10. NOISE EFFECTS ASSESSMENT

10.1 INTRODUCTION

This chapter presents the baseline noise conditions present in the Project Site (summarized in detail in Appendix 10-A), and undertakes a scoping and effects assessment process to characterize potential effects on noise as a result of the proposed Harper Creek Project (the Project). Noise is a valued component (VC) that is used to inform the effects assessment for other VCs (i.e., wildlife, human health and current use of lands and resources for traditional purposes).

Given that the Project is located within a relatively undeveloped area, baseline noise levels are low. The construction and operation of the Project will introduce noise sources primarily from construction equipment, open pit mining activities, haul vehicles, and vehicle traffic.

The objective of this chapter is to provide noise modelling results that can be used to assess potential noise effects to wildlife receptors (Chapter 16), human receptors (Chapter 21), commercial and non-commercial land use (Chapter 18), and the current users of lands and resources for traditional purposes by Aboriginal people (Chapter 22).

This chapter follows the effects assessment methodology described in Chapter 8 of this Application for an Environmental Assessment Certificate / Environmental Impact Statement (Application/EIS).

10.2 REGULATORY AND POLICY FRAMEWORK

The Project is subject to both provincial and federal environmental assessment (EA) requirements under the BC *Environmental Assessment Act* (2002) and *Canadian Environmental Assessment Act* (1992). The requirements for the noise effects assessment are defined in the Application Information Requirements (AIR) for the Project, approved by the British Columbia Environmental Assessment Office (BC EAO) on October 21, 2011 and in the Background Information Document issued by the Canadian Environmental Assessment Agency in April 2011. A baseline report has been prepared to support the submission of the Application/EIS.

There is currently no federal or provincial legislation that stipulates ambient noise levels for mine development projects in terms of wildlife, human or other environmental impacts. The AIR (BC EAO 2011) for the Project identified that the Application should address noise effects on humans in accordance with Health Canada's *Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise* (Health Canada 2011). References from this guidance document for the various assessment criteria and other applicable references are used in this assessment.

Noise levels in the workplace are also regulated by WorkSafeBC, which has an employee exposure threshold of less than 85 dBA for L_{ex} daily noise exposure level and 140 dBC peak sound level during work hours (WorkSafeBC 2014). The *Health, Safety and Reclamation Code for Mines in British Columbia* (BC MEMPR 2008) also limits the maximum permissible noise exposure for unprotected ears on a daily basis to be 85 dBA L_{ex} average for 8 hours or equivalent, with no exposure to steady state noise over

109 dBA and no exposure to peak impulse noise over 140 dBA. Because employees' exposure to noise during work hours is regulated by WorkSafeBC and the *Health, Safety and Reclamation Code for Mines in British Columbia,* noise effects are only considered for off-duty employees in this assessment. Noise effects on general public human health, wildlife, recreational land users and Aboriginal land users will be assessed based on recommended levels from various jurisdictions or literature, presented in Section 10.5.5.1. The detailed assessments on these receptors are provided in each of the relevant chapters (Chapters 16, 18, 21, and 22).

The Health Canada guideline (2011) states:

> *There are reasonable cause-and-effect associations linking noise exposure to hearing loss, sleep disturbance, interference with speech intelligibility, noise complaints and a high level of annoyance (WHO 1999). Health Canada's advice is based on the expected changes between existing and predicted daytime and nighttime sound levels (for construction, operation and decommissioning activities) at locations where people are or will be present, as well as on the characteristics of the noise (e.g., impulsive or tonal) or the type of community (e.g., urban, suburban, or quiet rural areas).*

In this assessment, three types of noise sources are identified—noise from mining operations, noise from an increase in traffic volume, and noise from blasting. Different approaches are taken to assess these three types of sources and more information is provided in Section 10.5.3.3.

Data and guidelines from the following sources were used in addition to Project-related information to assess noise levels in the study area:

- World Health Organization *Guidelines for Community Noise* (WHO 1999);
- Health Canada's *Useful Information for Environmental Assessments* (Section 6: Noise Effects; 2010);
- US Environmental Protection Agency's (US EPA's) *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety* (1974);
- Michaud, Bly, and Keith's *Using a Change in Percent Highly Annoyed with Noise as a Potential Health Effect Measure for Projects under the Canadian Environmental Assessment Act* (2008);
- US Federal Transit Administration's (FTA's) *Transit Noise and Vibration Impact Assessment* (Harris Miller Miller & Hanson Inc. 2006); and
- Standards Australia's AS2187.2-2006™ *Explosives—Storage and Use Part 2: Use of Explosives; (Appendix J)*.

10.3 Scoping the Effects Assessment

10.3.1 Valued Components

The BC EAO define VCs as components "that are considered important by the proponent, public, First Nations, scientists, and government agencies involved in the assessment process" (BC EAO 2013). To be included in the Application/EIS, there must be a perceived likelihood that the VC will be affected by the proposed Project. VCs proposed for assessment were identified in the AIR and in the Canadian Environmental Assessment Agency (CEA Agency; 2011) Background Information document.

10.3.1.1 Consultation Feedback on Proposed Valued Components

A preliminary list of proposed VCs was drafted early in project planning based on the expected physical works and activities of the reviewable project, the type of project being proposed, the local and regional area of the Project Site, and consultation with federal, provincial, and local government agencies. The Neskonlith Indian Band stated that noise impacts from operations have the potential to disturb wildlife on and adjacent to the Project Site. A summary of how scoping feedback was incorporated into the selection of assessment subject areas and VCs is provided below in Table 10.3-1.

Table 10.3-1. Consultation Feedback Related to Noise

Subject Area	Feedback by*				Issues Raised	Response
	AG	G	P/S	O		
Noise	X				Noise impact could potentially disturb wildlife on and adjacent to the Project Site.	Noise impact on wildlife on and adjacent to the Project Site will be assessed in Chapter 16.

**AG = Aboriginal Group; G = Government; P/S = Public/Stakeholder; O = Other*

10.3.1.2 Selecting Valued Components

Noise is defined as any undesirable sound that may irritate people, disturb rest or sleep, cause loss of hearing, or otherwise affect the quality of life of affected individuals (Health Insider 2002). Noise can result in psychological and physiological effects (e.g., stress), mental health effects, and effects on residential behaviour (WHO 1999).

Noise has been selected as a VC because of its intrinsic importance to local residents, Aboriginal users in the area, employees and wildlife. As previously indicated, workplace noise is not assessed for on-duty employees in this assessment. During the Construction phase, activities are expected for 70 hours a week. For this assessment, it was assumed these activities will take place only during the daytime (7 am to 10 pm) with no activity at night-time. Due to the *Mines Act* and WorkSafeBC requirements being in effect during the daytime combined with no activity at night, there is no potential for noise effects on employees during the Construction phase. Off duty employees that are off site will be considered in this assessment during the Operations phase.

The Construction, Operations, Closure, and Post-Closure phases of the Project will produce a variety of noise from haul trucks and open pit mining activities. Noise from mining activity will occur throughout the operation period, specifically in the areas adjacent to the pits and the process plant. Closure and Post-Closure noise levels will be lower, intermittent, and related to reclamation and maintenance.

The Project components and activities associated with each phase of the Project are screened to identify potential interactions with noise. A list of key Project components and activities was developed from the Project's Technical Report and Feasibility Study (refer to Tables 8.7-1 and 8.7-2, respectively, in Chapter 8 for the detailed list). A preliminary evaluation of potential interactions between the Project components and activities with the noise VC was conducted and is presented in Table 10.3-2 with "X" indicating a potential interaction between noise and the Project component or activity.

Table 10.3-2. Project Components and Activities with the Potential to Cause Noise

Category	Project Components and Activities	Noise
Construction		
Concrete production	Concrete batch plant installation, operation and decommissioning	X
Dangerous goods and hazardous materials	Hazardous materials storage, transport, and off-site disposal	X
	Spills and emergency management	
Environmental management and monitoring	Construction of fish habitat offsetting sites	X
Equipment	On-site equipment and vehicle use: heavy machinery and trucks	X
Explosives	Explosives storage and use	X
Fuel supply, storage and distribution	Fuel supply, storage and distribution	X
Open pit	Open pit development - drilling, blasting, hauling and dumping	X
Potable water supply	Process and potable water supply, distribution and storage	
Power supply	Auxiliary electricity - diesel generators	X
	Power line and site distribution line construction: vegetation clearing, access, poles, conductors, tie-in	X
Processing	Plant construction: mill building, mill feed conveyor, truck shop, warehouse, substation and pipelines	X
	Primary crusher and overland feed conveyor installation	X
Procurement and labour	Employment and labour	
	Procurement of goods and services	
Project Site development	Aggregate sources/ borrow sites: drilling, blasting, extraction, hauling, crushing	X
	Clearing vegetation, stripping and stockpiling topsoil and overburden, soil salvage handling and storage	X
	Earth moving: excavation, drilling, grading, trenching, backfilling	X
Rail load-out facility	Rail load-out facility upgrade and site preparation	X
Roads	New TMF access road construction: widening, clearing, earth moving, culvert installation using non-PAG material	X

(continued)

Table 10.3-2. Project Components and Activities with the Potential to Cause Noise (continued)

Category	Project Components and Activities	Noise
Construction *(cont'd)*		
Roads *(cont'd)*	Road upgrades, maintenance and use: haul and access roads	X
Stockpiles	Coarse ore stockpile construction	X
Stockpiles	Non-PAG waste rock stockpile construction	X
Stockpiles	PAG and non-PAG low-grade ore stockpiles foundation construction	X
Stockpiles	PAG waste rock stockpiles foundation construction	X
Tailings management	Coffer dam and south TMF embankment construction	X
Tailings management	Tailings distribution system construction	X
Temporary construction camp	Construction camp construction, operation, and decommissioning	X
Traffic	Traffic delivering equipment, materials and personnel to site	X
Waste disposal	Waste management: garbage, incinerator and sewage waste facilities	X
Water management	Ditches, sumps, pipelines, pump systems, reclaim system and snow clearing/stockpiling	X
Water management	Water management pond, sediment pond, diversion channels and collection channels construction	X
Operations 1		X
Concentrate transport	Concentrate transport by road from mine to rail load-out	X
Dangerous goods and hazardous materials	Explosives storage and use	X
	Hazardous materials storage, transport, and off-site disposal	X
	Spills and emergency management	
Environmental management and monitoring	Fish habitat offsetting site monitoring and maintenance	
Equipment fleet	Mine site mobile equipment (excluding mining fleet) and vehicle use	X
Fuel supply, storage and distribution	Fuel storage and distribution	X
Mining	Mine pit operations: blast, shovel and haul	X
Ore processing	Ore crushing, milling, conveyance and processing	X

(continued)

Table 10.3-2. Project Components and Activities with the Potential to Cause Noise (continued)

Category	Project Components and Activities	Noise
Operations 1 ***(cont'd)***		
Potable water supply	Process and potable water supply, distribution and storage	
Power supply	Backup diesel generators	
	Electrical power distribution	
Processing	Plant operation: mill building, truck shop, warehouse and pipelines	X
Procurement and labour	Employment and labour	
	Procurement of goods and services	
Rail load-out facility	Rail load-out activity (loading of concentrate; movement of rail cars on siding)	X
Reclamation and decommissioning	Progressive mine reclamation	X
Stockpiles	Construction of non-PAG tailings beaches	X
	Construction of PAG and non-PAG low-grade ore stockpile	X
	Non-PAG waste rock stockpiling	X
	Overburden stockpiling	X
Tailings management	Reclaim barge and pumping from TMF to Plant Site	
	South TMF embankment construction	X
	Sub-aqueous deposition of PAG waste rock into TMF	
	Tailings transport and storage in TMF	
	Treatment and recycling of supernatant TMF water	
Traffic	Traffic delivering equipment, materials and personnel to site	X
Waste disposal	Waste management: garbage and sewage waste facilities	X
Water management	Monitoring and maintenance of mine drainage and seepage	
	Surface water management and diversions systems including snow stockpiling/clearing	
Operations 2	***Includes the Operations 1 non-mining Project Components and Activities, with the addition of these activities:***	
Processing	Low grade ore crushing, milling and processing	X

(continued)

Table 10.3-2. Project Components and Activities with the Potential to Cause Noise (continued)

Category	Project Components and Activities	Noise
Operations 2 ***(cont'd)***		
Reclamation and decommissioning	Partial decommission and removal of open pit water management system	
	Partial reclamation of non-PAG waste rock stockpile	X
	Partial reclamation of TMF tailings beaches and embankments	X
Tailings management	Construction of North TMF embankment and beach	X
	Deposit of low-grade ore tailings into open pit	X
Water management	Surface water management	
Closure		
Environmental management and monitoring	Environmental monitoring including surface and groundwater monitoring	
	Monitoring and maintenance of mine drainage, seepage, and discharge	
	Reclamation monitoring and maintenance	
Open pit	Filling of open pit with water and storage of water as a pit lake	
Procurement and labour	Employment and labour	
	Procurement of goods and services	
Reclamation and decommissioning	Decommissioning of rail concentrate load-out area	
	Decommissioning and reclamation of mine site roads	X
	Decommissioning and removal of plant site, processing plant and mill, substation, conveyor, primary crusher, and ancillary infrastructure (e.g., explosives facility, truck shop)	X
	Decommissioning of diversion channels and distribution pipelines	X
	Decommissioning of reclaim barge	
	Reclamation of non-PAG low-grade ore stockpile, overburden stockpile and non-PAG waste rock stockpile	X
	Reclamation of TMF embankments and beaches	X

(continued)

Table 10.3-2. Project Components and Activities with the Potential to Cause Noise (completed)

Category	Project Components and Activities	Noise
Closure *(cont'd)*		
Reclamation and decommissioning *(cont'd)*	Removal of contaminated soil	X
	Use of topsoil for reclamation	X
Stockpiles	Storage of waste rock in the non-PAG waste rock stockpile	X
Tailings management	Construction and activation of TMF closure spillway	X
	Maintenance and monitoring of TMF	
	Storage of water in the TMF and groundwater seepage	
	Sub-aqueous tailing and waste rock storage in TMF	
	TMF discharge to T Creek	
Waste disposal	Solid waste management	X
Post-Closure		
Environmental management and monitoring	Environmental monitoring including surface and groundwater monitoring	
	Monitoring and maintenance of mine drainage, seepage, and discharge	
	Reclamation monitoring and maintenance	
Open pit	Construction of emergency spillway on open pit	
	Storage of water as a pit lake	
Procurement and labour	Procurement of goods and services	
Stockpiles	Storage of waste rock in the non-PAG waste rock stockpile	
Tailings management	Storage of water in the TMF and groundwater seepage	
	Sub-aqueous tailing and waste rock storage	
	TMF discharge	

10.3.2 Defining Assessment Boundaries

Assessment boundaries define the maximum limit within which the effects assessment and supporting studies (e.g., predictive models) are conducted. Boundaries encompass where and when the Project is expected to interact with the VCs; any political, social, and economic constraints; and limitations in predicting or measuring changes. Boundaries relevant to noise are described below.

10.3.2.1 Temporal Boundaries

Temporal boundaries, provided in Table 10.3-3 are the time periods considered in the assessment for various Project phases and activities. Temporal boundaries reflect those periods during which planned Project activities are reasonably expected to increase noise levels. Potential effects on noise levels will be considered for peak periods during the Construction and Operations phases of the Project when activity levels are at their maximum, thus generating the most noise. If the effects of noise are deemed to be not significant during these peak periods, effects from noise during the other periods should be even less. Each of the temporal boundaries has been chosen for having the highest intensity of significant noise-generating equipment and operations across the Project Site, therefore representing the highest potential for noise emission. Peak activity levels have been selected for the Construction and Operations phases of the Project, as follows.

Table 10.3-3. Temporal Boundaries Used in the Noise Effects Assessment

Phase	Project Year	Length of Phase	Description of Activities
Construction	-2 and -1	2 years	Pre-construction and construction activities
Operations 1	13	1 year	Active mining in the open pit in Year 13 representing the highest activity level in the Project Site.

Since the Construction phase includes a variety of construction activities such as construction of the mine haul roads, open pit pre-stripping, and construction of the mining processing area, scenarios were developed to represent the worst cases during the two years of Construction. Since the mine haul roads will need to be upgraded before the construction of the mining infrastructure and processing area, two scenarios were developed. The haul road upgrade is expected during the first six month of the Construction phase to establish basic site infrastructure (Scenario CON-01). After the mine haul roads are upgraded, the construction of the mining area will commence (Scenario CON-02).

During the Operations phase, the production and mining activities are expected to be fairly consistent. HCMC has indicated that from Year 3 to Year 15, the amount of waste rock and ore will be 60 million tonnes per year; however, it was predicted that the highest amount of fuel (35 million litres) will be used in Year 13. Moreover, the main 220-tonne haul trucks were also predicted to be the most active in Year 13, which is during Operations Phase 1. Year 13 was selected for modelling to represent the worst case during both Operations Phases 1 and 2. Noise effects during Closure and Post-Closure are anticipated to be significantly less than for the Construction and Operations phases and are therefore not modelled.

10.3.2.2 Spatial Boundaries

The spatial boundary was established based on the "zone of influence" beyond which the residual effects of the Project are expected to diminish to a negligible state. The expected zone of influence was determined using baseline studies, consultation, and expert knowledge.

Based on professional judgement, and other assessments in similar regions, Project-related noise may be audible under calm conditions at a distance of up to 10 km from the source (Golder 2002). As such, the regional study area (RSA; Figure 10.3-1) was defined to include a zone extending 10 km around the Project Site. This area was selected so that noise contours could be predicted to levels 5 to 10 decibels (dB) below the relevant criteria limits. This spatial boundary is defined as the RSA and the modelling domain for the computational noise modelling.

10.3.2.3 Administrative and Technical Boundaries

Due to the nature of noise and the likelihood of receptors that would be affected by the types of noise emissions from the Project, including steady continuous noise from the mining operations and intermittent noise from road traffic, there is a technical spatial boundary in terms of assessing the effects from both of these noise source types.

