Appendix 18-C

Murray River Coal Project: Environmental Noise Modelling Study

MURRAY RIVER COAL PROJECT

ENVIRONMENTAL NOISE MODELLING STUDY

PREPARED FOR:

ERM

ERM RESCAN

JULY 2014

REVISION 0

BKL Consultants in Acoustics

MURRAY RIVER COAL PROJECT

ENVIRONMENTAL NOISE MODELLING STUDY

PREPARED FOR:

ERM RESCAN

JULY 2014

REVISION 0

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EXECUTIVE SUMMARY

BKL Consultants Ltd. (BKL) has been retained by ERM Rescan to provide an environmental noise modelling study for the proposed Murray River Coal Project (the Project). This report documents the predicted noise climate during the Construction and Operation of the Project, and noise levels at nearby sensitive human and wildlife receptors.

The Project is located 12.5 km southwest of the town of Tumbler Ridge in northeastern British Columbia, and is an underground mine proposed to be operating over a 25-year period. The Project includes the consideration of an underground mine, coal processing and storage facilities, shaft ventilation, mobile equipment and a rail loadout.

The objective of this study was to complete noise predictions from various activities throughout Construction and Operation, including vehicle passbys and rail loadout activity to enable ERM Rescan to perform potential effects assessments on sensitive human and wildlife receptors.

A noise model was constructed using Cadna/A software which incorporated internationally or nationally recommended algorithms, such as ISO 9613-2:1996 *Attenuation of Sound During Propagation Outdoors - Part 2: General Method of Calculation* and SRM II *Railway Noise Calculation Method*, to predict the environmental noise levels. Predicted noise levels for various construction and operation scenarios were presented over representative areas and in metrics suitable for effects assessments on humans and wildlife, as appropriate, and are presented in a series of tables and graphical figures in Section 9.

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List of Abbreviations and Acronyms

Abbreviation/Acronym	Definition
%HA	Percentage of persons highly annoyed
Δ%HA	Increase in percentage of persons highly annoyed
ANSI	American National Standards Institute
μPa	Micropascal
BKL	BKL Consultants Ltd.
CN	Canadian National Railway
dB	Decibel
dBA	A-weighted decibel
dBZ	Decibel (no frequency weighting)
EA	Environmental Assessment
Hz	Hertz
km	Kilometre
km/h	Kilometres per hour
L_{AE}	Sound exposure level
L_{max}	Maximum A-weighted, fast time constant sound level
L_d	Daytime (07:00 to 22:00) equivalent sound level
L_{dn}	Day-night equivalent sound level
L_{eq}	Equivalent sound level
L_n	Nighttime (22:00 to 07:00) equivalent sound level
L_{Ndn}	Adjusted day-night equivalent sound level
m	Metre
Project	Murray River Coal Project
SWL	Sound power level
WHO	World Health Organization

1 INTRODUCTION

BKL Consultants Ltd. has been retained by ERM Rescan to provide an environmental noise modelling study for the proposed Murray River Coal Project (the Project).

This report documents the predicted noise climate during Construction and Operation at nearby human and wildlife receptors.

2 PROJECT DESCRIPTION

The Murray River Coal Project is located on the east side of the Rocky Mountains in north-western British Columbia at approximately latitude 54°56′59″N and longitude 112°54′03″W. The site is 12.5 km south of Tumbler Ride within the Peace River Regional District. The Project will be accessed via existing service roads which connect to the Heritage Highway (Hwy 52).

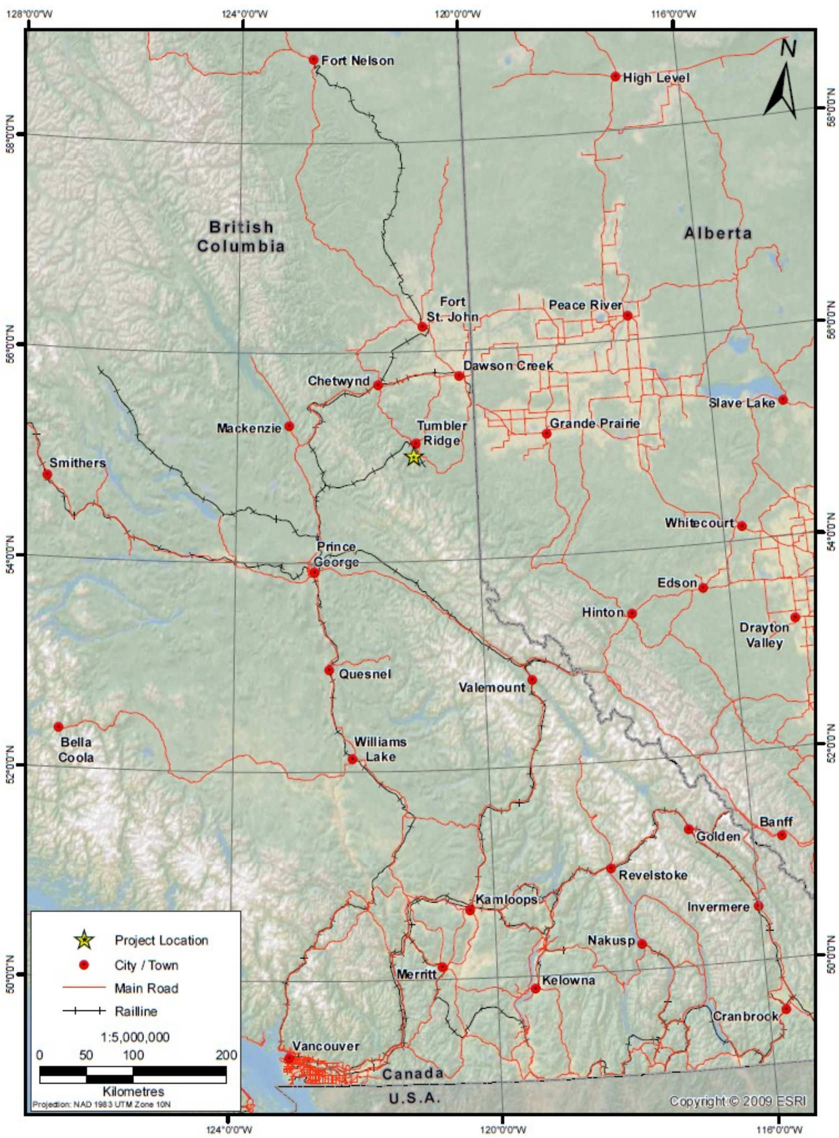

Figure 2-1 Murray River Coal Project Components (Source: ERM Rescan)

The Project includes the Decline Site, Shaft Site, Coal Processing Site, Secondary Shafts Site and an Underground Mine. Figure 2-2 below show the site layout of the Project site.

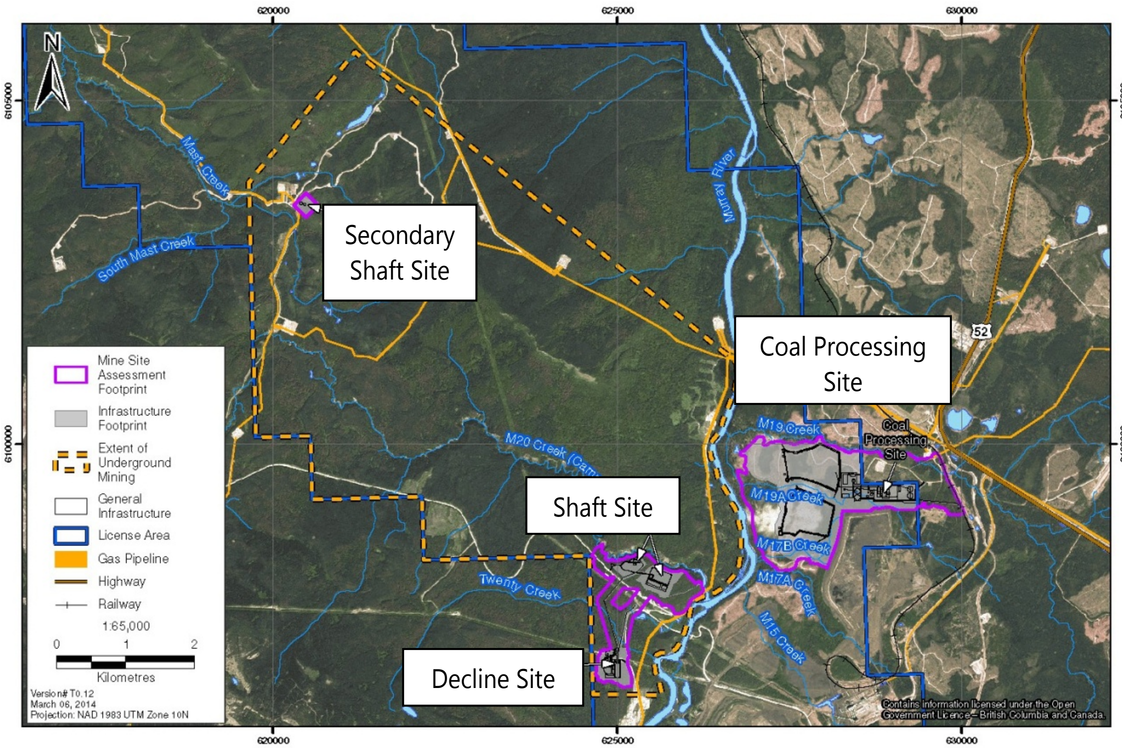

Figure 2-2 Murray River Coal Project Layout (Source: ERM Rescan)

The Project will include the following infrastructure and facilities:

- Underground mine and associated works;
- Waste rock facilities;
- Overburden and soil storage areas;
- Coal rejects storage area;
- Equipment and fuel storage areas and facilities;
- Maintenance, administration and warehouse facilities;
- Coal handling and preparation facilities;
- Coal conveyors;
- Rail loadout;
- Contact and non-contact water management structures;
- Water supply facilities;
- Sewage treatment and disposal facilities;
- Electricity transmission line; and,
- Natural gas pipeline

The Project is estimated to undergo approximately 3 years of construction before beginning operation. The underground mine is proposed to be operating for a 25-year period. (Rescan 2014).

3 STUDY OBJECTIVES

The objectives of this study have been as follows:

- To complete noise predictions for all Project-related activity during Construction and Operation;
- To provide predicted noise levels suitable for assessing potential environmental noise effects on humans; and,
- To provide predicted noise levels suitable for assessing potential environmental noise effects on wildlife.

4 IDENTIFICATION OF POTENTIAL EFFECTS

Although this study does not include an effects assessment, the identification of potential effects to establish appropriate criteria is required to ensure that:

1. Noise levels are calculated in metrics suitable for effects assessment; and
2. Noise levels are calculated over large enough areas to encompass all regions and noise-sensitive receptor populations where criteria may be exceeded.

Research has shown over the years that noise complaints do not necessarily correlate well with actual community disturbance/response. A proper assessment of the noise impact in situations such as that being considered here is important because the extent of the noise mitigation requirements should be based on the actual significance of the noise effects, having due regard to the magnitude of the predicted impacts and the sensitivity of the affected receptors to noise (Michaud et al 2008). This section summarizes four potential environmental effects pertaining to noise: sleep disturbance, interference with speech communication, high annoyance and loss of wildlife habitat. Potential occupational health effects are not included as part of this study.

