Table of Contents

LIST OF TABLES

LIST OF FIGURES

Abbreviations

%HA	Percent Highly Annoyed
AER	Alberta Energy Regulator
CEAA 2012	Canadian Environment Assessment Act, 2012
dB	decibel
dBA	decibel, A-weighted
EPA	Environmental Protection Agency
HC	Health Canada
HEI	high-energy impulsive
HI	highly impulsive
HWY	highway
Hz	hertz
ISO	International Organization for Standardization
LAA	Local Assessment Area
$L_{Amax,}$	Maximum sound level, A-weighted
L_d	daytime equivalent sound level
L_{dn}	day-night equivalent sound level
L_{eq}	equivalent sound level
L_{max}	maximum sound pressure level
L_n	nighttime equivalent sound level
MNL	Mitigation Noise Level

NAD83	North American Datum of 1983
PDA	Project Development Area
RAA	Regional Assessment Area
RI	regular impulsive
TNT	trinitrotoluene
US EPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VC	valued component
WHO	World Health Organization

4.0 ASSESSMENT OF POTENTIAL EFFECTS ON ACOUSTIC ENVIRONMENT

The Project would generate noise during construction. Noise is defined as unwanted sound and has the potential to affect the health and well-being of humans. The assessment focuses on construction because any noise generating activities during dry operations would be minimal compared to existing noise generation.

4.1 SCOPE OF THE ASSESSMENT

4.1.1 Regulatory and Policy Setting

The overall assessment scope for the acoustic environment is guided by the Canadian Environment Assessment Agency (CEA Agency) under the *Canadian Environmental Assessment Act, 2012* (CEAA 2012). CEAA aims to protect components of the environment from significant adverse environmental effects caused by a project. However, CEAA does not provide quantitative limits or methods to assess effects on the acoustic environment. The assessment was completed in accordance to guidance provided by the Health Canada (HC) publication *Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise* (Health Canada 2017). The Health Canada document provides preferred methods for evaluating various human health endpoints related to potential effects.

The effects assessment focuses on humans; it does not discuss effects on wildlife.

4.1.2 Engagement and Key Concerns

Engagement has been ongoing and will continue with agencies, Indigenous communities, and stakeholders through the life of the Project. Statements of concern related to the potential for noise effects have been received from Tsuut'ina Nation and Kainai First Nation. Traditional Land and Resource Use (TLRU) information was considered during the preparation of all aspects of the EIS, including both methodology and analysis, as stipulated by the CEA Agency project guidelines. TLRU information contributed to the understanding of the existing conditions and informed the assessment of potential Project effects. While this information did not directly affect the significance definition it has been incorporated into the analysis of effects on which the significance determination was based.

Tsuut'ina Nation has raised a general concern regarding noise during construction and Kainai First Nation has raised a concern regarding the effect of noise on animal movement patterns. The acoustic environment section of this report relates potential noise effects on humans only. The effect of noise on animal behavior is further discussed in Volume 3A, Section 11.

The impact on traditional use sites of concern due to noise were not identified by Indigenous groups thus far in the engagement process. Additional information will be considered should it be provided through ongoing engagement with Indigenous groups.

As of January 31, 2018, no project-specific intangible concerns were identified with respect to noise.

4.1.3 Potential Effects, Pathways and Measurable Parameters

Table 4-1 presents the potential effects, pathways and measurable parameters for the acoustic environment.

Table 4-1 Potential Effects, Effects Pathways and Measurable Parameters for Acoustic Environment

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change in existing acoustic environment	Project construction may result in temporary and localized increases in sound levels	L_d – Daytime equivalent sound, dBA L_n – Nighttime equivalent sound level, dBA L_{dn} – Day-night equivalent sound level, dBA L_{Amax} – Maximum Sound Pressure Level, dBA %HA – Percent highly annoyed

The measurable parameters for sound include:

- daytime and nighttime equivalent sound levels (L_d and L_n, respectively). The parameters L_d and L_n are the continuous equivalent A-weighted sound levels established for the daytime (L_d) (07:00 h to 22:00 h) and nighttime (L_n) (22:00 h to 07:00 h)
- day-night equivalent sound level (L_{dn}). L_{dn} is a 24-hour day-night equivalent sound level calculated using the daytime equivalent sound level (L_d) and nighttime equivalent sound level (L_n) with a 10 dB penalty applied to the L_n. Additional adjustments are applied to L_{dn} to reflect certain undesirable or perceived characteristics of sound such as tonality, impulsiveness or high-low frequency content.
- percent highly annoyed (%HA). The change in %HA parameter identifies the percentage of population highly annoyed because of a change in the existing sound level.
- Maximum A-weighted sound level (L_{Amax}). L_{Amax} represents the maximum sound pressure level during an event such as a vehicle pass-by.

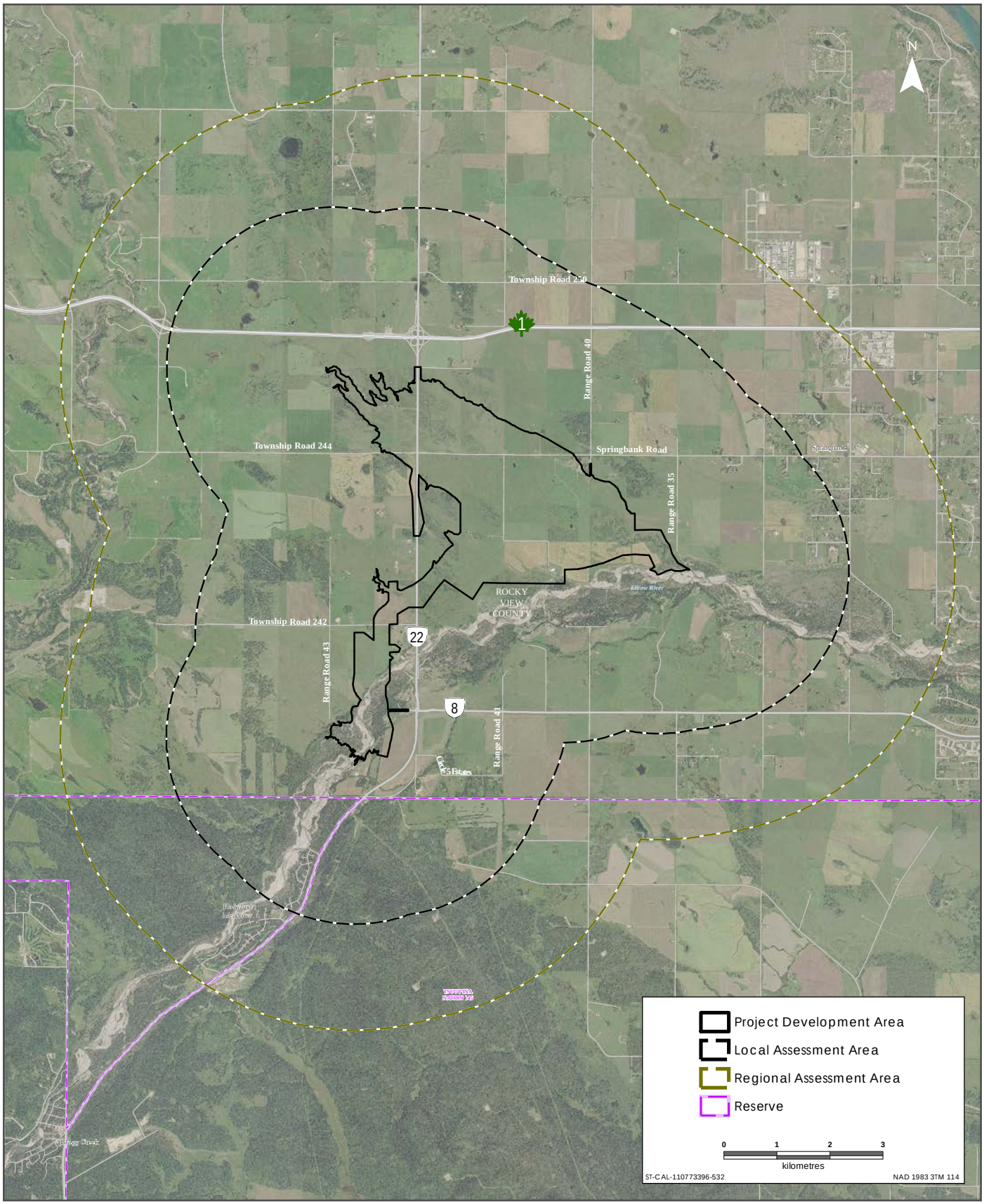
4.1.4 Boundaries

4.1.4.1 Spatial Boundaries

Spatial boundaries (Figure 4-1) were established on the basis for which the Project effects are captured. The project development area (PDA) is the area which the physical ground disturbance is planned in the construction of the Project. The local assessment area (LAA) extends 3 km from the PDA and within that boundary are receptors that may be affected. Noise emissions from construction equipment and activities are typically reduced to the background sound level, or below, at this distance. The regional assessment area (RAA) extends 5 km beyond the PDA to account for noise emissions from other works and area facilities that might interact with those from the Project. At distances greater than 5 km, these noise emissions are expected to attenuate to levels below the ambient sound level.

4.1.4.2 Temporal Boundaries

Project construction would take place over a 36-month period. Assuming regulatory approval by Q4 2018, construction would commence in Q1 2019. By Q4 2020, the Project would be able to accommodate a 1:100 year flood. Construction would be complete by Q1 2022 at which time the Project would be able to accommodate water volumes equal to the 2013 flood. Dry operations of the Project will occur indefinitely (i.e., permanent installation) after construction, with periods of dry operations alternating with flood and post-flood phases.



Sources: Base Data - ESRI, Natural Earth, Government of Alberta, Government of Canada
Thematic Data - ERBC, Government of Alberta, Stantec Ltd

Acoustic Environment Spatial Boundaries

Stantec

4.1.5 Residual Effects Characterization

Table 4-2 presents definitions for residual environmental effects on the acoustic environment.

Table 4-2 Characterization of Residual Effects on Acoustic Environment

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	Positive – a residual effect that changes measurable parameters in a direction beneficial to Acoustic Environment relative to existing sound levels. Adverse – a residual effect that changes measurable parameters in a direction detrimental to Acoustic Environment relative to existing sound levels. Neutral – no net change in measurable parameters for the Acoustic Environment relative to existing sound levels.
Magnitude	The amount of change in measurable parameters or the VC relative to established thresholds	Low – Project noise emissions would not exceed the established noise limits based on Health Canada guidance High – Project noise emissions would exceed the established noise limits based on Health Canada guidance
Geographic Extent	The geographic area in which a residual effect occurs	PDA – residual effects are restricted to the PDA LAA – residual effects extend into the LAA RAA – residual effects interact with those of other projects in the RAA
Frequency	Identifies how often the residual effect occurs and how often during a project phase	Single event – the event occurs only once Multiple irregular event – occurs sporadically at no set schedule Multiple regular event – occurs at regular intervals Continuous – occurs continuously
Duration	The time required until the measurable parameter or the acoustic environment returns to its existing condition, or the residual effect can no longer be measured or otherwise perceived	Short-term – residual effect restricted to construction Long-term – residual effect extends throughout operation

Table 4-2 Characterization of Residual Effects on Acoustic Environment

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Reversibility	Pertains to whether a measurable parameter or the acoustic environment can return to its existing condition after the project activity ceases	Reversible – the residual effect is likely to be reversed after activity completion and reclamation Irreversible – the residual effect is unlikely to be reversed
Ecological and Socio-economic Context	Existing condition and trends in the area where residual effects occur	Undisturbed – area is relatively undisturbed or not adversely affected by human activity Disturbed – area has been substantially previously disturbed by human development or human development is still present
Timing	Periods of time where residual effects from Project activities could affect the VC	Seasonality – residual effect is greater in one season than another (e.g., spring/summer vs. fall/winter) Time of day – residual effect is greater during daytime or nighttime Regulatory – provincial or federal restricted activity periods or timing windows (e.g., migration, breeding, spawning) related to the VC Not applicable - the residual effect of Project activities will have the same effect on the VC, regardless of timing

4.1.6 Significance Definition

A residual adverse effect on the acoustic environment is considered significant if the Project noise emissions at the identified receptor locations exceed the quantitative limits based on the Health Canada guidance for environmental assessments.