Road traffic noise tends to have a greater effect on those receptors in the immediate vicinity (within 50 m) of the roadway. Additionally, given that there is existing road traffic through Vavenby, the scope of this assessment is to quantify the increase in noise level attributable to the Project—namely along the roads upon which the majority of Project-related traffic will travel: McCorrie Road, Vavenby Road, and Capostinsky Road. The technical boundary described is encompassed in the RSA described previously and there is no administrative boundary applicable to the noise assessment.

10.4 BASELINE CONDITIONS

Human perception of sound pressure is non-linear: a 10-fold increase in sound pressure is perceived as a doubling of the noise level by the average person. This non-linearity is reflected in the use of the dB, a logarithmic measure of noise level. The dB is the logarithm of the ratio of the root mean square sound pressure relative to a standard root mean square sound pressure, usually 20 micropascals, the hearing threshold below which sound is not generally detectable by the human ear.

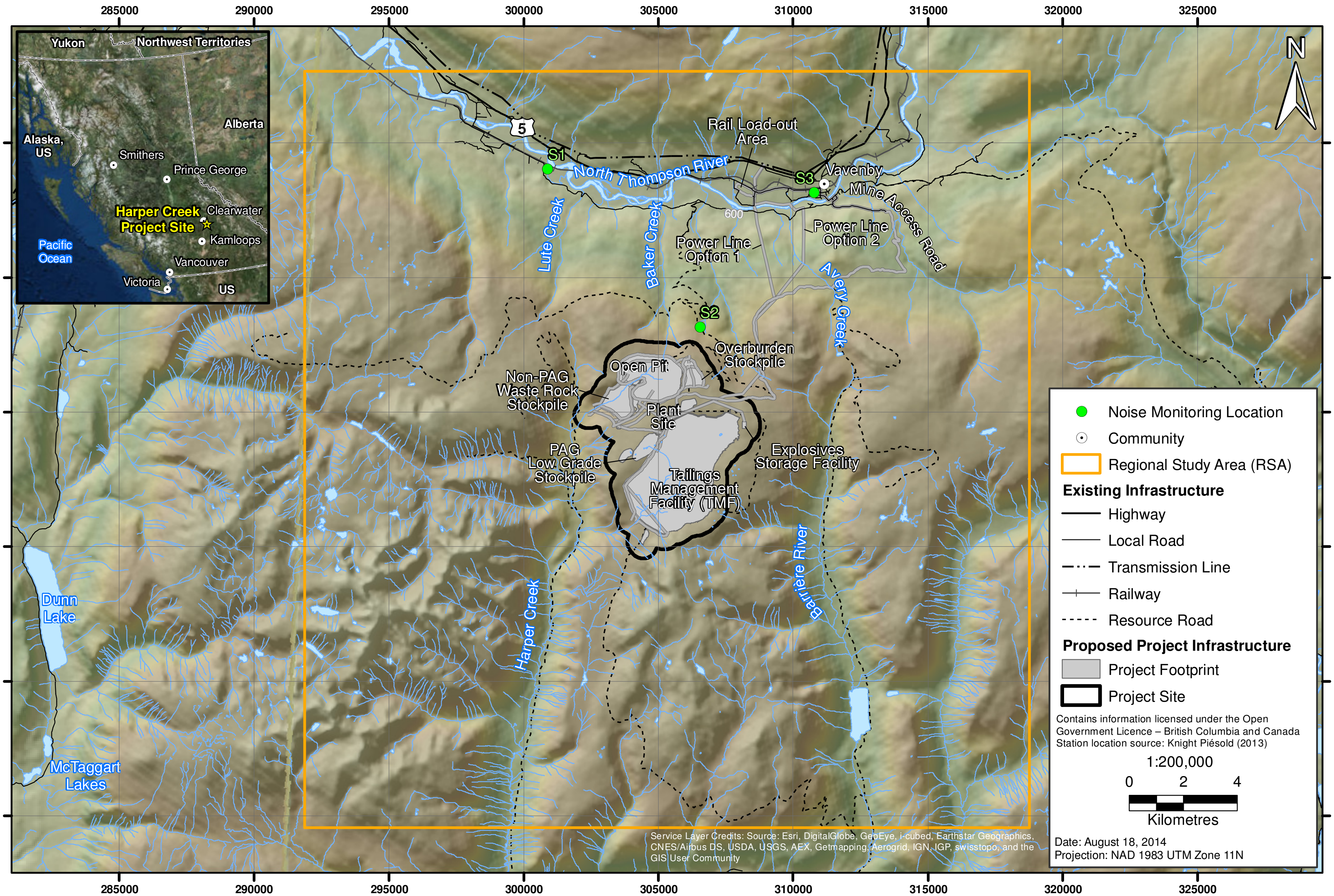
Noise is typically monitored as sound pressure level, in A-weighted decibels (dBA). The A-weighting is designed to match the average frequency response of the human ear. Some typical noise levels are as follows (in dBA):

- rustling leaves: 20;
- refrigerator humming: 40;
- normal conversation: 60;
- business office: 65;
- average city traffic: 80 to 85;
- jackhammer: 100;
- jet take-off at 100 m distance: 130; and
- motorcycles, firecrackers, small arms fire: up to 140.

In general, a 3 dBA difference is required by the average person to notice any alteration in noise level.

Figure 10.3-1
Noise Regional Study Area and Baseline Monitoring Locations

ERM



10.4.1 Regional and Historical Setting

Potential noise sources in the surrounding area include the unincorporated municipality of Vavenby, located approximately 10 km to the northwest of the proposed mine. There is also a lumber mill in Vavenby, and active logging in the area surrounding the Project location, with a network of FSRs. Highway 5 runs along the North Thompson River and at its closest point is approximately 7 km to the north of the Project Site. Highway 5 is a significant source of noise in the area.

10.4.2 Baseline Studies

The baseline noise study was undertaken to determine the existing noise levels in the vicinity of the Project. Three noise monitoring stations (S1, S2, and S3) were set up within the study area and noise levels were recorded over a 24-hour period at each location during the week of September 10 to 17, 2012. The locations were selected to characterize the range of baseline conditions in the region based on their proximity to proposed and local infrastructure and where future mining activities are expected. Table 10.4-1 provides the coordinates of the monitoring locations and the locations are shown in Figure 10.3-1.

Table 10.4-1. Locations of Noise Monitoring Stations

Monitoring Station	UTM Zone	UTM Easting (m)	UTM Northing (m)
S1	11U	300,887	5,719,051
S2	11U	306,541	5,713,176
S3	11U	310,770	5,718,169

Note: UTM coordinates refer to NAD 83.

Data analysis was done using BZ5503 – Measurement Partner Suite software. BZ5503 is used in the field to transfer the data files from the SD card in the noise monitor to the field laptop. BZ5503 also allows the technician to listen to the noise recordings and determine the length of the recording.

Data collected by Knight Piésold Ltd. were provided in Microsoft Excel with hourly L_{AMax}, L_{Amin}, L_{Aeq}, and L_{A90} values. Additional processing was performed to provide daily L_{AMax}, L_{Amin}, L_{Aeq}, and L_{A90} values. No noise monitoring was carried out during the winter months; therefore, seasonal variation cannot be assessed. Only one background noise monitoring location was installed, near the Project Site, and the results from this site have been assumed to be representative of background conditions throughout the RSA.

10.4.2.1 Station S1

Noise monitoring station S1 was located approximately 10 km to the northwest of the planned Project infrastructure. Noise monitoring started at 10:26 a.m. on September 10, 2012. The station was collected the following day, after recording 25 hours of noise data. The monitoring location was in the North Thompson River Valley approximately 0.75 km to the east of the hamlet of Birch Island and 10 km to the west of the town of Vavenby. The monitor was placed in a flat open area, approximately 150 m to the west of the Birch Island/Lost Creek Road and 150 m south of the North Thompson River (Appendix 10-A, Plate 3.2-1). A rail line was between the river and the noise monitor. Highway 5 is located less than 1 km from the monitoring site, on the north side of the river.

10.4.2.2 Station S2

Noise monitoring station S2 was located approximately 4 km to the north of the proposed plant site. The location was on the middle to upper slope of the north aspect of the North Thompson River Valley. The noise monitor was set up in an open area adjacent to a gravel road (Appendix 10-A, Plates 3.2-2 and 3.2-3). Trees and shrubs were approximately 5 m away. Noise monitoring started at 8:45 a.m. on September 14, 2012. The station was closed the following day, after recording 25 hours of noise data.

10.4.2.3 Station S3

Noise monitoring station S3 was located approximately 10 km to the northeast of the proposed plant site. The sampling location was near the Project core shack in the town of Vavenby (Appendix 10-A, Plates 3.2-4 and 3.2-5). Noise monitoring started at 9:45 a.m. on September 16, 2012. The station was collected the following day, after recording 25 hours of noise data. Numerous sources of anthropogenic noise existed at this location; in particular, the station was installed approximately 175 m away from the operating Vavenby Sawmill.

10.4.3 Existing Conditions

This section presents a summary of the results from the baseline noise measurements completed in September 2012. Results from each station are summarized in Table 10.4-2 and provided individually in Appendix 10-A.

Table 10.4-2. Baseline Noise Monitoring Summary

Location	Parameter	Sound Level (dBA)			
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A90}
S1	Maximum	53	64	48	49
	Minimum	38	44	32	34
	Overall average	48	57	38	40
S2	Maximum	41	54	25	27
	Minimum	21	23	20	21
	Overall average	32	48	20	21
S3	Maximum	66	78	50	52
	Minimum	36	44	30	32
	Overall average	56	73	40	42

Note: The sound levels are rounded to the nearest whole number

Natural background noise sources observed included birds, small mammals, wind, and rain. Anthropogenic noise sources included aircraft (helicopters and fixed wing), road vehicles, trains, and general human activity. Recorded noise levels were lowest at station S2 and highest at station S3. From the background data collected at the monitoring station during the monitoring period:

- the daily logarithmic average noise (L_{Aeq}) levels ranged from 32 (S2) to 56 (S3) dBA;

- the daily average noise (L_{A90}) levels ranged from 21 (S2) to 42 (S3) dBA;
- the daily minimum (L_{Amin}) noise levels ranged from 20 (S2) to 40 (S3) dBA; and
- the daily maximum (L_{Amax}) noise levels ranged from 48 (S2) to 73 (S3) dBA.

The L_{eq} values are in the range that would be expected for baseline rural noise levels: approximately 35 dBA during the nighttime and around 45 dBA during the daytime. Higher values, such as at station S3, are due to anthropogenic activity (mostly helicopters) in the RSA.

10.5 Effects Assessment and Mitigation

This section outlines the overall assessment methodologies and criteria used to identify and analyze potential effects, select mitigation measures for implementation, characterize residual effects on noise levels, and determine the significance of an increase in noise as a result of the Project.

10.5.1 Screening Potential Project Effects

Potential effects of the Project on noise were first explored by conducting a comprehensive review of all Project emission sources with the potential to emit noise above background levels. A risk rating exercise was then conducted to identify which Project components and activities have the greatest potential to emit the most noise, followed by a description of the potential effects of noise on key receptors, such as wildlife, human health, and land users (i.e., Aboriginal, commercial, and recreational users) in the vicinity of the Project. For more detailed information on the effects of noise on these receptors, see Chapters 16, 18, and 21.

10.5.1.1 Project Emission Sources

A review of existing Project data and information relevant to the noise effects assessment was completed, including a review of the Project Description (Chapter 5), Technical Report and Feasibility Study (Appendix 5-A), Traffic Impact Assessment (Appendix 5-E), and Project Site plans. Based on this review and discussions with HCMC, noise emission sources were identified.

Two main types of noise emission areas were characterized: fixed or contained noise sources, such as those normally experienced on a mine site, including blasting noise; and road traffic noise sources from the transportation of construction material and concentrate through Vavenby. Noise sources for construction and mining activities are summarized briefly below.

Construction Activities – Mine access road construction from the end of the Saskum Plateau Forest Service Road (FSR) to the mine entrance; construction of mine infrastructure (workshops, offices, processing plant); primary crusher; TMF embankment; initial clearing and ground works; mine haul roads; and road traffic from transportation of construction material and other supply loads to the Project Site via the Vavenby Mountain FSR, the Saskum Plateau FSR, and the Vavenby-Saskum FSR.

Mining Activities – Open pit mining (blasting, drilling, excavating, and hauling); use of overburden stockpiles; use of PAG and non-PAG waste rock stockpiles and low grade ore stockpiles; processing plant; primary crusher; use of the TMF; and road traffic from concentrate, materials, equipment and personnel trips from the Project Site via the mine access road to the Vavenby rail load-out facility.

The rail load-out facility is fully enclosed and has very limited potential to generate noise. No incremental increase in railway traffic as a result of the Project is expected. The rail load-out facility and rail transportation has not been included as a noise emission area of the Project.

Table 10.5-1 provides risk ratings of noise sources, with green indicating low risk interaction, yellow indicating moderate risk interaction, and red indicating high risk interaction.

The determination of risk interaction rating was based on the expected sound power level (SWL), L_W of each equipment/activity. The L_W, presented in Table 10.5-2 for the Construction phase and in Table 10.5-3 for the Operations phase included in this assessment, were provided by the manufacturer or from the ERM noise database. For the Construction phase, equipment and emission area assumed for the construction of access road (CON-01) and the construction of mine infrastructure (CON-02) were identified in Table 10.5-2.

10.5.1.2 Potential Effects of Noise on Wildlife

Disturbance to Wildlife and Loss of Wildlife Habitat

The potential effects on wildlife from the result of exposure to an increase in noise are described in terms of the reduction in biodiversity and population numbers due to an increase in continuous noise levels from mining operations; and flight response, freezing, or strong startle response due to event noise level such as blasting, resulting in loss of habitat. More detailed potential effects of noise effects on wildlife are discussed in Chapter 16.

10.5.1.3 Potential Effects of Noise on Human Health

Evaluation of the Project includes 68 human receptors within the noise RSA. Data sources used to determine human receptor locations include permanent or temporary locations such as cabins, snowmobile pullout areas, campground, off-duty mine workers, tourism facilities and houses in the town of Vavenby. Locations of domestic well and surface water licenses listed by the BC Health Authority (BC HA), the BC Ministry of Forests, Lands and Natural Resource Operations (BC MFLNRO), and the BC MOE are assumed to be associated with dwellings and therefore included in the assessment. A full list of receptor locations is presented in Appendix 21-B. A few noise effects on human health are described below with more detailed potential effects discussed in Chapter 21.

Sleep Disturbance

Sleep disturbance includes the following effects of noise: difficulty falling asleep, increased awakenings, curtailed sleep duration, alterations of sleep stages or depth, and increased body movements during sleep (WHO 1999). During the Operations phase, mining activities will occur both during the day and nighttime and will potentially cause sleep disturbance for off-site human receptors.

Table 10.5-1. Risk Ratings of Project Components and Activities on Noise Levels

Category	Project Components and Activities	Noise
Construction		
Concrete production	Concrete batch plant installation, operation and decommissioning	🟢
Dangerous goods and hazardous materials	Hazardous materials storage, transport, and off-site disposal	🟡
Environmental management and monitoring	Construction of fish habitat offsetting sites	🟢
Equipment	On-site equipment and vehicle use: heavy machinery and trucks	🟡
Explosives	Explosives storage and use	🟡
Fuel supply, storage and distribution	Fuel supply, storage and distribution	🟡
Open pit	Open pit development - drilling, blasting, hauling and dumping	🟡
Power supply	Auxiliary electricity - diesel generators	🟢
	Power line and site distribution line construction: vegetation clearing, access, poles, conductors, tie-in	🟢
Processing	Plant construction: mill building, mill feed conveyor, truck shop, warehouse, substation and pipelines	🟡
	Primary crusher and overland feed conveyor installation	🟢
Project Site development	Aggregate sources/ borrow sites: drilling, blasting, extraction, hauling, crushing	🟡
	Clearing vegetation, stripping and stockpiling topsoil and overburden, soil salvage handling and storage	🟡
	Earth moving: excavation, drilling, grading, trenching, backfilling	🟡
Rail load-out facility	Rail load-out facility upgrade and site preparation	🟢
Roads	New TMF access road construction: widening, clearing, earth moving, culvert installation using non-PAG material	🟢
	Road upgrades, maintenance and use: haul and access roads	🟡
Stockpiles	Coarse ore stockpile construction	🟡
	Non-PAG Waste Rock Stockpile construction	🟡
	PAG and Non-PAG Low-grade ore stockpiles foundation construction	🟡
	PAG Waste Rock stockpiles foundation construction	🟡

(continued)

Table 10.5-1. Risk Ratings of Project Components and Activities on Noise Levels (continued)

Category	Project Components and Activities	Noise
Construction ***(cont'd)***		
Tailings management	Coffer dam and South TMF embankment construction	🟢
	Tailings distribution system construction	🟢
Temporary construction camp	Construction camp construction, operation, and decommissioning	🟡
Traffic	Traffic delivering equipment, materials and personnel to site	🟡
Waste disposal	Waste management: garbage, incinerator and sewage waste facilities	🟢
Water management	Ditches, sumps, pipelines, pump systems, reclaim system and snow clearing/stockpiling	🟢
	Water management pond, sediment pond, diversion channels and collection channels construction	🟢
Operations 1		
Concentrate transport	Concentrate transport by road from mine to rail loadout	🟡
Dangerous goods and hazardous materials	Explosives storage and use	🟡
	Hazardous materials storage, transport, and off-site disposal	🟡
Equipment fleet	Mine site mobile equipment (excluding mining fleet) and vehicle use	🟡
Fuel supply, storage and distribution	Fuel storage and distribution	🟢
Mining	Mine pit operations: blast, shovel and haul	🟡
Ore processing	Ore crushing, milling, conveyance and processing	🟡
Processing	Plant operation: mill building, truck shop, warehouse and pipelines	🟡
Rail load-out facility	Rail-load out activity (loading of concentrate; movement of rail cars on siding)	🟢
Reclamation and decommissioning	Progressive mine reclamation	🟢
Stockpiles	Construction of Non-PAG tailings beaches	🟢
	Construction of PAG and Non-PAG Low Grade Ore Stockpile	🟢
	Non-PAG Waste Rock Stockpiling	🟢
	Overburden stockpiling	🟢

