.4.5) predicted a low-magnitude residual effect on attraction of grizzly bears, which was not significant (minor) with mitigation. Grizzly bears will likely be attracted to the odours from human activity within the Project footprint, such as camps, waste, or carrion along roads. This residual effect is brought forward into the CEA, which considers all residual effects of attractants due to all relevant projects and human use of the area (Table 18.9-18), which could impact the grizzly bear populations within and surrounding the KSM Project (Figure 18.9-3).

The majority of problem bears that are destroyed in North America are bears that were attracted to food such as compost, garbage, roadkill, or roadside litter. Food-acclimated bears lose their fear of humans, become a danger, and are often destroyed. From 1989 to 1993, an average of 20 grizzly bears were destroyed per year in BC because of conflict with humans (Rockwell 2012). An analysis of the Compulsory Inspection Database over the past three decades in BC shows that, on average, 7% of human-induced mortalities were due to the destruction of problem bears; this accounts for approximately 24 of 339 grizzly bear deaths per year (Rockwell 2012). As projects are added to the CEA Area, the amount of attractants and chances of creating problem bears also increases.

18.9.4.6.1 *Other Project/Activity Mitigations to Address Effects of Attractants*

The Proponent will consider participating in regional monitoring programs by contributing to regionally based monitoring initiatives where those monitoring initiatives replace proposed KSM Project-specific monitoring (Section 26.21.3), and these monitoring activities are approved by relevant provincial authorities and stakeholders (see Section 18.9.1.4).

It is expected that all other industrial projects within the CEA Area assessed in this report will include similar mitigation measures as adopted by the KSM Project for attractant management to minimize the impacts of increased attraction of grizzly bears to human-use sites, and will follow all relevant acts, regulations, and BMPs for the activities that they carry out. Reporting of any failures in project attractant management programs, including those of the KSM Project, will be important.

18.9.4.6.2 *Determination of Potential for Residual Cumulative Effect and Significance*

Table 18.9-20 characterizes the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance. The cumulative effect of attractants on grizzly bears is considered to have a low magnitude, as human presence and production of attractants is expected to increase but remain low due to proper management of wastes.

However, the overall role that attractants play in human-induced mortalities (7%) is relatively low compared to factors such as hunting (greater than 87%). The extent of the effect is regional, will extend into the far-future, is sporadic in frequency, and reversible in the long-term. The context of the population is neutral, with a high probability of the effect occurring and medium confidence due to the difficulty in knowing current or future rates of errors in attractant management. The cumulative effect of attractants on grizzly bears is assessed as **not significant (minor)**.

18.9.4.7 Overall Cumulative Effect on Grizzly Bears

The overall cumulative effect on grizzly bears is rated based on the knowledge that the individual effects may interact and create additive or synergistic effects that would have a different nature or greater impact on local grizzly bear populations as a whole, as effects may impact the survival rates and reproductive success of animals. The overall cumulative effect is considered to have a medium magnitude, to extend into the far-future, to be sporadic in frequency, and (largely, but not wholly) reversible in the long-term. The context of the population is high, as the resilience of the grizzly bear population will decrease with multiple effects impacting survival and reproductive rates. The effect has a medium probability of occurring and medium confidence due to the difficulty in knowing how many proposed projects will go forward and the precise timing of each project (Table 18.9-20). The cumulative overall effect on grizzly bears is assessed as **not significant (moderate)**.

18.9.5 Cumulative Effects Assessment for Black Bears

Black bears are the most common large carnivore in North America. Black bears are not at risk in BC, with estimates of 120,000 to 160,000 in the province (D. N. Demarchi 1999). There are no reliable estimates of black bear numbers within the CEA or Movement Areas (Figure 18.9-3) used in this cumulative effects assessment, but they are known to frequently occur in the area (Section 18.1.5.2; [Appendix 18-A](#) and [18-C](#)).

Table 18.9-22 summarizes the projects and activities that have the potential to have residual cumulative effects on black bears due to spatial and temporal overlap with the KSM Project.

18.9.5.1 Project-specific Residual Effects on Black Bears that Are Not Likely to Result in Cumulative Effects

All five residual effects on black bears identified for the KSM Project will interact with at least one project or activity. Therefore, there are no residual effects on black bears that are not likely to result in cumulative effects.

The cumulative effects assessment is conducted for the following potential cumulative effects on black bears:

1. habitat loss and alteration;
2. disruption to movement;
3. direct mortality;
4. indirect mortality;
5. attraction; and
6. overall effects (combined effects on black bears due to all other effects).

Table 18.9-22. Summary of Projects and Activities with Potential to Interact Cumulatively with Expected Project-specific Residual Effects on Black Bears

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities					
	Eskay Creek Mine	Granduc Mine	Johnny Mountain Mine	Kitsault Mine (Closed)	Snip Mine	Swamp Point Aggregate Mine
<i>Habitat Loss</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
<i>Movement</i>	Possible Interaction	Possible Interaction	No Interaction	Possible Interaction	No Interaction	No Interaction
<i>Direct Mortality</i>	Possible Interaction	Possible Interaction	No Interaction	Possible Interaction	No Interaction	No Interaction
<i>Indirect Mortality</i>	Possible Interaction	Possible Interaction	No Interaction	Possible Interaction	No Interaction	No Interaction
<i>Attractants</i>	No Interaction	No Interaction	No Interaction	Possible Interaction	No Interaction	No Interaction

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities					
	Forest Kerr Mine	NTL	Long Lake Hydroelectric	Bear River Gravel	Bronson Slope Mine	Brucejack Mine
<i>Habitat Loss</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
<i>Movement</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
<i>Direct Mortality</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
<i>Indirect Mortality</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
<i>Attractants</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities					
	Arctos Anthracite Coal				Treaty Creek Hydroelectric Project	
	Galore Creek Mine	Kitsault Mine	Mine	Schaft Creek Mine	Snowfield Project	
<i>Habitat Loss</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
<i>Movement</i>	Possible Interaction	Possible Interaction	Possible Interaction	No Interaction	No Interaction	No Interaction
<i>Direct Mortality</i>	Possible Interaction	Possible Interaction	Possible Interaction	No Interaction	No Interaction	No Interaction
<i>Indirect Mortality</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
<i>Attractants</i>	Possible Interaction	Possible Interaction	Possible Interaction	No Interaction	No Interaction	No Interaction

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities					
	Fishing	Guide Outfitting	Residential and Aboriginal Harvest	Mineral and Energy Exploration	Recreation and Tourism	Timber Harvest
<i>Habitat Loss</i>	No Interaction	No Interaction	No Interaction	Possible Interaction	No Interaction	Possible Interaction
<i>Movement</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
<i>Direct Mortality</i>	No Interaction	No Interaction	Possible Interaction	No Interaction	No Interaction	No Interaction
<i>Indirect Mortality</i>	No Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
<i>Attractants</i>	Possible Interaction	No Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction

Description of KSM Residual Effect	Projects and Activities	
	Traffic and Roads	McLymont Creek Hydroelectric
<i>Habitat Loss</i>	Possible Interaction	Possible Interaction
<i>Movement</i>	Possible Interaction	No Interaction
<i>Direct Mortality</i>	Possible Interaction	No Interaction
<i>Indirect Mortality</i>	Possible Interaction	Possible Interaction
<i>Attractants</i>	Possible Interaction	Possible Interaction

18.9.5.2 Cumulative Effect of Habitat Loss and Alteration on Black Bears

The KSM Project Application/EIS (Section 18.8.4.1) predicted a low-magnitude residual effect of habitat loss and alteration on black bears that was not significant (minor) with mitigation. This residual effect is brought forward into the CEA, which considers all sources of likely residual habitat loss and alteration due to relevant projects (Table 18.9-22) that could affect the black bear populations within and surrounding the KSM Project (Figure 18.9-3).

The cumulative assessment of habitat loss on black bears used the same habitat calculations as for grizzly bears. Table 18.9-19 summarizes habitat loss and alteration calculations for grizzly bears, which are also applicable to black bears. Section 18.9.4.2 describes the results of this assessment.

There are some differences in habitat usage between grizzly bears and black bears. While grizzly bears preferentially exploit open habitats (e.g., BAFA and ESSF BEC zones), black bears tend to favour forested BEC units (e.g., BWBS and ICH BEC zones). Additional projects in the CEA Area are more often in open BEC zones than forested ones, resulting in a larger predicted effect for grizzly bear than black bear (Section 18.9.4.2; Table 18.9-19). Black bears are also expected to be less affected by the increases in road density; while grizzly bears avoid habitat within 300 m of road, black bears avoid habitat within 100 m of road (Aune 1994).

Black bears are better able to adapt to human activities compared to grizzly bears. The higher reproductive rates of black bears compared to grizzly bears translates into relatively greater population resilience. The average age at which female black bears first give birth varies from three to six years of age (Kolenosky and Strathearn 1987). Most litters consist of two or three cubs and females reproduce every two to four years, depending on food availability (Samson and Huot 1995). Black bears are also better able to tolerate human activities compared to grizzly bears. Black bears continue to occupy 85% of their historical range, despite historical and current hunting and habitat encroachment.

18.9.5.2.1 Other Project/Activity Mitigations to Address Habitat Loss and Alteration

See “Other Project/Activity Mitigations” for grizzly bears in Section 18.9.4.2.

18.9.5.2.2 Determination of Potential for Residual Cumulative Effect and Significance

Table 18.9-23 characterizes the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance. The effect of habitat loss on black bears is considered to have a low magnitude, as cumulative habitat loss and alteration (less than 2%) will not approach the threshold level where greater than 25% of the habitat is modified, as identified for grizzly bears (Hargis and Bissonnette 1997; Hargis, Bissonette, and Turner 1999; Potvin, Courtois, and Belanger 1999; Poole et al. 2004), and available habitat will remain within the range of natural variation. The extent of the effect is regional, and the duration is far-future, as the habitat will be lost throughout life of the projects and longer. The frequency is sporadic, and the effect is irreversible, as much of the habitat will not be returned to baseline conditions at closure. The context of the black bear population is considered to be low. The probability of the effect occurring is medium and the confidence is medium. The significance of the cumulative effect of habitat loss for black bears is assessed as **not significant (minor)**.

Table 18.9-23. Summary of Cumulative Residual Effects on Black Bears

Description of Residual Effect	Project Component(s)	Timing of Effect	Magnitude	Magnitude Adjusted for CE	Extent	Extent Adjusted for CE	Duration	Duration Adjusted for CE	Frequency	Frequency Adjusted for CE	Reversibility	Reversibility Adjusted for CE	Context	Context Adjusted for CE	Likelihood of Effects				Significance	Significance Adjusted for CE	Follow up Monitoring	Follow-up Monitoring Adjusted by CE
															Probability	Probability Adjusted by CE	Confidence Level	Confidence Adjusted by CE				
Habitat Loss	All	Construction	Low	Low	Local	Regional	Far future	Far future	Sporadic	Sporadic	Irreversible	Irreversible	Low	Low	High	Medium	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Required	Not Required
Disruption of Movement	All	Construction	Low	Low	Landscape	Regional	Far future	Far Future	Sporadic	Regular	Reversible long-term	Reversible long-term	Low	Low	Medium	Medium	Low	Medium	Not Significant (Minor)	Not Significant (Minor)	Not Required	Not Required
Direct Mortality	TCAR, CCAR	Construction	Negligible	Low	Landscape	Regional	Long	Far Future	Sporadic	Sporadic	Reversible long-term	Reversible long-term	Low	Low	Medium	Medium	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Required	Not Required
Indirect Mortality	TCAR, CCAR	Construction	Low	Low	Landscape	Regional	Far future	Far Future	Sporadic	Sporadic	Reversible long-term	Reversible long-term	Low	Low	Medium	Medium	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Required	Not Required
Attractants	Camps, Project roads	Construction	Low	Low	Local	Regional	Far future	Far future	Sporadic	Sporadic	Reversible long-term	Reversible long-term	Low	Low	High	Medium	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Required	Not Required
Overall Effect	All	Construction	Low	Low	Landscape	Regional	Far future	Far Future	Sporadic	Sporadic	Reversible long-term	Reversible long-term	Low	Low	Medium	Medium	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Not Required	Not Required

CE = Cumulative Effect

18.9.5.3 Cumulative Effect of Disruption of Movement on Black Bears

The KSM Project Application/EIS (Section 18.8.4.2) predicted a low-magnitude residual effect of disruption of movement on black bears, which was not significant (minor) with mitigation. This residual effect is brought forward into the CEA, which considers all sources of likely residual movement disruptors due to all relevant projects and human land use activities (Table 18.9-22) that could affect the black bear populations within and surrounding the KSM Project footprint (Figure 18.9-3). The overall effect of combined effects on movement of black bears is assessed.