This section introduces several acoustic terms and metrics which are used throughout the study. Please consult Appendix A (Glossary) and Appendix B (Introduction to Sound and Environmental Noise Assessment) for definitions and further information on these terms.

4.1 Sleep Disturbance

Sleep disturbance includes the following effects from noise: difficulty falling asleep, awakenings, curtailed sleep duration, alterations of sleep stages or depth, and increased body movements during sleep. The recommendations and guidelines of the World Health Organisation (WHO) regarding sleep disturbance have been used to assess these adverse health effects.

The WHO *Guidelines for Community Noise* (WHO 1999) reports:

- "If negative effects on sleep are to be avoided the equivalent sound pressure level should not exceed 30 dBA indoors for continuous noise"; and,

- "For a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45 dB L_{Amax} more than 10–15 times per night."

Sound is attenuated as it is transmitted indoors and the amount of reduction mostly depends on whether windows are open or not. An outdoor-to-indoor noise reduction of 15 dB if windows are slightly open, or 27 dB reduction if windows are closed, can be used to estimate the inside noise level (EPA 1974). The actual reduction depends on construction materials, geometry, etc. of the room.

4.2 Interference with Speech Communication

If continuous project noise indoors or outdoors is high enough, the Project could interfere with speech communication, such that speakers will need to increase their vocal effort or move closer to each other. WHO (1999) states that when listening to complicated messages (e.g. receiving instruction, listening to foreign languages, telephone conversation, etc.) that "the signal-to-noise ratio should be at least 15 dB". Assuming normal indoor speaking levels of 55-58 dBA (Levitt and Webster 1991), potential effects could occur if indoor noise levels exceed 40 dBA.

Speech interference is less likely to occur outdoors since humans naturally tend to speak louder when outdoors. An outdoor noise level of 55 dBA or lower should enable good speech comprehension (EPA 1974).

4.3 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 (e.g. if it contains tones, impulses, strong low-frequency content, etc.);
- Absolute level of sound;
- Time of day;
- Local attitudes to the Project; and
- Expectations for quiet.

Studies have found a consistent relationship between the percentage of a community that is highly annoyed by noise and the "adjusted" noise level. Health Canada (2010) suggests that the "Percent Highly Annoyed" or "%HA" metric, which is calculated using the adjusted L_{dn} (ANSI 2005, ISO 2003) – or Rating Level, L_{Ndn} – 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. Health Canada (2010) suggests that Project L_{dn} should be less than 75 dBA and that the increase in %HA should be less than 6.5%.

4.4 Loss of Wildlife Habitat

There are no legislated noise limits that apply to wildlife, but there is considerable academic and industrial monitoring research that provides guidance on the types of noise that can cause adverse effects to wildlife. The effects of noise on wildlife are dependent both on the type of noise and the wildlife species in question. Some species are thought to be particularly susceptible to noise disturbance, while other species may become acclimatized over time. Some species may be attracted by noise, particularly where they associate noise with human habitation.

The Environment Code of Practice for Metal Mines (Environment Canada 2009) recommends that ambient noise from mining operations and its effect on wildlife should meet the objectives for residential areas: the sound pressure level from mining activities should not exceed 55 dBA during the day and 45 dBA at night.

Consequently, the potential effects on wildlife are described in terms of the following responses resulting in "loss of habitat":

- Reduction in biodiversity and population numbers due to 'above threshold' continuous noise levels; and
- Flight response, freezing or strong startle response due to event noise levels (passby events).

Based on the above mentioned studies, the following noise level limits have been used:

- Continuous Project noise during the day of 55 dBA;
- Continuous Project noise during the night of 45 dBA; and
- A-weighted sound exposure level (L_{AE}) from passby events of 75 dBA.

5 CRITERIA

Following the potential noise effects identified in the previous section, this section includes criteria suggested for best practice for assessing noise effects on humans and wildlife. Noise modelling for the Project has been performed to enable assessment of these 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, 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.

5.1 Human Receptors

Noise from construction activities often has the potential to negatively impact nearby human receptors, and is often the loudest noise source of project related noise. Health Canada (2010) advises the following assessments for construction noise:

- If construction noise lasts for less than 2 months at receptors it may be considered temporary, and community consultation is advised.
- If the construction period is less than one year, the assessment can be based on the US Environmental Protection Agency method (EPA 1974), where mitigation should be implemented if it is determined if the noise levels produced could cause widespread complaints.
- Construction noise should be treated the same as operation noise if the construction period is greater than one year.

Table 5-1 below lists the criteria applicable for the assessment of noise effects on humans residing in the area surrounding the Project.

Table 5-1 Criteria Applicable for Residing Human Receptors

Project Metric	Description	Outdoor Limit
L_d	Daytime continuous noise level for assessing speech interference	55 dBA
L_n	Nighttime continuous noise level for assessing sleep disturbance (assuming 15 dB façade attenuation)	45 dBA
	Nighttime continuous noise level for assessing sleep disturbance (no building façade attenuation) (e.g., campgrounds)	30 dBA
L_{dn}	Project noise mitigation required due to excessive annoyance	75 dBA
Δ %HA	Increase in %HA metric due to Project for assessing annoyance	6.5%
L_{max}	Maximum sound level not to be exceeded more than 10 times per night for assessing sleep disturbance	60 dBA

Note: The noise limit set for assessing sleep disturbance assumes that windows are open resulting in 15 dB of sound isolation.

All of the above criteria are for residing human receptors unrelated with worker accommodation of any projects in the area. Worker accommodation for the Project and other nearby projects need not to be included in the annoyance assessment, but should be included for sleep disturbance assessment. Since all employees of the Project will be living off-site in Tumbler Ridge, only worker accommodations for other projects were assessed. Health Canada suggests to assume an outdoor-to-indoor noise reduction of 27 dB if windows are closed, such as could be the case for worker accommodations where appropriate ventilation permitting closed windows could be assumed. Table 5-2 summarizes the applicable sleep disturbance criteria based on such an assumption. Note that this criterion would also apply to daytime noise if there is potential for shift workers to be sleeping during daytime hours.

Table 5-2 Criteria Applicable for Worker Accommodations of Other Projects

Project Metric	Description	Outdoor Limit
L_n (possibly L_d as well)	Continuous noise level for assessing sleep disturbance	57 dBA
L_{max}	Maximum sound level not to be exceeded more than 10 times per sleep shift for assessing sleep disturbance	72 dBA

5.2 Wildlife Receptors

Table 5-3 below lists the criteria applicable for the assessment of noise effects on wildlife.

Table 5-3 Criteria Applicable for Wildlife Receptors

Project Metric	Description	Limit
L_d	Daytime continuous noise level for assessing wildlife habitat loss	55 dBA
L_n	Nighttime continuous noise level for assessing wildlife habitat loss	45 dBA
L_{AE}	Sound exposure level for assessing wildlife sensitivity to vehicle passby noise	75 dBA

6 SPATIAL & TEMPORAL BOUNDARIES

6.1 Spatial Boundaries

The spatial boundary is defined as the area that could potentially be affected by noise sources associated with the Project. It is also the model domain that is examined as part of this study. The study area for noise is shown in Figure 6-1 below.

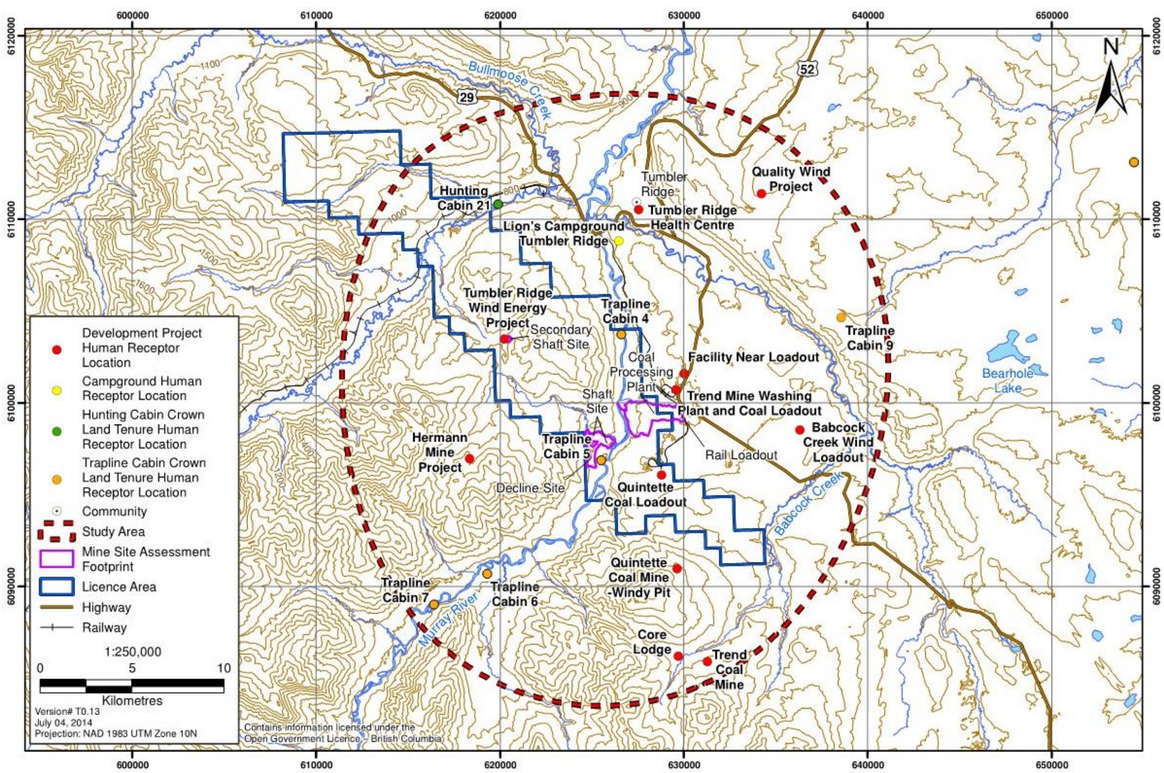

Figure 6-1 Noise Study Area (Source: ERM Rescan)

The study area was determined following consideration of the dominant worst-case noise sources, the characteristics of the surrounding areas and the likely propagation path of sound from the site so that noise contours could be predicted to levels at least 10 dB below the criteria limits presented in Table 5-1 and Table 5-3.

6.2 Temporal Boundaries

A temporal boundary is the period of time when the Project has an effect on the environment. Noise predictions were completed during two phases of the Project:

- The busiest year of Construction; and,
- An average typical year of Operation.

During the life of the mine, the production and mining activities are expected to be fairly consistent. Therefore, an average typical year was chosen to represent Operation.

The intent of the study is to predict the annual average daily noise levels during typical worse case years of the project in order to best correlate with the potential effects identified.

Noise during Decommissioning and Reclamation is expected to be less significant than during Construction and Operation and thus, was not considered in this study.