(continued)

Table 10.5-1. Risk Ratings of Project Components and Activities on Noise Levels (completed)

Category	Project Components and Activities	Noise
Operations 1 ***(cont'd)***		
Tailings management	South TMF embankment construction	● (green)
Traffic	Traffic delivering equipment, materials and personnel to site	● (yellow)
Waste disposal	Waste management: garbage and sewage waste facilities	● (green)
Operations 2	***Includes the Operations 1 non-mining Project Components and Activities, with the addition of these activities:***	
Processing	Low grade ore crushing, milling, and processing	● (yellow)
Reclamation and decommissioning	Partial reclamation of non-PAG waste rock stockpile	● (green)
	Partial reclamation of TMF tailings beaches and embankments	● (green)
Tailings management	Construction of north TMF embankment and beach	● (green)
	Deposit of low-grade ore tailings into open pit	● (green)
Closure		
Reclamation and decommissioning	Partial decommissioning and reclamation of mine site roads	● (green)
	Decommissioning and removal of plant site, processing plant and mill, substation, conveyor, primary crusher, and ancillary infrastructure (e.g., explosives facility, truck shop)	● (green)
	Decommissioning of diversion channels and distribution pipelines	● (green)
	Reclamation of non-PAG low-grade ore stockpile, overburden stockpile, and non-PAG waste rock stockpile	● (green)
	Reclamation of TMF embankments and beaches	● (green)
	Removal of contaminated soil	● (green)
	Use of topsoil for reclamation	● (green)
Stockpiles	Storage of waste rock in the non-PAG waste rock stockpile	● (green)
Tailings management	Construction and activation of TMF closure spillway	● (green)
Waste disposal	Solid waste management	● (green)

Notes:

** Includes Operations 1 and Operations 2 as described in the temporal boundaries.*

● (green) = *Low risk interaction: a negligible to minor adverse effect could occur; no further consideration warranted.*

● (yellow) = *Moderate risk interaction: a potential moderate adverse effect could occur; warrants further consideration.*

● (red) = *High risk interaction: a key interaction resulting in potential significant major adverse effect or significant concern; warrants further consideration.*

Table 10.5-2. Source Term Sound Power Levels – Construction Phase

Project Noise Emission Area	Equipment Type	Quantity	L_W per Unit (dBA)	Combined L_W (dBA)
Open Pit, Stockpiles, and Processing Area **(CON-02)**	Rotary Blasthole Drill - 311mm	1	116	116
	Hydraulic Drill - 150mm	1	110	110
	Hydraulic Face Shovel -42m^3	1	115	115
	Lighting Tower	4	100	106
	Hydraulic Hammer	1	107	107
	Haul Truck – 227t	14	115	126
	Wheel Loader - 18m^3	1	107	107
	Track Dozer - 600 Hp	5	108	115
	Wheel Dozer - 530 Hp	2	105	108
	Wheel Loader - 530 Hp	2	104	107
	Backhoe Excavator - 3m^3	1	107	107
	Vibratory Compactor	1	113	113
	Backhoe Loader	1	104	104
	Motor Grader - 4.9m	2	110	113
	Water Truck - 140t	1	107	107
	Sand Truck - 90t	1	107	107
	Rough Terrain Crane	1	105	105
	Rough Terrain Forklift	2	100	103
	Snow Plow and Sand Truck	1	105	105
Total L_W – Pit, Stockpiles, and Processing Area				**128**
Tailings Management Facility **(CON-02)**	Backhoe Excavator – 3m^3	1	107	107
	Lighting Tower	1	100	100
	Haul Truck – 227t	1	115	115
	Track Dozer – 600 Hp	1	108	108
Total L_W – Tailings Management Facility				**116**
Road Access (CON-01)	Backhoe Excavator – 3m^3	1	1	107
	Track Dozer - 600 Hp	1	108	108
	Vibratory Compactor	1	113	113
	Motor Grader – 4.9m	1	107	107
Total L_W – Road Access				**116**

Table 10.5-3. Source Term Sound Power Levels – Operations Phase

Project Noise Emission Area	Equipment Type	Quantity	L_w per Unit (dBA)	Combined L_w (dBA)
Processing Area	Primary Crusher	1	109	109
	Processing Plant	1	115	115
	Rough Terrain Crane	1	105	105
	Rough Terrain Forklift	2	100	103
Total L_w - Processing Area				**117**
Open Pit	Rotary Blasthole Drill - 311mm	3	116	121
	Hydraulic Drill - 150mm	1	110	110
	Hydraulic Face Shovel – 42m^3	3	115	119
	Lighting Tower	3	100	105
	Hydraulic Hammer	1	107	107
	Haul Truck - 227t	24	115	129
	Wheel Loader - 18m^3	1	107	107
	Track Dozer - 600 Hp	3	108	113
	Wheel Dozer - 530 Hp	2	105	108
	Wheel Loader - 530 Hp	1	104	104
	Backhoe Excavator - 3m^3	1	107	107
	Vibratory Compactor	1	113	113
	Backhoe Loader	1	104	104
	Motor Grader – 4.9m	2	110	113
	Water Truck – 140t	1	107	107
	Sand Truck - 90t	1	107	107
Total L_w – Open Pit				**131**
Overburden Stockpile	Lighting Tower	1	100	100
	Haul Truck – 227t	1	115	115
	Track Dozer – 600 Hp	1	108	108
	Motor Grader – 4.9m	1	107	107
Total L_w – Overburden Stockpile				**117**
Non-PAG Waste Rock Stockpile	Lighting Tower	1	100	100
	Haul Truck – 227t	1	115	115
	Track Dozer – 600 Hp	1	108	108
	Motor Grader – 4.9m	1	107	107
Total L_w – Non-PAG Waste Rock Stockpile				**117**
Non-PAG Low-grade Stockpile	Backhoe Excavator – 3m^3	1	107	107
	Track Dozer – 600Hp	1	108	108

(continued)

Table 10.5-3. Source Term Sound Power Levels – Operations Phase (completed)

Project Noise Emission Area	Equipment Type	Quantity	L_w per Unit (dBA)	Combined L_w (dBA)
Total L_w – Non-PAG Low-grade Stockpile				**111**
PAG Low-grade Stockpile	Backhoe Excavator – 3m^3	1	107	107
	Track Dozer – 600 Hp	1	108	108
Total L_w –PAG Low-grade Stockpile				**111**
Tailings Management Facility	Excavator – 3m^3	1	107	107
	Lighting Tower	1	100	100
	Haul Truck – 227t	1	115	115
	Track Dozer – 600 Hp	1	108	108
Total L_w – Tailings Management Facility				117

Interference with Speech Communication

If continuous Project noise indoors or outdoors is high enough, there could be interference with speech communication, such that speakers will need to increase their vocal effort or move closer to each other.

Complaints

The likelihood of a complaint is directly linked to the ability or willingness of an individual to make a complaint and his or her expectation that the complaint will result in noise reduction. Therefore, there is not always a strong link between the disturbance and the complaint. However, widespread complaints can be expected if the noise level is high.

High Annoyance

The response to noise is subjective and is affected by many factors such as the:

- difference between the Specific Sound (sound from the Project) and the Residual Sound (noise in the absence of the Specific Sound);
- characteristics of the sound (if it contains tones, impulses, etc.);
- absolute level of sound;
- time of day;
- local attitudes to the Project; and
- expectations for quiet.

Health Canada (2010) guidance suggests that the "Percent Highly Annoyed" or "%HA" metric, which is calculated using the adjusted L_{dn} (or Rating Level) pre- and post-Project, is "an appropriate indicator of noise-induced human health effects for project operational noise and for long-term construction noise exposure."

Blasting

Blasting has potential to cause noise and vibration impacts on human receptors in terms of either nuisance or discomfort. Blasting from mining activities can have impacts on surrounding residential with regard to ground-borne vibration and air-blast overpressure events.

It is recognised that air-blast overpressure and ground-borne vibration produced by blasting falls into two categories:

- those causing human discomfort; and
- those with the potential for causing damage to structures, architectural elements and services.

Ground-borne Blast Vibration

Ground-borne vibration from blasting is the radiation of mechanical energy within a rock mass or soil. It comprises various vibration phases travelling at different velocities. These phases are reflected, refracted, attenuated and scattered within the rock mass or soil, so that the resulting ground vibration at any particular location will have a complex character with various peaks and frequency content. Typically, higher frequencies are attenuated rapidly so that at close distances to the source such frequencies will be present in greater proportion than at far distances from the source.

Air-blast Overpressure

Air-blast is the pressure wave (sound) produced by the blast and transmitted through the air. Unlike ground vibration there is only one air-blast phase but it too is a complex wave-train consisting of various peaks and with a range of frequencies.

Air-blast overpressure may be heard by people if it contains energy in the audible frequency range, typically between 20 Hz and 20 kHz. However, some of the energy is sub-audible and lies in the frequency range between 2 Hz and 20 Hz. Such low frequency air-blast is often experienced indoors as secondary audible effects, such as rattling of windows and of sliding doors. A blast perceived as loud may have a low air-blast level. A blast that is barely noticeable outdoors may have a high air-blast level.

10.5.1.4 Potential Effects of Noise on Recreational and Traditional Land Use

Recreational users experience a change in noise level, as well as Aboriginal users particularly around culturally important places such as Harp Mountain and Dunn Peak. Aboriginal users will also be indirectly affected by the change in noise levels due to the disruption of wildlife movement and loss of habitat. Livestock owners may be affected by noise if the noise level is high enough to spook cattle and therefore keeps the cattle from grazing in certain areas, reducing the use of the grazing license. Moreover, recreational horse trail riders could be at elevated risk if the horses are spooked while riding. More detailed potential effects of noise on land users are discussed in Chapter 18 and Chapter 22.

10.5.2 Analysis of Potential Noise Effects

Noise modelling was conducted to predict noise levels within the RSA (modeling domain) in order to assess the residual effects of noise on receptors. Results of the noise modelling will inform the effects assessments for wildlife, human health, and land user experience.

10.5.2.1 Noise Modelling Methodology

The objectives of undertaking noise modelling are to quantitatively assess Project noise emissions for representative worst-case scenarios with a focus on higher risk Project-noise interactions as described in Table 10.5-1.

The following modelling approach has been taken:

- a review and validation of all relevant Project data and information;
- identification of all potential receptors situated in the vicinity of potential moderate to major risk Project noise emission sources; and
- development of construction and operational noise scenarios that include both on-site sources and off-site road traffic (i.e., project haulage).

Blasting Methodology

Appendix J of AS2187.2-2006™ presents methods for the preliminary estimation of ground-borne vibration and air-blast overpressure levels. Importantly, these methods do not account for the topography separating the blast site and potential receiver, which may be significant, and likely to provide attenuation to overpressure levels. The AS2187.2 equations offer a highly conservative method to estimate levels in the absence of measured site laws.

Where a long term blasting program is proposed with many blast events, the AS2187.2 equations are further refined via a series of test blasts, completed to more accurately determine site constants and exponents relevant to the equation.

In this case however, the limited blasting events may not warrant test blasting as it would only increase the number of blast events and potential impacts. As such the results of the conservative preliminary estimations (completed in the absence of a measured site law) are relied upon in this assessment.

Air-blast Overpressure

Preliminary estimations for overpressure have been completed using the following AS2187.2 equation:

$$P = K_a \left[\frac{R}{Q^{1/3}} \right]^a$$

Where **P** = Pressure, in kilopascals; **Q** = Explosives charge mass, in kilograms; **R** = Distance from charge, in metres; **Ka** = Site constant; and **a** = Site exponent.

In the absence of site law information and/or further guidance in AS2187.2 regarding the application of site constants and exponents; overpressure calculations have been made using these confined blast-hole charge default parameters: (a) of -1.45; and (Ka) of 45.

Ground-borne Vibration

Preliminary estimations for vibration have been completed using the following AS2187.2 equation:

$$V = K_g \left[\frac{R}{Q^{1/2}}\right]^{-B}$$

Where **V** = ground vibration as vector peak particle velocity, in mm/s; **R** = distance between charge and point of measurement, in metres; **Q** = maximum instantaneous charge (effective charge mass per delay), in kilograms; **Kg** = a constant related to site and rock properties for estimation purposes; and **B** = a constant related to site and rock properties for estimation purposes.

Where blasting is to be carried out to a free face in average conditions (typical of most open cut mining) the following equation can be used to estimate the mean vector peak particle velocity. Note this equation is using a site constant *Kg = 1140* and a site exponent of *B = -1.6*:

$$V = 1140 \left[\frac{R}{Q^{1/2}}\right]^{-1.6}$$

Thus, in the absence of site law information and/or further guidance in AS2187.2 regarding the application of site constants and exponents; vibration calculations have been completed using ‘average field conditions’ default parameters of (B) equals 1.6 and (Kg) equals 1140.

Given that vibration from blasting events are unlikely to be of significance at distances greater than 1,000 metres, the assessment has focussed on airblast overpressure as it has the has the potential to travel greater distances. During the Construction and Operations phases of the Project, blasting will be required, primarily for displacing overburden and wall control in the pit. The amount of explosives varies for different purposes.

The following blast design data in Table 10.5-4 has been provided by HCMC to inform the blasting assessment. Generally, the prediction of blasting impacts and overpressure involves the analysis of site blasting data. HCMC indicated that the maximum instantaneous charge (MIC) will be restricted to two holes and the delay time between charges will be at least 10 milliseconds; therefore, the MIC considered in this assessment was based on two holes (826kg per hole) with a total of 1,652 kg of explosive emulsion. Therefore, the aim of the blasting assessment is to determine the distance at which impact criteria for wildlife and humans are exceeded.

10.5.2.2 Modelling Scenarios

The Brüel & Kjær Predictor V9.01 noise modelling software package was used to calculate noise levels during Construction and Operations using the ISO 9613-2:1996 (ISO 1996) noise propagation algorithms. The Predictor software package allows topographic details to be combined with ground regions, water, grass, significant building structures etc. and Project-specific assessment locations (sensitive receptors) to create a detailed and accurate representation of the site and surrounding area.

Table 10.5-4. Blasting Design Data

Item	Units	Wall Control Line Holes	Trim Rows	Production Rock
Tonnage Factor	tonnes/bcm	2.77	2.77	2.77
Blast Pattern Details				
Bench Height	metres		12.00	12.00
Sub Drill	metres		1.50	2.00
Diameter of Hole	mm		311.00	311.00
Pattern Spacing	metres		6.90	11.50
Pattern Burden	metres		6.00	10.00
Hole Depth	metres		13.50	14.00
Height of Stemming or Unloaded Length	metres		11.00	5.30
Material Quantity				
Volume Blasted/Hole	m^3		496.8	1,380.0
Blasted Material/Hole	tonnes		1,376.1	3,822.6
Productivity	tonnes/metre		101.9	273.0
Explosives				
Density of Emulsion	g/cc		1.25	1.25
Loading Density	kg/m		94.96	94.96
Emulsion/hole	**kg**		**237.39**	**826.11**
Powder Factor	kg/tonne		0.17	0.22
Power Factor	kg/bcm		0.48	0.60

Noise emission sources deemed representative of conditions for each scenario were placed at relevant locations within the modelling domain. Site terrain was taken into account and modelled using available topographical data and maps. The method predicts the equivalent continuous A-weighted sound pressure level (as described in ISO 1996) under meteorological conditions.

The noise model allows quantification of noise levels from multiple sources, based on noise emission levels representative of the plant and equipment to be used for the Project as presented in Tables 10.5-2 and 10.5-3. The model computed the noise propagation in the Project's area of influence, providing overall A-weighted noise levels at identified sensitive receptors. It has been assumed that modelled sources will be operating concurrently during the worst case on a 24-hour basis.

Based on the sources identified, the following assessment scenarios have been developed to quantify potential worst-case mining operational and construction noise levels at the sensitive receptors.

Scenario CON-01 - Construction of Access Road

Since the construction of the road would have to be completed before the use of the road, this activity is not likely to overlap with the construction of mine infrastructure; therefore, the construction of the access road is assessed separately.

Scenario CON-02 – Construction of Mine Infrastructure

Construction of the mine infrastructure including workshops, offices, processing plant; crushing plant; TMF dam wall; initial clearing and ground works. This scenario also includes the use of the access road for construction material haulage.

Construction Phase Road Traffic

Road traffic from transportation of construction material and abnormal loads to the Project Site via Vavenby and the FSR to the mine access road. Although road traffic was already included in CON-02 scenario, a separate road traffic assessment was conducted to better represent noise impacts from increase in traffic.

Calculation of winter road transportation noise (L_{Aeq}) was determined using the US EPA traffic noise model. The US EPA's method for calculation of the L_{Aeq} noise levels from traffic is an internationally accepted theoretical traffic noise prediction model which takes into account the L_{Amax} vehicle noise level (light and heavy), receiver offset distance, pass-by duration, vehicle speed, ground absorption (based on the ratio of soft ground and average height of propagation), number of hourly vehicle movements, receiver height, truck exhaust height, and the height and location of any intervening barriers.

The general assumptions used in the calculation of road traffic noise are shown in Table 10.5-5. Traffic volumes have been extracted from the Traffic Impact Study (Appendix 5-E) and are shown in Tables 10.5-6 and 10.5-7. Note that the road traffic effect on each receptor is based on the distance of the receptor to the road traffic.

Table 10.5-5. Assumptions Road Traffic Noise Calculations

Vehicle Type	Typical Speed (km/h)	Sound Pressure Level at 10 m (dBA)	Average Propagation Height (m)	Receiver Height (m)
Truck	50	80	1.5	1.5
Car	60	70	0.8	0.75

Operations Phase Mining Activities

Open pit mining operations includes truck, shovel and haul; overburden stockpiles; waste rock stockpiles; various PAG and non-PAG stockpiles; processing plant; crushing plant; tailings management facility; and traffic.