4.2 EXISTING CONDITIONS FOR ACOUSTIC ENVIRONMENT

The determination of the existing sound levels may be measured or estimated based on the characteristics of the LAA (e.g., rural, adjacent to highways). A desktop analysis was conducted to determine the acoustic environment existing conditions at the identified receptors. A field survey was also conducted from September 7, 2016 to September 9, 2016 to augment the desktop analysis in order to quantify the existing sound levels in the LAA.

4.2.1 Methods

4.2.1.1 Receptor Locations

All existing and reasonably foreseeable human receptor locations within the study have been considered in the assessment. A comprehensive receptor list was developed for the assessment of Project effects. However, only those locations that meet the Health Canada definition of a receptor relative to an acoustic assessment are included in this assessment. Health Canada also recommends that locations that may have a heightened sensitivity to noise exposure (e.g., Indigenous peoples, schools, child care centres, hospitals) be included in the assessment. Since noise effects diminish with increasing distance, only the most affected receptor locations are presented in this assessment. Receptor locations at a farther distance would result in lower sound levels than those included in the assessment. The identification of human receptors within the LAA, including areas identified by Health Canada was carried out through desktop studies. The identified receptor locations are provided in Table 4-3 and Figure 4-2. Table 4-3 includes a list of receptors considered in the acoustic environment assessment. Each receptor is characterized according to frequency of use (e.g., permanent, seasonal, or temporary), type of land use (e.g., residential, recreational, industrial, educational), and sensitivity (sensitive receptors include schools, hospitals, retirement complexes, and assisted care homes). Receptors are also characterized as either Indigenous or non-Indigenous; Indigenous receptors correspond with receptors located on the Tsuut'ina Nation reserve.

The methods of derivation and presentation of the quantitative limits used for the assessment are provided in Section 4.4.1 and Volume 4, Appendix F, Attachment 4B.

Table 4-3 Receptor Summary

Receptor ID	Description	Indigenous Receptor	Type of Receptor	Approximate Distance to PDA (m)	UTM NAD83 Coordinates (Zone 11)	
					Easting (m)	Northing (m)
SR01	Rural residence 1,000 m from intersection of Highway 1 and Highway 22		Permanent Residential Non-sensitive	600	676781	5661331
SR02	Rural residence 750 m from intersection of Highway 1 and Highway 22		Permanent Residential Non-sensitive	580	678048	5662119
SR03	Rural residence 450 m south of Highway		Permanent Residential Non-sensitive	1050	678552	5662110
SR04	Rural residence adjacent to Springbank Road		Permanent Residential Non-sensitive	50	679819	5660800
SR05	Rural residence 255 m from intersection of Springbank Road and Range Road 40		Permanent Residential Non-sensitive	225	680547	5660633
SR06	Rural residence adjacent to Range Road 40		Permanent Residential Non-sensitive	1,150	681210	5661081
SR07	Rural residence adjacent to Range Road 35		Permanent Residential Non-sensitive	1,450	682145	5661009

Table 4-3 Receptor Summary

Receptor ID	Description	Indigenous Receptor	Type of Receptor	Approximate Distance to PDA (m)	UTM NAD83 Coordinates (Zone 11)	
					Easting (m)	Northing (m)
SR08	Rural residence adjacent to Springbank Road		Permanent Residential Non-sensitive	1,850	683263	5660232
SR09	Rural residence 520 m from intersection of Springbank Road and Highway 22		Permanent Residential Non-sensitive	220	677002	5660073
SR10	Rural residence adjacent to Highway 22		Permanent Residential Non-sensitive	620	676827	5659178
SR11	Rural residence adjacent to Highway 22		Permanent Residential Non-sensitive	100	677449	5658687
SR12	Rural residence 260 m from intersection of Springbank Road and Range Road 40		Permanent Residential Non-sensitive	220	680518	5660338
SR13	Rural residence 110 m from intersection of Springbank Road and Range Road 40		Permanent Residential Non-sensitive	100	680670	5660342
SR14	Rural residence 245 m from intersection of Springbank Road and Range Road 40		Permanent Residential Non-sensitive	60	680684	5660189

Table 4-3 Receptor Summary

Receptor ID	Description	Indigenous Receptor	Type of Receptor	Approximate Distance to PDA (m)	UTM NAD83 Coordinates (Zone 11)	
					Easting (m)	Northing (m)
SR15	Rural residence 545 m from intersection of Springbank Road and Range Road 40		Permanent Residential Non-sensitive	50	681089	5660000
SR16	Rural residence adjacent to Range Road 35		Permanent Residential Non-sensitive	70	682288	5658906
SR17	Rural residence adjacent to Range Road 34		Permanent Residential Non-sensitive	1,770	683867	5659434
SR18	Rural residence adjacent to Highway 22		Permanent Residential Non-sensitive	360	677183	5658119
SR19	Rural residence adjacent to Township Road 242		Permanent Residential Non-sensitive	35	677141	5657023
SR20	Rural residence adjacent to Township Road 242		Permanent Residential Non-sensitive	35	677303	5656695
SR21	Rural residence adjacent to Elbow River		Permanent Residential Non-sensitive	1,000	679639	5656960

Table 4-3 Receptor Summary

Receptor ID	Description	Indigenous Receptor	Type of Receptor	Approximate Distance to PDA (m)	UTM NAD83 Coordinates (Zone 11)	
					Easting (m)	Northing (m)
SR22	Rural residence in wooded area adjacent to Elbow River		Permanent Residential Non-sensitive	565	680364	5657430
SR23	Rural residence in wooded area adjacent to Elbow River		Permanent Residential Non-sensitive	950	681065	5657450
SR24	Rural residence in wooded area adjacent to Elbow River		Permanent Residential Non-sensitive	320	682806	5658064
SR25	Commercial premises adjacent to intersection of Township Road 242 and Highway 22		Permanent Industrial Non-sensitive	40	677404	5657030
SR26	Rural residence in wooded area adjacent to Elbow River		Permanent Residential Non-sensitive	310	676688	5654153
SR27	Rural residence in wooded area	✓	Permanent Residential Non-sensitive	880	677153	5653723
SR28	Entheos Conference and Retreat Centre	✓	Permanent Recreational Non-sensitive	850	677243	5653750

Table 4-3 Receptor Summary

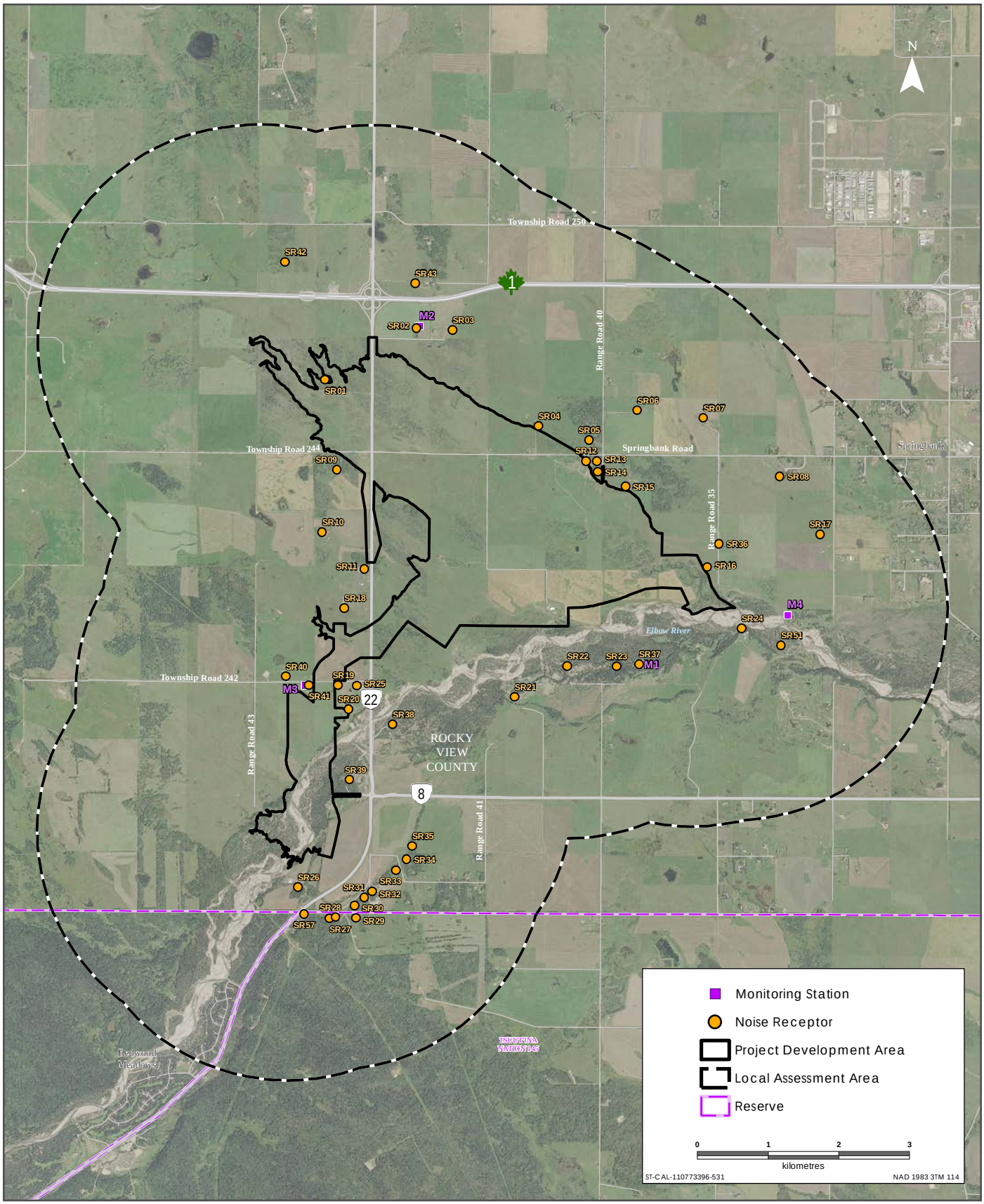
Receptor ID	Description	Indigenous Receptor	Type of Receptor	Approximate Distance to PDA (m)	UTM NAD83 Coordinates (Zone 11)	
					Easting (m)	Northing (m)
SR29	Rural residence in wooded area	✓	Permanent Residential Non-sensitive	950	677526	5653748
SR30	Rural residence in wooded area		Permanent Residential Non-sensitive	760	677499	5653923
SR31	Rural residence in wooded area		Permanent Residential Non-sensitive	740	677635	5654046
SR32	Rural residence in wooded area		Permanent Residential Non-sensitive	750	677739	5654132
SR33	Rural residence in wooded area		Permanent Residential Non-sensitive	950	678067	5654443
SR34	Rural residence in wooded area		Permanent Residential Non-sensitive	1,030	678209	5654605
SR35	Rural residence in wooded area		Permanent Residential Non-sensitive	1,080	678281	5654797