7 EXISTING ENVIRONMENTAL CONDITIONS

7.1 Existing Environment

As summarized by ERM Rescan in the Project Description, the Project is situated within the Hart Foothills Ecosection of the Sub-Boreal Interior Ecoprovince on the east side of the Rocky Mountains. The area is characterized by low, rounded mountains and wide valleys with gentle to moderate slopes. It has a continental climate with little precipitation, moderately warm summers and cold winters. The mean daily maximum summer temperatures are above 15°C and the mean daily minimum winter air temperature fall well below -10°C. (Rescan 2014)

Baseline noise monitoring was completed by ERM Rescan at four locations in the vicinity of the Project area, and the results are summarized in Table 7-1. Measurements were performed for both summer and winter conditions at all sites except S04 and the duration of each measurement is approximately 24 hours. General sources of noise included aircraft and road traffic and wildlife. (Rescan 2013)

Table 7-1 Summary of Baseline Noise Monitoring Results

Monitoring Station	Location Description	L_{Aeq} for Total Noise Logging Period [dBA]		L_{90} for Total Noise Logging Period [dBA]	
		Summer (Jul 2012)	*Winter (Jan 2013)*	*Summer (Jul 2012)*	*Winter (Jan 2013)*
S01	2.3km east of the Shaft Site	39	24	22	20
S02	900m northwest of the Shaft Site	49	25	25	20
S03	4.3km northeast of the Secondary Shaft Site	35	36	23	32
S04[1]	At northeast corner of Coal Processing Site and 300m southeast of Highway 52	-	39	-	30

[1] Station S4 was only monitored in the January Period

The baseline noise level at each of the noise sensitive receptor described in Section 7.2 was estimated based on proximity to the four baseline measurement locations. Figure D-1 in Appendix D shows the location of baseline stations in relation to receptors.

7.2 Inventory of Noise Sensitive Receptors

Table 7-2 below summarizes the identified residing human receptors and workers accommodation receptors, provided by ERM Rescan. These receptors represent existing and future human locations regarded as sensitive to changes in noise levels. Potential effects related to each receptor type are also included.

Table 7-2 Summary of Human Receptors

Receptor Type	Count	Potential Effects
Workers Accommodation Camp (Nearby Projects)	9	Sleep Disturbance
Human Cabin/Camping	9	Speech Interference, Sleep Disturbance, Annoyance

Project-related noise levels at these receptors were calculated for both phases of the Project. Wildlife receptors were not specified.

A complete inventory of human receptors can be found in Appendix D.

8 NOISE MODELLING METHODOLOGY

8.1 Acoustical Model

Transportation and industrial (airborne) noise levels have been predicted using the ISO 9613-2 (ISO 1996) and SRM II (VROM 1996) standards implemented in the outdoor sound propagation software Cadna/A, version 4.3. The Good Practice Guide for Noise Mapping (WG-AEN 2007) states that these noise calculation standards are recommended by the European Commission as current best practice to obtain accurate prediction results.

ISO 9613 describes a method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources. The method predicts the equivalent continuous A-weighted sound pressure level under meteorological conditions favourable for sound propagation. It has been used to predict noise transmission from industrial sources.

Due to the very low and intermittent number of vehicle movements on the access roads, the reliance on road traffic noise models is not considered necessary for this study. Consequently, noise levels from materials transportation have been calculated using standard acoustic algorithms in ISO 9613 which employ single event levels. The event levels determine the total noise energy produced by an event and, therefore, can be used to determine the noise levels associated with a number of repetitive events such as vehicle movements.

Rail traffic noise levels have been predicted using the SRM II (VROM 1996) standard also implemented in Cadna/A. SRM II describes a method for calculating rail transport noise based on train and railroad properties.

Due to the small number of reflective surfaces, and based on BKL's experience, reflections were not considered to be significant and were therefore not modelled. Model calculations were performed in octave bands, considering ground cover, topography and shielding objects (see following sections).

8.1.1 Ground Absorption

The acoustic properties of the ground surface can have a considerable effect on the propagation of noise. Flat non-porous surfaces such as concrete, asphalt, buildings, calm water etc. are highly reflective to noise, and according to ISO 9613-2 have a ground constant of G=0. Soft, porous surfaces such as foliage, loam, soft grass, fresh snow, etc. are highly absorptive to noise, and have a ground constant of G=1. The ISO standard does not use intermediate ground constants.

In order to approximate the ground effect on sound propagation, the majority of the ground surface has been modelled as absorptive (G=1) for evergreen forest areas with some areas identified as reflective (G=0) to represent barren soil or anthropogenically modified ground.

8.1.2 Meteorological Conditions

A temperature of 10ºC and relative humidity of 80% were used in the model settings to best represent weather conditions based on the selection available in Cadna/A. A moderate temperature inversion was assumed to represent typical, but not absolute, worst case conditions.

Variations in temperature and humidity have generally little effect on the overall noise propagation. However, detailed air absorption corrections with changing temperature are shown in Appendix C.

8.2 Geometrical Data

8.2.1 Topography

The intervening terrain has been modelled by directly importing ground contours of the area provided by ERM Rescan. Ground contours were imported at a 20 metre resolution.

8.2.2 Obstacles

The layout and dimensions of the Project buildings and equipment were incorporated into the model based on drawings and details provided by ERM Rescan.

8.3 Construction Noise Prediction Details

The following sections outline the noise sources, assumptions made and any other details relevant to noise predictions for each component of the construction noise assessment.

8.3.1 Project Construction

Project construction was modelled using several noise sources that each represented a larger group of equipment. These groups of equipment were based on equipment lists supplied by ERM Rescan, and BKL has estimated the spectral sound power level for each equipment item based on similar equipment items or using data from representative noise source libraries (e.g. British Standard BS5228:2009). The operating times and areas of operation were also incorporated into the calculations.

Table 8-1 lists the simplified noise sources incorporated in the noise modelling along with calculated sound power levels (*SWL)*. Appendix E has a detailed breakdown of each of the noise sources.

Table 8-1 Construction Sources

Source	Sound Power Level [dBA]		Modelling Description
	Day	Night	
Shaft Site construction noise sources including diesel generators	120	112	Area source covering Shaft Site
Decline Site construction noise sources including diesel generators	120	112	Area source covering Decline Site
Coal Processing Site noise sources including diesel generators, welder, rail bar machine and concrete pump	119	90	Area source covering Coal Processing Site
Coarse Coal Reject Site noise sources	119	0	Area source covering Coarse Coal Reject Site

8.3.2 Material and Personnel Transport during Construction

Construction material and Project personnel is periodically transported between Tumbler Ridge and the Project Sites. The routes for material transport are via Project service roads and Highway 52 and 29. Calculation of the noise sources for the modelling of material transport was completed in the same fashion as the Project construction, described in Section 8.3.1.

Two routes were modeled:

1. Shaft and Decline Sites to Tumbler Ridge via Highway 52 and 29; and
2. Coal Processing Site to Tumbler Ridge via Highway 52 and 29.

Table 8-2 lists the simplified noise sources incorporated in the noise modelling along with the calculated *SWL*. Appendix E has a detailed breakdown of each of the noise sources.

Table 8-2 Construction Material Transport Sources

Source	Sound Power Level [dBA]		Modelling Description
	Day	Night	
Material transport from Tumbler Ridge to Shaft/Decline Sites, 80 km/h	113	0	Line source from Shaft/Decline Sites to Tumbler Ridge via service road and Highway 52 and 29
Material transport from Tumbler Ridge to Coal Processing Site, 80 km/h	108	0	Line source from Coal Processing Site to Tumbler Ridge via service road and Highway 52 and 29

8.4 Operation Noise Prediction Details

8.4.1 Project Operation

Project operation noise was modelled in the same fashion as the project construction described in Section 8.3.1.

All equipment assumed operating indoors in the coal processing plant, boiler rooms and other noisy buildings was modelled as combined area sources (walls and roof) with the following characteristics of the building as a whole:

- Interior reverberant noise level of combined sources: 85 dBA; and
- 26 gauge corrugated steel with fibreglass lining façade.

Table 8-3 lists the simplified noise sources incorporated in the noise modelling along with the calculated *SWL*. Appendix E has a detailed breakdown of each of the noise sources.

Table 8-3 Operation Sources

Source	Sound Power Level [dBA]		Modelling Description
	Day	Night	
Shaft Site operation noise sources	117	0	Area source covering Shaft Site
Decline Site operation noise sources	110	0	Area source covering Decline Site
Coal Processing Site noise sources including diesel generators, welder, rail bar machine and concrete pump	117	0	Area source covering Coal Processing Site
Coarse Coal Reject Site noise sources	111	99	Area source covering Coarse Coal Reject Site
Pickup trucks travelling between Shaft and Decline Sites	112	0	Line source connecting between Shaft and Decline Sites
Coal Processing Site Conveyors	83/m	83/m	Line sources at Coal Processing Site
Boiler Stacks	81	81	Point sources at boiler plants
Coal Dryer Stack	85	85	Point source at Drying Workshop
Shaft Exhaust Fans	115	115	Point sources at Shaft Sites
Indoor Equipment Reverberant Level	85	85	Area source covering mill building and water treatment plant

8.4.2 Material and Personnel Transport during Operation

Material and Project personnel transport during operation was modelled in the same fashion as in the construction phase described in Section 8.3.2.

Two routes were modeled:

1. Shaft and Decline Sites to Tumbler Ridge via Highway 52 and 29; and
2. Coal Processing Site to Tumbler Ridge via Highway 52 and 29.

Table 8-4 lists the simplified noise sources incorporated in the noise modelling along with the calculated *SWL*. Appendix E has a detailed breakdown of each of the noise sources.

Table 8-4 Operation Material Transport Sources

Source	Sound Power Level [dBA]		Modelling Description
	Day	Night	
Material transport from Tumbler Ridge to Shaft/Decline Sites, 80 km/h	107	0	Line source from Shaft/Decline Sites to Tumbler Ridge via service road and Highway 52 and 29
Material transport from Tumbler Ridge to Coal Processing Site, 80 km/h	102	0	Line source from Coal Processing Site to Tumbler Ridge via service road and Highway 52 and 29

8.4.3 Train

Material is also transported from the Project site by train via an existing Canadian National (CN) Railway line which is shared with other nearby projects. Each train will be driven by 5 locomotives and carry up to 155 rail cars. Train traffic was modelled as a line source following the CN Railway line from the Project site to Tumbler Ridge.

Table 8-5 below summarizes the details of the train source modelled.

Table 8-5 Train Source

Fuel Type	# of Locomotives per Train	# of Rail Cars per Train	Average Speed (km/hr)	Average # of Daily Round-Trips
Diesel	5	155	80	2

8.5 Pass-by Events

Pass-by noise levels (sound exposure levels, L_{AE}, or maximum sound levels, L_{max}) were modelled for vehicles along the transport routes and trains along the CN Railway line.

Vehicle passby noise was modelled using the loudest mobile equipment, the heavy transport truck, travelling at a speed of 40 km/h.

The noise from one train passby was modelled using the same inputs as described in Section 8.4.3. Maximum sound levels were not calculated because the number of events is not expected to exceed 10 during a shift when workers may be sleeping.

8.6 Receptors

For all assessments, calculations were performed for assumed receptor heights of 4 m above the ground in order to minimize terrain effects close to receptors due to the coarse (20 m) ground contour resolution and provide a representative worst-case assessment.

Predicted average noise contours were calculated at 4 m high on 80 m by 80 m grids, to an extent that encompasses noise levels down to the 35 dBA noise contour. Predicted sound exposure level contours for single events were calculated to an extent that encompasses noise levels down to the 65 dBA noise contour.

8.7 Sound Source Adjustments

In order to calculate the *%HA*, adjustments must be made to the received noise levels depending on their relative annoyance (e.g. intermittent or distinctive noise may be more annoying than constant road traffic noise). Additionally, adjustments are applied to the sound character of the source if it is impulsive, tonal or has significant low-frequency content. Appendix B describes these adjustments in detail.