As with grizzly bears, roads were considered for their potential to act as barriers to black bear movement. A study by Beringer, Siebert, and Pelton (1990) reported that roads with traffic volumes greater than 10,000 vehicles per day (416 VPH), impeded road crossing by black bears, but did not totally restrict them. This study suggests that black bears will likely cross highways at relatively high traffic volumes—higher than those expected for Highway 37 and 37A. Black bears may be more likely to cross roads because they are more adaptable to humans, or because black bears are more reliant on low elevation habitat where most roads are concentrated.

The highest hourly traffic rates predicted within the CEA or Movement Areas for black bears is 39.5 VPH (Section 18.9.4.3; Figure 18.9-7; Table 18.9-21), which is below the traffic volumes reported by Beringer et al. (1990) to reduce road crossings for black bears (416 VPH).

18.9.5.3.1 Other Project/Activity Mitigations to Address Disruption of Movement

See “Other Project/Activity Mitigations” for grizzly bears in Section 18.9.4.3.

18.9.5.3.2 Determination of Potential for Residual Cumulative Effect and Significance

Table 18.9-23 characterizes the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance. The effect of disruption of movement on black bears is considered to have a negligible magnitude, as traffic rates are well below those shown to limit the permeability of roads to black bears. While some black bears may be more resistant to crossing Highway 37 and 37A (Figure 18.9-7) at times of particularly high traffic, roads are not expected to act as a barrier. The extent of the effect is regional, and the duration is into the far-future as traffic rates will increase throughout life of the projects and potentially continue after the KSM Project closes, due to contributions of other projects. The frequency is regular, and the effect is reversible long-term. The context of the black bear population is considered to be low. The probability of the effect occurring is medium and the confidence is Medium. The significance of cumulative disruption of movement for black bears is assessed as **not significant (minor)**.

18.9.5.4 Cumulative Effect of Direct Mortality on Black Bears

The KSM Project Application/EIS (Section 18.8) predicted a low-magnitude residual effect of direct mortality on black bears, which was not significant (minor) with mitigation. The potential residual effect for direct mortality of black bears predicted for the KSM Project was primarily due to vehicle collisions, since vehicles will be used during the construction and operation phases of the Project along Project roads (access, service, and haul roads) and Highway 37 and 37A. This residual effect is brought forward into the CEA, which considers the effects of all

residual sources of direct mortality due to relevant projects (Table 18.9-22) within and surrounding the KSM Project (Figure 18.9-3).

Human-induced causes of direct mortality that could affect black bear populations include vehicle strikes. Other factors influencing black bear mortality include illegal hunting, decreased natural longevity, defence of life kills, and destruction of problem bears (considered under Sections 18.9.5.5 and 18.9.5.6).

Warburton, Maddrey, and Rowe (1993) analyzed human-induced black bear mortalities from 1976 to 1991. This study reported that, of the 4,210 mortalities documented, harvest (considered in Indirect Mortality, Section 18.9.5.5) was responsible for 84% (3,538), followed by 11.9% due to vehicle kills (503). The slightly higher rates of direct mortality of black bear compared to grizzly bear due to vehicle collisions could be due to their greater use of low elevation areas (where roads are concentrated) and their willingness to cross roads at higher traffic volumes (Section 18.9.5.3). Accidental deaths of hibernating bears could also occur during tree felling of den trees during hibernation, which is mitigated via timing of clearing and pre-construction surveys. See Section 18.9.4.4 for the further discussion of the role of factors predicted to increase direct mortality of black bears, as considerations are similar for grizzly and black bears.

18.9.5.4.1 *Other Project/Activity Mitigations to Address Direct Mortality*

See “Other Project/Activity Mitigations” for grizzly bears in Section 18.9.4.4.

18.9.5.4.2 *Determination of Potential for Residual Cumulative Effect and Significance*

Table 18.9-23 characterizes the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance. The effect of direct mortality on black bears is considered to have a low magnitude, as vehicle collisions are not expected to rise to levels that will reduce population numbers to levels below natural variation, especially given the greater resilience of black bears compared to grizzly bears. The extent of the effect is regional, and the duration is into the far-future. The frequency is sporadic, and the effect is reversible long-term. The context of the black bear population is considered to be low. The probability of the effect occurring is medium and the confidence is Medium. The significance of the cumulative effect of direct mortality on black bears is assessed as **not significant (minor)**.

18.9.5.5 *Cumulative Effect of Indirect Mortality on Black Bears*

The KSM Project Application/EIS (Section 18.8) predicted a low-magnitude residual effect of indirect mortality on black bears, which was not significant (minor) with mitigation. The potential residual effect for indirect mortality predicted for the KSM Project was due to increased hunting pressure and human activity resulting from increased access. This residual effect is brought forward into the CEA, which considers all residual sources of indirect mortality due to relevant projects within and surrounding the KSM Project (Table 18.9-22; Figure 18.9-3).

Increased indirect mortality rates can occur as an unintended consequence of increased access routes/roads into an area, which can increase rates of hunting in an area. Illegal hunting is a problem for black bears in BC, due to trade of black bear parts on the black market in Canada.

Road density (km/km^2) acts as a proxy for predicting indirect mortality of black bears. A 14% increase in road density in the CEA Area and a 31.5% increase in road density in the Movement Area is expected in the future. It is predicted that increases in indirect mortality rates will mirror these percentages. The KSM Project will be responsible for creating 68 km of road ($0.0015 \text{ km}/\text{km}^2$) in the CEA Area and $0.0027 \text{ km}/\text{km}^2$ in the Movement Area. The KSM Project and other mining and hydroelectric projects will have controlled access, thus mitigating the effect of increased access. However, increased access on uncontrolled forestry and transmission line access roads may have an effect on black bear populations.

18.9.5.5.1 Other Project/Activity Mitigations to Address Indirect Mortality

See “Other Project/Activity Mitigations” for grizzly bears in Section 18.9.4.5.

18.9.5.5.2 Determination of Potential for Residual Cumulative Effect and Significance

Table 18.9-23 characterizes the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance. The effect of indirect mortality on black bears is considered to have a low magnitude, as human-induced indirect mortality rates at projected levels of development of the area are not expected to rise to levels that will affect population numbers beyond levels of natural variation, especially given the greater resilience of black bears compared to grizzly bears. The extent of the effect is regional, and the duration is into the far-future. The frequency is sporadic, and the effect is reversible long-term. The context of the black bear population is considered to be low. The probability of the effect occurring is medium and the confidence is medium. The significance of cumulative effects of indirect mortality for black bears is assessed as **not significant (minor)**.

18.9.5.6 Cumulative Effect of Attractants on Black Bears

The KSM Project Application/EIS (Section 18.8) predicted a low-magnitude residual effect of attractants on black bears, which was not significant (minor) with mitigation. Black bears will be attracted to the odours from human activity within the Project footprint, such as camps, waste, or carrion along roads. This residual effect is brought forward into the CEA, which considers all residual effects of attractants due to all relevant projects which could affect black bear populations within and surrounding the KSM Project (Table 18.9-22; Figure 18.9-3).

Over the past decade, Conservation Officers in BC have killed an average of 1,180 black bears per year because of a perceived threat from these bears (Morris 2002). This accounts for the loss of roughly 0.74 to 0.98% of the BC population of black bears each year. A discussion of the effects of waste management on grizzly bears is included in Section 18.9.4.6, which also applies to black bears. Attractants are expected to affect more black bears than grizzly bears due to the greater behavioural tolerance that black bears exhibit toward humans and human sites, and the greater overlap between human use areas and black bear habitats.

18.9.5.6.1 Other Project/Activity Mitigations to Address Effect of Attractants

See “Other Project/Activity Mitigations” for grizzly bears in Section 18.9.4.6.

18.9.5.6.2 *Determination of Potential for Residual Cumulative Effect and Significance*

Table 18.9-23 characterizes the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance. The cumulative effect of attractants on black bears is considered to have a low magnitude, as increased human presence is expected to result in increased attractants that could cause an increase in mortality that remains within levels of natural variation. The extent of the effect is regional, will extend into the far-future, is sporadic in frequency, and is reversible in the long-term. The context of the population is low, with a medium probability of the effect occurring and medium confidence due to the difficulty in knowing current or future success of attractant management. The cumulative effect of attractants on black bears is assessed as **not significant (minor)**.

18.9.5.7 Overall Cumulative Effect on Black Bears

The overall cumulative effect on black bears is considered to have a low magnitude, extend into the far-future, to be sporadic, and reversible in the long-term (Table 18.9-23). The context of the population is low, and the effect has a medium probability of occurring and medium confidence due to the difficulty in knowing how many proposed projects will go forward and the precise timing of each project. The overall cumulative effect on grizzly bears is assessed as **not significant (minor)**.

18.9.6 Cumulative Effects Assessment for American Marten

The American marten is a tree-dwelling member of the weasel family. This species is the most commonly trapped mammal in the Skeena Region surrounding the KSM Project, based on local trapping records ([Appendix 18-A](#)). American marten depend on old forests that contain large trees for dens, and coarse woody debris that supports small mammals as winter prey (Strickland and Douglas 1987; Ruggiero et al. 1994; Thompson and Harested 1994). American marten primarily feed on mice and voles, and less frequently on squirrels, snowshoe hares, pikas, birds, bird eggs, insects, and carrion. They also eat a variety of fruits and berries in summer. The cumulative effects on American marten were assessed within the CEA Area identified for American marten (Figure 18.9-4).

Table 18.9-24 summarizes the projects and activities that have the potential to have residual cumulative effects on American marten due to spatial and temporal overlap with the KSM Project.

18.9.6.1 Project-specific Residual Effects on American Marten that Are Not Likely to Result in Cumulative Effects

Two residual effects on American marten were identified for the KSM Project; both of these effects will interact with at least one project or activity. Therefore, there are no residual effects on American marten that are not likely to result in cumulative effects.

The cumulative effects assessment is conducted for the following potential cumulative effects on American marten:

1. habitat loss and alteration; and
2. direct mortality.