Table 4-3 Receptor Summary

Receptor ID	Description	Indigenous Receptor	Type of Receptor	Approximate Distance to PDA (m)	UTM NAD83 Coordinates (Zone 11)	
					Easting (m)	Northing (m)
SR36	Rural residence adjacent to Range Road 35		Permanent Residential Non-sensitive	350	682441	5659245
SR37	Rural residence in wooded area adjacent to Elbow River		Permanent Residential Non-sensitive	980	681384	5657499
SR38	Camp Gardner		Temporary Recreational Non-sensitive	570	677934	5656505
SR39	Kamp Kiwanis		Seasonal Recreational Non-sensitive	280	677362	5655699
SR40	Rural residence adjacent to Township Road 242		Permanent Residential Non-sensitive	35	676401	5657121
SR41	Rural residence adjacent to Township Road 242		Permanent Residential Non-sensitive	30	676726	5657009
SR42	Rural residence 1250 m from intersection of Highway 1 and Highway 22		Permanent Residential Non-sensitive	1,550	676149	5662976

Table 4-3 Receptor Summary

Receptor ID	Description	Indigenous Receptor	Type of Receptor	Approximate Distance to PDA (m)	UTM NAD83 Coordinates (Zone 11)	
					Easting (m)	Northing (m)
SR43	Rural residence 600 m from intersection of Highway 1 and Highway 22		Permanent Residential Non-sensitive	300	678003	5662753
SR51	River Spirit Golf Club		Seasonal Recreational Non-sensitive	870	683378	5657845
SR57	Bragg Creek Paintball	✓	Seasonal Recreational Non-sensitive	890	676793	5653775



Sources: Base Data - ESRI, Natural Earth, Government of Alberta, Government of Canada
Thematic Data - ERBC, Government of Alberta, Stantec Ltd

Acoustic Environment Monitoring Stations and Project Receptors

Stantec

4.2.1.2 Existing Sound Levels

A review of the LAA was carried out as a part of the desktop studies to qualify the existing sound levels as well as identify potential receptor locations within the LAA. Information gathered from the desktop study was augmented with the ambient sound monitoring and field survey of receptors. Ambient sound monitoring was conducted in four representative locations within the LAA; these locations were selected based on the desktop study. A summary of the acoustic monitoring locations and descriptions as well as the associated receptors represented by each is provided in Table 4-4 and shown in Figure 4-2.

Table 4-4 Ambient Sound Monitoring Locations

Monitoring Location ID	Description	Receptor Location(s) Represented	Monitoring Period	NAD 83 UTM Coordinates (Zone 11)	
				Easting (m)	Northing (m)
M1	Private Residence with adjacent pond surrounded by foliage. South of PDA	SR21, SR22, SR23, SR26, SR27, SR28, SR29, SR30, SR31, SR32, SR33, SR34, SR35, SR37, SR38, SR39, SR57	Sep. 7, 2016 – Sep. 9, 2016	681383	5657500
M2	Private residence near HWY 1 and HWY 22 intersection. North of PDA	SR01, SR02, SR03, SR42, SR43	Sep. 8, 2016 – Sep. 9, 2016	678081	5662150
M3	Vacant lot West of PDA adjacent to diversion channel	SR09, SR10, SR11, SR18, SR19, SR20, SR25, SR40, SR41	Sep. 7, 2016 – Sep. 9, 2016	676670	5657004
M4	Residence Southeast of PDA	SR04 SR05, SR06, SR07, SR08, SR12, SR13, SR14, SR15, SR16, SR17, SR24, SR36, SR51	Sep. 7, 2016 – Sep. 9, 2016	633448	5658277

Sound pressure level measurements were made using Bruel and Kjaer (model 2250 and 2270) Type 1 integrating sound level meters. The meters were factory calibrated within the past year, and calibration was verified with a portable acoustic calibrator unit before and after the measurement program.

Sound level meters were setup at approximately 1.5 m above grade and were configured to log equivalent sound levels in 1-minute intervals. In addition, sound level meters were also set to continuously record audio for the duration of the monitoring period. Finally, a portable weather station was also used to record local weather conditions (e.g., wind direction, wind speed, relative humidity) at each monitoring location. Recorded data points were reviewed and analyzed to determine the average daytime and nighttime sound levels over the monitoring period. The analysis incorporated audio recordings and collected weather information in order to exclude data points that were not representative of the ambient sound level (e.g., dogs barking, high winds, rain, vehicle idling).

The measured sound levels were subsequently compared to estimated values based on alternative approaches described by Health Canada. Health Canada advises that under a reasonable worst-case scenario a conservative (i.e., most protective) L_{dn} sound level of 35 dBA may be considered for rural areas. An additional approach in estimating the sound level considers a qualitative description of community characteristics and an average census-based population density. This method is based on a combination of the United States Environmental Protection Agency publication *Information on Levels of Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety* (US EPA 1974) and the Alberta Energy Regulator (AER), formerly the Energy Resources Conservation Board, publication *Directive 038: Noise Control* (AER 2007).

4.2.2 Overview

The acoustic environment in the LAA is rural and is characterized by a combination of natural environment and human activities including traffic and agricultural industry. These characteristics were confirmed based on the observed characteristics during the field survey.

The average and minimum daytime and nighttime sound levels were determined based on the analyses of the collected data and are provided in Table 4-5. A summary of field measurement data for each monitoring location is provided in Volume 4, Appendix F, Attachment 4A.

Table 4-5 Sound Monitoring Results – Average and Minimum Sound Levels

Monitoring Location	Receptor Location Represented	Average Measured Level			Minimum Measured Level		
		Daytime (L_d), dBA	Nighttime (L_n), dBA	Day-Night Equivalent Sound Level (L_{dn}), dBA	Daytime (L_d), dBA	Nighttime (L_n), dBA	Day-Night Equivalent Sound Level (L_{dn}), dBA
M1[a]	SR21, SR22, SR23, SR26, SR27, SR28, SR29, SR30, SR31, SR32, SR33, SR34, SR35, SR37, SR38, SR39, SR57	nd	nd	nd	41.1	32.9	41.9
M2[b]	SR01, SR02, SR03, SR42, SR43	54.5	52.1	58.2	52.8	49.5	56.6
M3	SR09, SR10, SR11, SR18, SR19, SR20, SR25, SR40, SR41	46.2	41.3	48.8	44.2	37.3	45.6
M4	SR04 SR05, SR06, SR07, SR08, SR12, SR13, SR14, SR15, SR16, SR17, SR24, SR36, SR51	39.2	34.9	42.2	37.3	34.6	41.5

NOTES:

[a] Data collected insufficient for calculating averages over multiple days due to excess data contamination. nd = not determined

[b] SR01 is located closer to measurement location M2 among all other measurement locations. However, its set back from Highway 1 is almost double compared to M2. Therefore, additional adjustments to the measured levels were applied. (See Section 4.2.1.2).

In order to determine the appropriate existing sound level, on-site observations, field measurement data and Health Canada recommended acceptable minimum sound levels, defined by community characteristics, are used. Sound levels for each receptor location were set based on the higher of either the measured L_{dn} (minimum) at the representative measurement location described in Table 4-5 or Health Canada minimum sound level. Consequently, since the L_{dn} based on the collected measurement data for receptor locations represented by M1 and M4 are below the Health Canada minimum (which is 45 dBA for the day and night values combined), the sound level are set equal to the Health Canada minimum for the assessment.

A further adjustment was made for receptor SR01 due to its relative location to Highway 1 when compared to measurement location M2. The distance of SR01 to the intersection of Highway 1 and Highway 22 compared M2 is nearly double (1,335 m vs 740 m). Furthermore, the distance of SR01 to Highway 22 is approximately equal to M2. As a result, the sound level of SR01 was conservatively adjusted by -4dB to account for the reduced noise contribution from Highway 1 compared to M2.

A summary of sound levels for all receptors is provided in Table 4-6.

Table 4-6 Receptor Sound Levels

Receptor Location	Equivalent Sound Level, dBA		
	Daytime	Nighttime	Day-Night (L_{dn})
SR01[1]	48.8	45.5	52.6
SR02	52.8	49.5	56.6
SR03	52.8	49.5	56.6
SR04	45.0	35.0	45.0
SR05	45.0	35.0	45.0
SR06	45.0	35.0	45.0
SR07	45.0	35.0	45.0
SR08	45.0	35.0	45.0
SR09	43.6	36.8	45.6
SR10	43.6	36.8	45.6
SR11	43.6	36.8	45.6
SR12	45.0	35.0	45.0
SR13	45.0	35.0	45.0
SR14	45.0	35.0	45.0
SR15	45.0	35.0	45.0
SR16	45.0	35.0	45.0

Table 4-6 Receptor Sound Levels

Receptor Location	Equivalent Sound Level, dBA		
	Daytime	Nighttime	Day-Night (L_{dn})
SR17	45.0	35.0	45.0
SR18	44.2	37.3	45.6
SR19	44.2	37.3	45. 6
SR20	44.2	37.3	45. 6
SR21	45.0	35.0	45.0
SR22	45.0	35.0	45.0
SR23	45.0	35.0	45.0
SR24	45.0	35.0	45.0
SR25	44.2	37.3	45. 6
SR26	45.0	35.0	45.0
SR27	45.0	35.0	45.0
SR28	45.0	35.0	45.0
SR29	45.0	35.0	45.0
SR30	45.0	35.0	45.0
SR31	45.0	35.0	45.0
SR32	45.0	35.0	45.0
SR33	45.0	35.0	45.0
SR34	45.0	35.0	45.0
SR35	45.0	35.0	45.0
SR36	45.0	35.0	45.0
SR37	45.0	35.0	45.0
SR38	45.0	35.0	45.0
SR39	45.0	35.0	45.0
SR40	44.2	37.3	45. 6
SR41	44.2	37.3	45. 6
SR42	52.8	49.5	56.6
SR43	52.8	49.5	56.6
SR51	45.0	35.0	45.0
SR57	45.0	35.0	45.0

NOTES:

[1] The sound level for SR01 was adjusted by -4 dB compared to measured data from M2 to account for M2's increased distance to intersection of Highway 1 and Highway 22.

4.3 PROJECT INTERACTIONS WITH ACOUSTIC ENVIRONMENT

Table 4-7 identifies the interaction of the acoustic environment with the Project. These interactions are discussed in detail in Section 4.4 in the context of effects pathways, standard and project-specific mitigation and residual effects. A justification for no interaction is provided following the table.