For L_{dn} and *%HA* calculations, +10 dBA was added to the assumed baseline and predicted future noise to account for a rural community's increased sensitivity to noise and +5 dBA was added to the Project L_{dn} predicted at each receptor to account for increased annoyance due to tones and impulses that may be audible at each receptor location.

8.8 Limitations

For sound calculated using the ISO 9613 standard, the indicated accuracy is ± 3 dBA at source to receptor distances of up to 1000 m and unknown at distances above 1000 m.

The estimated sound power levels for equipment were based on documented average noise levels for similar equipment. In general, for individually modelled noise sources (fixed and mobile equipment), the estimated accuracy of the sound power levels is ± 5 dBA, however, with many different sources combined the total sound power level is likely to be more accurate than this.

9 NOISE PREDICTION RESULTS

9.1 Continuous Construction Noise

Contours showing the day and night average noise levels during Construction are presented in Figure 9-1 and Figure 9-2.

Detailed construction results at human receptors can be found in Appendix F.

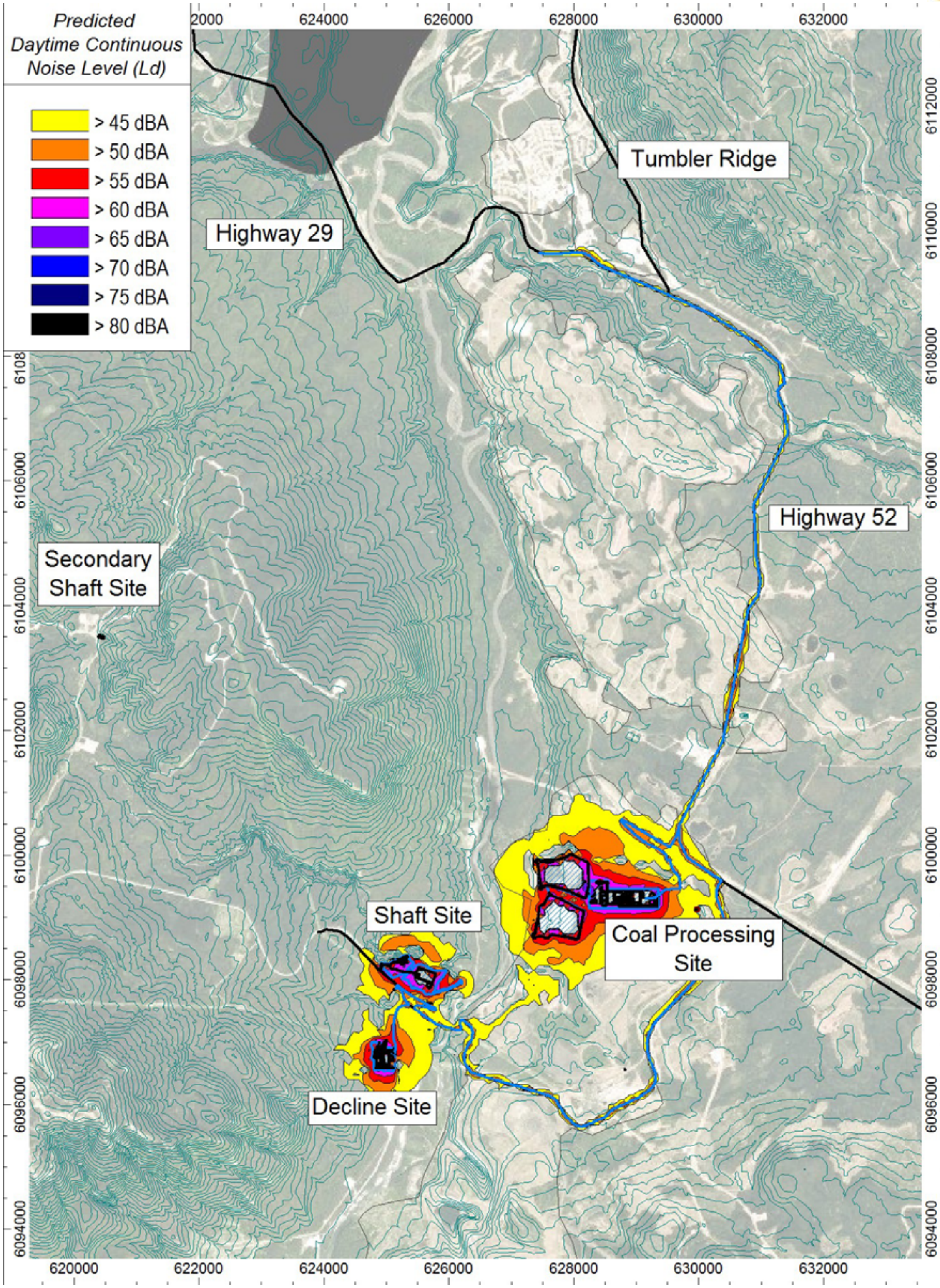

Figure 9-1 Construction Daytime Average Noise Level Contours

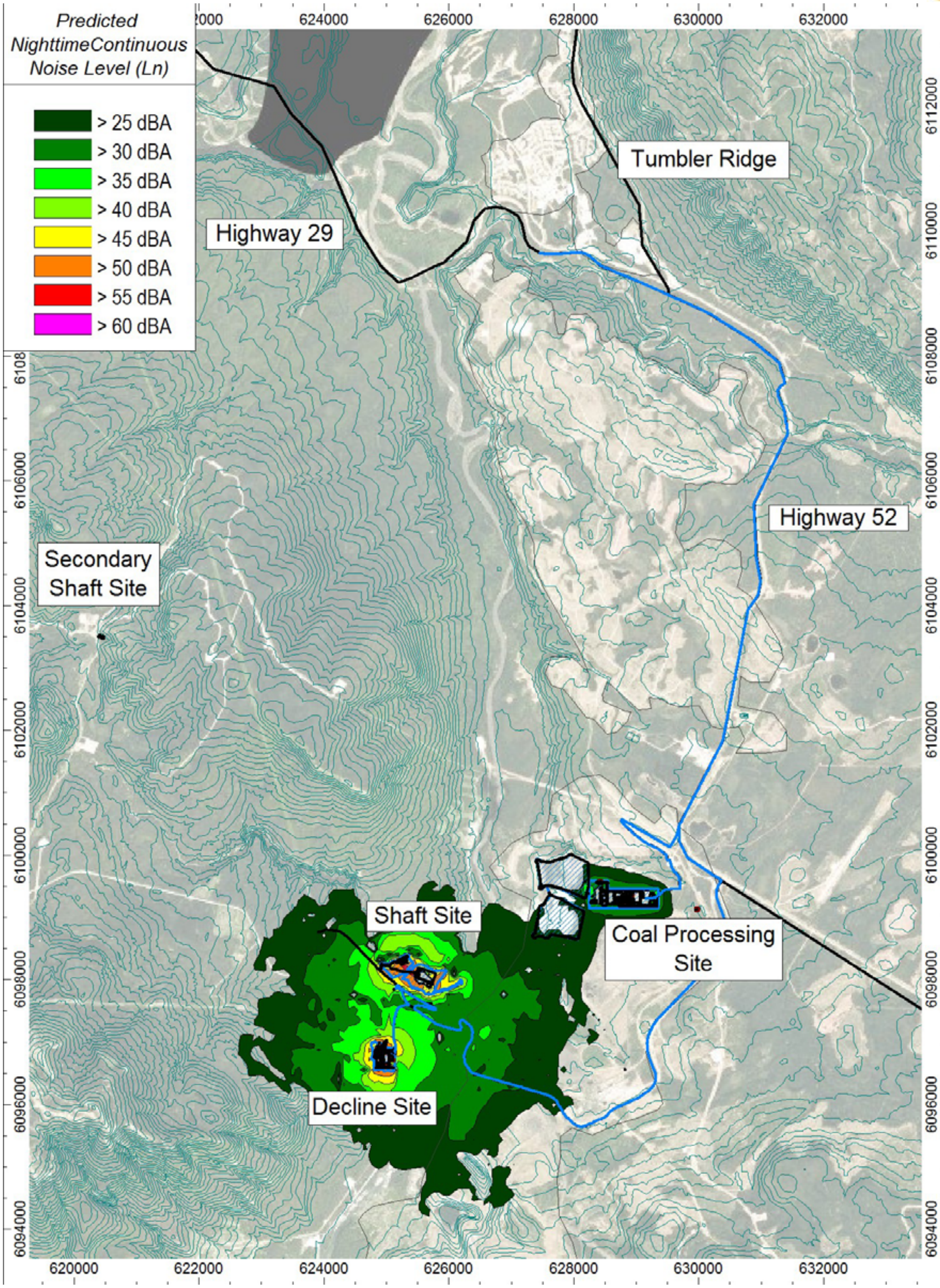

Figure 9-2 Construction Nighttime Average Noise Level Contours

9.2 Continuous Operation Noise

Contours showing the day and night average noise levels during Operation are presented in Figure 9-3 and Figure 9-4.

Detailed Operation results at human receptors can be found in Appendix F.