**Table 18.9-24. Summary of Projects and Activities with Potential to Interact Cumulatively with Expected
Project-specific Residual Effects on American Marten**

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities					
	Eskay Creek Mine	Forest Kerr Hydroelectric	NTL	Brucejack Mine	Snowfield Project	Treaty Creek Hydroelectric
<i>Habitat Loss</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
<i>Direct Mortality</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities					
	Resident and Aboriginal Harvest	Mineral and Energy Exploration	Fishing	Recreation and Tourism	Timber Harvest	Traffic and Roads
<i>Habitat Loss</i>	No Interaction	Possible Interaction	No Interaction	No Interaction	Possible Interaction	Possible Interaction
<i>Direct Mortality</i>	Possible Interaction	Possible Interaction	No Interaction	No Interaction	Possible Interaction	Possible Interaction

18.9.6.2 Cumulative Effect of Habitat Loss and Alteration on American Marten

The KSM Project Application/EIS (Section 18.8.5.1) predicted a low-magnitude residual effect of habitat loss and alteration (7.4% of available American marten habitat altered in the RSA) that was not significant (minor) with mitigation. This residual effect was brought forward into the CEA, which considers all likely sources of residual habitat loss and alteration due to relevant projects that could affect American marten populations within and surrounding the KSM Project (Table 18.9-24, Figure 18.9-4).

To determine the potential effects of habitat loss and alteration on American marten, permanent and transient (e.g., forest harvesting) habitat loss due to all relevant projects for this VC (Table 18.9-24) were quantified within the species-specific CEA Area (Figure 18.9-4), which corresponds to the RSA used for baseline studies plus an area to the east of Highway 37 to account for American marten movement.

Habitat loss calculations represent a worst-case scenario that assumes habitat loss or alteration due to all projects occurring simultaneously, as sufficient information on project-specific timing was not available. Information that could not be obtained included amounts of permanent habitat loss due to past projects, future exploration projects, and new roads. Linear road density (km/km²) was used as a proxy for habitat loss and alteration due to roads.

Due to overlap between project footprints, overlapping areas were counted only once. The total habitat loss and alteration values were summarized by sector and by BEC unit where possible.

Habitat loss was also analyzed by BEC unit to determine what habitat would be lost relative to the availability and importance of those units to American marten. American marten are most common in low-elevation mature forest in the winter, and require treed habitat in most seasons. Habitat fitting these criteria is found most commonly in the ICH, MH, and CWH BEC zones.

The CEA Area for American marten is 413,624 ha; of this area, 119,280 ha is considered high-quality habitat for American marten (ICH, MH, and CWH BEC zones). Of the available high-quality habitat in the CEA Area, 7,951 ha (1.9% of the entire CEA Area; 6.7% of available high-quality habitat in the CEA Area) is expected to be lost or altered with all projects considered, including the KSM Project. Of the area lost or altered, most is due to forest harvesting (61%), followed by mining (33%) and hydroelectricity projects (6%; Table 18.9-25).

While forest harvesting contributes to most of the habitat loss and alteration, this may not be permanent if forestry rotation allows for no net reduction in important habitat over time. Thus, this area lost due to forestry may be temporary. Excluding forestry from the calculations, 2.6% (3,054 ha) of the CEA Area will be lost or altered.

18.9.6.2.1 Other Project/Activity Mitigations to Address Habitat Loss and Alteration

The Proponent will consider participating in regional monitoring programs by contributing to regionally based monitoring initiatives where those monitoring initiatives replace proposed KSM Project-specific monitoring (Section 26.21.3), and these monitoring activities are approved by relevant provincial authorities and stakeholders (see Section 18.9.1.4).

Table 18.9-25. Summary of American Marten Habitat Loss and Alteration¹ due to all Projects in the CEA Area

Sector	CEA Area (119,280 ha) ²		
	Habitat Lost/Altered (ha)	% Habitat Lost/Altered (% of Habitat in CEA Area)	% Habitat Lost/Altered (% of Lost Habitat due to each Sector)
Mining Projects ³	2,594	2.2	33
Hydroelectric Projects	460	0.4	6
Forestry	4,897	4.1	61
Total	7,951	6.7	

¹Only suitable habitat in the ICH, MH, and CWH BEC zones are considered in calculations for habitat loss and alteration for American marten.

²This is the amount of available high-quality habitat in the CEA Area; see text for definition of high-quality habitat.

³Includes KSM Project in calculations.

It is expected that other industrial projects will include similar mitigation measures as adopted by the KSM Project to minimize the impacts of habitat loss and alteration to this species. Further, other proponents are expected to follow all relevant acts, regulations, and BMPs for the activities that they carry out.

18.9.6.2.2 Determination of Potential for Residual Cumulative Effect and Significance

Table 18.9-26 characterizes the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance. The cumulative effect of habitat loss for American marten is considered to have a low magnitude, as cumulative habitat loss (1.9% of total CEA Area; 6.7% of suitable BEC units in CEA Area) will not approach a threshold level where greater than 25% of the habitat is modified (Hargis and Bissonnette 1997; Hargis, Bissonnette, and Turner 1999; Potvin, Courtois, and Belanger 1999; Poole et al. 2004), and available habitat will remain within the range of natural variation. The extent of the effect is regional, the duration is far-future, and the effect is irreversible, as habitat (i.e., mature forests) will not return to baseline conditions. The context of the population is neutral, since the American marten population in the area is currently healthy. There is a medium probability of the effect occurring and medium confidence. The cumulative effect of habitat loss on American marten is assessed as **not significant (minor)**.

18.9.6.3 Cumulative Effect of Direct Mortality on American Marten

The KSM Project Application/EIS (Section 18.8.5.) predicted a low-magnitude residual effect of direct mortality that was not significant (minor) with mitigation. A residual effect of direct mortality for American marten could occur as a result of vehicle collisions and vegetation clearing. Project infrastructure and access road construction activities such as felling old growth trees (e.g., large cottonwoods and/or spruce trees) and removing coarse woody debris could cause incidental mortality of female American martens, or females and their offspring, if these activities are scheduled during the birthing and rearing periods. This residual effect was brought forward into the CEA, which considers all sources of direct mortality due to relevant projects (Table 18.9-24) that could impact American marten populations within and surrounding the KSM Project (Table 18.9-2; Figure 18.9-4).

The risk of direct mortality due to vegetation clearing will increase as more projects are constructed that require tree clearings. Female American marten select sites in old-growth trees, hollow logs, and beneath rocks to give birth to young, after which time young are often moved to a second den site (Ruggiero et al. 1994; Powell, Buskirk, and Zielinski 2003). Therefore, infrastructure and access road preparation requiring felling (particularly of old, large cottonwoods and/or spruce trees) and removing coarse woody debris could increase mortality of females and offspring if these activities occur during birthing and rearing periods. While pre-clearing surveys can be done to avoid cutting trees that could host birthing and rearing American marten, the forest harvesting sector is less able to schedule tree felling based on life history schedules of wildlife. Therefore, some mortality is expected, primarily as a result of forest harvesting.

Increases in traffic rates and the creation of new roads due to additional projects within the CEA Area could increase the risk of vehicle collisions for American marten. Road density is expected to increase by 61% in the American marten CEA Area, from a present density of 0.04 km/km² to a future density of 0.11 km/km². American marten will be susceptible to vehicle strikes during foraging periods, particularly in winter when marten hunt at night looking for carrion (Zielinski, Spencer, and Barrett 1983; Zielinski 2000). However, the risk of vehicle collisions is anticipated to be low since American marten tend to avoid roads and areas that lack overhead cover (Poole et al. 2004). This conclusion is supported by the low reported mortality rates of American marten along low- and high-use highways, with three vehicle/marten collisions in the Bulkley-Stikine District recorded between 1983 and 2007 (Sielecki 2004, 2010). Therefore, American marten mortality due to vehicle collisions is expected to occur infrequently.

18.9.6.3.1 Other Project/Activity Mitigations to Address Direct Mortality

The Proponent will consider participating in regional monitoring programs by contributing to regionally based monitoring initiatives where those monitoring initiatives replace proposed KSM Project-specific monitoring (Section 26.21.3), and these monitoring activities are approved by relevant provincial authorities and stakeholders (see Section 18.9.1.4).

It is expected that all other industrial projects will include similar mitigation measures as adopted by the KSM Project to minimize the impacts of new road creation and additional traffic, along with vegetation clearing activities, on direct mortality of American marten. Other proponents are also expected to follow all relevant acts, regulations, and BMPs for the activities that they carry out.

18.9.6.3.2 Determination of Potential for Residual Cumulative Effect and Significance

Table 18.9-26 characterizes the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance. The cumulative effect of direct mortality on American marten is considered to have a low magnitude, as increases in direct mortality are not expected to decrease numbers of American marten to below levels of natural variation. The extent of the effect is regional, and the duration is far-future as mortalities will continue following closure of the KSM Project and beyond. The frequency is sporadic, and the effect is reversible (i.e., with project closures or protection measures). The context of the population is neutral, since the American marten population in the area is currently healthy. There is a medium probability of the effect occurring and medium confidence. The cumulative residual effect of direct mortality on American marten is assessed as **not significant (minor)**.

Table 18.9-26. Summary of Cumulative Residual Effects on American Marten

Description of Residual Effect	Project Component(s)	Timing of Effect	Magnitude	Magnitude Adjusted for CE	Extent	Extent Adjusted for CE	Duration	Duration Adjusted for CE	Frequency	Frequency Adjusted for CE	Reversibility	Reversibility Adjusted for CE	Context	Context Adjusted for CE	Likelihood of Effects				Significance	Significance Adjusted for CE	Follow up Monitoring	Follow-up Monitoring Adjusted by CE
															Probability	Probability Adjusted by CE	Confidence Level	Confidence Adjusted by CE				
Habitat Loss	All	Construction	Low	Low	Local	Regional	Far future	Far future	Sporadic	Sporadic	Irreversible	Irreversible	Neutral	Neutral	High	Medium	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Not Required	Not Required
Direct Mortality	TCAR, CCAR, PTMA	Construction	Low	Low	Local	Regional	Far future	Far future	Sporadic	Sporadic	Reversible long-term	Reversible long-term	Neutral	Neutral	Medium	Medium	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Required	Not Required
Overall Effect	All	Construction	Low	Low	Local	Regional	Far future	Far future	Sporadic	Sporadic	Reversible long-term	Reversible long-term	Neutral	Neutral	Medium	Medium	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Not Required	Not Required

CE = Cumulative Effect

18.9.6.4 Overall Cumulative Effect on American Marten

The residual effects predicted for American marten are habitat loss and direct mortality. These two effects may interact, creating additive or synergistic effects that would have a different extent for local American marten populations. Considering the two residual effects on marten, the amount of high-quality habitat in the CEA Area, existing human disturbance and activity (i.e., forestry, roads, and hunting), and mitigation to prevent residual effects, the overall potential residual cumulative effect is not predicted to affect the overall American marten population (low magnitude; Table 18.9-26). The geographic extent of the overall effect will be regional, and the duration will be far-future. The frequency of the two effects is sporadic. The overall effect is largely reversible in the long term, because the removal of habitat will not be reversible, but road-based effects of direct mortality will be reversible at closure when traffic drops to lower levels. The context of the American marten population is neutral, and the probability of habitat loss and direct mortality acting synergistically on the American marten population is medium, with medium confidence. The overall cumulative effect on American marten is assessed as **not significant (minor)**.

18.9.7 Cumulative Effects Assessment for Hoary Marmots

Local Aboriginal peoples requested that potential effects on hoary marmot be assessed for the KSM Project. This species is valued culturally and as a subsistence species. Hoary marmots are found on rocky mountain slopes and hillsides and in alpine meadows where they feed on the leaves and blossoms of a variety of alpine grasses and forbs in spring and early summer. In late summer, they feed on seeds (D. S. Lee and Funderburg 1982). In fall, hoary marmots enter dens where they hibernate for up to eight months of the year (Nagorsen 2005). In areas of abundant food, hoary marmots tend to live in colonies. Hoary marmots feed on a variety of herbaceous plants, grasses, and seeds and usually forage within 100 m of dens (Banfield 1981), although home ranges can extend up to 13.5 ha (Armitage 2000).