Table 4-7 Project-Environment Interactions with Acoustic Environment during Construction and Dry Operations

Project Components and Physical Activities	Environmental Effects Change in Acoustic Environment
Construction	
Clearing	✓
Channel excavation	✓
Water diversion construction	✓
Dam and berm construction	✓
Low-level outlet works construction	✓
Road construction	✓
Bridge construction	✓
Lay down areas	✓
Borrow extraction	✓
Reclamation	✓
Dry Operations	
Maintenance	—
NOTES: ✓ = Potential interaction – = No interaction	

Blasting may occur during the Project construction. If blasting is required, the contractor would prepare a blasting safety plan and submit it to Alberta Transportation.

Since there are no major anthropogenic noise generating activities associated with operation, no interactions from the Project on the acoustic environment is expected during this phase. Consequently, noise associated with dry operations was not further assessed.

4.4 ASSESSMENT OF RESIDUAL ENVIRONMENTAL EFFECTS ON ACOUSTIC ENVIRONMENT

4.4.1 Analytical Assessment Techniques

4.4.1.1 Assessment Methods

Health Canada's (2016) preferred approach in assessing the potential health effects of noise is the following:

- identify receptors who may be affected by the project noise emissions
- determine the noise levels for each phase of the project and describe the sound characteristics
- compare predicted noise levels to relevant guidelines and/or standards
- identify and discuss the potential human health impacts associated with the predicted changes in noise levels
- consider mitigation measures, their implementation and any residual effects, after the measures are implemented
- consider community consultation and prepare a complaints-resolution plan
- consider the need for monitoring of noise levels

The effects assessment focuses on humans; it does not discuss effects on wildlife. Effects to both Indigenous and non-indigenous people are assessed the same way and only differ in the location of the receptors. Indigenous receptors are identified in Table 4-3, and are receptors within the RAA that are located on the Tsuut'ina Reserve. No locations outside the Tsuut'ina reserve where Indigenous people reside either permanently orseasonally (e.g., camps, cabins) have been identified, which is consistent with the location of the Project in an area that is predominantly private land.

The assessment of potential Project effects was carried out in accordance with Health Canada's preferred approach for short-term (i.e., less than one year) and long-term (i.e., greater than one year) noise exposures.

Health Canada suggests that short-term noise exposure be assessed on the basis of using the US EPA (1974) methodology. This method provides mitigation noise levels (MNLs) and associated adjustments for community types. The MNL is defined as the threshold for which Health Canada suggests that mitigation measures are implemented to avoid widespread complaints. The basic suggested MNL is 47 dB L_{dn} for quiet suburban or rural communities. Various adjustments to the basic MNL may be applied depending on receptor location, construction duration, and noise source characteristics. These adjustments are:

- Different community categories, including:
  - quiet suburban or rural: 0 dB L_{dn} (basic MNL)
  - normal suburban: +5 dB L_{dn}
  - urban: +10 dB L_{dn}
  - noisy urban: +15 dB L_{dn}
  - very noisy urban: + 20 dB L_{dn}
- Construction activities less than 2 months: + 10 dB L_{dn}
- Winter (or windows always closed): + 5 dB L_{dn}
- Negligible tonal or impulsive noise: + 5 dB L_{dn}

Health Canada suggests that long-term construction noise exposure be assessed as operational noise. This approach follows the methods provided in the International Organization for Standardization (ISO) publication *1996-1, Annex F – Estimated prevalence of a population highly annoyed as a function of adjusted day-evening-night or day-night sound level using a regression formulation* (ISO 2003). In this approach, noise mitigation measures are to be considered when a change in the calculated percentage highly annoyed (%HA) resulting from the addition of construction activities at any receptor location exceeds 6.5%. The calculation of %HA is based on a comparison between the existing sound level and project related sound and is obtained by the following equation:

$$\%HA = \left(\frac{100}{1 + e^{[10.4 - 0.132 * Ldn]}}\right)$$

Impulsive and tonal characteristics of source noise are addressed in the Health Canada guidance document because their presence can increase perceived effects. The guidance references ISO 1996-1 for adjustments that can be made to predicted sound levels so that impulsive noise and tonality in the %HA analysis are adequately addressed:

- tonal—noise containing prominent (audible) tones such as backup alarms on trucks
- regular impulsive (RI)—characterized as intrusive but not as intrusive as highly impulsive noise. Examples include the slamming of car doors and church bells.

- highly impulsive (HI)—: impulsive noise from any noise source with highly impulsive characteristics and a high degree of intrusiveness. Examples include impact pile driving, small arms firing, hammering on metal or wood, nail guns, drop-hammering, drop forging, punch pressing, pneumatic hammering, pavement breaking, or metal impacts in rail-yard shunting operations.
- high-energy impulsive (HEI)— impulsive noise from any high-energy impulsive sound sources including any explosive source in which the equivalent mass of TNT (trinitrotoluene) exceeds 50 g, or sources with comparable characteristics and degree of intrusiveness. Examples include sonic booms, blasting, quarry and mining explosions, demolition or industrial processes that use high explosives, explosive industrial circuit breakers and military ordnance

Tonal and impulsive characteristics of source noise are accounted for with adjustments in the L_{dn} level from predicted construction noise (see Table 4-8).

Table 4-8 Sound Characteristics Adjustments

Sound Characteristic	Sound Level Adjustment (dB)
Tonal	5
Regular impulsive (RI)	5
Highly impulsive (HI)	5
High energy impulsive (HEI)	12

Potential sleep disturbances are also incorporated in the assessment of noise effects. Sleep disturbance encompasses difficulty falling asleep, awakenings, curtailed sleep duration, alterations of sleep stages or depth and increased body movements during sleep. The assessment of sleep disturbance is based on recommended limits for noise provided by the World Health Organization (WHO) publication *Night Noise Guidelines for Europe* (WHO 2009) referenced by Health Canada.

The WHO report provides observed effect thresholds (i.e., level above which an effect starts to occur) for various effect types including biological, sleep quality, well-being and medical conditions. This assessment uses motility or the onset of motility as the threshold for which sufficient evidence is available that biological effects occur. The threshold for motility or the onset of motility is identified at $L_{Amax, inside}$ 32 dBA. The WHO assumes that an average insulating value between the outdoors and the sleeping quarters (e.g., home) is 21 dB, which also accounts for windows that are partially opened during the night. On the basis of $L_{Amax, inside}$ 32 dBA and 21 dB average insulating value, the maximum sound level at the plane of window at a receptor location is set to L_{Amax} 53 dBA.

Additional information relating to the determination of sound level limits and their calculations, formulae and sound level adjustments used in the assessment are provided in Volume 4, Appendix F, Attachment 4B.

Timing is daytime and nighttime for assessing the effects on the acoustic environment.

4.4.1.2 Assessment Scenarios

The assessment is based on a preliminary project execution and equipment schedule. Construction activities in each area of the PDA may occur at various times with some construction activities occurring simultaneously (e.g., dam site, raising of Highway 22). In order to capture the variability of these activities, five worst case scenarios (i.e., maximum potential noise effect) are used:

- Scenario 1 (less than 2 months)—piling for bridge on Township Road 242, dam embankment earthworks/roadworks, daytime operation only
- Scenario 2 (less than 2 months)—piling for bridge on Highway 22, dam embankment earthworks/roadworks, daytime operation only
- Scenario 3 (greater than 2 months but less than 1 year)—earthworks and roadworks, floodplain berm, diversion channel, raising Highway 22 and Springbank Road interchange, diversion structure, bridge works (Highway 22 and Township Road 242), daytime and nighttime operation
- Scenario 4 (greater than one year)—earthworks and roadworks, dam embankment, floodplain berm, diversion channel, daytime and nighttime operation
- Scenario 5 (sleep disturbance)—earthworks, dam embankment, diversion channel maximum sound level (L_{Amax}) during peak activity level over nighttime period

4.4.1.3 Acoustic Modelling and Emission Data

Modelling Methods

Acoustic models based on Cadna/A software are used to quantitatively assess the effects resulting from Project construction. Sound level predictions using Cadna/A were carried out in accordance with ISO standard 9613 *Acoustics – Attenuation of Sound during propagation outdoors* Parts1 (ISO 1993) and Part 2 (ISO 1996) for outdoor noise propagation. Calculations under this standard meet the requirements of provincial regulators and are also recognized by Health Canada. Parameters used in the model are summarized in Table 4-9.

Table 4-9 Modelling Parameters

Item	Model Parameters	Model Setting
1	Temperature	10^0C
2	Relative humidity	70%
3	Propagation standard	ISO 9613-2, ISO 9613-2
4	Ground conditions and attenuation factor	Ground absorption (G) 0.8
5	Receptor height	1.5 m above grade
6	Topography	Flat
7	Foliage attenuation	None (conservative)
8	Operating conditions	See Section 4.4.1.2

Overall prediction accuracy depends primarily on two factors: the accuracy of the noise source data and the accuracy of interpretation for the assessment scenarios and their associated sources for the sound propagation model.

Generally, excluding topography in the noise models does not affect the accuracy of the prediction over gently rolling terrain. In hilly areas, topography also may be excluded, and modelling can assume flat ground. In most cases, such modelling over predicts sound levels and are, therefore, conservative.

For the LAA, substantial terrain elevation changes do not occur and neither is there substantial foliage that reduces sound propagation. Although there is some foliage and hedge rows in the LAA, they are not included (conservative) in the model.

The LAA is generally set in rural areas with low lying open fields and arterial roadways adjacent to some receptor locations. The ground absorption constant used in the model varies between 0 for hard, reflective ground (e.g., water, pavement) and 1 for porous ground (e.g., grass and other vegetation). Under summertime conditions, the land in the LAA is covered in vegetation. Therefore, the ground factor G = 0.8 was selected which, based on our professional experience, is representative of the ground condition within the study area.

The ISO 9613 sound propagation algorithms have a published accuracy of +/-3 dB over source to receiver distances of between 100 m and 1,000 m. To accommodate this level of uncertainty, the following assumptions are made: downwind conditions exist 100% of the time and that all normally operated equipment is operating at 100% throughput during their use. These conditions do not occur at all times and, therefore, the model predictions are conservative.

Noise Emissions Data

Noise source emissions were established using manufacturer published data, past measurements of similar equipment, and commonly accepted engineering methods in estimating machinery noise emissions. Where applicable, sound levels also incorporate the appropriate adjustments (e.g., impulsive, tonal characteristics) for known sources in accordance with ISO 1996-1. The calculated sound power levels are conservative. A summary of the Project noise source emission levels and equipment list for each assessment scenario are provided in Volume 4, Appendix F, Attachment 4C.