Table 10.5-6. Road Traffic Volumes for Construction Vehicles per Hour (Two-way)

Road	Existing Trucks	Existing Cars	Project Truck	Project Cars	Total Trucks	Total Cars
McCorrie	0	86	2	9	2	95
Vavenby	4	99	2	23	6	122
Capostinsky	4	31	2	3	6	34

Table 10.5-7. Road Traffic Volumes for Operations Vehicles per Hour (Two-way)

Road	Existing Trucks	Existing Cars	Project Truck	Project Cars	Total Trucks	Total Cars
McCorrie	0	86	2	34	2	120
Vavenby	4	99	2	52	6	151
Capostinsky	4	31	2	12	6	43

Operations Phase Road Traffic

Road traffic from product haulage from the Project Site via the mine access road to the Vavenby rail load-out facility. Similar to the Construction phase, although road traffic is included in Operations phase mining activities, a separate road traffic assessment was conducted to represent noise impacts from increase in traffic.

10.5.2.3 Receptor Locations

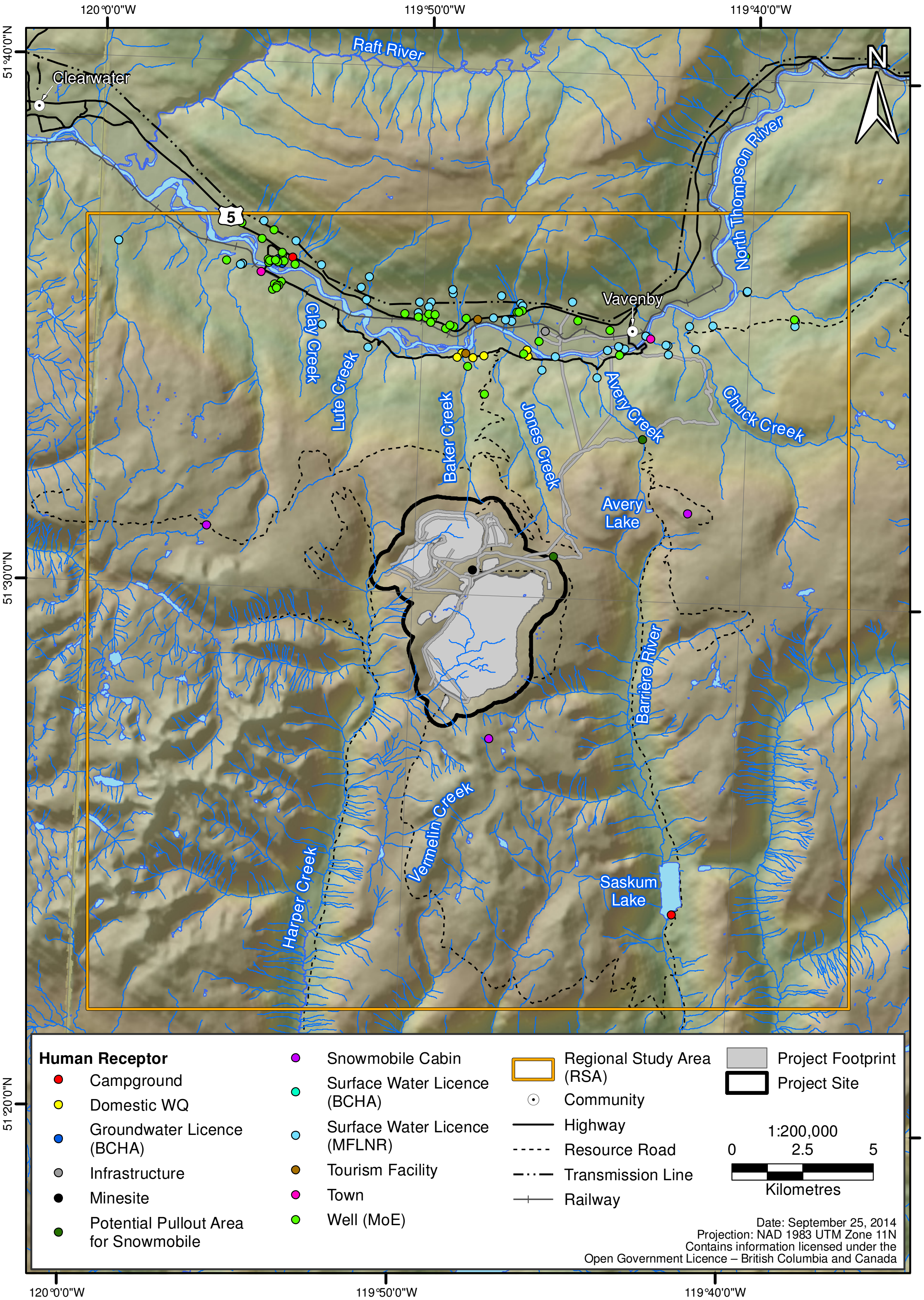
A receptor is defined as any point (beyond the Project Site) occupied by people or wildlife which are subject to extraneous noise from the Project. Examples of human receptor locations include permanent or seasonal residences such as snowmobile traffic pullout areas, snowmobile cabins, surface water licence or groundwater well locations, and residents of the town of Vavenby.

Receptors likely to be affected by noise from the Project Site have been identified as M (mine) while the receptors along the road are identified as T (traffic). Receptors that are farther away from the traffic are identified by the location with respect to the traffic source (i.e., northeast of the traffic would be NET). A full list of receptor locations is presented in Appendix 21-B and shown in Figure 10.5-1.

Pullout areas for snowmobile traffic will be developed during the Construction phase of the Project. For the purpose of this assessment, it is assumed that the pullout areas will be built during the access road upgrade. The pullout areas are designed to allow vehicles hauling snowmobiles to pull over when concentrate haul trucks or other Project vehicles are approaching. Since people are expected to stay at the pullout area for a few minutes, the snowmobile pullout areas have been included as receptors in this assessment. However, since the snowmobiles are not associated with the Project, the snowmobile noise is not included in the assessment. People are also expected to stay overnight at the snowmobile cabins occasionally (there are two snowmobile cabins; one directly east of the Project Site and one directly west of the Project Site, see Figure 10.5-1). Receptors identified as town, surface water licence (BC MFLNRO, BC Health Authority), groundwater licence (BC Health Authority) and wells, are assumed to be associated with residential dwellings.

Figure 10.5-1

Receptor Locations within the Noise Study Area



There are several noise receptors potentially sensitive to road traffic noise in Vavenby. The incremental increase in road traffic noise is considered the dominant aspect when assessing road traffic noise. Therefore, increases in road traffic noise from the Construction and Operations phases of the Project have been calculated on Project traffic flows (Traffic Impact Study, Appendix 5-E) at the nearest receptor on the following roads:

- McCorrie Road – nearest receptor is 13 m from road edge;
- Vavenby Road – nearest receptor is 13 m from road edge; and
- Capostinsky Road – nearest receptor is 20 m from road edge.

10.5.2.4 Noise Modelling Results

Predictive modelling results, using methodologies described in Section 10.5.2, are presented in this section for each scenario. Predicted noise levels are compared to relevant criteria and details about each criterion are discussed in Section 10.5.5.1.

Scenario CON-01: Construction of Access Road

Calculated noise levels for Scenario CON-01 with respect to human receptors are presented in Table 10.5-8, with noise level contours presented in Figure 10.5-2. Note that results are not presented for receptors with minimal noise levels (i.e., less than 30 dBA). The full summary of results can be found in Appendix 21-B.

The highest noise level predicted during construction of the access road is 49 dBA at the surface water licence location (C124889) northeast of the Project Site and in close vicinity to the access road, but below the L_d criteria of 55 dBA for interference with speech communication (US EPA 1974).

Scenario CON-02: Construction of Mine Infrastructure

Calculated noise levels from the construction scenario with respect to human receptors are presented in Table 10.5-9, with noise level contours presented in Figure 10.5-3. Note that receptors with minimal noise levels (i.e., less than 30 dBA) are not presented. A full summary of results can be found in Appendix 21-B.

The only receptor with predicted exceedance over the speech interference criterion of 55 dBA (US EPA 1974) is at the potential upper pullout area for snowmobile traffic outside the mining area (M01). The predicted noise level is 55.6 dBA, 0.6 dBA above the criterion.

Construction Phase - Road Traffic

Calculated noise levels from the construction road traffic scenario with respect to human receptors are presented in Table 10.5-10. Predicted external road traffic noise levels (L_d) are not expected to increase by more than 2 dBA at any of the assessment locations.

Table 10.5-8. Predicted Noise Levels for Scenario CON-01: Construction of Access Road

ID	Receptor	L_d[1] (dBA)	L_d[1] Criteria (dBA)
T02	Surface Water Licence (BC MFLNRO) - C124889	49	55
T04	Surface Water Licence (BC MFLNRO) - C130960	38	
T05	Surface Water Licence (BC MFLNRO) - C130960	38	
T06	Surface Water Licence (BC MFLNRO) - C036251, C036252, C036257, C036258, C036469, and C056116	31	
T11	Surface Water Licence (BC MFLNRO) - C036251, C036252, C036257, C036258, C036469, and C056116	31	

Note: All noise levels are external dBA re 2 x 10^{-5} Pa
Construction activities occurs during the daytime only
[1]Daytime noise level for assessing speech interference

Table 10.5-9. Predicted Noise Levels for Scenario CON-02: Construction of Mine Infrastructure

ID	Receptor	L_d[1] (dBA)	L_d[1] Criteria (dBA)
M01	Potential Pullout Area for Snowmobile Traffic – Upper Pullout Area	**56**	55
T01	Potential Pullout Area for Snowmobile Traffic – Lower Pullout Area	52	
T02	Surface Water Licence (BC MFLNRO) - C124889	47	
T04	Surface Water Licence (BC MFLNRO) - C130960	38	
T05	Surface Water Licence (BC MFLNRO) - C130960	38	
T06	Surface Water Licence (BC MFLNRO) - C036251, C036252, C036257, C036258, C036469, and C056116	31	
T11	Surface Water Licence (BC MFLNRO) - C036251, C036252, C036257, C036258, C036469, and C056116	31	

Note: Bold face indicates exceedance
All noise levels are external dBA re 2 x 10^{-5} Pa
Construction activities occurs during the daytime only
[1]Daytime noise level for assessing speech interference

Table 10.5-10. Predicted Traffic Noise Levels during Construction

Road	Nearest Receptor (m)	Calculated Existing Road Traffic Noise Level $L_{Aeq,1hr}$[1] (dBA)	Predicted Project Construction Road Traffic $L_{Aeq,1hr}$ (dBA)	Predicted Total Road Traffic Noise Level $L_{Aeq,1hr}$ (dBA)	Increase (dBA)
McCorrie	13	54.0	51.2	55.8	1.8
Vavenby	13	57.0	52.4	58.3	1.3
Capostinsky	20	52.7	48.0	53.9	1.2

[1] Based on worst-case afternoon peak traffic volumes and maximum existing logging trucks of 50 vehicles per day (two-way)
All noise levels are external dBA re 2 x 10^{-5} Pa

Figure 10.5-2
Construction Phase Scenario CON-01 – Construction of Access Road – Daytime Noise (Ld)

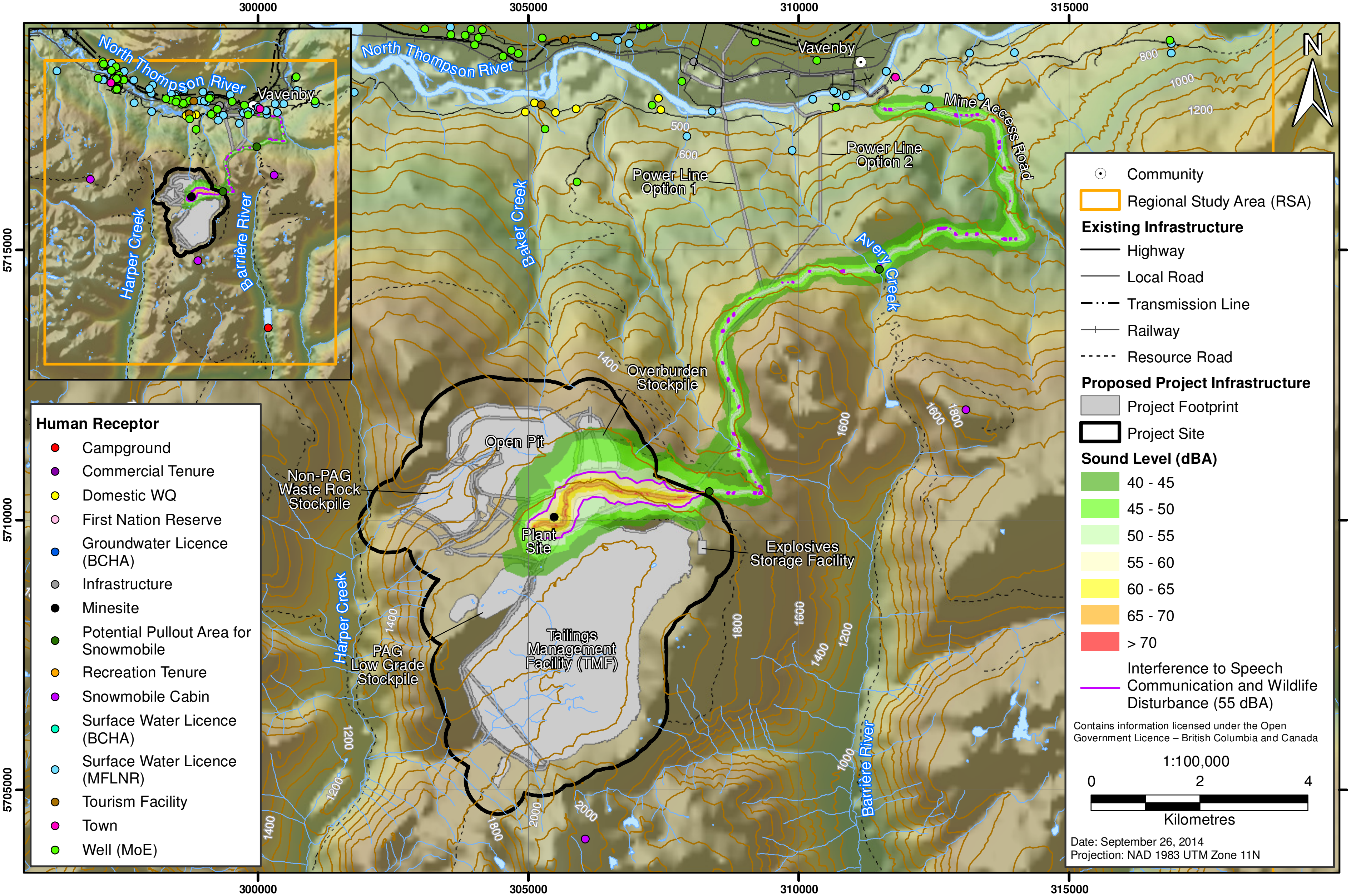
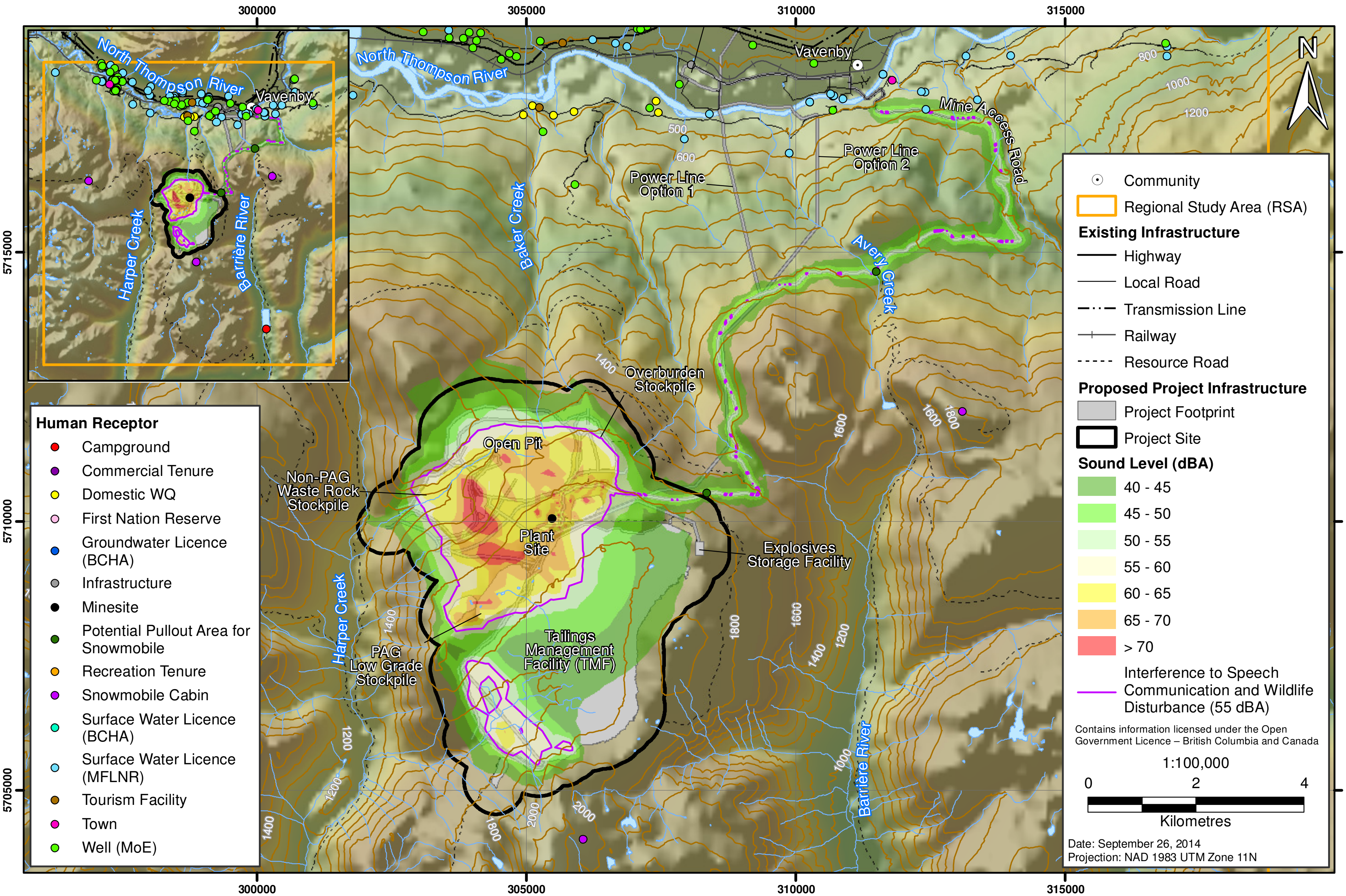


Figure 10.5-3
Construction Phase Scenario CON-02 – Construction of Mine Infrastructure – Daytime Noise (Ld)



Operations Phase - Mining Activities

Modelled noise levels from mining activities during the Operations phase are presented in Table 10.5-11, with daytime and nighttime noise contours shown in Figures 10.5-4 and 10.5-5. Note that receptors with minimal noise levels (i.e., less than 30 dBA) are not presented. A summary of results can be found in Appendix 21-B.