Table 18.9-27 summarizes the projects and activities that have the potential to have residual cumulative effects on hoary marmots due to spatial (Figure 18.9-6) and temporal overlap with the KSM Project.

18.9.7.1 Project-specific Residual Effects on Hoary Marmot that Are Not Likely to Result in Cumulative Effects

Two residual effects on hoary marmots were identified for the KSM Project; both of these effects will interact with at least one Project or Activity. Therefore, there are no residual effects on hoary marmots that are not likely to result in cumulative effects.

The cumulative effects assessment is conducted for the following potential cumulative effects on hoary marmot:

- habitat loss and alteration; and
- direct mortality.

**Table 18.9-27 Summary of Projects and Activities with Potential to Interact Cumulatively with Expected
Project-specific Residual Effects on Hoary Marmots**

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities					
	Eskay Creek	Sulphurets Project	NTL	Brucejack Mine	Snowfield Project	Treaty Creek Hydroelectric
<i>Habitat Loss</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
<i>Direct Mortality</i>	Possible Interaction	No Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities					
	Residential and Aboriginal Harvest	Fishing	Recreation and Tourism	Mineral and Energy Exploration	Timber Harvest	Traffic and Roads
<i>Habitat Loss</i>	No Interaction	No Interaction	No Interaction	Possible Interaction	Possible Interaction	Possible Interaction
<i>Direct Mortality</i>	Possible Interaction			Possible Interaction	Possible Interaction	Possible Interaction

18.9.7.2 Cumulative Effect of Habitat Loss and Alteration on Hoary Marmot

The KSM Project Application/EIS (Section 18.8.6.1) predicted a low-magnitude residual effect of habitat loss and alteration that was not significant (minor) with mitigation. A total loss or alteration of 29.6% of available habitat in the KSM Project LSA was predicted, which could displace nine known colonies that occur within a 300-m buffer, two of which overlap directly with the KSM Project footprint. This residual effect is brought forward into the CEA, which considers all sources of likely residual habitat loss due to relevant projects (Table 18.9-27) that could affect hoary marmot populations within and surrounding the KSM Project (Figure 18.9-6).

To determine the potential effects of habitat loss and alteration on hoary marmots, permanent and transient (e.g., forest harvesting) habitat loss and alteration due to all relevant projects for this VC were quantified within the species-specific CEA Area (Figure 18.9-6). Calculated numbers represent a worst case scenario that assumes habitat loss and alteration due to all projects occurring simultaneously, as sufficient information on the timing of all projects was not available. Information that could not be obtained included amounts of permanent habitat loss due to past projects, future mineral exploration and hydroelectric projects, and due to a majority of new roads. Therefore, linear road density km/km² was used as a proxy for habitat loss due to roads.

Due to overlaps between project footprints, overlapping areas were counted only once. The total habitat loss values were calculated by sector and by BEC unit where possible.

Habitat loss was also analyzed by BEC unit to determine what habitat would be lost relative to the availability and importance of those units to hoary marmots. High-quality hoary marmot habitat occurs above the treeline within the BAFA and ESSF BEC zones.

The CEA Area for hoary marmots is 338,080 ha; of this area, 169,513 ha is considered high-quality habitat for marmots (BAFA and ESSF BEC zones). Of the available high-quality habitat in the CEA Area, 11,274 ha (3.3% of the entire CEA Area; 6.7% of available high-quality habitat in the CEA Area) is expected to be lost or altered with all projects considered, including the KSM Project. Of the area lost or altered, most is due to forest harvesting (79%), followed by mining (21%; Table 18.9-28).

While forest harvesting contributes to most of the habitat loss and alteration, this may not be permanent if forestry rotation allows for no net reduction in important habitat over time. In addition, forested habitat is not considered highly suitable for marmots, as their distribution is generally above treeline. Thus, this area lost due to forestry may be temporary or not be applicable to marmots. Excluding forestry from the calculations, 1.4% (2,336 ha) of the CEA Area will be lost or altered due to mining projects.

18.9.7.2.1 Other Project/Activity Mitigations to Address Habitat Loss and Alteration

It is expected that all other industrial projects will include similar mitigation measures as adopted by the KSM Project to minimize the impacts of habitat loss and alteration to this species. Further, other proponents are expected to follow all relevant acts, regulations, and BMPs for the activities that they carry out.

Table 18.9-28. Summary of Hoary Marmot Habitat Loss¹ and Alteration due to all Projects in the CEA Area

Sector	CEA Area (169,513 ha) ²		
	Habitat Lost/Altered (ha)	Habitat Lost/Altered (% of Habitat in CEA Area)	Habitat Lost/Altered (% of Lost Habitat due to each Sector)
Mining Projects ³	2,336	1.4	21
Hydroelectric Projects	0	0	0
Forestry	8,939	5.3	79
Total	11,274	6.7	

¹Only suitable habitat in the BAFA and ESSF BEC zones are considered in calculations for habitat loss and alteration for hoary marmots.

²This is the amount of available high-quality habitat in the CEA Area; see text for definition of high-quality habitat.

³Includes KSM Project in calculations.

18.9.7.2.2 Determination of Potential for Residual Cumulative Effect and Significance

Table 18.9-29 characterizes the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance. The cumulative effect of habitat loss on hoary marmots is considered to be of low magnitude, as cumulative habitat losses will not approach a threshold level where greater than 25% of the habitat is modified (Hargis and Bissonnette 1997; Hargis, Bissonnette, and Turner 1999; Potvin, Courtois, and Belanger 1999; Poole et al. 2004), and available habitat will remain within the range of natural variation. The extent of the effect is regional, and the duration is far-future, as habitat loss will continue following closure of the KSM Project and beyond. The frequency is sporadic, and the effect is irreversible in the long-term, as the majority of lost habitat will likely be under permanent Project infrastructure. The context of the hoary marmot population is low, as the overall population is large. There is a high probability of the effect occurring and medium confidence. The cumulative residual effect of habitat loss on hoary marmots is assessed as **not significant (minor)**.

18.9.7.3 Cumulative Effect of Direct Mortality on Hoary Marmot

The KSM Project Application/EIS (Section 18.8.6.2) predicted a low-magnitude residual effect of direct mortality on hoary marmots that was not significant (minor) with mitigation. There are two predicted means by which direct mortality of hoary marmots were predicted to be affected by the KSM Project: destruction of marmot burrows during Project road construction and pit excavations, and vehicle collisions with marmots along roads. Development of the Kerr, Mitchell, and Sulphurets pits and the construction of haul roads from these pits will remove two marmot burrows and their inhabitants. Although some colonies will be affected, population-level effects are not anticipated. This residual effect is brought forward into the CEA, which considers all residual effects on direct mortality of hoary marmot due to relevant projects (Table 18.9-27) that could affect hoary marmot populations within and surrounding the KSM Project (Table 18.9-2; Figure 18.9-6).

Table 18.9-29. Summary of Cumulative Residual Effects on Hoary Marmots

Description of Residual Effect	Project Component(s)	Timing of Effect	Magnitude	Magnitude Adjusted for CE	Extent	Extent Adjusted for CE	Duration	Duration Adjusted for CE	Frequency	Frequency Adjusted for CE	Reversibility	Reversibility Adjusted for CE	Context	Context Adjusted for CE	Likelihood of Effects				Significance	Significance Adjusted for CE	Follow up Monitoring	Follow up Monitoring Adjusted by CE
															Probability	Probability Adjusted by CE	Confidence Level	Confidence Level Adjusted by CE				
Habitat Loss	Mine Site	Construction	Low	Low	Local	Regional	Far future	Far future	Sporadic	Sporadic	Irreversible	Irreversible	Low	Low	High	High	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Not Required	Not Required
Direct Mortality	Mine Site	Construction	Low	Low	Local	Regional	Long	Far future	Sporadic	Sporadic	Reversible long-term	Reversible long-term	Low	Low	Medium	Medium	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Required	Not Required
Overall Effect	Mine Site	Construction	Low	Low	Local	Regional	Far future	Far future	Sporadic	Sporadic	Reversible long-term	Reversible long-term	Low	Low	Medium	Medium	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Not Required	Not Required

CE = Cumulative Effect

Direct mortality risk may also increase as additional projects are constructed within the hoary marmot CEA Area and within the elevation range wherein hoary marmots are expected. Pre-construction surveys can be done to identify the locations of hoary marmot colonies such that they can be avoided; however, some mining projects may be unable to avoid all areas that are above deposits. Therefore, some mortality is expected for high elevation mining projects within the hoary marmot CEA Area (i.e., the KSM Project, Sulphurets Project, Treaty Creek (exploration), the upper portion of the Brucejack Mine road, and sites associated with the Treaty Creek Hydroelectric Power Project). In addition, vehicle collisions may increase along high-elevation sections of roads associated with these projects.

18.9.7.3.1 *Other Project/Activity Mitigations to Address Direct Mortality*

It is expected that all other industrial projects will include similar mitigation measures as adopted by the KSM Project to minimize the impacts of new road creation and additional traffic, along with pit excavation and clearing activities, on direct mortality of hoary marmots. Other proponents are also expected to follow all relevant acts, regulations, and BMPs for the activities that they carry out.

18.9.7.3.2 *Determination of Potential for Residual Cumulative Effect and Significance*

Table 18.9-29 characterizes the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance. The cumulative effect of direct mortality on hoary marmots is considered to be of low magnitude, as some individuals may experience mortality due to project traffic and construction, but the overall population is not expected to be reduced to below the range of natural variation. The geographic extent of the effect is landscape, as each project is expected to affect only a small portion of the overall population (i.e., only effects of individuals within small populations of a meta-population are expected). The duration is far-future, as direct mortality will continue following closure of the KSM Project and beyond. The frequency is sporadic, and the effect is reversible in the long-term. The context of the hoary marmot population is considered low as the overall population is large. There is a medium probability of the effect occurring and medium confidence. The cumulative residual effect of direct mortality on hoary marmot is assessed as **not significant (minor)**.

18.9.7.4 *Overall Cumulative Effect on Hoary Marmots*

The residual effects predicted for hoary marmots are habitat loss and direct mortality. Considering the two residual effects on hoary marmots, an overall potential residual effect is not predicted to affect the larger hoary marmot population in the CEA Area, and the magnitude is predicted to be low (Table 18.9-29). The geographic extent of the overall effect is landscape, as each project is expected to affect only a small portion of the overall population (i.e., only effects of individuals within small populations of a meta-population are expected). The duration will be far-future. The frequency of the two effects is sporadic, and will be reversible in the long-term. The context of the hoary marmot population is low, and the probability of an overall effect on the hoary marmot population is medium, with medium confidence. The overall effect on hoary marmot is assessed as **not significant (minor)**.

18.9.8 Cumulative Effects Assessment for Bats

The cumulative effects on bats are assessed within the RSA used for baseline studies and for the Application/EIS (Figure 18.9-6). Background information on bat VCs is provided in Section 18.1.5.6, Environmental Setting.

Table 18.9-30 summarizes the projects and activities that have the potential to have residual cumulative effects on bats due to spatial and temporal overlap with the KSM Project.

18.9.8.1 Project-specific Residual Effects on Bats that Are Not Likely to Result in Cumulative Effects

The effect of chemical hazards on bats is the only residual effect identified for bats due to the KSM Project. This effect will not interact with any other project or activity in the bat CEA Area (Table 18.9-30). Therefore, no cumulative effects assessment is conducted for bats.

18.9.9 Cumulative Effects Assessment for Birds

The cumulative effects on raptors, wetland birds, and forest and alpine birds are assessed within the RSA used for baseline studies and for the Application/EIS. Background information on avian VCs is provided in Section 18.1.6, Environmental Setting.