4.4.2 Change in Acoustic Environment

4.4.2.1 Project Pathways

Project noise emission levels at identified receptor locations are predicted for each assessment scenario and compared to the applicable thresholds, based on Health Canada's preferred approach. The prediction results and comparison to the noise thresholds for each scenario are provided in the following tables and figures:

- Scenario 1: Table 4-10 with Figure 4-3 showing locations of MNL exceedances
- Scenario 2: Table 4-11; there are no MNL exceedances
- Scenario 3: Table 4-12 with Figure 4-4 showing locations of MNL exceedances
- Scenario 4: Table 4-13 with Figure 4-5 showing locations of exceedances of % HA
- Scenario 5: Table 4-14 with Figure 4-6 showing location of World Health Organization exceedances

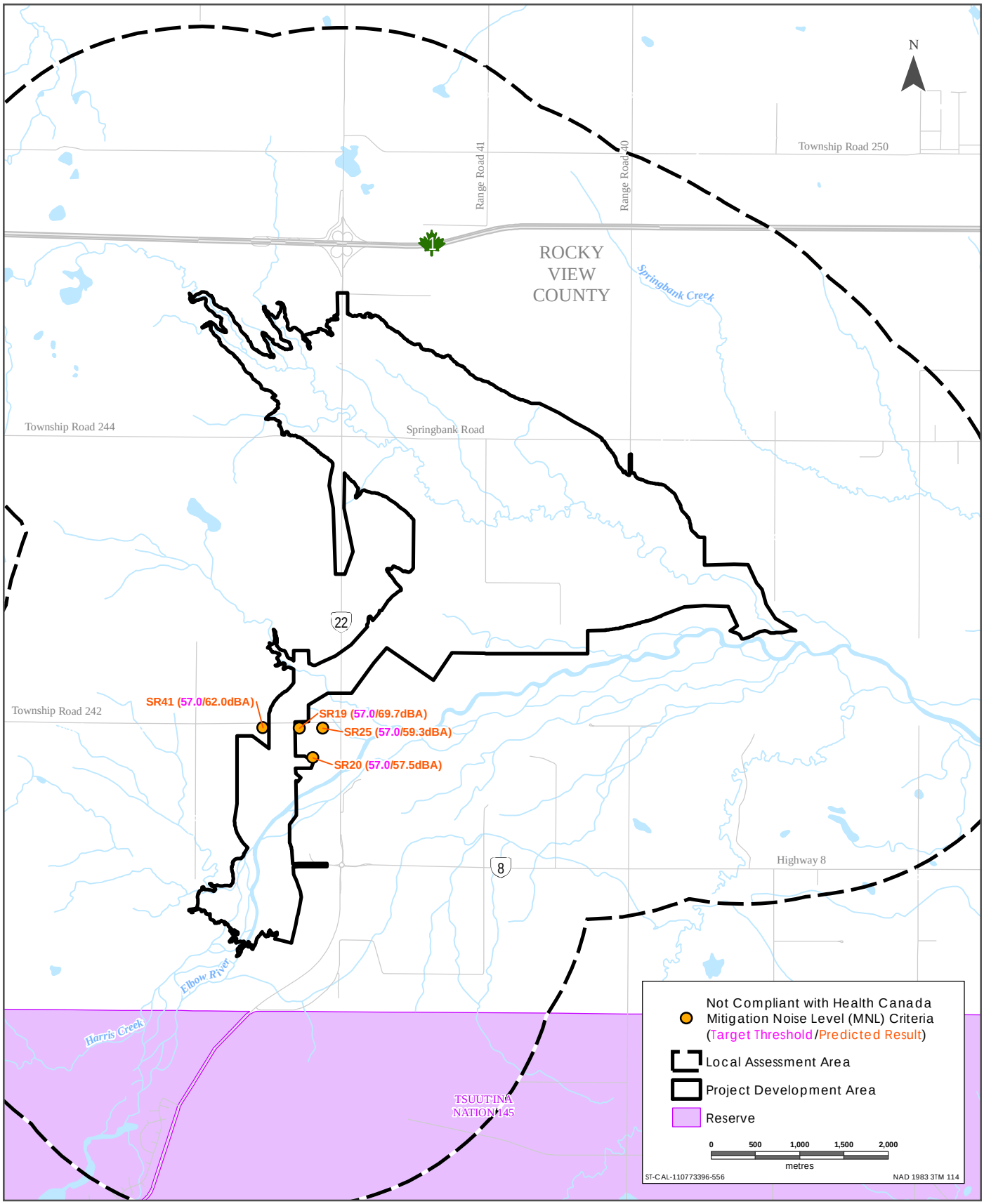
The prediction results are based on the current execution plan for the Project and do not include the application of mitigation measures. Further development of mitigation and refinement of the prediction results may be completed once a detailed construction execution plan is available.

Table 4-10 Predicted Sound Levels and Compliance– Scenario 1

Scenario 1 (less than 2 months)—piling for bridge on Township Road 242, dam embankment earthworks/roadworks, daytime operation only					
	Noise Contribution from Project				
Receptor ID	**Daytime (L_d), (dBA)**	**Nighttime (L_n), (dBA)**	**Day-Night Equivalent (L_{dn}), (dB)**	**MNL Criteria L_{dn}, (dB)**	**Compliance with MNL Criteria (Yes/No)**
SR01	32.8	0	30.8	57	Yes
SR02	31.4	0	29.4	62	Yes
SR03	32.7	0	30.7	62	Yes
SR04	45.6	0	43.6	57	Yes
SR05	47.3	0	45.3	57	Yes
SR06	41.5	0	39.5	57	Yes
SR07	39.2	0	37.2	57	Yes
SR08	37.4	0	35.4	57	Yes
SR09	38.0	0	36.0	57	Yes
SR10	42.2	0	40.2	57	Yes
SR11	45.4	0	43.4	57	Yes
SR12	51.7	0	49.7	57	Yes
SR13	50.6	0	48.6	57	Yes
SR14	53.1	0	51.1	57	Yes
SR15	52.8	0	50.8	57	Yes
SR16	48.1	0	46.1	57	Yes
SR17	35.6	0	33.6	57	Yes
SR18	50.5	0	48.5	57	Yes
SR19	71.7	0	69.7	57	No
SR20	59.5	0	57.5	57	No
SR21	42.9	0	40.9	57	Yes
SR22	46.6	0	44.6	57	Yes
SR23	46.6	0	44.6	57	Yes
SR24	41.3	0	39.3	57	Yes
SR25	61.3	0	59.3	57	No
SR26	37.0	0	35.0	57	Yes
SR27	35.0	0	33.0	57	Yes
SR28	35.1	0	33.1	57	Yes

Table 4-10 Predicted Sound Levels and Compliance– Scenario 1

Scenario 1 (less than 2 months)—piling for bridge on Township Road 242, dam embankment earthworks/roadworks, daytime operation only					
Receptor ID	**Noise Contribution from Project**			**MNL Criteria L_{dn}, (dB)**	**Compliance with MNL Criteria (Yes/No)**
	Daytime (L_d), (dBA)	**Nighttime (L_n), (dBA)**	**Day-Night Equivalent (L_{dn}), (dB)**		
SR29	34.9	0	32.9	57	Yes
SR30	35.8	0	33.8	57	Yes
SR31	36.3	0	34.3	57	Yes
SR32	36.7	0	34.7	57	Yes
SR33	38.3	0	36.3	57	Yes
SR34	37.8	0	35.8	57	Yes
SR35	39.1	0	37.1	57	Yes
SR36	46.2	0	44.2	57	Yes
SR37	46.1	0	44.1	57	Yes
SR38	50.5	0	48.5	57	Yes
SR39	47.2	0	45.2	57	Yes
SR40	56.5	0	54.5	57	Yes
SR41	64.0	0	62.0	57	No
SR42	18.6	0	16.9	62	Yes
SR43	28.7	0	26.7	62	Yes
SR51	37.2	0	35.2	57	Yes
SR57	35.2	0	33.2	57	Yes



Sources: Base Data - ESRI, Government of Alberta, Government of Canada
Thematic Data - ERBC, Government of Alberta, Stantec Ltd

Prediction Results – Scenario 1
(Bridge Piling on Township Road 242)

Table 4-11 Predicted Sound Levels and Compliance – Scenario 2

Scenario 2 (less than 2 months)—piling for bridge on Highway 22, dam embankment earthworks/roadworks, daytime operation only					
	Noise Contribution from Project				
Receptor ID	**Daytime (L_d), (dBA)**	**Nighttime (L_n), (dBA)**	**Day-Night Equivalent (L_{dn}), (dB)**	**MNL Criteria L_{dn}, (dB)**	**Compliance with MNL Criteria (Yes/No)**
SR01	34.8	0	32.8	57	Yes
SR02	34.0	0	32.0	62	Yes
SR03	34.7	0	32.7	62	Yes
SR04	45.7	0	43.7	57	Yes
SR05	47.4	0	45.4	57	Yes
SR06	41.7	0	39.7	57	Yes
SR07	39.2	0	37.2	57	Yes
SR08	37.4	0	35.4	57	Yes
SR09	41.0	0	39.0	57	Yes
SR10	46.0	0	44.0	57	Yes
SR11	52.7	0	50.7	57	Yes
SR12	51.7	0	49.7	57	Yes
SR13	50.6	0	48.6	57	Yes
SR14	53.1	0	51.1	57	Yes
SR15	52.8	0	50.8	57	Yes
SR16	48.2	0	46.2	57	Yes
SR17	35.6	0	33.6	57	Yes
SR18	58.9	0	56.9	57	Yes
SR19	52.6	0	50.6	57	Yes
SR20	49.8	0	47.8	57	Yes
SR21	43.9	0	41.9	57	Yes
SR22	46.9	0	44.9	57	Yes
SR23	46.7	0	44.7	57	Yes
SR24	41.3	0	39.3	57	Yes
SR25	53.9	0	51.9	57	Yes
SR26	33.1	0	31.1	57	Yes
SR27	31.6	0	29.6	57	Yes
SR28	31.7	0	29.7	57	Yes