Predicted daytime noise at the upper pullout area (M01) and lower pullout area (T01) exceed the criteria for speech interference of 55 dBA (US EPA 1974).

Predicted nighttime noise levels exceeded the sleep disturbance criteria at T02, a surface water licence location (C124889) close to the town of Vavenby. It is assumed that each surface water licence location is associated with a house in close proximity. The source of noise that affected this location is traffic noise, given that T02 is 5,835 m from the mine and 25 m from the access road. Since this location is close to the access road, it is assumed that the existing noise level, from existing traffic, would already be high. As discussed in Section 10.5.4.1, increase in traffic noise will be assessed using FTA's method.

Table 10.5-11. Predicted Operations Phase Noise Levels

		Calculated Noise Level		Threshold	
ID	Receptor	L_d	L_n[1]	L_d[2]	L_n[3]
M01	**Potential Pullout Area for Snowmobile Traffic – Upper Pullout Area**	**59**	n/a[4]	55	45
T01	**Potential Pullout Area for Snowmobile Traffic– Lower Pullout Area**	**55**	n/a[4]		
T02	**Surface Water Licence (BC MFLNRO) - C124889**	51	**49**		
T04	Surface Water Licence (BC MFLNRO) - C130960	41	40		
T05	Surface Water Licence (BC MFLNRO) - C130960	42	40		
T06	Surface Water Licence (BC MFLNRO) - C036251, C036252, C036257, C036258, C036469, and C056116	35	34		
T07	Surface Water Licence (BC MFLNRO) - C102945	30	29		
T11	Surface Water Licence (BC MFLNRO) - C036251, C036252, C036257, C036258, C036469, and C056116	35	34		
T12	Town - Vavenby	30	29		

Note: bold face indicates exceedance
n/a = not applicable
All noise levels are external dBA re 2 x 10^{-5} Pa
[1] Construction noise is during the daytime only
[2] Daytime noise level for assessing speech interference
[3] Nighttime noise level for assessing sleep disturbance inside the Project boundary
[4] People are not expected to be sleeping overnight at the pullout area; therefore, sleep disturbance is not assessed.

Figure 10.5-4
Operation Phase Mining – Daytime Noise (Ld)

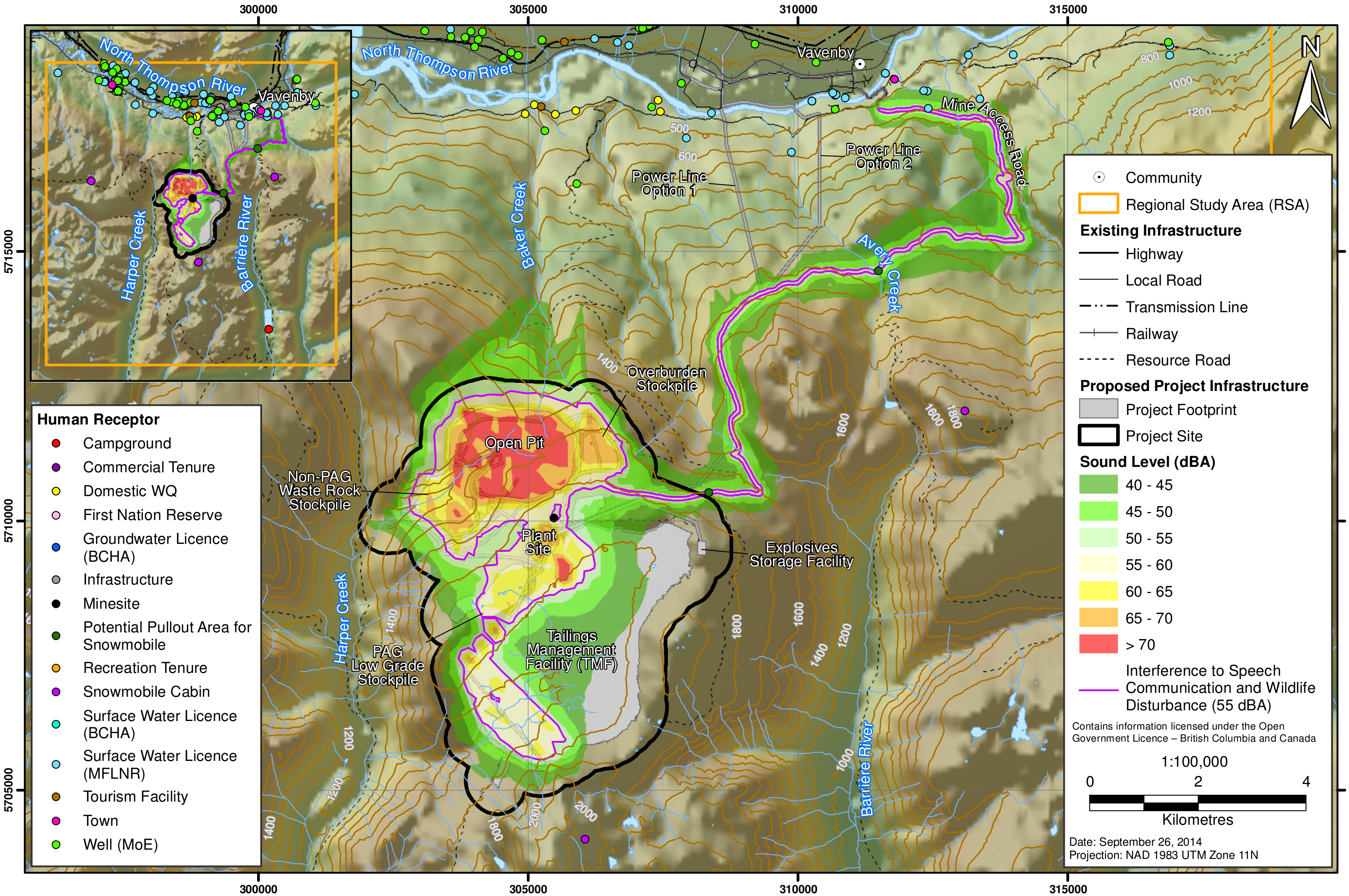
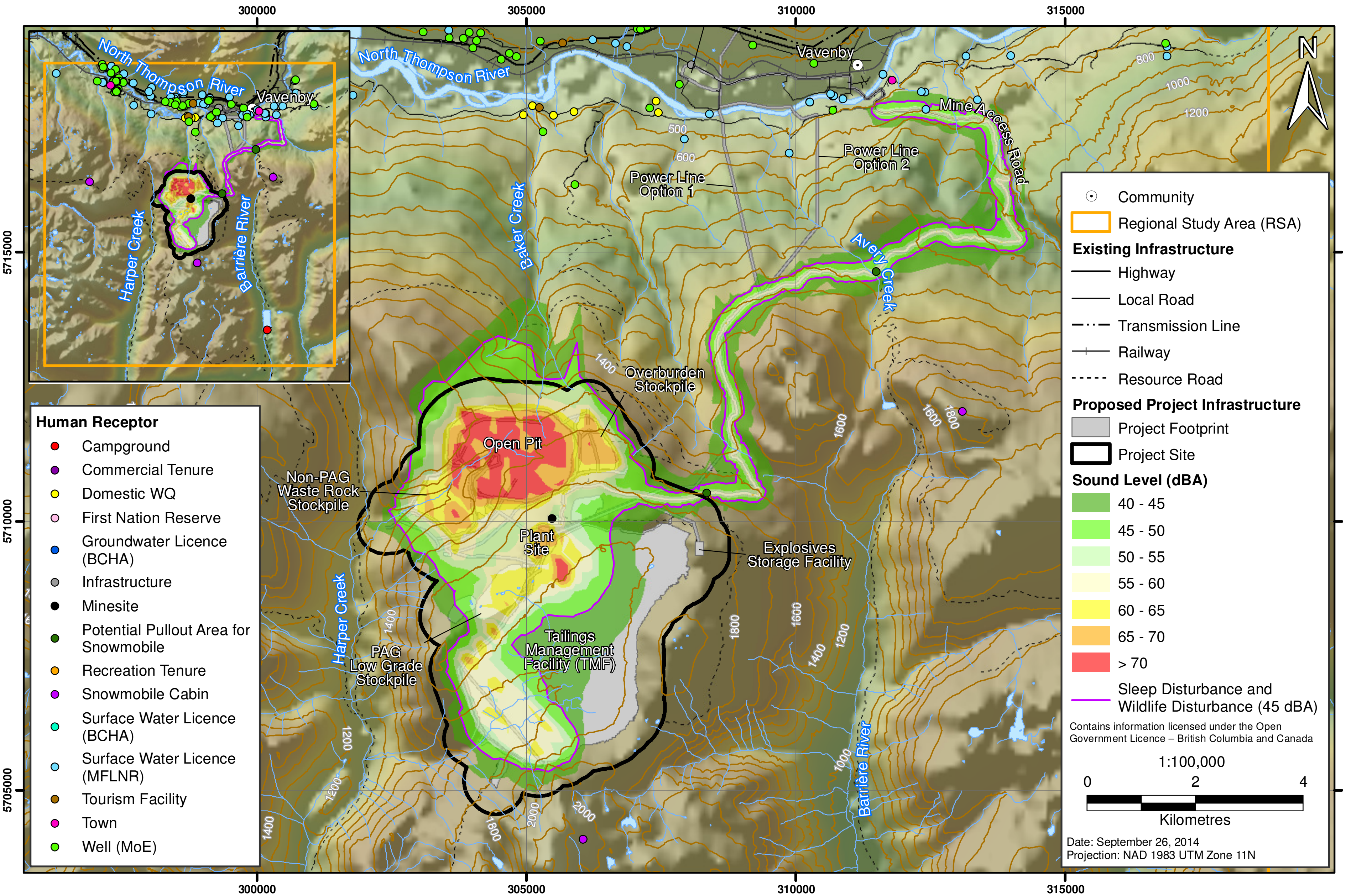


Figure 10.5-5
Operation Phase: Mining – Nighttime Noise (Ln)

ERM



Operations Phase - Road Traffic

Calculated noise levels from Operations phase road traffic are presented in Table 10.5-12. Predicted external road traffic noise levels are not expected to increase by more than 2 dBA at Vavenby and Capostinsky. At McCorrie Road, an increase of 2.6 dBA is predicted.

Table 10.5-12. Predicted Traffic Noise Levels during Operation

Road	Nearest Receptor (m)	Calculated Existing Road Traffic Noise Level $L_{Aeq,1hr}$[1]	Predicted Project Construction Road Traffic $L_{Aeq,1hr}$	Predicted Total Road Traffic Noise Level $L_{Aeq,1hr}$	Increase dB
McCorrie	13	54.0	53.1	56.6	2.6
Vavenby	13	57.0	54.1	58.8	1.8
Capostinsky	20	52.7	49.4	54.3	1.6

Based on worst-case afternoon peak traffic volumes and maximum existing logging trucks of 50 vehicles per day (two-way)
All noise levels are external dBA re 2 x 10^{-5} Pa

10.5.2.5 Blasting Calculations

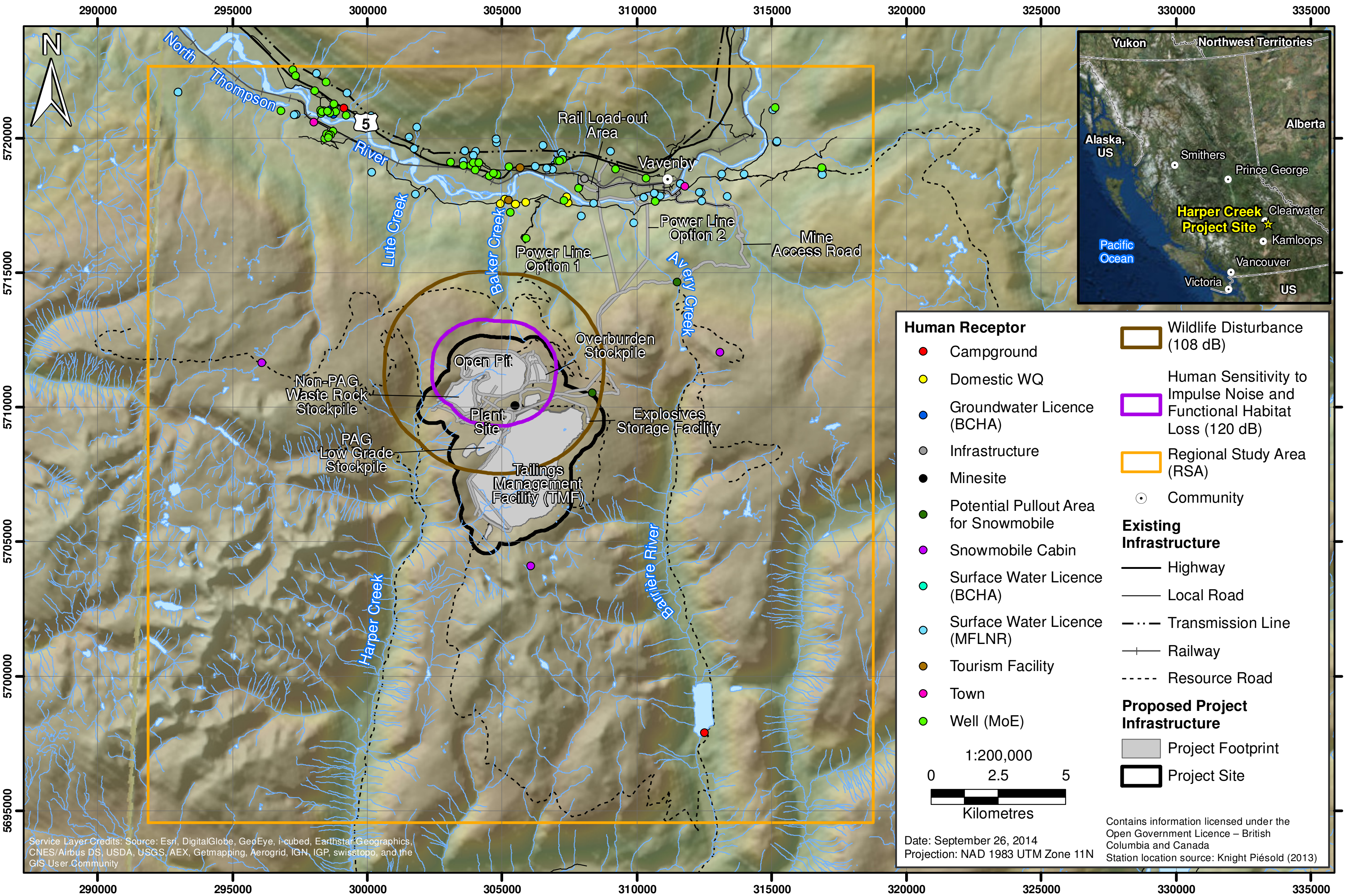
Calculated air-blast overpressure was based on a MIC of 1652 kg as presented in Table 10.5-13. A distance of more than 2,886 m is required for air-blast overpressure to be below 108 dB; and more than 1,113 m is required to for air-blast overpressure to be below 120 dB. The extents of 108 dB and 120 dB from blasting are presented in Figure 10.5-6.

Table 10.5-13. Predicted Noise Levels for Blasting

Number of holes per charge	Explosive amount per charge (kg)	Distance required for < 108 dB (m)	Distance required for < 120 dB (m
1	826	2291	884
2	**1652**	**2886**	**1113**
3	2478	3304	1274
4	3304	3637	1402
5	4130	3917	1511
6	4956	4163	1605
7	5782	4382	1690
8	6608	4582	1767
9	7434	4765	1838
10	8260	4936	1903
11	9086	5095	1965

Figure 10.5-6
Construction and Operation Phases: Blasting L_{peak} Noise

ERM



10.5.3 Measures to Mitigate Noise Emission Sources

There are three main mitigation strategies for noise control: controlling noise at the source, controlling the noise pathway, and controlling noise at the receptor. These noise mitigation strategies should follow a hierarchy of control, with source control the preferred option where reasonable and feasible, and control at the receptor the least favourable option.

Controlling noise at the source can be achieved through management. There are two primary approaches applicable to controlling the noise pathway: using barriers and land-use controls. An example of the latter would be attenuating noise by increasing the distance between the source and the receptor. Controlling noise at the receptor is applied when other methods of noise control have been evaluated, and implemented if practical, and further improvements are still required.

The noise mitigation proposed focuses on the first of these noise control strategies (controlling noise at the source), followed by mitigation of the pathways. Additional measures to control the noise pathway and noise at the receptor are addressed, if needed, in the applicable management plans for human health, wildlife and land use.

The mitigation methods considered for implementation are listed in Table 10.5-14. The anticipated effectiveness of each mitigation measures is defined in Chapter 8 as follows:

- Low effectiveness: After implementation of the mitigation measure, there is still a major change from the baseline condition.
- Moderate effectiveness: After implementation of the mitigation measure, there is a measurable change from the baseline condition.
- High effectiveness: After implementation of the mitigation measure, there is no change from the baseline (e.g., it returns to its original condition before the construction of the Project) or an environmental enhancement is evident.

