Associated Engineering
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May 27, 2020
File: 2018 3170 00.E 01 01

Shane De Lorey, M.Eng., P.Eng.
Project Director
Alberta Transportation
Main Floor, 803 Manning Road NE
Calgary, AB T2E 7M8

Re: MAY 27, 2020 DETAILED DESIGN NOISE ANALYSIS REPORT FOR WEST CALGARY RING ROAD TRANS-CANADA HIGHWAY TO OLD BANFF COACH ROAD SEGMENT (WCRR DB1)

Dear Shane:

Please find attached Patching Associates Acoustical Engineering's (Patching's) Detailed Design Noise Analysis Report for the WCRR DB1 project, dated May 27th, 2020

The attached noise study was completed for the WCRR DB1 project based on the detailed design, serving as an update to the functional design noise study produced by Patching in October of 2018 (and updated May 26th, 2020 to correct a clerical error).

The detailed design noise study confirms the results of the functional plan, concluding that new noise attenuation is required only for the north facing homes on Valley Meadow Close NW that back onto the TUC.

The WCRR DB1 contractor, EllisDon Construction Services Inc. (EllisDon) and their designers will proceed with the construction plans of the required attenuation for our review and acceptance prior to implementation; we will also make arrangements with EllisDon and the Province to contact affected homeowners as necessary

Yours truly,

Jim Zagas, P L.(Eng)
Project Manager

JZ/lp

PATCHING ASSOCIATES
ACOUSTICAL ENGINEERING LTD

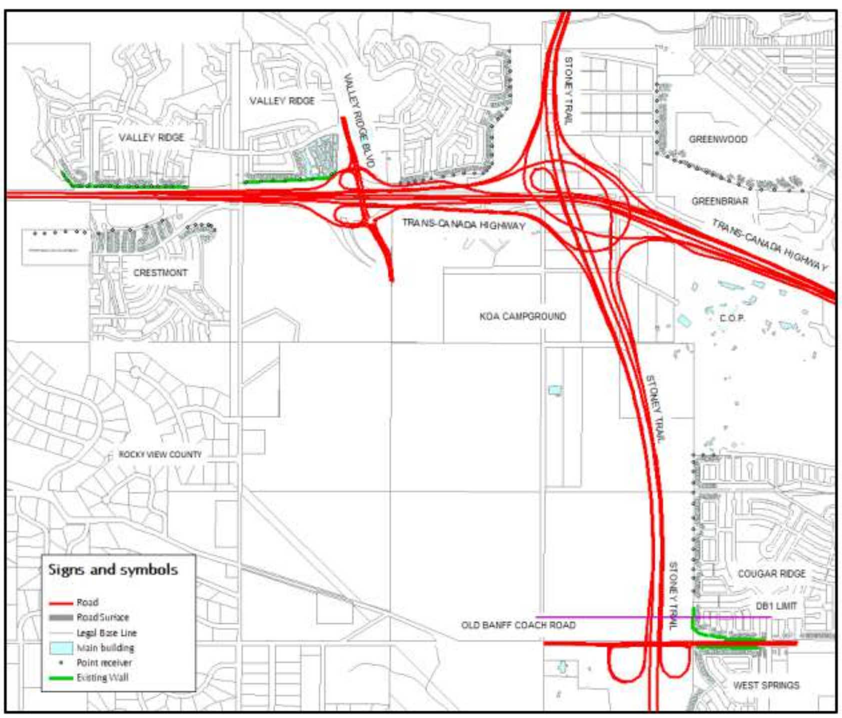
Noise Analysis Report
Detailed Design

Alberta Transportation
West Calgary Ring Road (WCRR DB1)
(TransCanada Hwy - Old Banff Coach Road)

Prepared for:
Jim Zagas, P.L. (Eng.).
Associated Engineering Alberta Ltd.

Prepared by:
Patching Associates Acoustical Engineering Ltd.
Consultants in Acoustics, Noise Control and Vibration

2020-05-27
Document ID: 5090-AT-WCRR-N-000-DD



Report Disclaimer

This report has been prepared based on the Ellis Don and AECOM Design Build Team's design of the West Calgary Ring Road for use by Alberta Transportation and Associated Engineering Alberta Ltd. (working on behalf of the Province).

Professional Notice

This report has been prepared by Patching Associates Acoustical Engineering Ltd (PAAE) in response to a specific request for service from, and for the exclusive use of, the Client to whom it is addressed. The findings contained in this report are based, in part, upon information provided by others. The information contained in this study is not intended for the use of, nor is it intended to be relied upon, by any person, firm, or corporation other than the Client to whom it is addressed, with the exception of the applicable regulating authority to whom this document may be submitted. PAAE accepts no liability or responsibility for any damages that may be suffered or incurred by any third party as a result of the use of, reliance on, or any decision made based on this report.

Professional Authentication

Project Role: Engineer of Record

Date: 2020-05-27
Patching Associates Acoustical Engineering Ltd. Permit to Practice: P05273
Title: Principal
Name: Neil Morozumi, P.Eng.