Table 4-11 Predicted Sound Levels and Compliance – Scenario 2

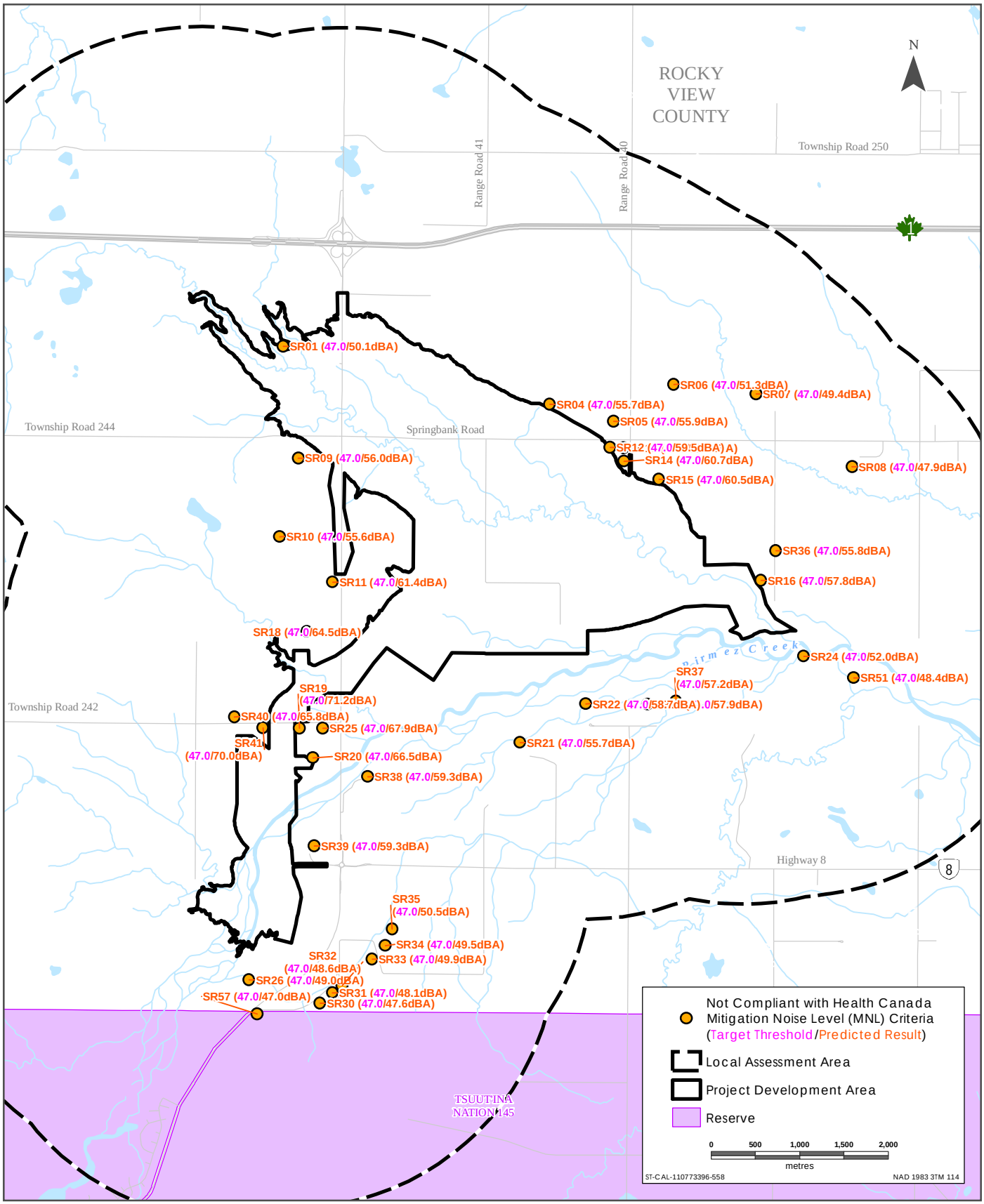
Scenario 2 (less than 2 months)—piling for bridge on Highway 22, dam embankment earthworks/roadworks, daytime operation only					
Receptor ID	**Noise Contribution from Project**			**MNL Criteria L_{dn}, (dB)**	**Compliance with MNL Criteria (Yes/No)**
	Daytime (L_d), (dBA)	**Nighttime (L_n), (dBA)**	**Day-Night Equivalent (L_{dn}), (dB)**		
SR29	31.8	0	29.8	57	Yes
SR30	32.5	0	30.5	57	Yes
SR31	33.1	0	31.1	57	Yes
SR32	33.6	0	31.6	57	Yes
SR33	35.7	0	33.7	57	Yes
SR34	35.0	0	33.0	57	Yes
SR35	36.6	0	34.6	57	Yes
SR36	46.2	0	44.2	57	Yes
SR37	46.2	0	44.2	57	Yes
SR38	47.8	0	45.8	57	Yes
SR39	42.0	0	40.0	57	Yes
SR40	47.7	0	45.7	57	Yes
SR41	49.6	0	47.6	57	Yes
SR42	18.6	0	16.9	62	Yes
SR43	31.4	0	29.4	62	Yes
SR51	37.2	0	35.2	57	Yes
SR57	31.6	0	29.6	57	Yes

Table 4-12 Predicted Sound Levels and Compliance – Scenario 3

Scenario 3 (greater than 2 months but less than 1 year)—earthworks and roadworks, floodplain berm, diversion channel, raising Highway 22 and Springbank Road interchange, diversion structure, bridge works (Highway 22 and Township Road 242), daytime and nighttime operation					
Receptor ID	**Noise Contribution from Project (dBA)**			**MNL Criteria L_{dn}, (dB)**	**Compliance with MNL Criteria (Yes/No)**
	Daytime (L_d)	**Nighttime (L_n)**	**Day-Night Equivalent (L_{dn})**		
SR01	49.7	40.6	50.1	47	No
SR02	47.2	39.9	48.4	52	Yes
SR03	44.6	40.3	47.6	52	Yes
SR04	52.7	48.4	55.7	47	No
SR05	50.7	49.3	55.9	47	No
SR06	45.5	44.8	51.3	47	No
SR07	43.3	42.9	49.4	47	No
SR08	41.7	41.5	47.9	47	No
SR09	56.2	45.6	56.0	47	No
SR10	51.0	48.8	55.6	47	No
SR11	55.7	54.8	61.4	47	No
SR12	53.8	52.9	59.5	47	No
SR13	52.6	52.0	58.5	47	No
SR14	54.5	54.2	60.7	47	No
SR15	54.3	54.1	60.5	47	No
SR16	51.9	51.3	57.8	47	No
SR17	40.1	40.0	46.4	47	Yes
SR18	59.0	57.9	64.5	47	No
SR19	68.2	63.9	71.2	47	No
SR20	61.3	59.9	66.5	47	No
SR21	49.5	49.3	55.7	47	No
SR22	52.0	52.3	58.7	47	No
SR23	51.2	51.5	57.9	47	No
SR24	45.7	45.6	52.0	47	No
SR25	66.5	59.5	67.9	47	No
SR26	45.2	42.0	49.0	47	No
SR27	42.3	40.0	46.8	47	Yes

Table 4-12 Predicted Sound Levels and Compliance – Scenario 3

Scenario 3 (greater than 2 months but less than 1 year)—earthworks and roadworks, floodplain berm, diversion channel, raising Highway 22 and Springbank Road interchange, diversion structure, bridge works (Highway 22 and Township Road 242), daytime and nighttime operation					
Receptor ID	**Noise Contribution from Project (dBA)**			**MNL Criteria L_{dn}, (dB)**	**Compliance with MNL Criteria (Yes/No)**
	Daytime (L_d)	**Nighttime (L_n)**	**Day-Night Equivalent (L_{dn})**		
SR28	42.4	40.1	46.9	47	Yes
SR29	42.1	39.9	46.7	47	Yes
SR30	43.2	40.8	47.6	47	No
SR31	43.7	41.2	48.1	47	No
SR32	44.0	41.8	48.6	47	No
SR33	44.9	43.2	49.9	47	No
SR34	44.7	42.8	49.5	47	No
SR35	45.5	43.8	50.5	47	No
SR36	49.8	49.3	55.8	47	No
SR37	50.5	50.8	57.2	47	No
SR38	54.4	52.6	59.3	47	No
SR39	55.0	52.4	59.3	47	No
SR40	65.6	56.0	65.8	47	No
SR41	68.3	61.9	70.0	47	No
SR42	36.7	29.5	38.0	52	Yes
SR43	42.3	36.7	44.5	52	Yes
SR51	42.0	42.0	48.4	47	No
SR57	42.6	40.2	47.0	47	Yes



Sources: Base Data - ESRI, Government of Alberta, Government of Canada
Thematic Data - ERBC, Government of Alberta, Stantec Ltd

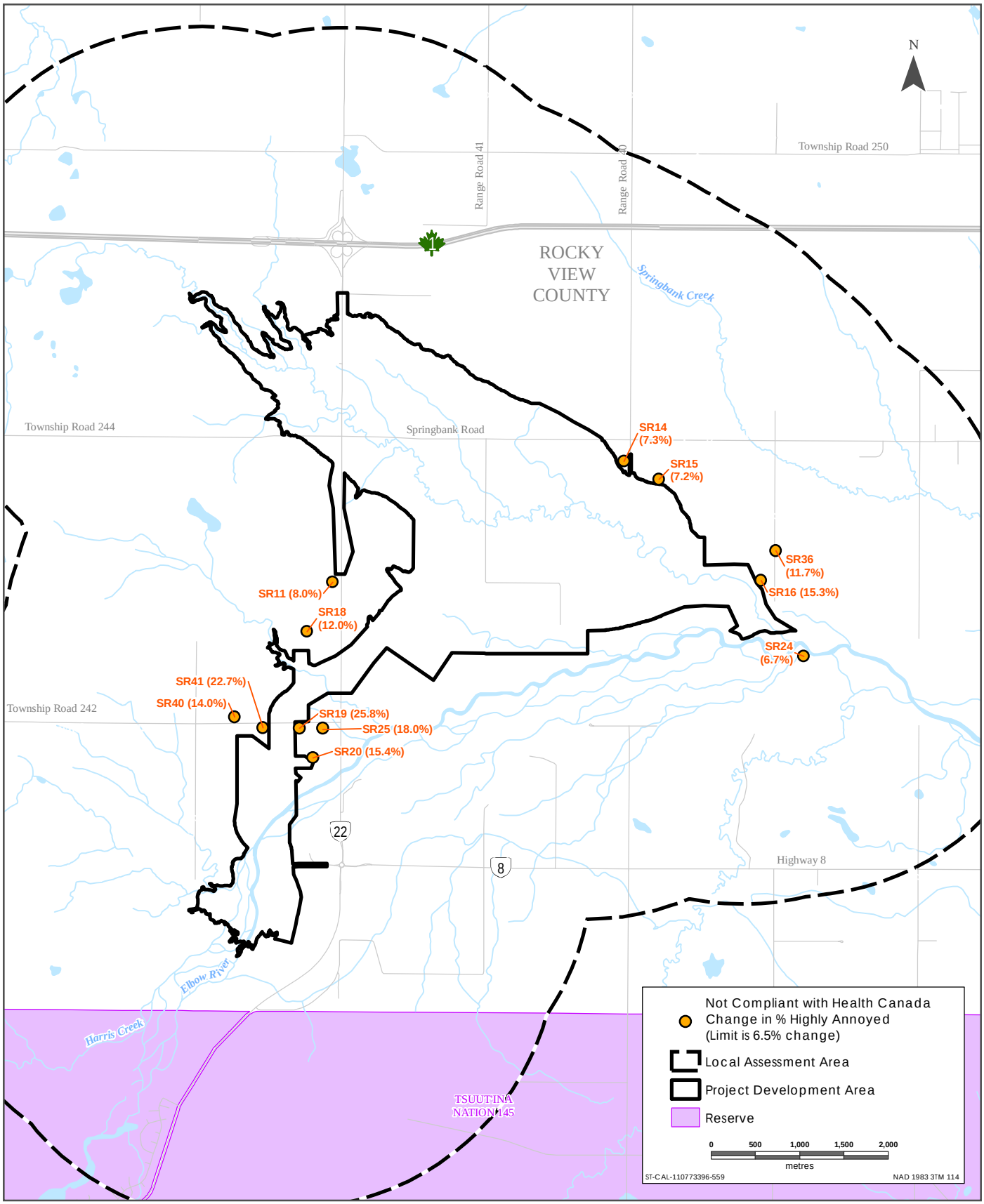
Prediction Results – Scenario 3
(General Construction Greater than 2 Months but Less than 1 Year)