Due to the nature of noise, mitigation measures typically only reduce noise levels as opposed to eliminating it; however, the above definitions focus only on the residual effect compared to baseline conditions. Unless the source is eliminated completely, the effectiveness of the mitigation measures as defined above may still indicate measurable change in noise compared to the baseline conditions. For example, mitigation measures for a pump or compressor may reduce the noise level drastically; however, the residual noise level after mitigation may still indicate a change from the baseline conditions. For this reason, using the above definitions, mitigation methods are typically classified as low or moderate effectiveness without completely removing the source of noise.

A Noise Management Plan (Section 24.10) has been developed that summarizes the management objectives, best management practises, mitigation measures and monitoring approach taken to minimize noise effects as a result of the Project. Briefly, the objectives of the Noise Management Plan are to:

- ensure all relevant regulatory requirements are met;

- manage and minimize the changes to noise levels from mining operations on human and wildlife receptors to minimize reasonable noise complaints;
- maintain an effective response mechanism to deal with any issues and complaints to ensure that all complaints are followed up promptly and a plan to investigate and address the issues are developed as soon as feasible; and

Table 10.5-14. Proposed Mitigation Measures and their Effectiveness

Noise			
Potential Effect	Proposed Mitigation Measure	Mitigation Effectiveness (Low/Moderate/ High/Unknown)	Residual Effect (Y/N)
Increase in noise level	Consider noise levels in equipment selection	Moderate	Y
Increase in noise level	Equipment will be adequately maintained to minimize noise, including lubrication and replacement of worn parts, especially exhaust systems	Moderate	Y
Increase in noise level	The operation of equipment will be optimized to minimize noise, e.g., reducing vehicle speeds	Moderate	Y
Increase in noise level	Site layout will be optimized to minimize noise impact, e.g., through use of natural screens such as buildings, locating doors away from noise sources and facing away from relevant receptors, minimizing the need for mobile equipment to use their backup alarms	Moderate	Y
Increase in noise level	Site procedures will be optimized to minimize noise changes, e.g., keeping doors closed	Moderate	Y
Increase in noise level	Loud procedures will be conducted indoors, where practical, and enclosures, berms, acoustic screening, and shrouding where stationary sources require control will be identified.	Moderate	Y
Increase in noise level	Turning off equipment when not in use where practical to avoid unnecessary idling of motors	High	Y
Increase in noise level	Diesel-powered vehicles will be fitted with mufflers meeting manufacturers' recommendations for optimal attenuation, and will be maintained in effective working condition	Moderate	Y
Increase in noise level	Blasting configurations will be limited to two holes detonating simultaneously	Low	Y
Increase in noise level	Blast holes will be stemmed to at least 6 m and ensuring impulse noise, such as blasting, are limited to certain times of the day	Low	Y

10.5.4 Characterizing Residual Effects on Noise

Prior to determining the significance of residual effects of the Project on noise, the residual effect needs to be characterized. Noise criteria used for assessing noise are presented in the following sections.

10.5.4.1 Assessment Criteria

Noise criteria can be specified based on Project noise levels or the total (baseline plus project) noise levels. For relative criteria, that is, criteria based on the increase in noise from existing conditions such as annoyance, total noise has been used. For absolute criteria, that is, noise criteria that do not change depending on existing conditions, project noise has been used. This interpretation is consistent with past guidance communicated by Health Canada and avoids the impasse that would otherwise be created if the existing noise already exceeds an absolute criterion.

Based on the previously discussed identification of potential effects, Project-specific criteria have been chosen to rate potential effects for off-site receptors as shown in Table 10.5-15. Assessments of noise impacts in situations such as this are important because decisions regarding noise mitigation requirements should be based on the expected significance of the noise impact. Noise level metrics considered for impact from noise are listed below.

Table 10.5-15. Project Noise Impact Criteria

Project Metric	Description	Criteria
Wildlife Receptors		
L_n	Project noise level for assessing wildlife disturbance	45 to 55 dBA
L_{peak}	Peak sound pressure level for assessing wildlife sensitivity to impulse blasting noise (disturbance of wildlife)	108 dB
	Peak sound pressure level for assessing wildlife sensitivity to impulse blasting noise (functional habitat loss)	120 dB
Human Receptors (Off Site)		
L_d	Daytime noise level for assessing speech interference	55 dBA
L_n	Nighttime noise level for assessing sleep disturbance outside the Project boundary (i.e., campground)	30 dBA
	Nighttime noise level for assessing sleep disturbance outside the Project boundary (i.e., indoor with windows open)	45 dBA[1]
	Nighttime noise level for assessing sleep disturbance inside the Project boundary (i.e., windows closed)	57 dBA[1]
L_{dn}	Assessing the likelihood of complaints	62 dBA
	Legal action/Project noise mitigation required	75 dBA
L_{peak}	Blasting operations lasting longer than 12 months at sensitive site[2]	120 dBL[3]
Δ %HA	Increase in %HA metric before and after Project initiation	6.5%

[1] *This is an external noise level and assumes that internal noise levels are in the order of 15 dBA lower with open windows and 27 dBA lower with closed windows (which would be the expected normality in the Project's climate). In addition, WHO (1999) recommends that internal sound levels should not exceed approximately 45 dBA more than 10 to 15 times per night.*
[2] *A sensitive site includes houses and low rise residential buildings, hospitals, theatres, schools, etc, occupied by people.*
[3] *Unless agreement is reached with occupier that a higher limit may apply*

Assessment Criteria for Wildlife

Project-related noise was considered and assessed based on noise levels predicted for the Construction and Operations phases using limits below and the criteria are summarized in Table 10.5-15.

- Continuous Project noise level during the night (L_n) exceeding 45 to 55 dBA is considered a wildlife disturbance;
- Peak noise level (L_{peak}) for assessing wildlife sensitivity to impulse blasting of 108 dB is considered for disturbance of wildlife and 120 dB is considered to be functional habitat loss.

Details of the assessment criteria and effect of noise on wildlife can be found in Chapter 16.

Assessment Criteria for Human Health

Sleep Disturbance

The World Health Organization recommends that in quiet, rural areas and for susceptible populations, such as those in hospitals or convalescent or senior homes, the threshold for sleep disturbance of an indoor nighttime sound level (L_n, L_{Aeq}, 10:00 p.m. to 7:00 a.m.) is no more than 30 dBA for continuous noise (WHO 1999).

In addition, for a good sleep, it is generally considered that indoor sound pressure levels should not exceed approximately 45 dBA L_{Amax} more than 10 to 15 times per night (WHO 1999). Sensitivity to noise disturbance varies considerably between individuals, and this guideline is taken to apply to the entire population; therefore, the vast majority of the population would not suffer sleep disturbance above these levels. Using a 45 dBA maximum limit not to be exceeded more than 10 to 15 times a night is thus a conservative criterion not generally applicable to EAs, but does provide a point of reference from which to understand potential noise impacts on humans.

A temporary modular construction camp will be positioned at the Project Site to house the construction workforce peaking at 600 construction personnel, and will be removed at the end of the Construction phase. In the assessment, it is assumed that the 70 hour construction work week occurs during the daytime only and there are no construction activities during nighttime. Therefore, sleep disturbance is not assessed for the Construction phase. During the Operations phase, personnel will reside off site in local communities such as Vavenby and Clearwater, and the surrounding areas.

Sound is attenuated as it is transmitted indoors and the amount of reduction mostly depends on whether or not windows are open. This assessment assumes an outdoor-to-indoor noise reduction of 15 dBA if windows are open and 27 dBA if windows are closed (US EPA 1974). The actual reduction depends on construction materials, geometry, etc., of the room. Given that the Project is located in a low temperature climate, building shells will be built more airtight, and actual noise reduction levels are expected to be higher. Since it is expected people will be sleeping indoors at cabins and residences in the towns, it is assumed that a minimum noise reduction of 15 dBA applies. The reduction is not applied at outdoor residences such as campgrounds.

Interference with Speech Communication

The US EPA (1974) advises that an indoor vocal level of 40 dBA or an outdoor vocal level of 55 dBA or greater would be required for good speech comprehension.

Complaints

Although the likelihood of compliant is subjective, widespread complaints have been found to be more likely above an L_{dn} of 62 dBA and vigorous community action should be expected if the Project L_{dn} is greater than 75 dBA (US EPA 1974).

Day-night sound level L_{dn} is the A-weighted equivalent sound level for 24 hour period with an additional 10 dBA imposed on the equivalent sound level for night time hour (L_n). Since the criterion for L_d used in this assessment is 55 dBA, and the criterion for L_n used in the assessment is 45 dBA, with the 10 dBA penalty added to the nighttime L_n, L_{dn} will not exceed 62 dBA. Therefore, using L_d of 55 dBA and L_n of 45 dBA is deemed sufficient for the assessment and L_{dn} criteria of 62 dBA and 75 dBA are not used.

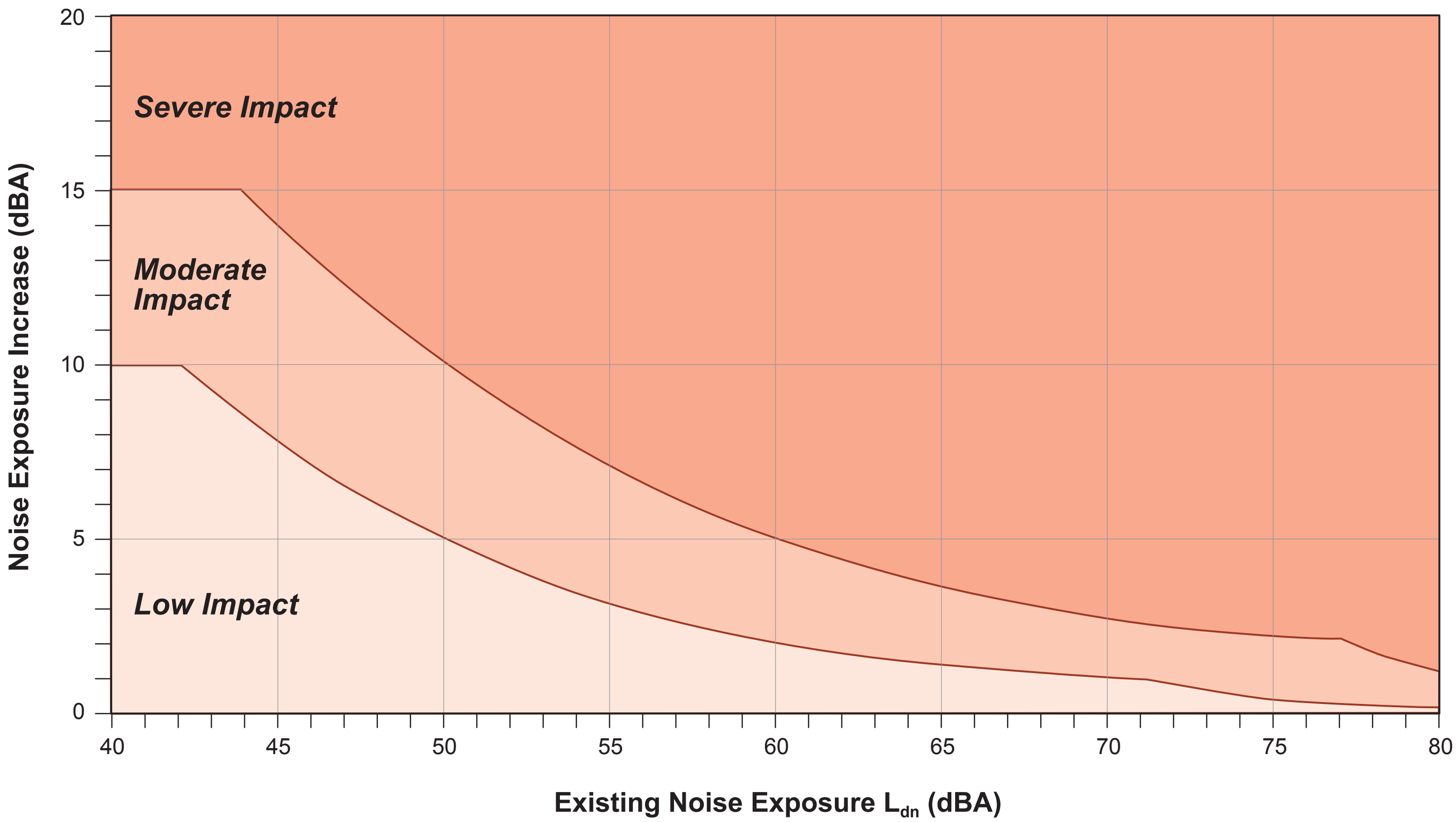
High Annoyance

Health Canada (2010) suggests using %HA metric based on pre- and post-Project noise, including adjustments to account for more annoying sound characteristics: specifically if the sound at the receiver location can be characterized as having tones, impulses, or strong low-frequency content. The penalty for tones and regular impulsive sound is a + 5 dBA adjustment to the predicted, calculated, or measured sound pressure level. The penalty for highly impulsive noise is a + 12 dBA adjustment. The penalties for high-energy impulsive sound and sound with strong low frequency content are variable and calculated according to the American National Standards Institute standard S12.9-2005/Part 4 (ANSI 2005). The penalty for sound with strong low frequency content should only be considered if the C-weighted sound pressure level is more than 10 dB higher than the A-weighted sound pressure level. Health Canada (2010) advises that "noise mitigation measures be considered when a change in the calculated %HA at any given receptor exceeds 6.5%" or if the Project L_{dn} exceeds 75 dBA.

However, this criterion does not specifically address road traffic noise. In a document, *Using a Change in Percent Highly Annoyed with Noise as a Potential Health Effect Measure for Projects under the Canadian Environmental Assessment Act* (Michaud, Bly, and Keith 2008), it was stated that the FTA's document *Transit Noise and Vibration Impact Assessment* (Harris Miller Miller & Hanson Inc. 2006) developed criteria that assess the significance of noise increase from traffic projects. The assessment criteria were developed based on noise impact from transit noise sources and are more applicable to address the increase in noise due to an increase in traffic. The referenced noise impact criteria provided by the FTA are based on the relationship between the percentage of "highly annoyed" people and the noise exposure levels of their residential environment, resulting from transportation noise. This relationship, shown in Figure 10.5-7, has been used to provide an indication of the likelihood of noise impacts from the road traffic noise generated by the Project. The FTA's suggested noise impact criteria are dependent on the existing noise exposure levels at the assessment locations. Below the lower curve, the Project is considered to have no noise impact since, on the average, the in-traffic noise associated with the Project will result in an insignificant increase in the number of people highly annoyed by the new noise. Project noise above the upper curve is considered to cause severe impact since a significant percentage of people would be highly annoyed by the new noise. The criterion for severe impact (upper curve) is based on an increase of 6.5% in %HA for baseline values between 43 to 77 dBA. Between the two curves, the proposed Project is considered to have moderate impact where the change in noise is noticeable to most people, but may not be sufficient to cause strong, adverse reaction from the community.

Figure 10.5-7

FTA Noise Criteria - Noise Exposure Increase vs Existing Noise Exposure



In the context of the Project, where existing road traffic noise levels are in the range of 50 to 55 dBA, an increase of:

- 3 to 5 dB would be considered a **Low Impact**;
- 5 to 8 dB would be considered a **Moderate Impact;** and
- Greater than 8 dB would be considered a **Major Impact.**

The FTA guideline was created to outline procedures for the prediction and assessment of noise impacts of proposed mass transit projects (i.e., rail rapid transit, light rail transit, commuter rail, and automated guide way transit) including fixed facilities such as storage and maintenance yards. The noise impact criteria provided by the FTA are based on the relationship between the percentage of "highly annoyed" people and the noise exposure levels of their residential environment resulting from transportation noise. This includes noise exposures from both road and rail traffic. As such, the FTA guideline is also applicable to the impact assessment of noise from road projects.

Blasting

Generally, ground-borne vibration and air-blast overpressure levels that result in human discomfort are set by regulatory authorities less than those likely to cause damage to structures, architectural elements and services. Though, standardised criteria for air-blast overpressure and ground-borne vibration are used to evaluate a blast for each potential impact category.

As is apparent in the various international standards and guidelines applicable to blasting, the effect of blast events on people is subjective, as one person may tolerate high levels that would be unacceptable to someone else. It is therefore difficult to offer absolute levels of ground-borne vibration and air-blast overpressure because of the uncertainties in the understanding of human response to them. Limits need to consider local conditions and the nature of the workings. Ground-borne blast vibration limits are typically in the range 2 to 10 mm/s and air-blast overpressure from 115 to 130 dBL.

It can be difficult for a blasting engineer to design a blast to ensure it stays under an absolute limit because of the natural variability in vibration levels and because a prediction is being made it is not possible to be 100% certain that a level will not be exceeded. Therefore, a confidence level of 95 % (close to two standard deviations) is often taken.

There are various jurisdictions and sources for these criteria and *Standards Australia AS2187.2-2006™ (AS2187.2) – Explosives – Storage and Use Part 2: Use of Explosives; (Appendix J)* presents pertinent information and references to it. AS2187.2 also states that blasts should be designed and monitored according to the prevailing regulatory controls from both a human comfort and damage point of view.

AS2187.2 presents recommendations for both human comfort and damage criteria and levels that reflect current best practice globally. It addresses two common environmental effects of blasting: ground-borne vibration and air-blast overpressure; providing background information, guidelines for measurement and criteria for peak levels, but only air-blast overpressure, which has the potential to affect areas with a greater distance (> 1,000 m).

Human comfort limits for air-blast are linked to the annoyance produced. Several factors contribute to annoyance such as loudness, duration and number of events plus the time of day and the nature of the disturbance. In all cases the "sensitive site" criteria applicable to blast operations lasting longer than 12 months, or more than 20 blasts, means that for 95% of blast events the recommended value should be achieved and for the remaining blast events the maximum value should be achieved. For example, if 100 blast events are scheduled then 95 should be designed to meet the recommended value and five to meet the maximum value. In this assessment, since the higher amount of explosive is assumed, the assessment is based on the maximum instantaneous noise level of 120 dBL and not the 95th percentile of 115 dBA.