Tables 18.9-31 to 18.9-33 summarize the projects and activities that have the potential to have residual cumulative effects on raptors, wetland birds, and forest and alpine birds due to spatial (Figure 18.9-6) and temporal overlap with the KSM Project.

18.9.9.1 Project-specific Residual Effects on Bird Valued Components that Are Not Likely to Result in Cumulative Effects

Two residual effects on bird VCs were identified for the KSM Project; both of these effects will interact with at least one project or activity. Therefore, there are no residual effects on birds that are not likely to result in cumulative effects.

The cumulative effects assessment is conducted for the following potential cumulative effects on the identified bird VCs:

- habitat loss and alteration (raptors, wetland birds, and forest and alpine birds);
- chemical hazards (wetland birds); and
- overall effects (combined impacts on wetland birds due to all other effects).

18.9.9.2 Cumulative Effect of Habitat Loss and Alteration on Raptors, Wetland Birds, and Forest and Alpine Birds

The KSM Project Application/EIS (Section 18.8) predicted a low-magnitude residual effect of habitat loss and alteration for raptors, wetland birds, and forest and alpine birds that were not significant (minor) with mitigation. These residual effects are brought forward into the CEA, which considers all sources of habitat loss and alteration due to relevant projects that could affect these avian VCs within and surrounding the KSM Project (Figure 18.9-6). The three avian groups use all BEC zones throughout the year for different life requisites. Therefore, calculations of lost and altered habitat are presented as a proportion of all BEC zones altered in the entire CEA Area.

Table 18.9-30. Summary of Projects and Activities with Potential to Interact Cumulatively with expected Project-specific Residual Effects on Bats

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities				
	Eskay Creek Mine	NTL	Brucejack Mine	Snowfield Project	Treaty Creek Hydroelectric
<i>Chemical</i>	No Interaction	No Interaction	No Interaction	No Interaction	No Interaction

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities		
	Mineral and Energy Exploration	Timber Harvest	Traffic and Roads
<i>Chemical</i>	No Interaction	No Interaction	No Interaction

Table 18.9-31. Summary of Projects and Activities with Potential to Interact Cumulatively with Expected Project-specific Residual Effects on Raptors

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities					
	Eskay Creek Mine	NTL	Brucejack Mine	Snowfield Project	Treaty Creek Hydroelectric	Mineral and Energy Exploration
<i>Habitat Loss</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities	
	Timber Harvest	Traffic and Roads
<i>Habitat Loss</i>	Possible Interaction	Possible Interaction

Table 18.9-32. Summary of Projects and Activities with Potential to Interact Cumulatively with Expected Project-specific Residual Effects on Wetland Birds

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities					
	Eskay Creek Mine	NTL	Brucejack Mine	Snowfield Project	Treaty Creek Hydroelectric	Residential and Aboriginal Harvest
<i>Habitat Loss</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	No Interaction
<i>Chemical</i>	No Interaction	No Interaction	No Interaction	Possible Interaction	No Interaction	No Interaction

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities		
	Mineral and Energy Exploration	Timber Harvest	Traffic and Roads
<i>Habitat Loss</i>	Possible Interaction	Possible Interaction	Possible Interaction
<i>Chemical</i>	No Interaction	No Interaction	No Interaction

Table 18.9-33. Summary of Projects and Activities with Potential to Interact Cumulatively with Expected Project-specific Residual Effects on Forest and Alpine Birds

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities								
	Eskay Creek Mine	NTL	Brucejack Mine	Snowfield Project	Treaty Creek Hydroelectric	Residential and Aboriginal Harvest	Mineral and Energy Exploration	Timber Harvest	Traffic and Roads
<i>Habitat Loss</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	No Interaction	Possible Interaction	Possible Interaction	Possible Interaction

The CEA Area for avian VCs is 338,080 ha; of this area, 19,777 ha (5.8%) is expected to be lost or altered due to a combination of all projects in the CEA Area (Table 18.9-34). The KSM Project accounts for loss or alteration to 1.2% of the CEA Area. The largest proportional habitat loss and alteration (i.e., loss of habitat within a BEC unit relative to the availability of habitat within that unit) are predicted to be incurred from the following: ESSF wv (2.90%), MH un (0.92%), CMA unp (0.80%), ICH vc (0.76%) and BAFA unp (0.44%). All of these BEC units are used by the various bird VCs (raptors, wetland birds, and forest and alpine birds).

Table 18.9-34. Summary of Habitat Loss¹ and Alteration for Bird Valued Components due to all Projects in the CEA Area

Sector	CEA Area (338,080 ha) ²		
	Habitat Lost/Altered (ha)	Habitat Lost/Altered (% of Habitat in CEA Area)	Habitat Lost/Altered (% of Lost Habitat due to each Sector)
Mining Projects ³	6,415	1.9	32
Hydroelectric Projects	76	0.02	0.4
Forestry	13,286	3.9	67
Total	19,777	5.8	

¹Suitable habitat occurs in all BEC zones; therefore, the entire area is considered in calculations for habitat loss and alteration for all bird VCs.

²This is the size of the entire CEA Area, as avian VCs use all BEC zones; see text for more information.

³Includes KSM Project in calculations.

Some habitat loss and alteration for all three groups of birds is expected, with the loss of small numbers of nesting structures or nesting habitat during land clearing posing the greatest risk to these groups. This effect can be mitigated with pre-clearing surveys and by avoiding clearing vegetation during the peak nesting season. However, these mitigation practices may not be undertaken during forestry operations, which account for the highest percentage of habitat loss (3.9% of the CEA Area; 67% of the habitat being altered or lost).

18.9.9.2.1 Other Project/Activity Mitigations to Address Habitat Loss and Alteration

It is expected that all other industrial projects will include similar mitigation measures as adopted by the KSM Project to minimize the impacts of habitat loss and alteration to avian VCs. Further, other proponents are expected to follow all relevant legislation, regulations, and BMPs for the activities that they carry out.

It is noted in the Cassiar Iskut-Stikine LRMP that, where nests are identified for forest-dependent raptors, harvesting at the landscape scale should be planned such that it provides contiguous canopy closure appropriate to raptor habitat requirements. This strategy will require the coordination of information collection (projects planned, project footprints, nest survey monitoring data, etc.) from various proponents by a regulating body.

18.9.9.2.2 Determination of Potential for Residual Cumulative Effect and Significance

Tables 18.9-35, 18.9-36, and 18.9-37 characterize the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance for these three avian VCs. The cumulative effect of habitat loss for all avian VCs is considered to be of low

magnitude, since cumulative habitat loss and alteration will be below 1% in applicable BEC subzones. Impacts of habitat loss on destruction of nests can also be reduced via mitigation. The extent of the effect is regional, and the duration is far-future. The frequency is sporadic, and the effect is irreversible, as not all areas will return to baseline conditions. The context of the avian VCs is neutral. There is a high probability of the effect occurring and medium confidence. The cumulative residual effect of habitat loss on raptors, wetland birds, and forest and alpine birds is assessed as **not significant (minor)**.

18.9.9.3 Cumulative Effect of Chemical Hazards on Wetland Birds

The KSM Project Application/EIS (Section 18.8) predicted a medium magnitude residual effect of chemical hazards on wetland birds that was not significant (minor) with mitigation. This residual effect is brought forward into the CEA, which considers all sources of chemical hazards due to relevant projects (Tables 18.9-32) that could affect wetland birds within and surrounding the KSM Project (Figure 18.9-6).

The Snowfield Project is the only project that may interact with the KSM Project resulting in chemical hazards. The proposed Snowfield Project may have a TMF in close proximity to the KSM Project. Wetland birds using the TMF for staging during migration periods may be exposed to elevated concentrations of chemicals in these areas. However, it is expected that if monitoring programs implemented by other proponents indicate wetland birds are using the TMF, then they will prevent them from accessing the site.

18.9.9.3.1 Other Project/Activity Mitigations to Address Chemical Hazards

It is expected that all other industrial projects will include similar mitigation measures as adopted by the KSM Project to minimize the impacts of chemical hazards on wetland birds, such as preventing access to the TMF if monitoring indicates that birds are using the area. Further, other proponents are expected to follow all relevant acts, regulations, and BMPs for the activities that they carry out, and to adaptively mitigate if monitoring activities suggest chemical levels may be unsafe for wetland birds.

18.9.9.3.2 Determination of Potential for Residual Cumulative Effect and Significance

Table 18.9-36 characterizes the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance for wetland birds. The cumulative effect of chemical hazards for wetland birds is considered to be of low magnitude, since wetland bird use of a TMF will be monitored and impacts can be reduced via adaptive mitigation. The extent of the effect is regional, and the duration is far-future. The frequency is continuous as the chemicals will be present continuously within the facilities, and the effect is reversible long-term. The context of wetland birds is neutral. There is a low probability of the effect occurring and a low confidence. The cumulative residual effect of chemical hazards on wetland birds is assessed as **not significant (minor)**.

Table 18.9-35. Summary of Cumulative Residual Effects on Raptors

Description of Residual Effect	Project Component (s)	Timing of Effect	Magnitude	Magnitude Adjusted for CE	Extent	Extent Adjusted for CE	Duration	Duration Adjusted for CE	Frequency	Frequency Adjusted for CE	Reversibility	Reversibility Adjusted for CE	Context	Context Adjusted for CE	Likelihood of Effects				Significance	Significance Adjusted for CE	Follow up Monitoring	Follow up Monitoring Adjusted by CE
															Probability	Probability Adjusted by CE	Confidence Level	Confidence Level Adjusted by CE				
Habitat Loss	All	Construction	Low	Low	Local	Regional	Far future	Far future	Sporadic	Sporadic	Irreversible	Irreversible	Neutral	Neutral	High	High	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Not Required	Not Required

CE = Cumulative Effect

Table 18.9-36. Summary of Cumulative Residual Effects on Wetland Birds																						
Description of Residual Effect	Project Component (s)	Timing of Effect	Magnitude	Magnitude Adjusted for CE	Extent	Extent Adjusted for CE	Duration	Duration Adjusted for CE	Frequency	Frequency Adjusted for CE	Reversibility	Reversibility Adjusted for CE	Context	Context Adjusted for CE	Likelihood of Effects				Significance	Significance Adjusted for CE	Follow up Monitoring	Follow up Monitoring Adjusted by CE
															Probability	Probability Adjusted by CE	Confidence Level	Confidence Level Adjusted by CE				
Habitat Loss	All	Construction	Low	Medium	Local	Regional	Far future	Far future	Sporadic	Sporadic	Irreversible	Irreversible	Neutral	Neutral	High	High	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Not Required	Not Required
Chemical Hazards	TMF, WSF, receiving waters of Unuk River	Operation	Medium	Low	Landscape	Regional	Far future	Far future	Continuous	Sporadic	Reversible long-term	Reversible long-term	Neutral	Neutral	Medium	Low	Low	Low	Not Significant (Moderate)	Not Significant (Minor)	Required	Not Required
Overall Effect	All	Construction	Low	Low	Landscape	Regional	Far future	Far future	Sporadic	Sporadic	Reversible long-term	Reversible long-term	Neutral	Neutral	Medium	Medium	Low	Medium	Not Significant (Minor)	Not Significant (Minor)	Not Required	Not Required

CE = Cumulative Effect

Table 18.9-37. Summary of Cumulative Residual Effects on Forest and Alpine Birds																						
Description of Residual Effect	Project Component(s)	Timing of Effect	Magnitude Magnitude Adjusted for CE		Extent Extent Adjusted for CE		Duration Duration Adjusted for CE		Frequency Frequency Adjusted for CE		Reversibility Reversibility Adjusted for CE		Context Context Adjusted for CE		Likelihood of Effects				Significance Significance Adjusted for CE		Follow up Monitoring Follow up Monitoring Adjusted by CE	
															Probability Probability Adjusted by CE		Confidence Level Confidence Level Adjusted by CE					
Habitat Loss	All	Construction	Low	Low	Local	Regional	Far future	Far future	Sporadic	Sporadic	Irreversible	Irreversible	Neutral	Neutral	High	High	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Not Required	Not Required
CE = Cumulative Effect																						

CE = Cumulative Effect

18.9.9.4 Overall Cumulative Effect on Wetland Birds

Wetland birds are the only avian VC that may experience more than one residual effect. The residual effects predicted for wetland birds are habitat loss and chemical hazards. Considering the two residual effects on wetland birds, an overall potential residual effect is not predicted to affect the larger wetland bird population, and the magnitude is predicted to be low (Table 18.9-36). The geographic extent of the overall effect is regional, the duration will be far-future, the frequency of the two effects is sporadic, and will be reversible in the long-term. The context of the wetland bird population is neutral, and the probability of an overall effect on wetland birds is medium, with medium confidence. The overall cumulative effect on wetland birds is assessed as **not significant (minor)**.