Table 4-13 Predicted Sound Levels and Compliance – Scenario 4

Scenario 4 (greater than one year)—earthworks and roadworks, dam embankment, floodplain berm, diversion channel, daytime and nighttime operation								
	Noise Contribution from Project (dBA)			**Combined Project and Existing Sound LevelL_{dn} (dBA)**				
Receptor ID	**Daytime (L_d)**	**Nighttime (L_n)**	**Day-Night Equivalent (L_{dn})**		**Existing %HA**	**Combined Existing and Project % HA**	**Change in %HA**	**Meets Change in %HA limit of less than 6.5% (Yes/No)**
SR01	49.7	40.6	50.1	54.5	3.0	3.9	0.9	Yes
SR02	47.2	39.9	48.4	57.2	5.1	5.5	0.4	Yes
SR03	44.6	40.3	47.6	57.1	5.1	5.4	0.3	Yes
SR04	52.7	48.4	55.7	56.1	1.1	4.8	3.6	Yes
SR05	50.7	49.3	55.9	56.3	1.1	4.9	3.7	Yes
SR06	45.5	44.8	51.3	62.2	4.1	10.1	6.0	Yes
SR07	43.3	42.9	49.4	60.7	4.1	8.4	4.3	Yes
SR08	41.7	41.5	47.9	49.7	1.1	2.1	1.0	Yes
SR09	56.2	45.6	56.0	56.4	1.2	4.9	3.7	Yes
SR10	51.0	48.8	55.6	56.0	1.2	4.7	3.5	Yes
SR11	55.7	54.8	61.4	61.5	1.2	9.2	8.0	No
SR12	53.8	52.9	59.5	59.6	1.1	7.4	6.2	Yes
SR13	52.6	52.0	58.5	58.7	1.1	6.6	5.4	Yes
SR14	54.5	54.2	60.7	60.8	1.1	8.5	7.3	No
SR15	54.3	54.1	60.5	60.7	1.1	8.4	7.2	No
SR16	51.9	51.3	57.8	68.0	4.1	19.5	15.3	No
SR17	40.1	40.0	46.4	58.8	4.1	6.7	2.5	Yes
SR18	59.0	57.9	64.5	64.5	1.2	13.2	12.0	No
SR19	68.2	63.9	71.2	71.3	1.2	27.0	25.8	No
SR20	61.3	59.9	66.5	66.6	1.2	16.6	15.4	No
SR21	49.5	49.3	55.7	56.1	1.1	4.8	3.6	Yes
SR22	52.0	52.3	58.7	58.9	1.1	6.7	5.6	Yes
SR23	51.2	51.5	57.9	58.1	1.1	6.1	5.0	Yes
SR24	45.7	45.6	52.0	62.8	4.1	10.8	6.7	No
SR25	66.5	59.5	67.9	67.9	1.2	19.2	18.0	No
SR26	45.2	42.0	49.0	50.5	1.1	2.3	1.2	Yes

Table 4-13 Predicted Sound Levels and Compliance – Scenario 4

Scenario 4 (greater than one year)—earthworks and roadworks, dam embankment, floodplain berm, diversion channel, daytime and nighttime operation								
Receptor ID	**Noise Contribution from Project (dBA)**			**Combined Project and Existing Sound LevelL_{dn} (dBA)**	**Existing %HA**	**Combined Existing and Project % HA**	**Change in %HA**	**Meets Change in %HA limit of less than 6.5% (Yes/No)**
	Daytime (L_d)	**Nighttime (L_n)**	**Day-Night Equivalent (L_{dn})**					
SR27	42.3	40.0	46.8	49.0	1.1	1.9	0.8	Yes
SR28	42.4	40.1	46.9	49.1	1.1	1.9	0.8	Yes
SR29	42.1	39.9	46.7	48.9	1.1	1.9	0.8	Yes
SR30	43.2	40.8	47.6	49.5	1.1	2.1	0.9	Yes
SR31	43.7	41.2	48.1	49.8	1.1	2.1	1.0	Yes
SR32	44.0	41.8	48.6	50.2	1.1	2.2	1.1	Yes
SR33	44.7	42.8	49.5	50.8	1.1	2.4	1.3	Yes
SR34	44.9	43.2	49.9	51.1	1.1	2.5	1.4	Yes
SR35	45.5	43.8	50.5	51.6	1.1	2.7	1.5	Yes
SR36	49.8	49.3	55.8	66.1	4.1	15.8	11.7	No
SR37	50.5	50.8	57.2	57.4	1.1	5.6	4.5	Yes
SR38	54.4	52.6	59.3	59.5	1.1	7.2	6.1	Yes
SR39	55.0	52.4	59.3	59.4	1.1	7.2	6.1	Yes
SR40	65.6	56.0	65.8	65.8	1.2	15.3	14.0	No
SR41	68.3	61.9	70.0	70.0	1.2	23.9	22.7	No
SR42	36.7	29.5	38.0	56.6	5.1	5.1	0.0	Yes
SR43	42.3	36.7	44.5	56.8	5.1	5.2	0.2	Yes
SR51	42.0	42.0	48.4	50.0	1.1	2.2	1.1	Yes
SR57	42.6	40.2	47.0	49.2	1.1	2.0	0.8	Yes



Sources: Base Data - ESRI, Government of Alberta, Government of Canada
Thematic Data - ERBC, Government of Alberta, Stantec Ltd

Prediction Results – Scenario 4
(Changes in % Highly Annoyed; General Construction Greater than 1 Year)

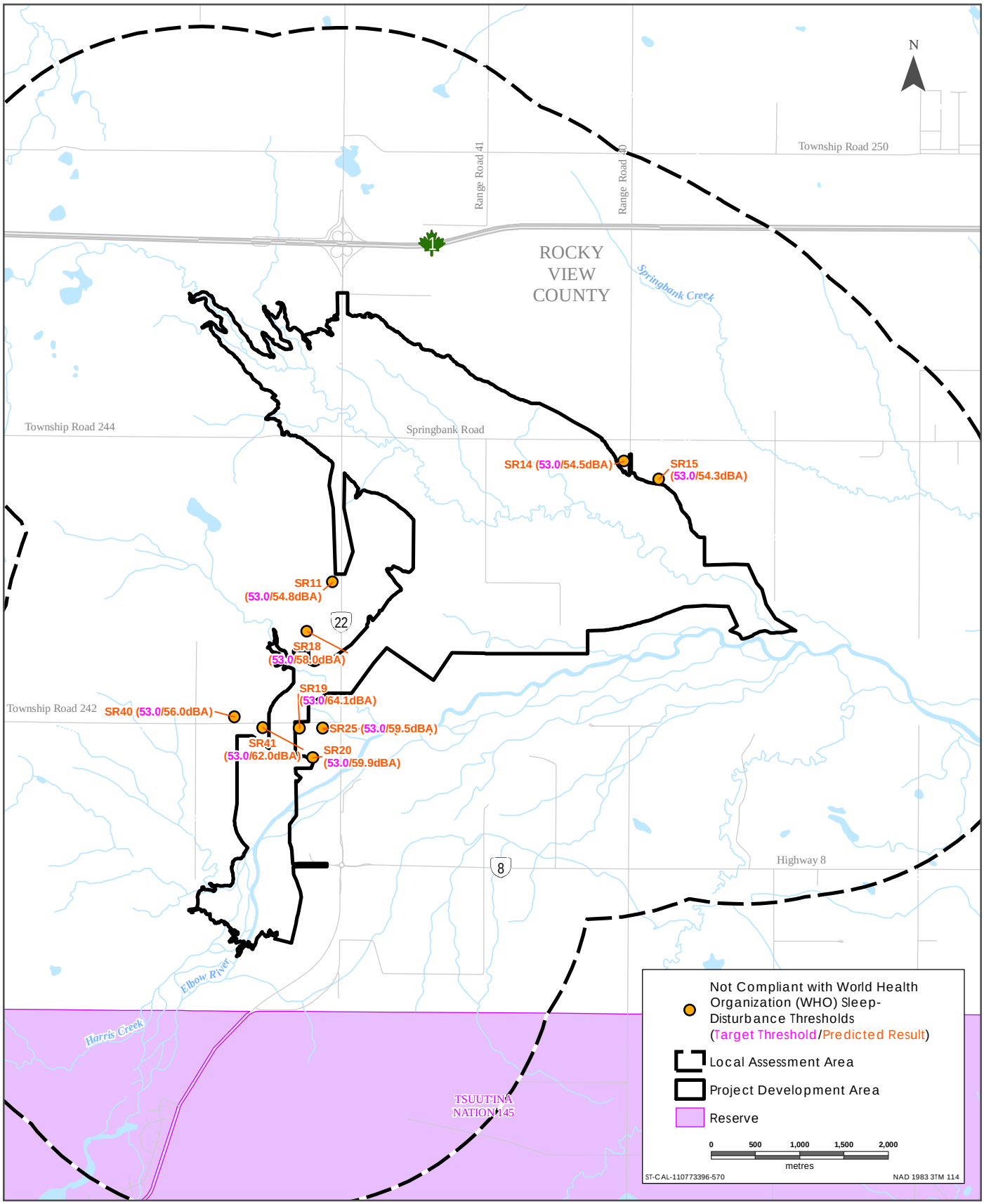
Stantec

Table 4-14 Predicted Sound Levels and Compliance – Scenario 5 (Sleep Disturbance)

Scenario 5 (sleep disturbance)—earthworks, dam embankment, diversion channel maximum sound level (L_{Amax}) during peak activity level over nighttime period			
Receptor ID	**Project Maximum Nighttime Sound Level (L_{Amax}), dBA**	**Maximum Sound Level Criteria (L_{Amax}), dBA**	**Meets Criteria? (Yes/No)**
SR01	40.6	53	Yes
SR02	39.9	53	Yes
SR03	40.3	53	Yes
SR04	48.7	53	Yes
SR05	49.5	53	Yes
SR06	44.9	53	Yes
SR07	43.0	53	Yes
SR08	41.5	53	Yes
SR09	45.6	53	Yes
SR10	48.9	53	Yes
SR11	54.8	53	No
SR12	53.1	53	Yes
SR13	52.2	53	Yes
SR14	54.5	53	No
SR15	54.3	53	No
SR16	51.4	53	Yes
SR17	40.1	53	Yes
SR18	58.0	53	No
SR19	64.1	53	No
SR20	59.9	53	No
SR21	49.3	53	Yes
SR22	52.3	53	Yes
SR23	51.5	53	Yes
SR24	45.6	53	Yes
SR25	59.5	53	No
SR26	42.0	53	Yes
SR27	40.0	53	Yes
SR28	40.1	53	Yes
SR29	40.0	53	Yes

Table 4-14 Predicted Sound Levels and Compliance – Scenario 5 (Sleep Disturbance)

Scenario 5 (sleep disturbance)—earthworks, dam embankment, diversion channel maximum sound level (L_{Amax}) during peak activity level over nighttime period			
Receptor ID	**Project Maximum Nighttime Sound Level (L_{Amax}), dBA**	**Maximum Sound Level Criteria (L_{Amax}), dBA**	**Meets Criteria? (Yes/No)**
SR30	40.8	53	Yes
SR31	41.2	53	Yes
SR32	41.8	53	Yes
SR33	43.2	53	Yes
SR34	42.8	53	Yes
SR35	43.9	53	Yes
SR36	49.4	53	Yes
SR37	50.9	53	Yes
SR38	52.7	53	Yes
SR39	52.4	53	Yes
SR40	56.0	53	No
SR41	62.0	53	No
SR42	29.5	53	Yes
SR43	36.7	53	Yes
SR51	42.0	53	Yes
SR57	40.2	53	Yes



Sources: Base Data - ESRI, Government of Alberta, Government of Canada
Thematic Data - ERBC, Government of Alberta, Stantec Ltd

Prediction Results – Scenario 5 (Sleep Disturbance)

4.4.2.2 Mitigation

The need for mitigation depends on the type of activity and the proximity of receptors to project activities. Mitigation measures were not incorporated in the acoustic models for the assessment of effects since the construction equipment list and schedule are preliminary. Mitigation, would be developed further for each of the identified assessment scenarios when project schedule and construction equipment are finalized.