Annoyance from blasting can also be estimated using research conducted on sonic booms. According to the United States Environmental Protection Agency (US EPA 1974), little or no public annoyance is expected to result from any number of daytime sonic booms per day if the measured or predicted peak level is less than (125 – 10 log N) dBL, with N being the number of booms per day. In this case, HCMC plans to have 159 blasts per year during the Construction phase and 331 blasts per year during the Operations phase with a maximum of one blast per day; therefore, the peak level threshold is 125 dBL. WHO (1999) also provides guideline levels for noise-induced hearing impairment with peak value of 140 dB for adults, and 120 dB for children.

With the criteria from these three references described, the assessment for human health is based on 120 dB for blasting noise as a conservative approach.

Details of the assessment criteria and effect of noise on human health can be found in Chapter 21.

<u>Assessment Criteria for Current Users of Lands and Resources</u>

Since for current users of land, including recreational users, aboriginal users and commercial users, the end points of the noise effects are human and animals, the effect of noise on current users of land can be assessed using noise criteria for wildlife and human health. For example, commercial user such as livestock owners may be affected by increase in noise level such that cattle can be spooked and avoid from grazing in certain areas. Blasting noise level is assessed for such a "spooking" effect of livestock and wildlife. For other human land users, human health criteria such as interference with speech communication and sleep disturbance, etc. will be used in the assessment of noise on land users.

Details of the assessment criteria and effect of noise on current users of lands and resources can be found in Chapter 18, Commercial and Non-commercial Land Use, and Chapter 22, Current Use of Lands and Resources for Traditional Purposes.

10.5.4.2 Construction Phase

Criteria used to characterize residual effects are described in Table 8.5-1 in Chapter 8 Assessment Methodology, and consider the magnitude, geographic extent, duration, frequency, and reversibility of effects, and resiliency of the receiving environment. Residual effects characterization criteria have been refined to reflect specific noise thresholds and are defined in Table 10.5-16.

Table 10.5-16. Definitions of Residual Effects Characterization Criteria for Noise

Timing*	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Resiliency
When will the effect begin?	*How severe will the effect be?*	*How far will the effect reach?*	*How long will the effect last?*	*How often will the effect occur?*	*To what degree is the effect reversible?*	*How resilient is the receiving environment or population? Will it be able to adapt to or absorb the change?*
Construction phase	**Negligible:** no detectable change from baseline conditions.	**Discrete:** perceptible effect is limited to area within metres from the source.	**Short-term:** effect lasts less than 2 years (i.e., during the Construction phase of the Project).	**One Time:** effect is confined to one discrete event.	**Reversible:** effect can be reversed.	**High:** the receiving environment or population has a high natural resilience to imposed stresses, and can respond and adapt to the effect.
Operations phases (Stages 1 and 2)	**Low:** differs from the average value for baseline conditions but remains within the range of natural variation and below a guideline or threshold value.	**Local:** perceptible effect is limited to a 5 kilometres from the sources.	**Medium-term:** effect lasts from 2 to 30 years (i.e., during the Operations phases of the Project).	**Sporadic:** effect occurs rarely and at sporadic intervals.	**Partially Reversible:** effect can be partially reversed.	**Neutral:** the receiving environment or population has a neutral resilience to imposed stresses and may be able to respond and adapt to the effect.
Closure phase	**Medium:** differs substantially from the average value for baseline conditions and approaches the limits of natural variation, but equal to or slightly above a guideline or threshold value such as speech interference, sleep disturbance, human sensitivity to blasting, increase in annoyance, wildlife disturbance, and habitat loss.	**Regional:** effect occurs throughout the Regional Study Area beyond 5 km from the source.	**Long-term:** effect lasts more than 30 years (e.g., during the Closure phase of the Project).	**Regular:** effect occurs on a regular basis.	**Irreversible:** effect cannot be reversed, is of permanent duration.	**Low:** the receiving environment or population has a low resilience to imposed stresses, and will not easily adapt to the effect.
Post-Closure phase	**High:** differs substantially from baseline conditions and is significantly beyond a guideline or threshold value, resulting in a detectable change beyond the range of natural variation.	**Beyond regional:** effect extends beyond the Regional Study Area.		**Continuous:** effect occurs constantly.		

The residual effects are assessed for all scenario modelled, including the construction of access road (CON-01), construction of mine infrastructure, and road traffic during the Construction phase. None of the predicted noise levels at human receptors exceeded the criteria level for speech interference at 55 dBA during the construction of the road for Scenario CON-01 (Table 10.5-8). During the construction of the mine infrastructure (Scenario CON-02), predicted external daytime noise levels (L_d) are expected to comply with the recommended criteria of 55 dBA in order to avoid interference with speech communication with the exception of the potential upper pullout area for snowmobile traffic outside the mining area (M01). At this pullout area, people are expected to stay for only a few minutes. Moreover, the noise level from snowmobiles, regulated to be less than 73 dBA at 50 feet away while travelling at 15 miles/hour (International Snowmobile Manufacturers Association 2014), is likely to be higher than the noise from the trucks passing by. For these reasons, the exceedance predicted at this pullout area is considered negligible. For the road traffic, compared to the current noise level, the total road traffic noise level increased less than 2 dBA compared to the existing road traffic noise. Based on the FTA noise criteria presented in Figure 10.5-7, an increase of less than 2 dBA is considered to have low impact on the increase in number of people highly annoyed. For blasting noise, none of the human receptor is affected by instantaneous noise level of more than 120 dB (Figure 10.5-6). Since none of the criteria is exceeded for CON-01, traffic noise and blasting noise, and the exceedance for CON-02 is considered negligible, the magnitude is low.

The predicted Project noise is mainly limited to within 50 m from the road for traffic noise, and a few kilometres from the mines for CON-01 and CON-02 (Figures 10.5-2 and 10.5-3). For blasting, the area affected for disturbance to wildlife is limited to 2.9 km from the blast, and area affected for human sensitivity to impulse blasting noise and functional loss of wildlife habitat is limited to 1.1 km from the blasting. Since the effect of construction activities (CON-01 and CON-02), traffic and blasting are limited to less than 5 km from the sources, the geographic extent is local.

During the two-year Construction phase, the frequency of increased noise levels is regular for construction activities (CON-01 and CON-02) and traffic for transporting construction material, as the construction activities are expected to occur 70 hours a week. Blasting is planned to take place once a day and 159 times a year which is considered to be sporadic in frequency. The overall frequency for the Construction phase is considered to be regular, with the majority of the noise sources occurring on a regular basis.

Increased noise levels will occur throughout the entire two-year Construction phase (construction activities, traffic, and blasting) and is considered to be of short-term duration. The noise effect is considered reversible as the effect will disappear once the sources stop after construction activities end. The baseline noise level is at 32 dBA at a location away from traffic, which is within the range expected for baseline rural noise levels. However, some areas that are affected by anthropogenic activities were found to have a baseline noise level of 56 dBA. Since the baseline condition in the area is affected by some anthropogenic activities, the receiving environment is considered to have a neutral resilience to an increase in noise. Table 10.5-17 provides a summary of the residual effects characterization criteria rankings.

Table 10.5-17. Summary of Residual Effects on Noise

Valued Component	Project Phase (Timing of Effect)	Cause-Effect [1]	Mitigation Measure(s)	Residual Effect
Noise	Construction and Operations phases	Project Construction and Operations noise sources are predicted to increase noise levels at off-site receptors.	Consider noise levels in equipment selection, adequate maintenance, reduce vehicle speed, avoid idling, and optimize construction design and site layout	Increase in noise levels

[1] *"Cause-effect" refers to the relationship between the Project component or physical activity that is causing the change or effect in the condition of the VC.*

10.5.4.3 Operations Phase

During the Operations phase, predicted noise levels from mining activities are not expected to exceed the criteria level for speech interference of 55 dBA, with the exception of the potential pullout areas for snowmobile traffic at the Upper Pullout Area and Lower Pullout Area (Table 10.5-11); however, considering the use of the location, such an exceedance would be considered as negligible impact as people are expected to be present at the location for a matter of minutes. As mentioned earlier, the noise level from snowmobiles, regulated to be less than 73 dBA at 50 feet away while travelling at 15 miles/hour (International Snowmobile Manufacturers Association 2014), is likely to be higher than the noise from the trucks passing by. Predicted nighttime noise level exceeded the sleep disturbance criteria at T02, a surface water licence location (C124889) close to the town of Vavenby. Since this location is much closer to traffic (25 m) than to the mine (5,835 m), this location is characterized suing the FTA guideline for traffic noise.

The predicted total road traffic noise levels indicated an increase of up to 2.6 dB (Table 10.5-12) from the existing road traffic noise level. From the FTA's suggestion shown on Figure 10.5-7, it can be seen that at an existing noise exposure level of 54 dBA, an increase of less than 3 dBA is considered to be low impact. Furthermore, an increase of 3 dB would be considered barely perceptible. With a few exceedances from mining operation noise and low impact from traffic noise, the overall magnitude of noise during the Operations phase is considered medium.

The traffic noise is mainly limited to those receptors directly facing the road up to a few kilometres for the mining operation (Figures 10.5-4 and 10.5-5). For blasting, the area affected for disturbance to wildlife is limited to 2.9 km from the blast, and the area affected for human sensitivity to impulse blasting noise and functional loss of wildlife habitat is limited to 1.1 km from the blasting; since the extent of noise affect is less than 5 km for the mining operations, traffic, and blasting, geographic extent is considered local.

During the Operations phase, the frequency of increase in noise level is continuous as noise from mining operations and road traffic for hauling material is expected whenever the equipment is operating, and mining operations are expected 24 hours a day and 365 days a year. Blasting is expected to be 331 blasts a year with a maximum of one blast a day. Although the blasting effect is considered to be sporadic, the overall mining operation effect, expected to last throughout the 23 years of active mining, is considered medium term.

The noise effect is considered reversible, as the effect will diminish once the sources cease operation. Since the baseline noise indicates that some areas are affected by anthropogenic activities, the receiving environment is considered to have a neutral resilience to increases in noise.

10.5.4.4 Likelihood of Noise Residual Effect

Likelihood refers to the probability of the predicted noise residual effect occurring and is determined according to the attributes identified in Table 10.5-18 below.

Table 10.5-18. Attributes of Likelihood of Noise Effects

Probability Rating	Quantitative Threshold
High	> P80 (effect has > 80% chance of effect occurring)
Moderate	P40 - P80 (effect has 40 - 80% chance of effect occurring)
Low	< P40 (effect has < 40% chance of effect occurring)

It is expected that noise is generated when equipment and vehicles are operating, or while mining operations are taking place. The probability of an increase in noise level observed during the Project's Construction and Operations phases is more than 80%; therefore, the likelihood of residual effects of the Project causing increased noise levels is high.

10.5.4.5 Significance of Residual Effects on Noise

During the Construction phase, the residual effects of the Project on increased noise levels are low in magnitude, local geographic extent, of regular frequency, and of short-term duration.

During the Operations phase the magnitude is medium, geographic extent is local, frequency is continuous, and duration is medium term. Noise impact is considered reversible with neutral resiliency in the RSA. Following the methodology described in Chapter 8, the residual effects of the Project on noise levels during both the Construction and Operations phases is considered minor and **not significant**.

10.5.5 Confidence and Uncertainty in Determination of Significance

Confidence, which can also be understood as the level of uncertainty associated with the assessment, is a measure of how well residual effects are understood and the confidence associated with the baseline data, modelling techniques used, assumptions made, effectiveness of mitigation, and resulting predictions. In predictive assessment involving modelling, the uncertainty associated with the assessment is closely related to model limitations.

For sound calculated using the ISO 9613 standard, the indicated accuracy is ± 3 dBA at source to receiver distances of up to 1,000 m and unknown at distances above 1,000 m. The noise modelling software is limited to calculate all sources within 10 km of a receiver point, as items at distances greater than 10 km would have no influence on the calculation.

The estimated sound power levels for mobile equipment are generally based on new and well-maintained equipment. Older pieces of mobile equipment would likely produce higher noise emissions. For individually modelled noise sources (fixed and mobile equipment and roads), the estimated accuracy of the sound power levels is ± 5 dBA.

Confidence level was determined using attributes outlined in Table 8.6-4. Uncertainty is expected with any predictive study although modelling is useful in determining effects. There is a fairly good understanding established for the cause-effect relationship of noise, but human response to it is highly subjective. For the above reasons, the confidence level for noise residual effect is considered moderate.

10.5.6 Summary of the Residual Effects Assessment for Noise

Residual effect for noise is summarized in Table 10.5-17, including the associated characterization criteria (Table 10.5-19), significance, likelihood, and confidence in the determination.

10.6 CUMULATIVE EFFECTS ASSESSMENT

10.6.1 Scoping Cumulative Effects

Cumulative effects are the result of Project-related residual effects interacting with the residual effects of other human actions (i.e., anthropogenic developments, projects, or activities) to produce a combined effect. The methodologies used in the cumulative effects assessment (CEA) are outlined in Section 8.7.

10.6.1.1 Valued Components and Project-related Residual Effects

Two minor residual effects resulting in increased noise levels during construction and operations were identified in the project effects assessment as described in Table 10.5-14 above. The cumulative increase in noise levels will be compared to criteria previously used to compare to Project-related effects.

10.6.1.2 Defining Assessment Boundaries

Similar to the Project-related effects, assessment boundaries define the maximum limit within which the cumulative effects assessment (CEA) is conducted. Boundaries relevant to noise are described below. The definition of these assessment boundaries is an integral part of the noise CEA, and encompasses possible direct, indirect, and induced changes of the Project on noise.

The temporal boundaries for the identification of physical projects and activities have been categorized into past, present, and reasonably foreseeable projects and are defined as follows.

- **Past**: no longer operational projects and activities that were implemented in the past 50 years. This temporal boundary enables taking into account any far-future effects from past projects and activities.

Table 10.5-19. Summary of Key Effects, Mitigation, Residual Effects Characterization Criteria, Likelihood, Significance, and Confidence

Key Effect	Mitigation Measures	Summary of Residual Effects Characterization Criteria *(Magnitude, Geographic Extent, Duration, Frequency, Reversibility, Resiliency)*	Likelihood *(High, Moderate, Low)*	Significance of Adverse Residual Effects		Confidence *(High, Moderate, Low)*
				Scale (*Minor, Moderate, Major*)	Rating *(Not Significant; Significant)*	
Increase in noise levels during Construction phase	Consider noise in equipment selection, adequate maintenance, reducing vehicle speed, and avoid idling, and optimize construction design and site layout	Low magnitude, local geographic extent, short-term duration, regular frequency, reversible, and neutral resiliency	High	Minor	Not significant	Moderate
Increase in noise levels during Operations phase	Consider noise in equipment selection, adequate maintenance, reducing vehicle speed, and avoid idling, and optimize construction design and site layout	Medium magnitude, local geographic extent, medium-term duration, continuous frequency, reversible, and neutral resiliency	High	Minor	Not significant	Moderate

- **Present**: active and inactive projects and activities.
- **Future**: certain projects and activities that will proceed, and reasonably foreseeable projects and activities that are likely to occur. These projects are restricted to those that 1) have been publicly announced with a defined project execution period and with sufficient project details for assessment, and/or 2) are currently undergoing an EA, and/or 3) are in a permitting process.

Noise levels will immediately return to baseline levels after Project noise sources are removed. Therefore, the noise CEA only considers projects with construction and/or operation phases that overlap with the Project phases. As such, past projects or activities will not be considered, and the assessment will focus on existing and potential future sources of noise.

Noise impacts are typically restricted to within 10 km of the noise source as previously mentioned; therefore, the noise CEA focuses on projects and activities within 10 km of the Project which coincides with the Project's RSA. Figure 10.6-1 shows the location of the CEA boundary.

10.6.1.3 Projects and Activities Considered

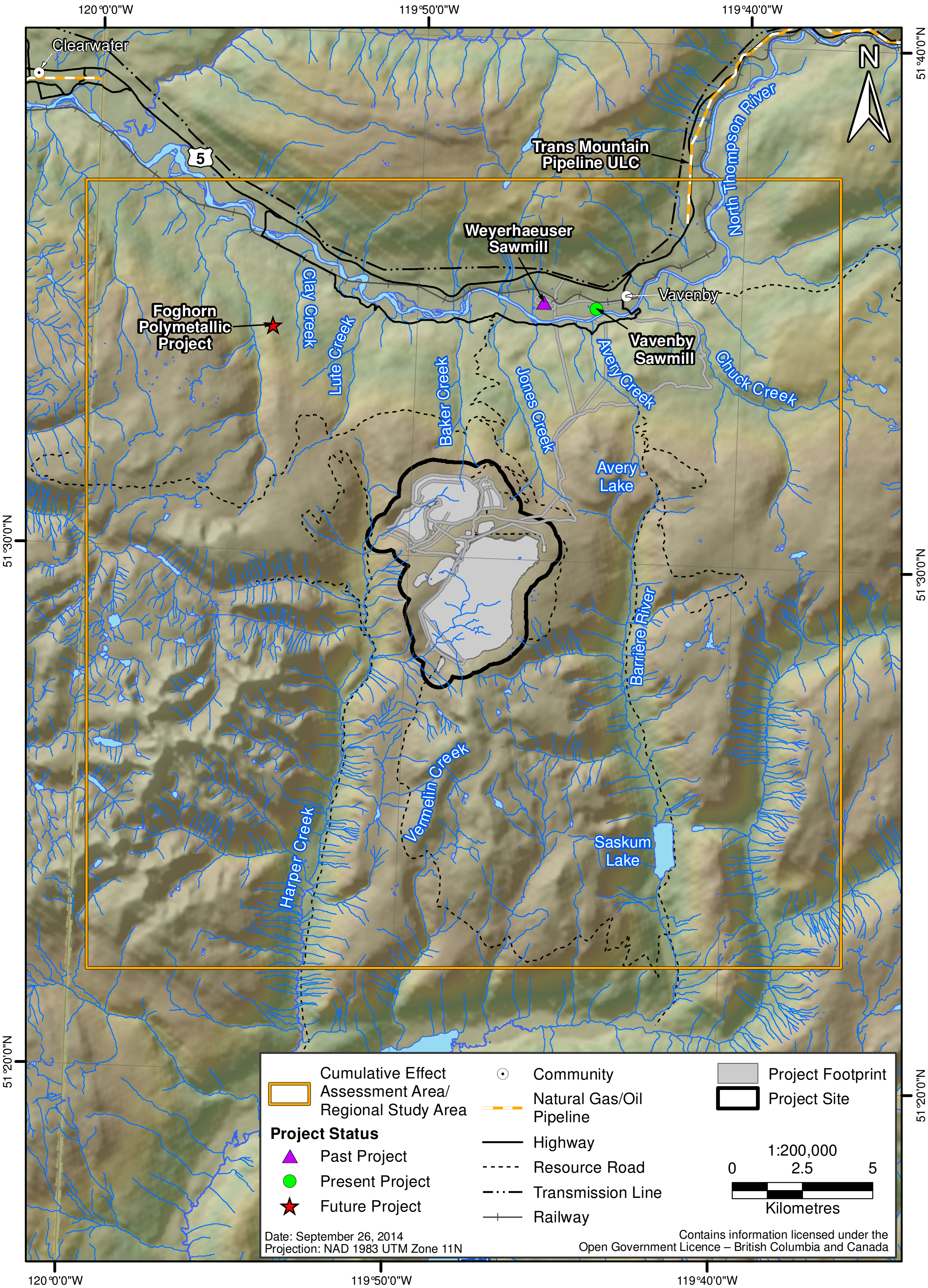
Present and reasonably foreseeable future projects and activities, with timelines overlapping with the Project's Construction or Operations phases and within the boundaries described above, were considered in the CEA. The project list was developed from a wide variety of information sources, including municipal, regional, provincial, and federal government agencies; other stakeholders; and companies' and businesses' websites. The projects and activities considered in the CEA are presented in Chapter 8 in Tables 8.7-1 and 8.7-2, respectively. Figure 10.6-1 shows the past, present and future projects that fall within the CEA boundary for noise.