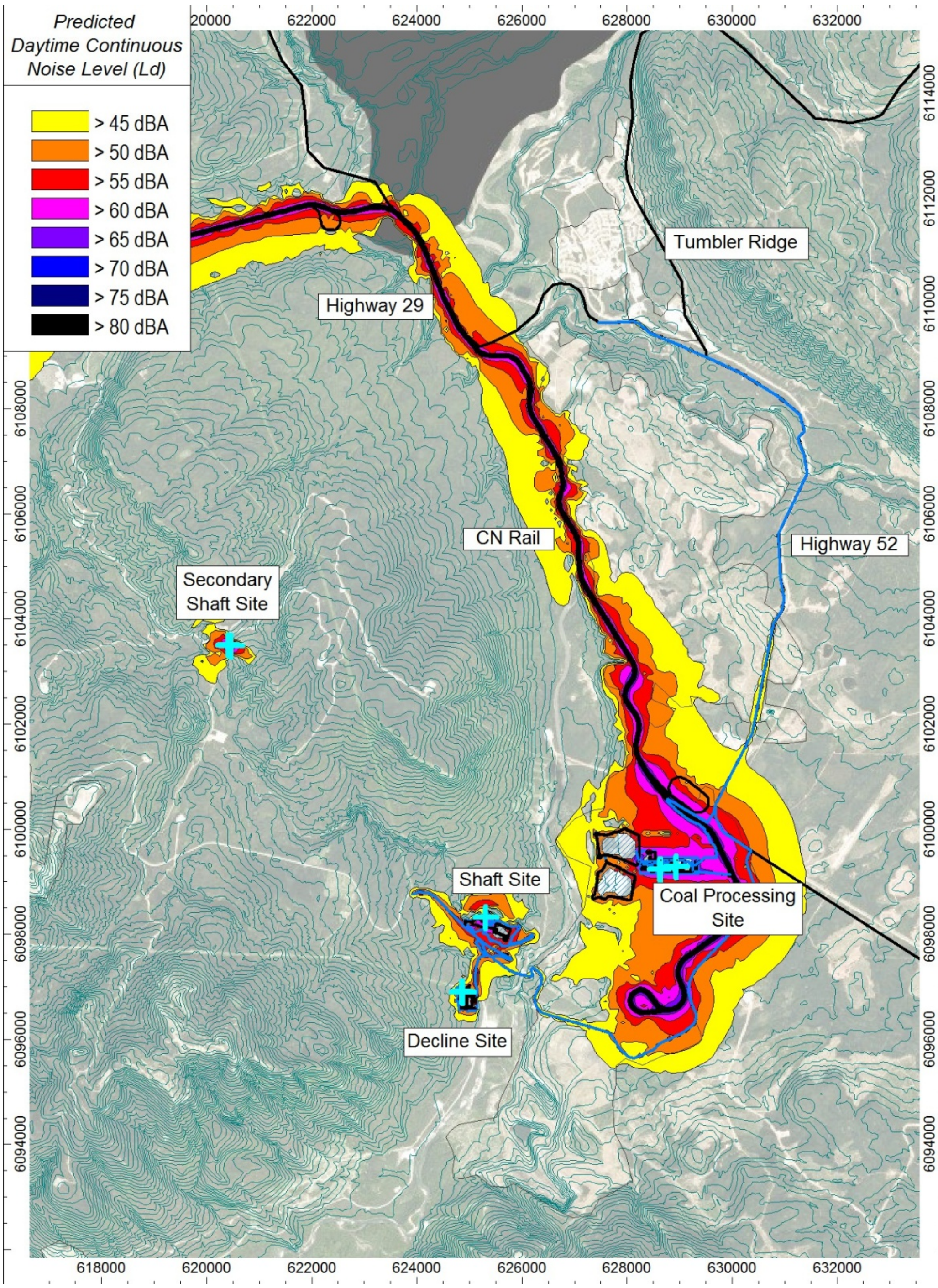

Figure 9-3 Operation Daytime Average Noise Level Contours

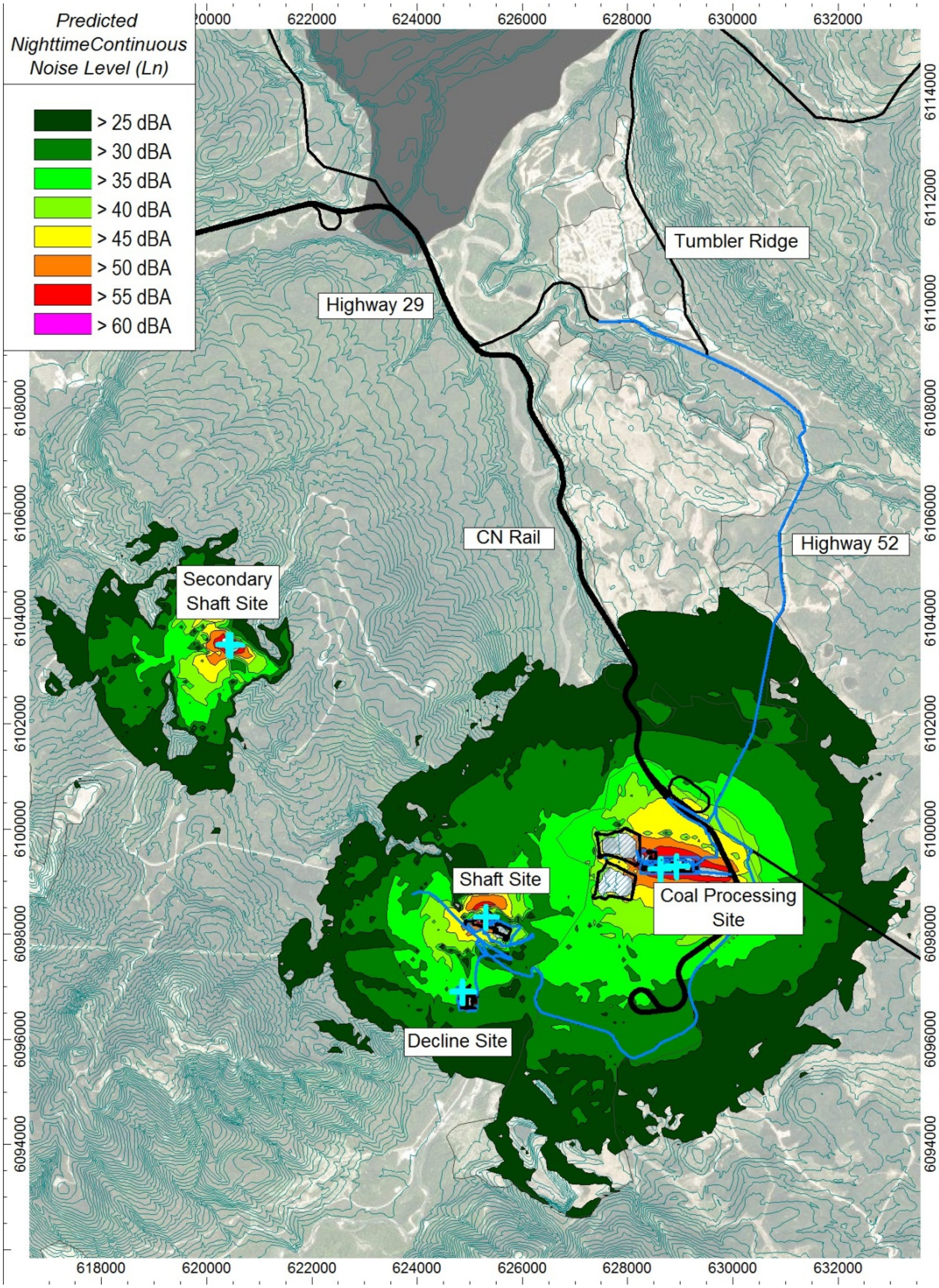

Figure 9-4 Operation Nighttime Average Noise Level Contours

9.3 Adjusted Total Noise during Construction and Operation

The adjusted day-night equivalent noise (L_{Ndn}) during Construction and Operation were calculated for all human receptors. Pre-Project L_{Ndn} were also estimated using the baseline noise data collected.

Detailed results at human receptors can be found in Appendix F.

9.4 Vehicle Passby Noise

Single event sound exposure levels (L_{AE}) from a heavy truck passby event are presented in Figure 9-5 below.

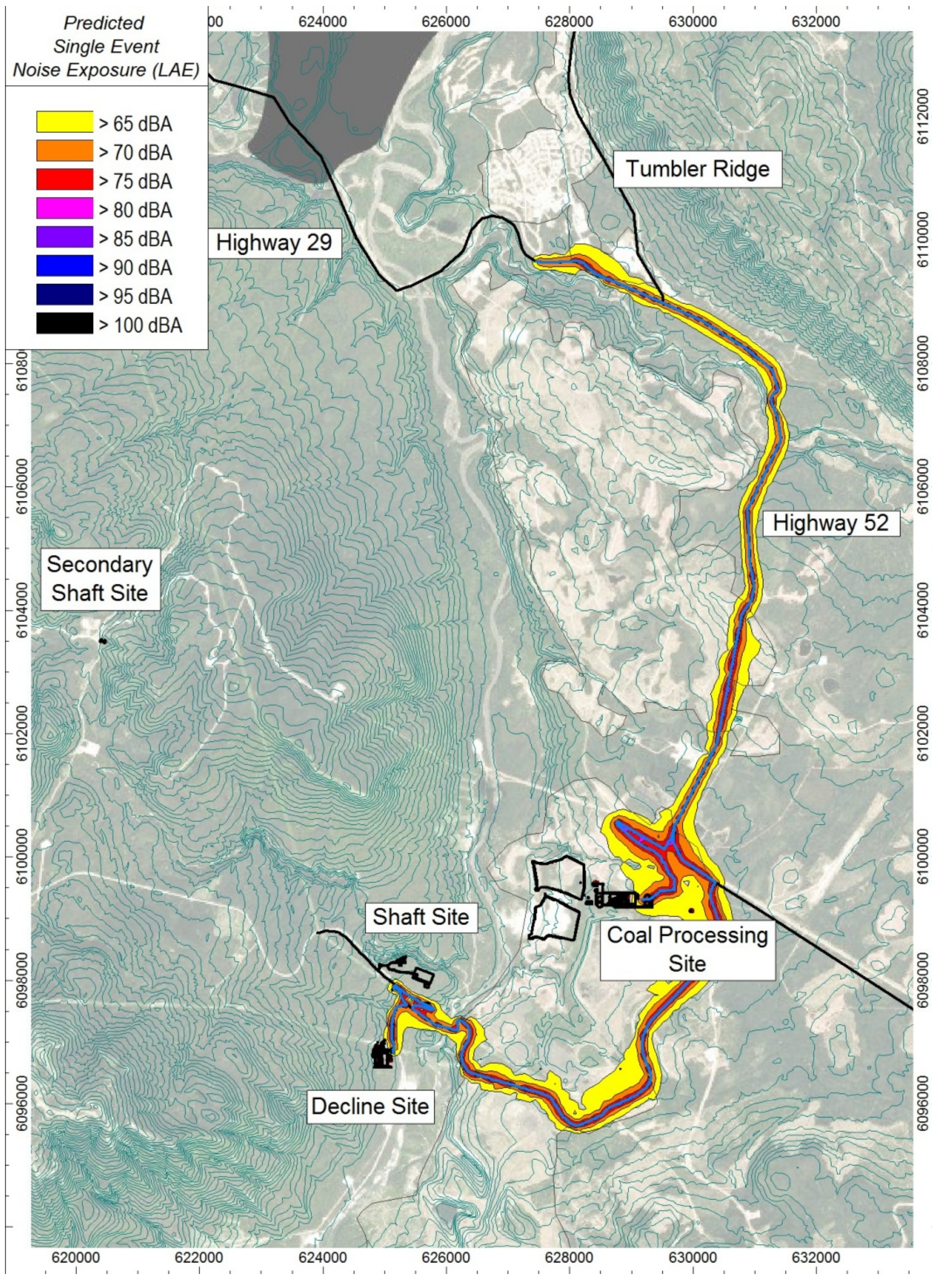

Figure 9-5 Single Event Exposure (L_{AE}) Contours for Heavy Truck Passby

When assuming the terrain is flat (worst case), the predicted L_{AE} versus distance from a heavy truck passby over hard and soft ground are presented in Figure 9-6. Realistically, the noise will be less at a given distance than predicted in the figure as the terrain will provide noise shielding.