18.9.10 Cumulative Effects Assessment for Western Toads

The western toad is the only amphibian of conservation concern that occurs in the area ([Appendix 18-A](#)). The cumulative effects on western toad were assessed within the CEA Area identified for western toads (Figure 18.9-5). Background information on western toads is provided in Section 18.1.7, Environmental Setting.

Table 18.9-38 summarizes the projects and activities that have the potential to have residual cumulative effects on western toads due to spatial and temporal overlap with the KSM Project.

18.9.10.1 Project-specific Residual Effects on Western Toad that Are Not Likely to Result in Cumulative Effects

One residual effect on western toads was identified for the KSM Project (direct mortality); this effect may interact with at least one Project or Activity. Therefore, there are no residual effects on western toads that are not likely to result in cumulative effects. The cumulative effects assessment is conducted for the potential cumulative effect of direct mortality on western toads.

18.9.10.2 Cumulative Effect of Direct Mortality on Western Toads

The KSM Project Application/EIS (Section 18.8.9.1) predicted a low-magnitude residual effect of direct mortality for western toad that was not significant (minor) with mitigation. This residual effect was due to predicted risks associated with vehicle collisions during movements or migrations, due to vegetation clearing, which could lead to direct mortality due to crushing by heavy machinery or felled trees, or due to increased sedimentation in ponds. These risks could be mitigated for, but not eliminated. This residual effect is brought forward into the CEA, which considers all sources of direct mortality due to relevant projects (Table 18.9-38) that could affect western toad populations within and surrounding the KSM Project (Figure 18.9-5).

Direct mortality could increase due to cumulative effects of vegetation clearing and use of heavy machinery during construction of multiple projects in the western toad CEA Area (Figure 18.9-5). If construction is occurring during the breeding season, it may also affect toad breeding ponds due to sedimentation.

Table 18.9-38. Summary of Projects and Activities with Potential to Interact Cumulatively with Expected Project-specific Residual Effects on Western Toads

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities					
	Eskay Creek Mine	NTL	Brucejack Mine	Snowfield Project	Treaty Creek Hydroelectric	Recreation and Tourism
<i>Direct Mortality</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities			
	Aboriginal and Residential Harvest (traffic)	Mineral and Energy Exploration	Timber Harvest	Traffic and Roads
<i>Direct Mortality</i>	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction

Migrations of western toads also typically occur within a few days, and a large proportion of the local population can cross roads near breeding sites within hours. Therefore, the risk of direct mortality of this species will increase as more roads and cumulative traffic is added to the area. Increases in traffic rates and the creation of new roads due to additional projects within the CEA Area could increase the risk of vehicle collisions for western toads. Road density is expected to increase by 61% in the western toad CEA Area, from a present density of 0.04 km/km² to a future density of 0.11 km/km² (see Section 18.9.6.3 for road density calculations) and will therefore result in an increase in traffic (Figure 18.9-7). The probability of western toads experiencing mortality by vehicles may increase proportional to the scale of road and traffic increases.

18.9.10.2.1 Other Project/Activity Mitigations to Address Direct Mortality

It is expected that all other industrial projects will include similar mitigation measures as adopted by the KSM Project to minimize the effects of direct mortality due to new road creation. Further, other proponents are expected to follow all relevant acts, regulations, and BMPs for the activities that they carry out.

18.9.10.2.2 Determination of Potential for Residual Cumulative Effect and Significance

Table 18.9-39 characterizes the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance. The cumulative effect of direct mortality on western toads is considered to be of low magnitude, as the likelihood that direct mortality due to vehicle collisions and vegetation clearing could affect population sizes beyond levels of natural variation is considered limited with mitigation. The extent of the effect is regional, and the duration is far-future as mortality will continue following closure of the KSM Project and beyond. The frequency is sporadic, and the effect is reversible in the long-term. The context of the population is high, as western toads are listed on Schedule 1 of SARA (2002b), although the local population in BC is considered healthy (blue-listed in the province). There is a medium probability of the effect occurring and medium confidence. The cumulative residual effect direct mortality on western toads is assessed as **not significant (minor)**.

18.10 Summary of Assessment of Potential Environmental Effects on Wildlife and Wildlife Habitat

Table 18.10-1 provides a summary of all potential and residual effects considered in this assessment.

18.11 Wildlife and Wildlife Habitat Conclusions

The scoping process identified 11 wildlife VCs: moose, mountain goat, grizzly bear, black bear, American marten, hoary marmots, bats, raptors, wetland birds, forest and alpine birds, and western toads. Potential effects on wildlife include: 1) habitat loss and alteration; 2) disruption of movement; 3) sensory disturbance; 4) direct mortality; 5) indirect mortality; 6) attractants; and 7) chemical hazards. Despite application of mitigation measures, residual effects of the seven potential effects are possible. Medium magnitude effects for moose (overall additive effect), mountain goats (habitat loss, sensory disturbance, and overall additive effect), grizzly and black bears (overall additive effect), and wetland birds (chemical hazards) are predicted. However, through a process of design changes and with the implementation of the mitigation and monitoring, no residual effects are assessed as significant associated with the KSM Project.

The assessment of cumulative effects was also conducted, which evaluated the effects of the KSM Project in addition to other mining projects, hydroelectric projects, forestry, and other land use activities in the area. A scoping process identified which wildlife VCs, additional projects, and potential effects were evaluated (Section 18.9). All 11 of the wildlife VCs were evaluated. No significant residual effects due to cumulative effects were predicted for mountain goats, grizzly bears, black bears, American marten, hoary marmots, bats, raptors, wetland birds, forest and alpine birds, or western toad.

Because the Nass moose population has declined, Seabridge conducted a population viability analysis of the Nass moose population to be used for the cumulative effects assessment, which found the moose population is sensitive to relatively minor changes in overall mortality due to its current state/health. When a range of projects, traffic, and resulting mortality was added to the modelled population, the current population size declined under certain development and traffic scenarios (KSM Project traffic alone did not cause the population to decline). Therefore, because the level of future industrial development along the Highway 37 corridor is uncertain, the determination of significance for the overall cumulative effect on moose was assessed for two possible future scenarios, primarily driven by mortality from traffic accidents: 1) a “likely development” scenario, with one to three mining projects being concurrently in production, and 2) an “unlikely development” scenario where all or most projects go ahead as planned.

The likely development scenario has a medium probability of occurring and a medium confidence, as it is more likely that one to three projects occur, rather than all projects considered in the cumulative effects assessment. The overall cumulative effect on moose under the likely development scenario was assessed as not significant (moderate). The unlikely development scenario, in contrast, has a low probability of occurring, as it is unlikely that all projects will occur simultaneously, and the confidence is low due to the difficulty in knowing how many proposed projects will go forward and the precise timing of each project. The overall cumulative effect on the moose population under the unlikely scenario of high development is predicted to result in a significant (major) effect due to increased mortality due to traffic accidents. However, this assessment has relatively low certainty because the likelihood of all proposed projects occurring simultaneously is low and the model structure is posited to cause it to be overly sensitive to small reductions in survival.

Several species or groups were evaluated in the scoping section and excluded from the assessment as potential VCs because other species with similar habitat requirements were selected as a VC and could act as a proxy for other species. Fisher and wolverine were considered to have the same responses as American marten, grizzly bear, and black bear assessments (Tables 18.8-5 and 18.8-6). Hence, potential residual effects on fisher and wolverine from construction and operation of the Project are also considered not significant. Lynx, fox, coyote, and weasel were considered to have the same responses as the American marten assessment (Table 18.8-6); therefore, potential residual effects on these four species are also considered not significant. Wolf was considered under the moose assessment, as moose are a primary prey source for wolf. The potential residual effects on wolf from the Project are therefore also considered not significant.

Table 18.9-39. Summary of Cumulative Residual Effects on Western Toads

Description of Residual Effect	Project Component (s)	Timing of Effect	Magnitude	Magnitude Adjusted for CE	Extent	Extent Adjusted for CE	Duration	Duration Adjusted for CE	Frequency	Frequency Adjusted for CE	Reversibility	Reversibility Adjusted for CE	Context	Context Adjusted for CE	Likelihood of Effects				Significance	Significance Adjusted for CE	Follow up Monitoring	Follow up Monitoring Adjusted by CE
															Probability	Probability Adjusted by CE	Confidence Level	Confidence Level Adjusted by CE				
Direct Mortality	PTMA, CCAR, TCAR	Construction	Low	Low	Local	Regional	Long	Far future	Sporadic	Sporadic	Reversible long-term	Reversible long-term	High	High	Medium	Medium	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Required	Not Required

CE = Cumulative Effect

Table 18.10-1. Summary of Assessment of Potential Environmental Effects: Wildlife

Valued Component	Phase of Project	Significance Analysis of Project		Significance Analysis of Cumulative Residual Effects
		Potential Effect	Key Mitigation Measures	Residual Effects
Moose	Construction	Habitat Loss and Alteration	Partial deactivation of some mine components (e.g., Coulter Creek access road) and partial revegetation post-closure. Majority of TMF will be reclaimed; however, during the early years of closure phase wildlife may need to be prevented from accessing the TMF until monitoring programs indicate water quality and associated vegetation are safe.	Not Significant (Minor)
		Disruption of Movement	Partial revegetation post closure, including development of movement corridor across the valley on TMF dams; design bridges over Unuk river crossings to allow animals to move under and the Mitchell-Treaty Twinned Tunnels will no longer daylight across the valley, eliminating the potential barrier, as it will remain underground. Refuge areas along access roads will be ploughed along the road during winter; gaps in snow on roads will be created at best spacing to allow an escape for moose; partial decommissioning of roads and linear corridors; implement speed limits; road signs in areas where road traverses suitable wildlife habitats; monitor saddle area for moose movement.	Not Significant (Minor)
		Sensory Disturbance	Noise specifications will be considered when selecting equipment to purchase; noise dampening measures will be applied where possible; helicopter flight paths will be followed to minimize disturbance; noise will be monitored periodically at various human and wildlife receptor locations.	N/A
		Direct Mortality	Prevent the seeding or planting of attractive vegetation near roads; maintain ROW clearing; speed limits implemented and monitored; road signs warning of moose along road; additional precautions taken during high moose activity hours (crepuscular hours); monitoring and adaptive management of wildlife-vehicle interactions.	Not Significant (Minor)
		Indirect Mortality	Controlled access (e.g., gated road); Project area designated as no hunting zone and no personal firearms permitted within project area; partial deactivation of Coulter Creek access road post-closure.	Not Significant (Minor)
		Attractants	Minimize the use of roadside salts for winter road management; mitigation along KSM access roads will include creating breaks in snow banks along ploughed Project access roads.	N/A
		Overall Effect - Likely Development Scenario	See above for mitigation of all effects on moose	Not Significant (Moderate)
		Overall Effect - Unlikely Development Scenario	See above for mitigation of all effects on moose	N/A
		Post-closure	Chemical Hazards	Water quality in the TMF will be monitored as per the Site-wide Water Management Plan (Section 26.17). If water quality does not meet guidelines, wildlife will be prevented from accessing the TMF until guidelines are met.
				Not Significant (Minor)
Mountain Goat	Construction	Habitat Loss and Alteration	In the Mine Site, rock storage suitable for reclamation post-closure; management plan for ungulate winter range habitat (Section 26.21.2).	Not Significant (Moderate)
		Disruption of Movement	Partial revegetation post closure; manage roads and traffic to minimize interactions with vehicles; helicopter flight paths to minimize disturbance	Not Significant (Minor)