Land use and activities identified within the CEA area includes the following (see figures in Section 8.7 of the Chapter 8):

- Trapping: trapline tenure (7) and trapline cabin tenure (0);
- Non-commercial recreation: protected area (1 – Dunn Peak Protected Area), recreation cabin (3 - Foghorn snowmobile cabin, Harp cabin, and Avery lookout), recreation site for fishing, camping and hunting (1: Saskum Lake south), and recreation trail (2 - Foghorn-Harp snowmobile trail, and Dunn Peak trail);
- Public and commercial recreation tenure: commercial recreation (3: guided freshwater recreation and snowmobiling), environment conservation and recreation (2), private campground (1: Clearwater-Birch Island Campground), potential pullout area for snowmobile (2), and the Serenity Performing Arts Centre;
- Mineral Exploration: mineral claims (161), mineral leases (0), and placer claims (0);
- Agriculture: range tenure (7), agricultural land reserve (11) and the Vavenby Trail Ride;
- Forestry: active cutblocks (93) and community forest (1);
- Water Use: water intake extraction points (64) and water licences (173); and
- Private Lands (494).

Figure 10.6-1

Location of Past, Present and Reasonably Foreseeable Future Projects for the Cumulative Effects Assessment for Noise



These land use and activities identified are screened and analyzed for cumulative noise effects.

10.6.2 Screening and Analyzing Cumulative Effects

As described in Section 10.6.1.2, noise levels will immediately return to baseline levels after Project noise sources are removed and effects are restricted to within 10 km (Golder 2012) of the sources (the CEA area). For the construction of the access road (CON-01) and the construction of the mine infrastructure (CON-02) noise effects are limited to a few kilometres from the mine while the traffic effect is limited to within 50 m from the road. For the Operations phase, noise is mainly limited to areas within a few kilometres and within 50 m from the road. For blasting, the area affected for disturbance to wildlife is limited to 2.9 km from the blast, and area affected for human sensitivity to impulse blasting noise and functional loss of wildlife habitat is limited to 1.1 km from the blasting. Therefore, a CEA area of 10 km from the mining operation is considered sufficient. Since noise will return to baseline once Project noise sources are removed, the noise CEA only considers projects with construction and/or operation phases that overlap with the Project phases within the CEA area, or activities that are existing and that are emitting noise.

Projects and activities with the potential to interact with the Project that may lead to cumulative residual effects on noise are identified in Table 10.6-1. The same risk ratings used for Project effects on noise are used in the CEA, with green indicating low risk interaction, yellow indicating moderate risk interaction, and red indicating high risk interaction.

Activities such as trapping, hunting, harvesting, fishing, use of recreation or private cabins, camping, trail riding or hiking, water extraction, and utility corridors would produce negligible noise levels compared to noise levels as a result of the Project and therefore there is no cumulative interaction. For activities such as transportation guided freshwater recreation and snowmobiling, a perceptible noise would be produced. However, since the noise baseline monitoring was conducted in 2012, baseline noise levels already include all the existing activities. Moreover, noise from guided freshwater recreation and snowmobiling is expected to be transient and therefore, the interaction is limited to minutes. Although there is an interaction with transportation and forestry activities, the interaction and effect of existing activities producing noise are already accounted for in the noise baseline assessment.

Vavenby Sawmill is the only existing project inside the noise CEA area. Historically, there was a Weyerhaeuser Sawmill operating nearby the Vavenby Sawmill; however, the Weyerhaeuser Sawmill has been closed since 2003 with no plans for resuming operation. The property, now owned by Yellowhead Mining Inc., is being proposed by HCMC for use for concentrate storage, rail access, and staging grounds for the Project. The potential noise sources from Vavenby Sawmill may include lumber processing and traffic along the access road. Since the Traffic Impact Study (Appendix 5-E) was conducted in 2014, the existing traffic presented in the assessment already includes the traffic from the Vavenby Sawmill. Moreover, the baseline noise monitoring conducted in 2012 would also include noise sources from Vavenby Sawmill. Lumber processing noise is considered to be localized enough for there to be minimal interaction with noise produced by the activities associated with Project construction and operation, as evidenced by the noise levels found near the sawmill during baseline monitoring. Although there is a possibility of interaction between the Project (Construction and Operations phases) and Vavenby Sawmill, this interaction is considered low-risk with the potential to result in a negligible to minor adverse effect.

Table 10.6-1. Impact Matrix for Screening and Ranking Potential Cumulative Effects of Noise

Residual Effects of the Harper Creek Project on Noise	Past Projects				Present Projects								Reasonably Foreseeable Future Projects							Activities											
	Weyerhaeuser Sawmill	Samatosum Project	Weyerhaeuser Sawmill	Louis Creek Sawmill	Highland Valley Copper	Bone Creek	Trans Mountain Pipeline	Kamloops Groundwater Project	New Afton	Cache Creek Landfill Extension	Vavenby Sawmill	Barriere Sawmill	North Thompson Transmission Project	Ruddock Creek Project	Trans Mountain Pipeline Expansion	Foghorn Project	Tranquille on the Lake	Shannon Creek	Ajax Project	Aboriginal Harvesting	Hunting	Trapping	Fishing	Non-commercial Recreation	Commercial Recreation	Mineral Exploration	Utility Corridor (Gas/Oil pipeline)	Transportation	Agriculture	Forestry	Water Use
Noise																															
Increase in Noise Levels during Construction											● (green)					● (green)												● (green)		● (green)	
Increase in Noise Levels during and Operations											● (green)					● (green)												● (green)		● (green)	

Notes:
* *Includes Operations 1 and Operations 2 as described in the temporal boundaries.*
● (green) = *Low risk interaction: a negligible to minor adverse effect could occur; no further consideration warranted.*
● (yellow) = *Moderate risk interaction: a potential moderate adverse effect could occur; warrants further consideration.*
● (red) = *High risk interaction: a key interaction resulting in potential significant major adverse effect or significant concern; warrants further consideration.*

The only other reasonably foreseeable future project in the RSA is the Foghorn Polymetallic Project on the northwest corner of the CEA area. The Foghorn Polymetallic Project is a mineral claim and proposed uranium mine with the potential for future mining of other commodities including fluorite, celestite, rare earth metals, and molybdenum; however, the project is currently on hold due to a provincial ban on uranium exploration and mining. At this point, the expected ban removal or project start timeline is unknown. It is highly unlikely that the Foghorn Polymetallic Project will be in construction or operation during the two-year Construction phase of the Project. As previously mentioned, noise effects are eliminated immediately after the source(s) are removed. It is uncertain if the Foghorn Polymetallic Project will start construction before the end of Project's LOM. As presented in Figures 10.5-2 to 10.5-7, the limit for speech interference of 55 dBA is only expected to be reached within metres of the sources. Therefore, it is unlikely that the Foghorn Polymetallic Project and the Project will interact to create a cumulative residual adverse effect, even if the Foghorn Polymetallic Project is active during the Operations phase of the Project. Due to the low likelihood of an adverse effect between Foghorn Polymetallic Project and the Project, and the unknown timeline of the Foghorn Polymetallic Project, further assessment is not warranted.

10.6.3 Mitigation Measures

There are no specific mitigation or management measures proposed to explicitly address potential cumulative changes that would be implemented by the proponent on the Vavenby sawmill site. Mitigation measures provided in Section 10.5.2 and the Noise Management Plan (Section 24.10) are applicable to the potential cumulative changes.

10.6.4 Cumulative Residual Effects and Characterization

Only a negligible or minor cumulative residual adverse effect on noise is expected as a result of the interaction of the Project with Vavenby Sawmill. During the Construction phase of the Project, the cumulative noise effect from the Project and the Vavenby Sawmill is not considered to interact except for traffic noise. In the traffic assessment during the Construction phase, noise level from existing traffic would have already accounted for the traffic associated with Vavenby Sawmill (Table 10.5-10), with the impact being limited to 50 m (Figure 10.5-3); therefore, the extent is considered local with low magnitude. Since the Construction phase of the Project is only two years, the duration is short-term. Traffic is expected on a regular basis (frequency).

During the Operations phase of the Project, the traffic volume is expected to be higher than that during the Construction phase. Despite the increase in traffic, existing traffic noise level, including traffic associated with Vavenby Sawmill, is compared to future traffic noise level (Table 10.5-12). Model results showed that traffic noise only impacts an area within 50 m from the roads (Figure 10.5-7); therefore, the magnitude is medium and the extent is local. Since the cumulative interaction will occur throughout the Operations phase, duration is medium-term. Although traffic noise is regular, noise from mining is continuous.

Since the baseline condition in the area is somewhat affected by anthropogenic activities, such as the Vavenby Sawmill, the receiving environment is considered to have a neutral resilience to an increase in noise. The cumulative residual effects on noise are summarized in Table 10.6-2.

Table 10.6-2. Summary of Cumulative Residual Effects on Noise

	Cause-Effect [1]	Mitigation Measure(s)	Cumulative Residual Effect
Noise			
Increase in Noise Level	Project Construction and Operations noise sources are predicted to increase noise levels at off-site receptors.	Consider noise levels in equipment selection, adequate maintenance, reduce vehicle speed, avoid idling, and optimize construction design and site layout	Increase in noise levels during construction and operations

10.6.5 Significance of Cumulative Residual Effects on Noise

Since the risk of noise interaction is low between the Project and the Vavenby Sawmill, with only low magnitude, short-term duration and regular frequency during the Construction phase, and medium magnitude, medium-term and continuous frequency during the Operations phase, with local geographic extent, reversible, and neutral resiliency, the predicted significance of cumulative residual effects on noise remaining after the implementation of all mitigation measures is not significant, and remains unchanged from the Project-related effects assessment summarized in Table 10.6-3.

10.6.6 Confidence and Uncertainty in Determination of Significance

As discussed in Section 10.6.2, although the Foghorn Polymetallic Project is a reasonably foreseeable future project, the project timeline is unknown. Due to the nature of noise being localized and the ability to return to baseline conditions once the sources are removed, the confidence level for CEA remains the same as that for the determination of significance for Project-associated effects.

10.7 Conclusions for Noise

None of the predicted noise levels at sensitive receptors exceeded the criteria level for speech interference at 55 dBA during the construction of the road. During the construction of the mine infrastructure, exceedance over the speech interference criterion was predicted at the potential upper pullout area for snowmobile traffic. Considering the use of the location, such an exceedance would be considered low impact; therefore, the magnitude is considered low. Construction activities are not expected during the nighttime and sleep disturbance is therefore not considered. The predicted Project noise is mainly limited to within 50 m from the road, and a few kilometres from the Project Site; therefore, the geographic extent of noise emanating from Project sources is local. During the two-year Construction phase the frequency of an increase in noise levels is regular, as noise from construction activities is expected for 70 hours a week. The duration of the effects will occur throughout the two years of construction and is considered short term. Residual noise effects are reversible as the effect disappears once the sources cease operation. The baseline noise level of 32 dBA at a location away from traffic is typical of baseline rural noise levels. Areas within the RSA that were affected by anthropogenic activities, such as the Vavenby Sawmill, were found to have a baseline noise level of 56 dBA. Since the baseline condition in the area is somewhat affected by anthropogenic activities, the receiving environment is considered to have a neutral resilience to an increase in noise. The significance of the residual effect on noise during the Construction phase is considered to be **not significant**.

Table 10.6-3. Summary of Key Cumulative Effects, Mitigation, Cumulative Residual Effects Characterization Criteria, Likelihood, Significance, and Confidence

Key Cumulative Effect	Mitigation Measures	Summary of Cumulative Residual Effects Characterization Criteria *(Magnitude, Geographic Extent, Duration, Frequency, Reversibility, Resiliency)*	Likelihood *(High, Moderate, Low)*	Significance of Adverse Cumulative Residual Effects		Confidence *(High, Moderate, Low)*
				Scale (*Minor, Moderate, Major*)	Rating *(Not Significant; Significant)*	
Increase in noise levels during Construction phase	Consider noise in equipment selection, adequate maintenance, reduce vehicle speed, avoid idling, and optimize construction design and site layout	Low magnitude, local geographic extent, short-term duration, regular frequency, reversible, and neutral resiliency	High	Minor	Not significant	Moderate
Increase in noise levels during Operations phase	Consider noise in equipment selection, adequate maintenance, reduce vehicle speed, avoid idling, and optimize construction design and site layout	Medium magnitude, local geographic extent, medium-term duration, continuous frequency, reversible, and neutral resiliency	High	Minor	Not significant	Moderate

During the Operations phase, predicted noise levels from mining activities are not expected to exceed the criteria level for speech interference of 55 dBA, with the exception of the potential pullout areas for snowmobile traffic at the Upper Pullout Area and Lower Pullout Area; however, people are only expected to be present at these locations for a few minutes. Considering the use of the locations, such exceedances are considered to have a low impact. Incremental noise from road traffic during the Operations phase is predicted to be less than 2.6 dBA, indicating low impact according to the FTA's suggested noise impact criteria. Therefore, the magnitude of noise impact is considered medium. Project noise is mainly limited to a distance of 50 m from the road and a few kilometres from the mining area; therefore, geographic extent is local.

During the Operations phase, the frequency of increase in noise level is continuous as noise from equipment is expected whenever the equipment is operating, and mining operations will occur 24 hours a day, 365 days a year. The effect is expected to occur throughout the 23 years of active mining, so duration is deemed medium term. The noise effect is considered reversible as it will disappear once the sources cease operation. Since the baseline noise levels indicate that some areas are affected by anthropogenic activities, the receiving environment is considered to have a neutral resilience to increase in noise. The significance of the residual effect on noise during the Operations phase is considered **not significant**.

Existing activities such as hunting, harvesting, and fishing would produce negligible noise levels compared to the Project; therefore, there is no cumulative effect. For activities such as transportation and forestry, a perceptible noise increase may be produced. However, since the noise baseline monitoring was conducted in 2012, baseline noise levels already account for noise emanating from transportation and forestry activities.

Vavenby Sawmill is the only existing project inside the noise CEA area. The potential noise sources from Vavenby Sawmill may include lumber processing and traffic along the access road. Since the Traffic Impact Study (Appendix 5-E) was conducted in 2014, the existing traffic presented in the assessment would already include the traffic from Vavenby Sawmill. Moreover, the baseline noise monitoring conducted in 2012 would also include noise sources from Vavenby Sawmill. Lumber processing noise is considered to be localized enough for there to be minimal interaction with noise produced at the Project Site as evidenced by the noise levels found near the sawmill during baseline monitoring. Although there is a possibility of interaction between the Project and Vavenby Sawmill, a negligible to minor adverse effect is expected.

The only other reasonably foreseeable future project in the RSA is Foghorn Polymetallic Project on the northwest corner of the RSA. The project is currently on hold due to a provincial ban on uranium exploration and mining. The expected ban removal or project start timeline is unknown. As previously mentioned, noise effects diminish immediately after the sources are removed. It is uncertain if the Foghorn Polymetallic Project will start construction before the end of the Project's LOM. From predicted noise levels of the Project's effect, it can be seen that the limit for speech interference of 55 dBA is only exceeded within metres of the sources. Therefore, it is unlikely that the Foghorn Polymetallic Project and the Project will interact to create an adverse cumulative effect. Since the noise associated with the Vavenby Sawmill would have been captured in the noise monitoring, included in the traffic assessment, the cumulative effect is considered low risk and therefore **not significant.** A summary of key Project and cumulative residual effects is presented in Table 10.7-1.

Table 10.7-1. Summary of Key Project and Cumulative Residual Effects, Mitigation, and Significance for Noise

Key Residual Effects	Project Phase	Mitigation Measures	Significance of Residual Effects	
			Project	Cumulative
Noise				
Increase in Noise Level	Construction	Consider noise in equipment selection, adequate maintenance, reduce vehicle speed, avoid idling, and optimize construction design and site layout	Not significant	Not significant
Increase in Noise Level	Operations	Consider noise in equipment selection, adequate maintenance, reduce vehicle speed, avoid idling, and optimize construction design and site layout	Not significant	Not significant

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