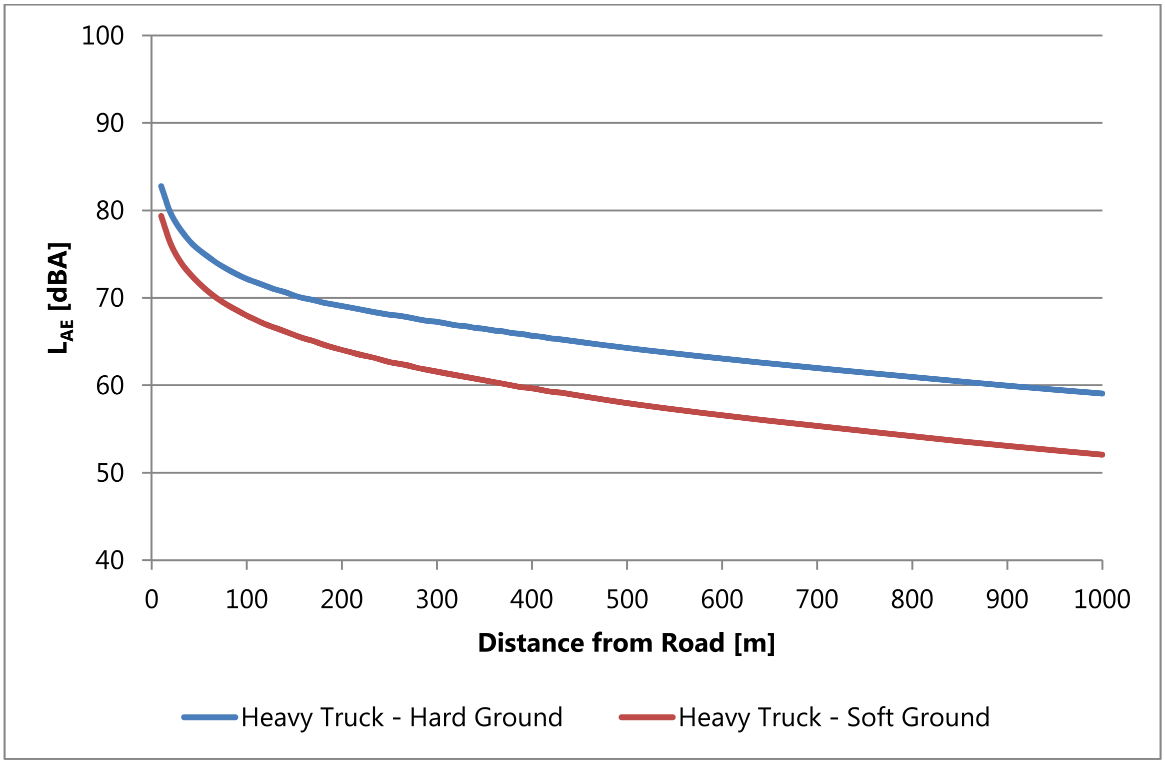

Figure 9-6 Single Event Exposure (L_{AE}) versus Distance from Heavy Truck Passby

Table 9-1 below shows the predicted L_{max} of a heavy truck passing by the closest receptors along the material transport route.

Table 9-1 Heavy Truck Passby Maximum Sound Level

Receptor	L_{max} (dBA)
Human - Quintette Coal Mine	58
Human - Trend Mine washing plant and coal loadout	46
Human - Facility Near Loadout	41
Human - Trapline Cabin 5	40
Human - Tumbler Ridge Health Centre	28
Human - Lions Campground	24

9.5 Train Passby Noise

Single event sound exposure levels (L_{AE}) from a train passby event are presented in Figure 9-7 below.

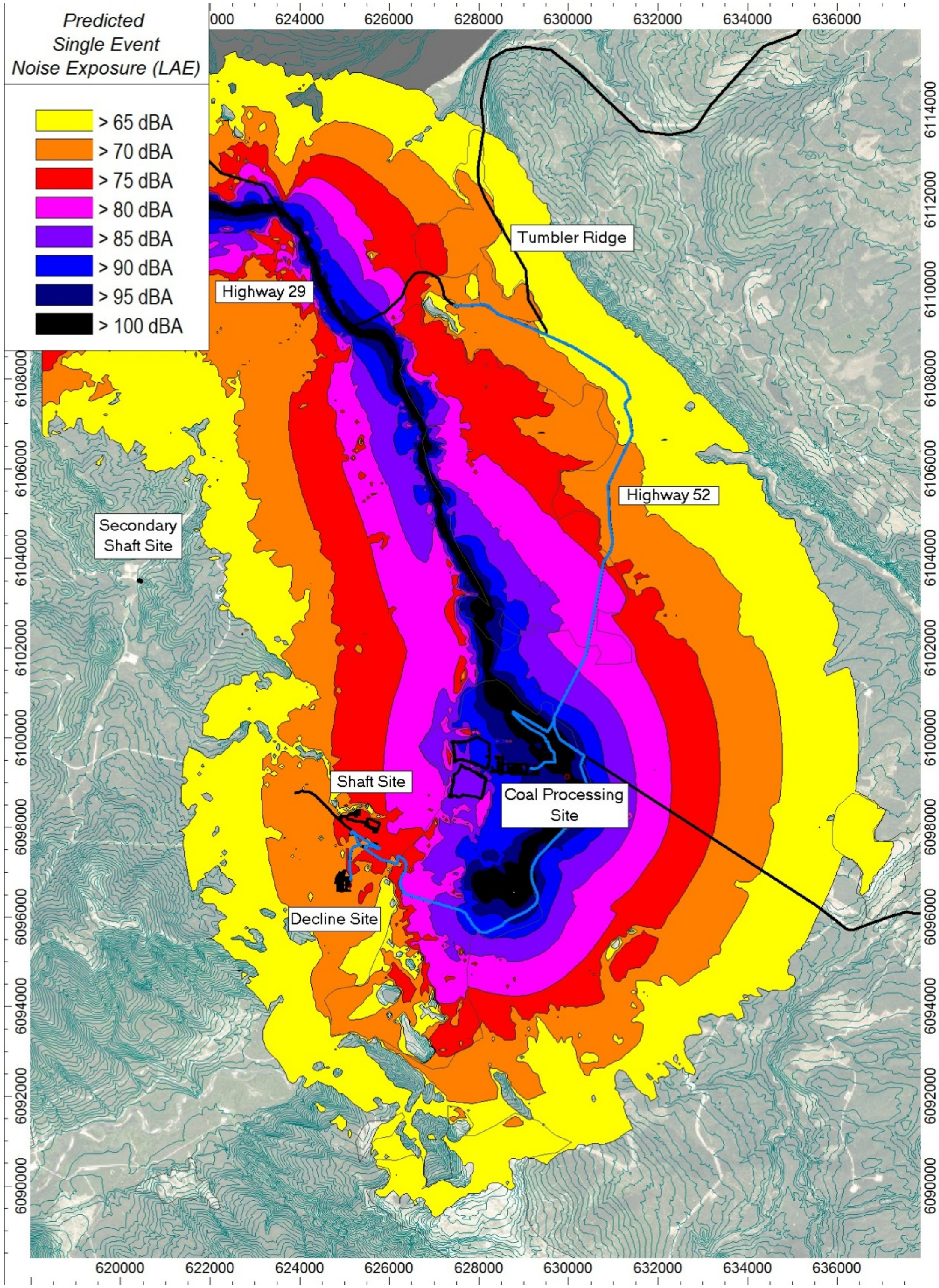

Figure 9-7 Single Event Exposure (L_{AE}) Contours for Train Passby

When assuming the terrain is flat (worst case), the predicted L_{AE} versus distance from a train passby over hard and soft ground are presented in Figure 9-8. Realistically, the noise will be less at a given distance than predicted in the figure as the terrain will provide noise shielding.

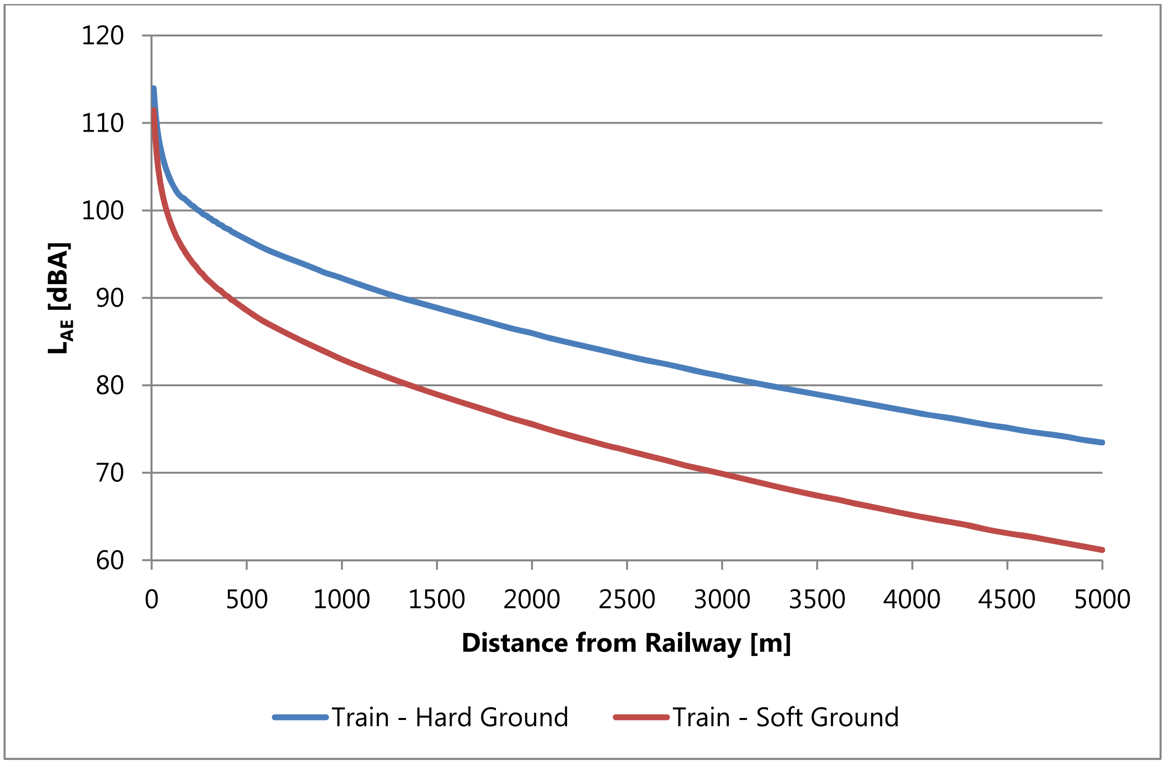

Figure 9-8 Single Event Exposure (L_{AE}) versus Distance from Train Passby

10 CONCLUSIONS

BKL has been retained by ERM Rescan to provide an environmental noise modelling study for the proposed Murray River Coal Project. The study has considered typical noise source levels obtained by measurement or from representative data sources and noise-sensitive receptors (both human and wildlife) potentially affected by the project for the purposes of an assessment of the significance of noise effects associated with the Project.

Noise predictions have been completed for a variety of Construction and Operation activities on the Murray River Coal Project, including Project Construction and Operation, train activity, and vehicle passby.

Predicted noise levels have been presented over representative study areas and in metrics suitable for an effects assessment on human and wildlife receptors.

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APPENDIX A GLOSSARY

A-weighting – A standardised filter used to alter the sensitivity of a sound level meter with respect to frequency so that the instrument is less sensitive at low and high frequencies where the human ear is less sensitive. Also written as dBA.

Ambient/baseline/existing level – The pre-project noise or vibration level.

C-weighting – The C-weighting provides a more discriminating measure of the low frequency sound pressures than provided by A-weighting. Unlike the A-weighting, the C-weighting retains its sensitivity to sounds between 100 and 1000 Hz. Also written as dBC.

Continuous sound level – Generally defined by many BC municipal noise bylaws as the A-weighted sound level, measured using the "slow" time constant, for any sound occurring for a duration of more than three minutes in a fifteen minute period.

Cumulative – The summation of individual sounds into a single total value related to the effect over time.

Day-night equivalent sound level (L_{dn}) – The sound exposure level for a 24-hour day calculated by logarithmically adding the sound exposure level obtained during the daytime (L_d) (7:00 am to 10:00 pm) to 10 times the sound exposure level obtained during the nighttime (L_n) (10:00 pm to 7:00 am) to account for greater human sensitivity to nighttime noise.