(continued)

Table 18.10-1. Summary of Assessment of Potential Environmental Effects: Wildlife (continued)

Valued Component	Phase of Project			Significance Analysis of Project	Significance Analysis of Cumulative Residual
		Potential Effect	Key Mitigation Measures	Residual Effects	Effects
Mountain Goat	Construction	Sensory Disturbance	A noise management plan will be developed with the objective to ensure that noise levels during all phases of the Project are acceptably low for human and wildlife receptors and receptors of concern in the vicinity of the project, as per human health guidelines. Mountain goat response to noise will be monitored as part of the WEMP; helicopter flight paths will be followed to minimize disturbance; noise will be monitored periodically at various human and wildlife receptor locations.	Not Significant (Moderate)	Not Significant (Moderate)
		Direct Mortality	Speed limits implemented and monitored; road signs warning of mountain goats along road; additional precautions taken during high mountain goat activity hours; monitoring and adaptive management of wildlife-vehicle interactions; partial reclamation of Coulter Creek access road post-closure; an avalanche hazard plan will be produced in consultation with the BC MFLNRO, or the applicable government agency, to minimize the effects of avalanche control on mountain goats.	Not Significant (Minor)	Not Significant (Minor)
		Indirect Mortality	Controlled access (e.g., gated road); Project area designated as no hunting zone and no personal firearms permitted within Project area; partial deactivation of Coulter Creek access road post-closure. Monitoring of mountain goat distribution near the Mine Site.	Not Significant (Minor)	Not Significant (Minor)
		Attractants	Minimize the use of roadside salts for winter road management.	N/A	N/A
		Chemical Hazards	Mitigation and management of ML/ARD will be addressed in the ML/ARD Prediction and Prevention Management Plan (Section 26.13). If goats are found using the pit walls or RSF prior to reclamation, adaptive management may be implemented to prevent them from accessing these areas. Mitigation and management of fugitive dust is addressed in the Fugitive Dust Emissions Management Plan (Section 26.2.2) and the Traffic and Road Use Management Plan (Section 26.18). Vegetation growing in dusted areas will be monitored as per the Terrestrial Plant Tissue Metal Concentrations Monitoring Plan (Section 26.17.2).	Not Significant (Minor)	N/A
		Overall Effect	See above for mitigation of all effects on mountain goats	Not Significant (Moderate)	Not Significant (Moderate)
Grizzly Bear	Construction	Habitat Loss and Alteration	Partial deactivation of some mine components (Coulter Creek access road) and partial revegetation at mine closure. Majority of TMF will be reclaimed but wildlife will be excluded until monitoring programs indicate water quality and associated vegetation are safe.	Not Significant (Minor)	Not Significant (Minor)
		Disruption of Movement	Development of movement corridor on TMF dam across the valley during post-closure phase of the Project; partial reclamation of Coulter Creek access road during closure phase; implement speed limits on access roads; road signs in areas where road traverses suitable wildlife habitats.	Not Significant (Minor)	Not Significant (Moderate)
		Sensory Disturbance	Noise specifications will be considered when selecting equipment to purchase; noise dampening measures will be applied where possible; helicopter flight paths will be followed to minimize disturbance; noise will be monitored periodically at various human and wildlife receptor locations.	N/A	N/A

(continued)

Table 18.10-1. Summary of Assessment of Potential Environmental Effects: Wildlife (continued)

Valued Component	Phase of Project	Significance Analysis of Project		Significance Analysis of Cumulative Residual Effects
		Potential Effect	Key Mitigation Measures	Residual Effects
Grizzly Bear	Construction	Direct Mortality	Prevent the seeding or planting of attractive vegetation near roads; maintain ROW clearing; speed limits implemented and monitored; road signs warning of bears along road; additional precautions taken during high bear activity hours; partial reclamation of Coulter Creek access road post-closure; monitoring and adaptive management of wildlife-vehicle interactions.	Not Significant (Minor)
		Indirect Mortality	Controlled access (e.g., gated road); Project area designated as no hunting zone and no personal firearms permitted within project area; deactivation of Coulter Creek access road post-closure.	Not Significant (Minor)
		Attractants	Eliminate attractive odours by incinerating appropriate garbage items and properly storing items that cannot be incinerated, enforce proper waste disposal procedures for all employees and contractors.	Not Significant (Minor)
		Chemical Hazards	All chemical storage and handling will meet the specifications identified in the Dangerous Goods and Hazardous Materials Management plan (Section 26.6), the Explosives Manufacture, Storage, Handling, and Use Management Plan (Section 26.8), the Waste Management Plan (Section 26.19), and the Spill Prevention and Emergency Response Plan (Section 26.16). Effluent water quality monitoring will be conducted and designed to ensure regulatory compliance with permitted discharge criteria outlined in the Aquatic Effects Monitoring Plan (Section 26.9.2).	N/A
		Overall Effect	See above for mitigation of all effects on grizzly bears	Not Significant (Moderate)
Black Bear	Construction	Habitat Loss and Alteration	Partial deactivation of some mine components (Coulter Creek access road) and partial revegetation at mine closure. Majority of TMF will be reclaimed but wildlife will be excluded until monitoring programs indicate water quality and associated vegetation are safe.	Not Significant (Minor)
		Disruption of Movement	Development of movement corridor on TMF dam across the valley during post-closure phase of the Project; partial reclamation of Coulter Creek access road during closure phase; implement speed limits on access roads; road signs in areas where road traverses suitable wildlife habitats.	Not Significant (Minor)
		Sensory Disturbance	Noise specifications will be considered when selecting equipment to purchase; noise dampening measures will be applied where possible; helicopter flight paths will be followed to minimize disturbance; noise will be monitored periodically at various human and wildlife receptor locations.	N/A
		Direct Mortality	Prevent the seeding or planting of attractive vegetation near roads; maintain ROW clearing; speed limits implemented and monitored; road signs warning of bears along road; additional precautions taken during high bear activity hours; partial reclamation of Coulter Creek access road post-closure; monitoring and adaptive management of wildlife-vehicle interactions; clearing outside of the denning period or if this is not possible, pre-clearing surveys for dens in identified denning habitat.	Not Significant (Minor)
		Indirect Mortality	Controlled access (e.g., gated road); Project area designated as no hunting zone and no personal firearms permitted within project area; deactivation of Coulter Creek access road post-closure.	Not Significant (Minor)
		Attractants	Eliminate attractive odours by incinerating appropriate garbage items and properly storing items that cannot be incinerated, enforce proper waste disposal procedures for all employees and contractors.	Not Significant (Minor)

(continued)

Table 18.10-1. Summary of Assessment of Potential Environmental Effects: Wildlife (continued)

Valued Component	Phase of Project	Potential Effect	Key Mitigation Measures	Significance Analysis of Project Residual Effects	Significance Analysis of Cumulative Residual Effects
Black Bear	Construction	Chemical Hazards	All chemical storage and handling will meet the specifications identified in the Dangerous Goods and Hazardous Materials Management plan (Section 26.6), the Explosives Manufacture, Storage, Handling, and Use Management Plan (Section 26.8), the Waste Management Plan (Section 26.19), and the Spill Prevention and Emergency Response Plan (Section 26.16). Effluent water quality monitoring will be conducted and designed to ensure regulatory compliance with permitted discharge criteria outlined in the Aquatic Effects Monitoring Plan (Section 26.9.2).	N/A	N/A
		Overall Effect	See above for mitigation of all effects on black bears	Not Significant (Minor)	Not Significant (Minor)
American Marten	Construction	Habitat Loss and Alteration	Partial deactivation of some mine components and roads and partial revegetation post closure.	Not Significant (Minor)	Not Significant (Minor)
		Disruption of Movement	Ensuring corridors of mature forest for dispersal whenever possible during development, development of corridors through TMF valley, decommissioning of access roads. American marten are known to use drainage culverts to access habitats on either side of roads and will therefore likely use such culverts placed along the access road. In general, drainage culverts assist in mitigating the potentially harmful effects of roads by providing a vital habitat linkage.	N/A	N/A
		Direct Mortality	Timing construction outside of the breeding season and/or conduct pre-clearing surveys for dens; speed limits implemented and monitored; additional precautions taken during high marten activity hours; monitoring and adaptive management of wildlife/vehicle interactions.	Not Significant (Minor)	Not Significant (Minor)
		Attractants	Eliminate attractive odours by incinerating appropriate garbage items and properly storing items that cannot be incinerated, enforce proper waste disposal procedures for all employees and contractors; Monitor use of structures by martens, recommend actions (e.g., building skirting) based on usage.	N/A	N/A
		Chemical Hazards	All chemical storage and handling will meet the specifications identified in the Dangerous Goods and Hazardous Materials Management plan (Section 26.6), the Explosives Manufacture, Storage, Handling, and Use Management Plan (Section 26.8), the Waste Management Plan (Section 26.19), and the Spill Prevention and Emergency Response Plan (Section 26.16). Effluent water quality monitoring will be conducted and designed to ensure regulatory compliance with permitted discharge criteria outlined in the Aquatic Effects Monitoring Plan (Section 26.9.2).	N/A	N/A
		Overall Effect	See above for mitigation of all effects on American marten	Not Significant (Minor)	Not Significant (Minor)
Hoary Marmot	Construction	Habitat Loss and Alteration	Partial deactivation of some mine components and roads and partial revegetation post closure.	Not Significant (Minor)	Not Significant (Minor)
		Direct Mortality	There are limited ways to mitigate mortality of marmots during construction of the pits and roads. Translocation of wild animals to alternate areas is a labour intensive and expensive technique that has been met with limited success (Armstrong and Seddon 2008; Massei et al. 2010); therefore, translocation may not be a viable option to prevent mortality of marmots as a result of construction and operation.	Not Significant (Minor)	Not Significant (Minor)

(continued)

Table 18.10-1. Summary of Assessment of Potential Environmental Effects: Wildlife (continued)