Overall noise emissions are expected to be reduced during the construction of the diversion channel as excavation proceeds and occurs below the existing ground level. In addition, the spoil sites located along the channel are expected to act as noise barriers.

A potential mitigation that would be implemented is reducing or restricting equipment activities for specific areas or during specific time periods

The following list of best management practices would be implemented to further mitigate noise effects:

- residents near to construction noise-generating activities will be notified. Noise abatement barriers may be used to reduce noise levels. If noise abatement barriers are ineffective residents may have to be moved temporarily to alternative accommodation during the construction phase producing the noise.
- machinery and factory supplied noise-abatement equipment (e.g., mufflers) will be maintained in good working order.
- a complaint response procedure will be implemented to address noise complaints should they arise.

4.4.2.3 Project Effects

Table 4-15 summarizes the environmental effects on the acoustic environment during construction without the application of mitigation measures. As shown in Table 4-10 to Table 4-14, out of 45 receptors, there are up to 33 that have the potential to exceed the threshold limits, depending on the assessment scenario. No exceedances of threshold limits were predicted for Indigenous receptors in any of the assessment scenarios. The predicted number of exceedances without the implementation of noise mitigation measures for each scenario are as follows:

- Scenario 1: ([less than 2 months]—piling for bridge on Township Road 242, dam embankment earthworks/roadworks, daytime operation only) Sound levels at 4 of 45 receptor locations are predicted to exceed the MNL thresholds. These receptors are located close to the bridge construction site on Township Road 242.
- Scenario 2: ([less than 2 months]—piling for bridge on Highway 22, dam embankment earthworks/roadworks, daytime operation only) Sound levels at all 45 receptor locations are predicted to meet the MNL noise thresholds.
- Scenario 3: ([greater than 2 months but less than 1 year]—earthworks and roadworks, floodplain berm, diversion channel, raising Highway 22 and Springbank Road interchange, diversion structure, bridge works (Highway 22 and Township Road 242), daytime and nighttime operation) Sound levels at 33 of 45 receptor locations are predicted to exceed the MNL thresholds. These receptors are located throughout the LAA.
- Scenario 4: ([greater than one year]—earthworks and roadworks, dam embankment, floodplain berm, diversion channel, daytime and nighttime operation) Sound levels at 12 of 45 receptor locations are predicted to exceed the change in %HA threshold of 6.5%. These receptors are located near the intersection of Township Road 242 and Highway 22, Range Road 40 immediately south of Springbank Road and along the Elbow river between Range Road 40 and Range Road 34.
- Scenario 5: ([sleep disturbance]—earthworks, dam embankment, diversion channel maximum sound level (L_{Amax}) during peak activity level over nighttime period) Sound levels at 9 of 45 receptor locations are predicted to exceed the sleep disturbance threshold of 53 dBA (L_{Amax}). These receptors are located near the intersection of Township Road 242 and Highway 22 as well as Range Road 40 immediately south of Springbank Road.

The application of mitigation options discussed in Section 4.4.2.2, may be applied in order to reduce the noise contribution from the construction activities and achieve compliance with the thresholds. The extent of the mitigation measures will be developed further for each of the identified assessment scenarios when project schedule and construction equipment are finalized.

Table 4-15 Project Residual Effects on Acoustic Environment during Construction

Residual Effect	Residual Effects Characterization								
	Project Phase	Timing	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change in Acoustic Environment	C	T	A	High	LAA	ST	R	R	D

KEY

See Table 4-2 for detailed definitions

Project Phase

C: Construction

DO: Dry Operation

Timing Consideration

T: Time of day

S: Seasonality

R: Regulatory

Direction:

P: Positive

A: Adverse

N: Neutral

Magnitude:

L: Low

H: High

Geographic Extent:

PDA: project development area

LAA: local assessment area

RAA: regional assessment area

Duration:

ST: Short-term;

LT: Long-term

N/A: Not applicable

Frequency:

S: Single event

IR: Multiple Irregular event

R: Multiple Regular event

C: Continuous

Reversibility:

R: Reversible

I: Irreversible

Ecological/Socio-Economic Context:

D: Disturbed

U: Undisturbed

4.5 DETERMINATION OF SIGNIFICANCE

The unmitigated sound levels at most receptor locations during some phases of construction exceed the noise limits established based on Health Canada's preferred approach for environmental assessments. The acoustic modelling assumed downwind conditions exist 100% of the time and that all normally operated equipment is operating at 100% throughput during their use. These conditions do not occur at all times and, therefore, the model predictions are expected to be conservative.

Mitigation measures were not applied nor developed in the prediction models for the assessment of effects due to the preliminary status of the construction execution plan. However, with the application of mitigation, such as those discussed in Section 4.4.2.2, the residual effect on the acoustic environment are expected to be reduced to achieve Health Canada's noise objectives at many of the receptor sites.

4.6 PREDICTION CONFIDENCE

The assessment of Project effects was conducted based on industry standards for modelling the propagation of noise. Input data used in the model are based on information provided from vendors or conservative estimates considering equipment horse power ratings or capacity and commonly accepted engineering methods, as well as past measurements of similar equipment. Based on the conservative assumptions applied to the acoustic modelling, source sound power data and propagation algorithms used in predictions of residual effects, and the effectiveness of the proposed mitigation measures, the prediction confidence is high.

4.7 CONCLUSIONS

The residual environmental effects assessment shows that out of 45 receptors considered for the assessment, up to 33 have the potential to exceed the Health Canada limits without mitigation. It is feasible, that with the application of mitigation options, the sound levels at many of the identified receptor locations would meet noise thresholds. Because the type, number and operating scenarios of equipment are preliminary, noise mitigation options were not incorporated in the acoustic model. Upon development of the detailed construction execution plan, mitigation measures would be developed to meet assessment noise thresholds.

4.8 REFERENCES

AER (Alberta Energy Regulator). 2007. Directive 038: Noise Control. Revised Edition February 16, 2007. Calgary Alberta.

CEAA 2012. Canadian Environmental Assessment Act. S.C. 2012, c.19, s. 63. 2012. Available online at: http://laws-lois.justice.gc.ca/PDF/C-15.21.pdf.

Department for Environment Food and Rural Affairs (DEFRA). 2005. Update of Noise Database for Prediction of Noise on Construction and Open Sites. London, England.

Health Canada. 2017. Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.

ISO (International Organization for Standardization). 2003. ISO 1996-1:2003 acoustics – Description, measurement and assessment of environmental noise – Part 1: Basic quantities and assessment procedures.

ISO. 1993. ISO 9613-1, Acoustics – Attenuation of sound during propagation outdoors – Part 1: Calculation of absorption of sound by the atmosphere. Geneva, Switzerland.

ISO. 1996. ISO 9613-2, Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation. Geneva, Switzerland.

WHO (World Health Organization). 1999. Guidelines for Community Noise. Berglund, B., Lindvall, T. & Schwela, D.H. (eds.). Available online at: http://www.who.int/docstore/peh/noise/guidelines2.html.

WHO 2009. Night Noise Guidelines for Europe. Hurtley, C. (Ed.). Available online at: http://www.euro.who.int/en/health-topics/environment-and-health/noise/publications/2009/night-noise-guidelines-for-europe.

US EPA 1974. United States Environmental Protection Agency Office of Noise Abatement and Control. Information on Levels of Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety.

4.9 GLOSSARY

A-weighting	The weighting network used to account for changes in level sensitivity as a function of frequency. The A-weighting network de-emphasizes the low frequencies in an effort to reflect the relative response of the human ear to noise. See also frequency weighting.
Day–night equivalent sound level (DNL/L_{dn})	A 24-hour equivalent continuous equivalent sound level with a 10 decibel penalty applied to the nighttime period. L_{dn} may also be referenced as DNL.
Daytime	Defined as the hours from 07:00h to 22:00h
Daytime Sound Level (L_d)	An equivalent continuous sound level taken over 15 hours daytime from 07:00h to 22:00h.
Decibel (dB)	A logarithmic unit commonly used to quantify magnitudes of sound and vibration levels.

Decibel addition	Due to the nature of the decibel scale, the addition of two or more sound pressure levels (SPLs) is performed using the logarithmic addition and considering the coherency of the sounds. For incoherent sounds denoted as SPL1, SPL2 … SPL_n, the addition is performed using the following formula: $SPL1 + SPL2 + \ldots SPLn = 10 \log (10^{(SPL1/10)} + 10^{(SPL2/10)} + \ldots + 10^{(SPLn/10)})$ As an example: 50 dB + 50 dB = 53 dB 50 dB + 47 dB = 52 dB 50 dB + 40 dB = 50 dB
Decibel, A-weighted (dBA)	A logarithmic unit used to quantify sound levels to which A-weighting has been applied.
Energy equivalent sound level (L_{eq})	A continuous equivalent (energy-averaged) sound level calculated over a specified period. It represents the equivalent sound pressure encountered for the period. The time period is often added as a suffix to the label (e.g., $L_{eq}(24)$ for the 24-hour equivalent sound level). L_{eq} is usually A-weighted. A L_{eq} value expressed in dBA is a good, single value descriptor of the level of environmental noise.
Frequency	The number of cycles per second that a periodic signal such as a sound wave oscillates. It is usually expressed in hertz (Hz).
Frequency weighting	A method used to account for differences in sensitivity as a function of frequency. Three standard weighting networks, A, B and C, are used to account for different responses to sound pressure levels. Note: The absence of frequency weighting is referred to as "flat" response or linear weighting.
Hertz (Hz)	The unit of frequency equivalent to a number cycles per second.
International Organization for Standardization (ISO)	An international body that provides scientific standards and guidelines related to various technical subjects and disciplines.

Mitigation	Measures taken to reduce, eliminate or control effects on the environment.
Night-time	Defined as the hours from 22:00h to 07:00h
Night-time Sound Level	An equivalent continuous sound level taken over 9 hours from 22:00h to 07:00h.
Noise	Any unwanted sound. Noise and sound are used interchangeably in this document.
Receptor	A location that may be affected by project noise. Types of locations considered receptors are defined in accordance with Health Canada guidance.
Sound	A combination of pressure waves of different frequencies and amplitudes travelling through a medium such as air or water.
Sound level	Amplitude of sound pressure expressed in decibels (dB). It is commonly used to refer to sound pressure level.
Sound power	The rate with which acoustic energy radiates from a source.
Sound pressure	The root-mean-square (RMS) of the instantaneous sound pressures during a specified time interval. The unit of sound pressure is in pascals (Pa).
Sound pressure level (SPL)	The magnitude of sound pressure expressed in decibels. The sound pressure level is defined by the following equation where P_0 is the reference pressure. In air, P_0 is usually taken as 2.0×10^{-5} pascal. $$SPL\ (dB) = 20 \log\left(\frac{P_{rms}}{P_0}\right)$$ The unit for sound pressure level is decibels (dB).