Decibel – The standard unit of measurement for sound pressure and sound power levels. It is the unit of level which denotes the ratio between two quantities that are proportional to pressure or power. The decibel is 10 times the logarithm of this ratio. The reference pressure used for airborne sound is 20 µPa while the typical reference pressure used for underwater sound is 1 µPa. Also written as dB.

Equivalent sound level - The steady level that would contain the same amount of energy as the actual time-varying level. Although it is, in a sense, an "average", it is strongly influenced by the loudest events because they contain the majority of the energy.

Frequency – The number of times that a periodically occurring quantity repeats itself in one second.

Frequency spectrum – Distribution of frequency components of a noise or vibration signal.

Hertz – The unit of acoustic or vibration frequency representing the number of cycles per second.

Impulsive sound – Non-continuous sound characterised by brief bursts of sound pressure. The duration of a single burst of sound is usually less than one second.

Intermittent – Non-continuous or transient noise or vibration that occurs at regular or irregular time intervals with each occurrence lasting more than about five seconds.

Intervening terrain – The terrain in between the noise/vibration source and sensitive receptor.

Maximum sound level – The highest exponential time-averaged sound level, in decibels, that occurs during a stated time period, using a "slow" or "fast" time constant.

Metric – Measurement parameter or descriptor.

Non-continuous sound level - Generally defined by many BC municipal noise bylaws as the maximum A-weighted sound level using the "slow" time constant.

Noise - Noise is unwanted sound, which carries no useful information and tends to interfere with the ability to receive and interpret useful sound.

Noise sensitive human receptors – A place occupied by humans with a high sensitivity to noise. These include residences, hospitals, schools, hotels etc.

Octave bands – A standardized set of bands making up a frequency spectrum. The centre frequency of each octave band is twice that of the lower band frequency. The bands are centred at standardized frequencies.

Peak sound level – The maximum absolute value of the instantaneous sound pressure. Most other metrics use root mean square (RMS) and not instantaneous values of sound pressure.

Project noise – Noise attributable to the Project directly, during any phase of the Project.

Receiver/Receptor – A stationary far-field position at which noise or vibration levels are specified.

Sound – The fluctuating motion of air or other elastic medium which can produce the sensation of sound when incident upon the ear.

Sound exposure level – Defined as the constant sound level which has the same amount of energy in one second as the original noise event.

Time constant (slow, fast) – Used to describe the exponential time weighting of a signal. The standardised time periods are 1 second for "slow" and 0.125 seconds for "fast" exponential weightings.

Tonal sound – Sound characterized by a single frequency component or multiple distinct frequency components that are perceptually distinct from the total sound.

Total noise – Results from a combination of multiple noise sources at multiple spatial locations, including both Existing and Project noise, and is typically described using an equivalent sound level.

Vibration – An oscillation wherein the quantity is a parameter that defines the motion of a mechanical system.

Z-weighting – The Z-weighting denotes "zero" or no frequency weighting and is commonly used for communicating octave band or peak sound levels. Also written as dBZ.

APPENDIX B INTRODUCTION TO SOUND AND ENVIRONMENTAL NOISE ASSESSMENT

B.1 General Noise Theory

The two principle components used to characterize sound are loudness (magnitude) and pitch (frequency). The basic unit for measuring magnitude is the decibel (dB), which represents a logarithmic ratio of the pressure fluctuations in air relative to a reference pressure. The basic unit for measuring pitch is the number of cycles per second, or Hertz (Hz). Bass tones are low frequency and treble tones are high frequency. Audible sound occurs over a wide frequency range, from approximately 20 Hz to 20,000 Hz, but the human ear is less sensitive to low and very high frequency sounds than to sounds in the mid frequency range (500 to 4,000 Hz). "A-weighting" networks are commonly employed in sound level meters to simulate the frequency response of human hearing, and A-weighted sound levels are often designated "dBA" rather than "dB".

If a continuous sound has an abrupt change in level of 3 dB it will generally be noticed while the same change in level over an extended period of time will probably go unnoticed. A change of 6 dB is clearly noticeable subjectively and an increase of 10 dB is generally perceived as being twice as loud.

B.2 Basic Sound Metrics

While the decibel or A-weighted decibel is the basic unit used for noise measurement, other indices are also used to describe environmental noise. The Equivalent Sound Level, abbreviated L_{eq}, is commonly used to indicate the average sound level over a period of time. The L_{eq} represents the steady level of sound which would contain the same amount of sound energy as the actual time-varying sound level. Although the L_{eq} is an average, it is strongly influenced by the loudest events occurring during the time period, because these loudest events contain most of the sound energy. Another common metric used is the L_{90}, which represents the sound level exceeded for 90% of a time interval and is typically referred to as the background noise level.

The L_{eq} can be measured over any period of time using an integrating sound level meter. Some common time periods used are 24 hours, noted as the L_{eq24}, daytime hours (07:00 to 22:00), noted as the L_d, and night time hours (22:00 to 07:00), noted as the L_n. As the impact of noise on people is judged differently during the day and during the night, 24 hour noise metrics have been developed that reflect this.

The day-night equivalent sound level (L_{dn}) is one metric commonly used to represent community noise levels. It is derived from the L_d and the L_n with a 10 dB penalty applied to the L_n to account for increased sensitivity to night time noise.

B.3 Human Annoyance to Noise

Studies have consistently shown that an increase in noise in a community will bring an increase to the amount of people who are highly annoyed (ISO 2003). However, the sound pressure level is not the only factor in how annoying noise is. The type of noise, or the quality of it, can also greatly affect how annoying the sound is perceived. In general, tonal, impulsive or sounds with excessive low frequency content can all increase the level of annoyance. These characteristics are often referred to as intrusive noise characteristics.

Tonal (e.g. backup alarms on trucks) and impulsive noise (e.g. hammering) are often perceived as more annoying than continuous neutral noise and have a higher potential to disturb receptors (ISO 2003). Therefore noise with these characteristics should be penalized to reflect their true impact. ISO 2003 recommends making a +3-6 dB adjustment to tonal noise, +5 dB adjustment to regular impulsive noise and a +12 dB adjustment to highly impulsive noise. In practice, these adjustments should be made to the noise at the receptor.

APPENDIX C TEMPERATURE AND HUMIDITY EFFECTS

Variations in temperature and humidity generally have little effect on the overall noise propagation. A graph showing the correction that can be applied to the received level for a range of temperatures, based on a typical noise spectrum emission relevant to the Project, has been produced based on the air absorption tables in ANSI S1.26 (ANSI 1995). The graph is shown in Figure C-1.

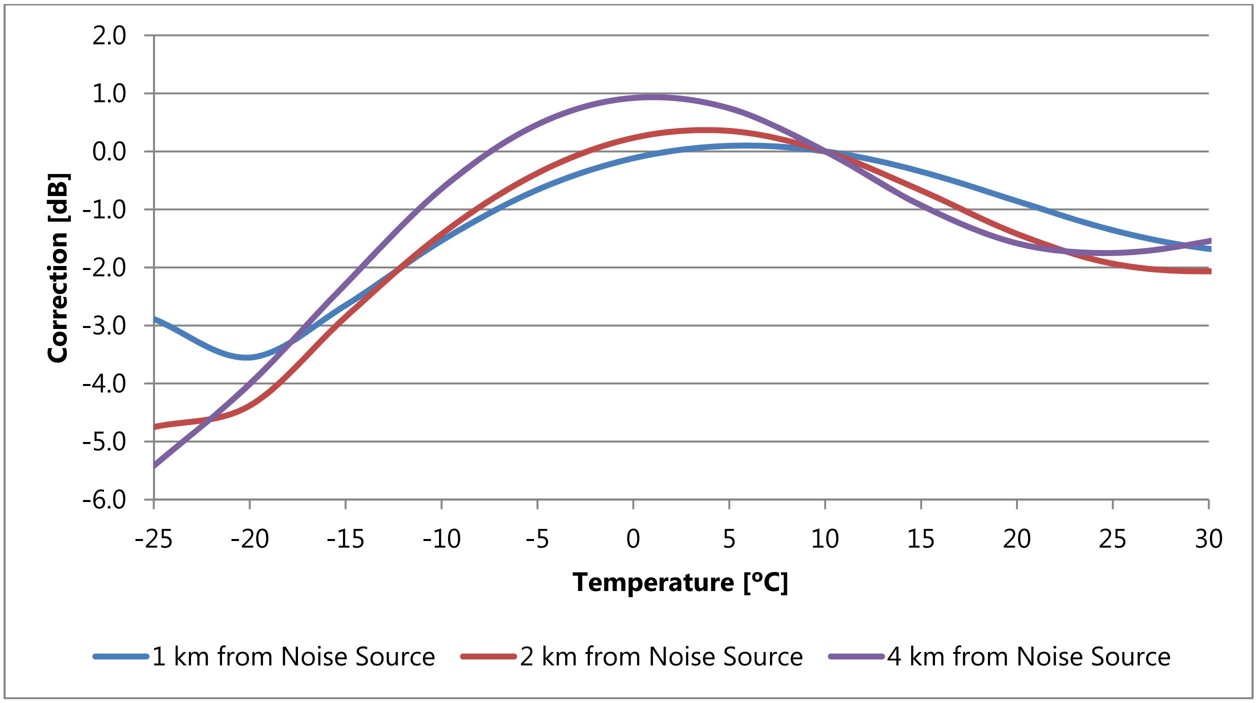

Figure C-1 Correction for Modelled Results for Different Temperatures at Various Distances at 80% Relative Humidity