Valued Component	Phase of Project	Significance Analysis of Project		Significance Analysis of Cumulative Residual Effects
		Potential Effect	Key Mitigation Measures	Residual Effects
Hoary Marmot	Construction	Chemical Hazards	Mitigation and management of fugitive dust is addressed in the Fugitive Dust Emissions Management Plan (Section 26.2.2) and the Traffic and Road Use Management Plan (Section 26.18). Vegetation growing in dusted areas will be monitored as per the Terrestrial Plant Tissue Metal Concentrations Monitoring Plan (Section 26.17.2).	N/A
		Overall Effect	See above for mitigation of all effects on hoary marmots	Not Significant (Minor)
Bats	Construction	Habitat Loss and Alteration	Prior to Project construction, the McTagg valley will be surveyed for bat hibernacula; if a cave-based bat hibernacula is found, MFLRO or the applicable agency will be notified and mitigation enacted, as possible.	N/A
		Sensory Disturbance	Noise: noise will be monitored periodically at various human and wildlife receptor locations. Lights: Use of directed/focused lighting rather than broad area lighting and by shielding lights to minimize stray light. Lighting in non-essential areas will be regulated to permit use only when necessary.	N/A
		Direct Mortality	Pre-clearing surveys of mature forests (in association with black bear and marten den surveys).	N/A
		Attractants	Prevent bats from accessing tunnels. Monitor for use of tunnels and buildings by roosting bats, recommend actions based on species and location of roost.	N/A
	Operation	Chemical Hazards	Effluent water quality monitoring will be conducted and designed to ensure regulatory compliance with permitted discharge criteria outlined in the Aquatic Effects Monitoring Plan (Section 26.9.2). In addition, benthic invertebrate monitoring will be conducted in receiving waters. Water quality in the TMF and WSF will be monitored as per the Site-wide Water Management Plan (Section 26.17).	Not Significant (Minor)
Raptors	Construction	Habitat Loss and Alteration	Conduct clearing outside raptor sensitive periods where active raptor nests are present and establish and adhere to buffer zones and working procedures established for working around identified active raptor nests during raptor sensitive periods. Pre-clearing surveys to identify active and non-active raptor nests. If an active nest cannot be avoided or work must be undertaken within buffer areas, a nest monitoring program would be initiated. Inactive raptor nests or nests found outside of the breeding season would be maintained or relocated, in consultation with BC MFLNRO, or the appropriate agency.	Not Significant (Minor)
		Sensory Disturbance	Noise: noise will be monitored periodically at various human and wildlife receptor locations. Lights: Use of directed/focused lighting rather than broad area lighting and by shielding lights to minimize stray light. Lighting in non-essential areas will be regulated to permit use only when necessary.	N/A
		Direct Mortality	Clearing of vegetation will occur outside the breeding period if possible; if not feasible in all instances, pre-clearing surveys will be conducted to monitor for nests during the breeding period. Implementation of design features to reduce the risk of collisions and electrocutions with the transmission line, including increasing visibility of the line; prevent raptor nesting on posts; monitoring for effects and adaptive management where areas with a higher incidence of bird strikes are identified.	N/A

(continued)

Table 18.10-1. Summary of Assessment of Potential Environmental Effects: Wildlife (continued)

Valued Component	Phase of Project	Significance Analysis of Project		Significance Analysis of Cumulative Residual Effects
		Potential Effect	Key Mitigation Measures	Residual Effects
Raptors	Construction	Attractants	Monitor use of transmission line towers and pits by nesting raptors, recommend actions based on species and location of nest.	N/A
		Chemical Hazards	Mitigation and management of ML/ARD on wildlife will be addressed in the ML/ARD Prediction and Prevention Management Plan (Section 26.13). If raptors are found using the pit walls or RSF prior to reclamation, adaptive management may be implemented.	N/A
Wetland Birds	Construction	Habitat Loss and Alteration	Avoid active wetland bird nests by conducting clearing outside breeding periods (April 1 to July 31; Section 34 of the Wildlife Act) or through pre-clearing surveys for wetland bird nests in suitable habitat when clearing is required within the breeding period. If nests are found, a buffer area, free of noise and construction activity, would be established and implemented around wetland bird nests for the duration of the breeding period. Majority of TMF will be reclaimed but wildlife excluded until monitoring programs indicate water quality and associated vegetation are safe.	Not Significant (Minor)
		Sensory Disturbance	Noise: noise will be monitored periodically at various human and wildlife receptor locations. Lights: Use of directed/focused lighting rather than broad area lighting and by shielding lights to minimize stray light. Lighting in non-essential areas will be regulated to permit use only when necessary.	N/A
		Direct Mortality	Clearing of vegetation outside the breeding period if possible; if not feasible in all instances, conduct pre-clearing surveys to monitor for nests during the breeding period. Implementation of design features to reduce the risk of collisions and electrocutions with the transmission line, including increasing visibility of the line near wetlands, monitoring for effects and adaptive management where areas with a higher incidence of bird strikes are identified.	N/A
		Attractants	Monitor wetland bird use of the TMF and WSF; if wetland birds are attracted to the area and it is considered a potential hazard, then wetland bird species will be prevented from using any water within the proposed TMF and WSF.	N/A
		Overall Effect	See above for mitigation of all effects on wetland birds	Not Significant (Minor)
		Chemical Hazards	Effluent water quality monitoring will be conducted and designed to ensure regulatory compliance with permitted discharge criteria outlined in the Aquatic Effects Monitoring Plan (Section 26.9.2). In addition, benthic invertebrate monitoring outlined in the Aquatic Effects Monitoring Plan (Section 26.9.2) and vegetation monitoring outlined in the Terrestrial Plant Tissue Metal Concentrations Monitoring Plan (Section 26.17.2) will be conducted in receiving waters downstream of discharge sites. Water quality in the TMF and WSF will be monitored as per the Site-wide Water Management Plan (Section 26.17). If water quality guidelines are not met, wetland birds will be prevented from accessing the TMF and WSF until guidelines are met.	Not Significant (Moderate)
	Operation	Chemical Hazards	Effluent water quality monitoring will be conducted and designed to ensure regulatory compliance with permitted discharge criteria outlined in the Aquatic Effects Monitoring Plan (Section 26.9.2). In addition, benthic invertebrate monitoring outlined in the Aquatic Effects Monitoring Plan (Section 26.9.2) and vegetation monitoring outlined in the Terrestrial Plant Tissue Metal Concentrations Monitoring Plan (Section 26.17.2) will be conducted in receiving waters downstream of discharge sites. Water quality in the TMF and WSF will be monitored as per the Site-wide Water Management Plan (Section 26.17). If water quality guidelines are not met, wetland birds will be prevented from accessing the TMF and WSF until guidelines are met.	Not Significant (Minor)

(continued)

Table 18.10-1. Summary of Assessment of Potential Environmental Effects: Wildlife (continued)

Valued Component	Phase of Project			Significance Analysis of Project	Significance Analysis of
		Potential Effect	Key Mitigation Measures	Residual Effects	Cumulative Residual Effects
Forest and Alpine Birds	Construction	Habitat Loss and Alteration	Avoid active forest bird nests by conducting clearing outside breeding periods (April 1 to July 31; Section 34 of the Wildlife Act) or through pre-clearing surveys for bird nests in suitable habitat when clearing is required within the breeding bird period. If a nest is found, a buffer area, free of noise and construction activity, would be established and implemented around nests for the duration of the breeding period.	Not Significant (Minor)	Not Significant (Minor)
		Sensory Disturbance	Noise: noise will be monitored periodically at various human and wildlife receptor locations. Lights: Use of directed/focused lighting rather than broad area lighting and by shielding lights to minimize stray light. Lighting in non-essential areas will be regulated to permit use only when necessary.	N/A	N/A
		Direct Mortality	Clearing of vegetation outside the breeding period if possible; if not feasible in all instances, conduct pre-clearing surveys to monitor for nests during the breeding period. Follow speed limits on roads.	N/A	N/A
		Chemical Hazards	Effluent water quality monitoring will be conducted and designed to ensure regulatory compliance with permitted discharge criteria outlined in the Aquatic Effects Monitoring Plan (Section 26.9.2). In addition, benthic invertebrate monitoring outlined in the Aquatic Effects Monitoring Plan (Section 26.9.2) and vegetation monitoring outlined in the Terrestrial Plant Tissue Metal Concentrations Monitoring Plan (Section 26.17.2) will be conducted in receiving waters downstream of discharge sites.	N/A	N/A
Western Toad	Construction	Habitat Loss and Alteration	Partial deactivation of some mine components and partial revegetation at mine closure.	N/A	N/A
		Disruption of Movement	Monitoring to identify locations along the access roads where there is a high probability of bisecting any movement corridors between terrestrial and aquatic habitat. Where these corridors are identified road construction will include provisions for toad movement such as culverts under the road (toad tunnels) to facilitate movement. During construction, monitoring will direct placement of tunnels if mass migration events occur. Monitoring for road mortality during operations.	N/A	N/A
		Direct Mortality	Pre-clearing surveys conducted on identified ponds that would likely be affected by construction during the breeding (May) and emergence periods (mid-July to mid-August) to identify western toad breeding ponds. Use of machinery and associated construction activities (i.e., tree felling) would be avoided in identified breeding ponds during those periods. During operation, appropriate protection for toads will be provided to minimize collisions with vehicles, which may include toad tunnels or other effective mitigation. The effectiveness of mitigation measures, if implemented, will be monitored.	Not Significant (Minor)	Not Significant (Minor)

(continued)

Table 18.10-1. Summary of Assessment of Potential Environmental Effects: Wildlife (completed)

Valued Component	Phase of Project			Significance Analysis of Project	Significance Analysis of
		Potential Effect	Key Mitigation Measures	Residual Effects	Cumulative Residual Effects
Western Toad	Construction	Attractants	Eliminate pools being formed in roadside ditches that may be attractive toad breeding areas by ensuring that ditches are free-draining; monitor roadside pools that are formed for toad breeding activities.	N/A	N/A
	Operation	Chemical Hazards	Effluent water quality monitoring will be conducted and designed to ensure regulatory compliance with permitted discharge criteria outlined in the Aquatic Effects Monitoring Plan (Section 26.9.2). In addition, benthic invertebrate monitoring outlined in the Aquatic Effects Monitoring Plan (Section 26.9.2) will be conducted in receiving waters downstream of discharge sites. Water quality in the TMF and WSF will be monitored as per the Site-wide Water Management Plan (Section 26.17).	N/A	N/A

Note: If there is only one residual effect on a VC, no overall effect is assessed.

Northern goshawk, trumpeter swan, grouse, ptarmigan, olive-sided flycatcher, rusty black bird, and common nighthawk were not considered separate VCs for this assessment because any potential effects on these species would be addressed in the raptor, wetland bird, and forest and alpine bird assessments. Potential effects on birds were evaluated for these three groups. The primary concerns are direct mortality and habitat loss. These potential effects will be mitigated through avoiding tree clearing during breeding periods, conducting pre-clearing surveys, buffering any identified active nests, and monitoring where buffers cannot be maintained around active nests (Section 26.21). Secondary concerns from the Project on birds include mortality from bird strikes with transmission lines (raptors and wetland birds). The overall potential Project-related residual effect on the local raptor, wetland bird, and forest and alpine bird populations is predicted to cause a minor change from baseline conditions for a short time but not affect the sustainability of the local bird populations, and thus is assessed as not significant. Hence, potential residual effects on the four SARA-listed bird species (northern goshawk, olive-sided flycatcher, rusty blackbird, and common nighthawk), and on trumpeter swan, grouse, and ptarmigan are also considered not significant.

Aquatic furbearers—beaver, mink, muskrat, and river otters—were considered in assessment of the loss of wetland features (Chapter 16) and in the wetland bird habitat assessment. Loss of wetlands was considered not significant, and closure and compensation plans may mitigate the loss of extent and function. No potential residual effects of the Project are therefore predicted for these furbearer species.

Frog species, such as wood frogs and Columbia spotted frogs, were excluded from the assessment because any potential effects on the species are addressed in the assessment of alteration to wetland extent in the wetlands section (Chapter 16). Generally, the magnitude of the effects of the Project on wetlands is expected to be low or negligible, thus the interactions were not considered significant. Therefore, potential residual effects on wood frogs and Columbia spotted frogs are also considered not significant.

References

1992. *Canadian Environmental Assessment Act*, SC. C. 37.
1994. *Migratory Birds Convention Act*, SC. C. 22.
- 1996a. *Land Act*, RSBC. C. 245.
- 1996b. *Water Act*, RSBC. C. 483.
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