APPENDIX D HUMAN RECEPTORS AND BASELINE MONITORING LOCATIONS

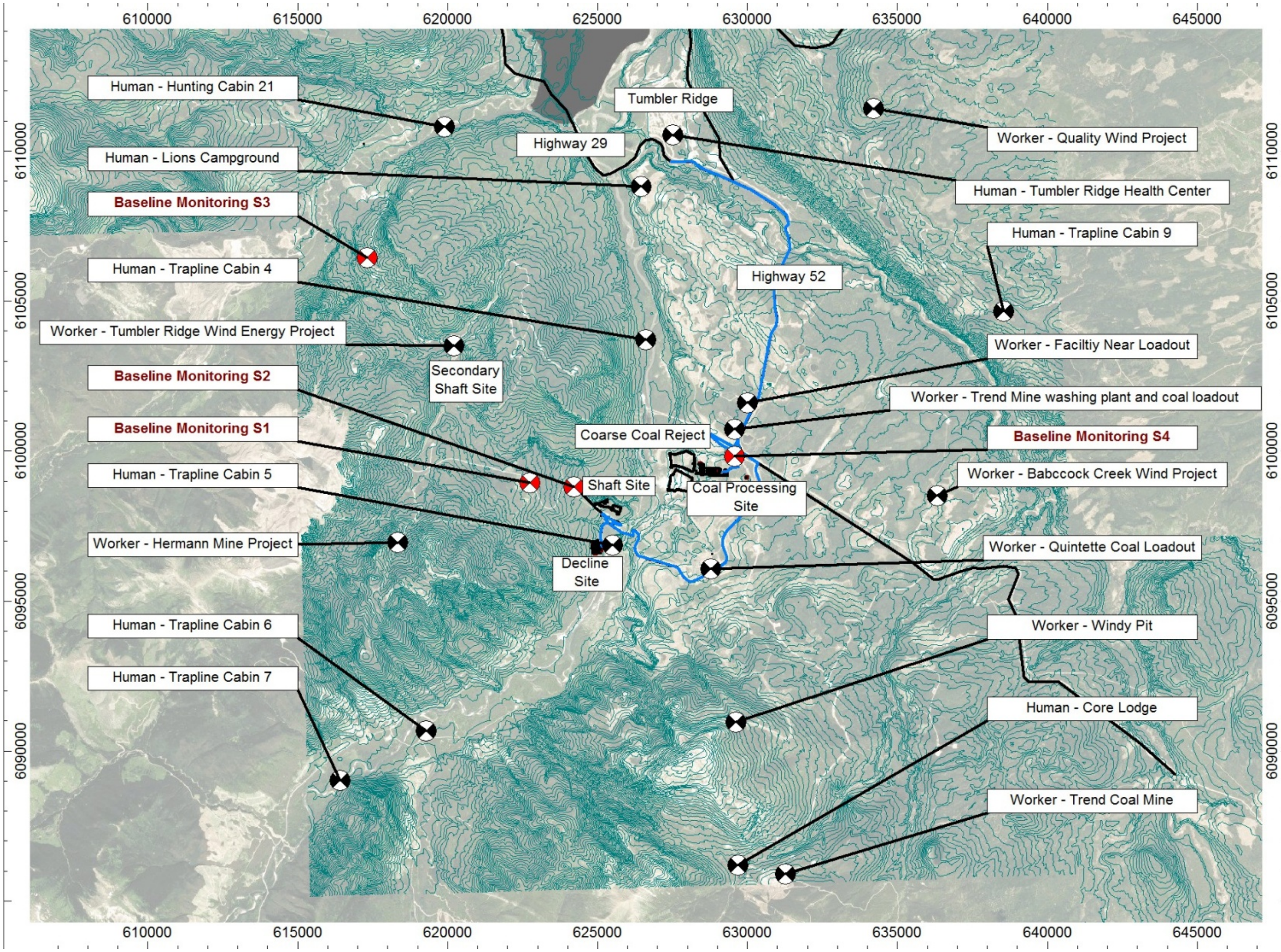

Figure D-1 Human Noise Sensitive Receptors and Baseline Monitoring Locations

Table D-1 Inventory of Noise Sensitive Human Receptors

Residing Human Receptors	Coordinates			Worker Accommodation Receptors	Coordinates		
	X	Y	Z		X	Y	Z
	(m)	(m)	(m)		(m)	(m)	(m)
Human - Tumbler Ridge Health Center	627510	6110551	834	Worker - Facility Near Loadout	629992	6101615	909
Human - Lions Campground	626449	6108834	847	Worker - Trend Mine Washing Plant And Coal Loadout	629563	6100738	897
Human – Core Lodge	629685	6086195	1348	Worker - Tumbler Ridge Wind Energy Project	620211	6103508	1097
Human - Trapline Cabin 4	626603	6103714	759	Worker - Quintette Coal Loadout	628767	6096069	922
Human - Trapline Cabin 5	625490	6096859	765	Worker - Trend Coal Mine	631258	6085909	1421
Human - Trapline Cabin 6	619290	6090672	786	Worker - Quality Wind Project	634201	6111425	1126
Human - Trapline Cabin 7	616419	6089012	784	Worker - Quintette Coal Mine - Windy Pit	629613	6090971	1531
Human - Hunting Cabin 9	638532	6104656	783	Worker - Hermann Mine Project	618338	6096948	1403
Human - Hunting Cabin 21	619883	6110822	1024	Worker - Babcock Creek Wind Project	636314	6098515	1075

APPENDIX E NOISE SOURCE TABLES

Table E-1 Construction Equipment Noise Emissions

Activity Area	Type of Equipment	Qty.	Operating Hours Per Day		SWL [dBA]
			Daytime (7 am to 10 pm)	Nighttime (10 pm to 7 am)	
Shaft and Decline Sites	Excavator	3	8	0	106
	Forklift	3	8	0	106
	Loader	2	8	0	106
	Mobile Crane	1	8	0	109
	Dozer	2	8	0	106
	Grader	1	8	0	105
	Compacter	1	6	0	112
	Dump Truck	2	15	3	109
	Water truck	1	6	0	107
	Manlift	1	6	0	94
	Ford 350PU	15	6	0	107
	Main diesel generator	6	15	9	101
	Diesel auxiliary generator	2	15	9	100
	Diesel auxiliary generator	2	15	9	99
	Backup Alarms	32	2.0	0.1	114
Coal Processing Site	Excavator	1	8	0	106
	Enloader	1	8	0	106
	Mobile Crane	2	8	0	109
	Mobile Crane	2	8	0	109
	Mobile Crane	1	8	0	110
	Dump Truck	1	2	0	109
	Water truck	1	5	0	107
	Pick up	3	8	0	107
	Main diesel generator	1	10	0	100
	Diesel auxiliary generator	1	15	1	99
	Welder	10	8	0	98
	Rail bar machine	3	8	0	96

Activity Area	Type of Equipment	Qty.	Operating Hours Per Day		SWL [dBA]
			Daytime (7 am to 10 pm)	Nighttime (10 pm to 7 am)	
	Concrete pump	1	8	0	100
	Backup Alarms	12	1.7	0	114
Coarse Coal Reject	Excavator	3	8	0	106
	Dozer	1	8	0	106
	Enloader	1	8	0	106
	Dump Truck	5	8	0	109
	Main diesel generator	1	8	0	100
	Grader	1	8	0	105
	Backhoe	1	8	0	106
	Backup Alarms	13	2	0	114
Material Transport (Tumbler Ridge – Shaft/Decline Sites)	Cement* (25% concrete tonnage)	1	2.1	0	107
	Construction plant and equipment	1	0.6	0	107
	Fuel transport	1	0.2	0	107
	Construction material	1	1.5	0	107
	Underground equipment	4	0.2	0	107
	Commuter bus	4	12.9	0	107
Material Transport (Tumbler Ridge – Coal Processing Site)	Concrete Truck	1	4.3	0	107
	Construction plant steel, plate work, piping and equipment	1	1.1	0	107
	Fuel transport	1	0.2	0	107
	Construction material	2	1.5	0	107
	Commuter bus	2	4.3	0	107

Table E-2 Operation Equipment Noise Emissions

Activity Area	Type of Equipment	Qty.	Operating Hours Per Day		SWL [dBA]
			Daytime (7 am to 10 pm)	Nighttime (10 pm to 7 am)	
Shaft Site	Excavator	1	6	0	106
	Forklift	1	8	0	106
	Loader	1	6	0	106
	Mobile Crane	1	8	0	86
	Grader	1	2	0	105
	Dump Truck	1	12	0	109
	Manlift	1	6	0	94
	Backup Alarms	14.5	1.6	0	114
	Ford 150PU	10	3	0	107
Decline Site	Grader	1	2	0	105
	Backup Alarms	8.5	0.6	0	114
	Ford 150PU	5	3	0	107
Coal Processing Site	Ford F-150	3	3	0	107
	Ford(Explorer)	2	4	0	107
	Forklift	2	8	0	106
	Loader	2	8	0	106
	Loader	1	4	0	101
	Dozer	1	8	0	106
	Backup Alarms	11	1.5	0	114
Coarse Coal Reject	Dozer	1	15	1	106
	Backup Alarms	1	3.8	0.3	114
Material Transport (Tumbler Ridge – Shaft/Decline Sites)	Fuel transport	1	0.2	0	107
	Equipments/parts transport	1	1	0	107
	Commute bus	4	3.2	0	107
Material Transport (Tumbler Ridge – Coal Processing Site)	Fuel transport	1	0.2	0	107
	Bottled Agent transport	1	0.1	0	107
	Magnetite transport	1	0.2	0	107
	Equipments/parts transport	1	0.6	0	107
	Commute bus	2	2.1	0	107

APPENDIX F RESULT TABLES

Table F-1 Noise Prediction Results at Worker Accommodation Receptors

Receptor Name	Construction		Operation	
	Average Noise L_d	Average Noise L_n	Average Noise L_d	Average Noise L_n
	dBA	dBA	dBA	dBA
Worker - Facility Near Loadout	36	10	44	30
Worker - Trend Mine Washing Plant and Coal Loadout	42	16	52	38
Worker - Tumbler Ridge Wind Energy Project	12	2	58	58
Worker - Trend Coal Mine	8	0	12	7
Worker - Quintette Coal Loadout	46	19	55	32
Worker - Quality Wind Project	7	0	14	5
Worker - Quintette Coal Mine - Windy Pit	18	7	27	18
Worker - Hermann Mine Project	13	5	19	17
Worker - Babcock Creek Wind Project	16	2	27	20

Table F-2 Construction Noise Prediction Results at Residing Human Receptors

Receptor Name	Baseline			Construction							
	Assumed L_{dn}	Adjusted L_{dn} for Rural Quiet Area	%HA	Avg Noise L_d	Avg Noise L_n	Project L_{dn}	+5 dB Tonal /Impulsive Penalty	Total Adj. L_{dn} (L_{Ndn})	Adjusted L_{dn} for Rural Quiet Area	% HA	Δ% HA
	dBA	dBA	%	dBA	dBA	dBA	dBA	dBA	dBA	%	%
Human - Tumbler Ridge Health Centre	47	57	5.3	24	0	22	27	37	57	5.3	0
Human - Lions Campground	47	57	5.3	19	0	17	22	32	57	5.3	0
Human - Core Lodge	47	57	5.3	8	0	8	13	23	57	5.3	0
Human - Trapline Cabin 4	47	57	5.3	23	7	22	27	37	57	5.3	0
Human - Trapline Cabin 5	39	49	1.9	49	39	49	54	64	64	12.4	10.5
Human - Trapline Cabin 6	35	45	1.1	10	2	11	16	26	45	1.1	0
Human - Trapline Cabin 7	35	45	1.1	5	0	7	12	22	45	1.1	0
Human - Trapline Cabin 9	47	57	5.3	8	0	7	12	22	57	5.3	0
Human - Hunting Cabin 21	39	49	1.9	6	0	6	11	21	49	1.9	0

Table F-3 Operation Noise Prediction Results at Residing Human Receptors

Receptor Name	Baseline			Operation							
	Assumed L_{dn}	Adjusted L_{dn} for Rural Quiet Area	%HA	Avg Noise L_d	Avg Noise L_n	Project L_{dn}	+5 dB Tonal /Impulsive Penalty	Total Adj. L_{dn} (L_{Ndn})	Adjusted L_{dn} for Rural Quiet Area	% HA	Δ% HA
	dBA	dBA	%	dBA	dBA	dBA	dBA	dBA	dBA	%	%
Human - Tumbler Ridge Health Centre	47	57	5.3	33	14	31	36	46	57	5.3	0
Human - Lions Campground	47	57	5.3	45	13	43	48	58	61	8.7	3.4
Human - Core Lodge	47	57	5.3	11	7	14	19	29	57	5.3	0
Human - Trapline Cabin 4	47	57	5.3	43	22	41	46	56	60	7.7	2.4
Human - Trapline Cabin 5	39	49	1.9	43	34	43	48	58	59	6.8	4.9
Human - Trapline Cabin 6	35	45	1.1	13	9	16	21	31	45	1.1	0
Human - Trapline Cabin 7	35	45	1.1	5	2	9	14	24	45	1.1	0
Human - Trapline Cabin 9	47	57	5.3	15	8	16	21	31	57	5.3	0
Human - Hunting Cabin 21	39	49	1.9	50	7	48	53	63	63	11.1	9.2