Prepared by:

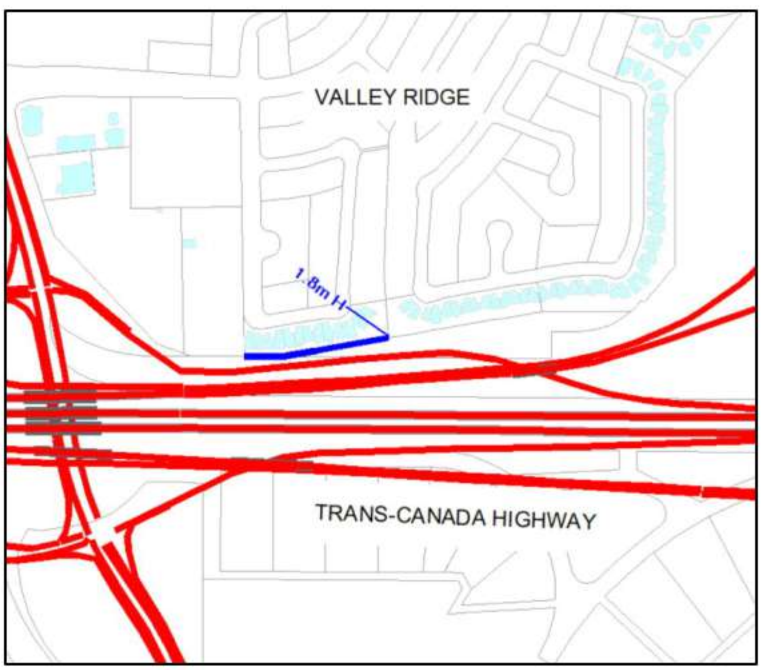
Analyst and Report Author: Sheying Sun, Ph.D.
Principal In Charge & Engineer of Record: Neil Morozumi, P.Eng.
Project Manager: Sharna Batey, BA (Hons.), CAPM.

Executive Summary

Associated Engineering Alberta Ltd. (the client) retained Patching Associates Acoustical Engineering Ltd. (PAAE) on behalf of Alberta Transportation (AT) to conduct an updated noise study for the West Calgary Ring Road (WCRR) roadway network north project (DB1) from the Trans-Canada Highway Interchange to north of Old Banff Coach Road Interchange (the subject roadways) based on the detailed road design by Ellis Don and AECOM for 2035 traffic horizon. This study was conducted in accordance with the requirements of the Alberta Transportation *Noise Attenuation Guidelines for Provincial Highways under Provincial Jurisdiction within Cities and Urban Areas* (the Guideline).

The purpose of this study is to determine the predicted noise levels, generated by the 2035-year horizon traffic volume projections on the subject roadways, for the existing (2020) first row residential developments adjacent to the roadways; and if required, the height of barrier needed to comply with the Guideline. This study also determines the 45.0 dBA L_{eq} (24 Hours) to 95.0 dBA L_{eq} (24 Hours) noise contours for the proposed roadways.

The modeled results indicate that the L_{eq} (24 Hours) noise levels without additional attenuation for the developments in the study area range from 43.1 to 65.4 dBA for the 2035-year horizon forecast. The majority of the predicted results are within the 65 dBA L_{eq} (24 Hour) noise target, except for a small area in the south end of the community of Valley Ridge, and additional attenuation is required for this area. The proposed noise barrier is shown in the figure below.



The table below gives a summary for each of the modified and proposed noise barrier. See Appendix C for drawings showing the barrier locations. See Appendix D for tables giving details on the barrier segments.

Table: Barrier Design Summary

Barrier Name	Status	Barrier Length (m)	Barrier Height (m)	Barrier Area (m^2)
Valley Ridge South	Proposed	168.83	1.8	303.89

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Introduction

Associated Engineering Alberta Ltd. (the client) retained Patching Associates Acoustical Engineering Ltd. (PAAE) on behalf of Alberta Transportation (AT) to conduct an updated noise study for the West Calgary Ring Road (WCRR) roadway network north project (DB1) from the Trans-Canada Highway Interchange to north of Old Banff Coach Road Interchange (the subject roadways) based on the detailed road design by Ellis Don and AECOM. This study was conducted in accordance with the requirements of the Alberta Transportation *Noise Attenuation Guidelines for Provincial Highways under Provincial Jurisdiction within Cities and Urban Areas* (the Guideline). See Appendix A for a glossary of terms used in the report.

The purpose of this study is to determine the predicted noise levels, generated by the 2035-year horizon traffic volume projections on the subject roadways, for the existing (2020) first row residential developments adjacent to the roadways; and if required, the height of barrier needed to comply with the Guideline. This study also determines the 45.0 dBA to 95.0 dBA L_{eq} (24 Hours) noise contours for the proposed roadways.

Study Area

The subject roadways which make up the West Calgary Ring Road (WCRR) north project (DB1), are located between the Trans-Canada Highway Interchange to Old Banff Coach Road Interchange. The crossing roads include Trans-Canada Highway and Old Banff Coach Road. The interchange of Trans-Canada Highway and Valley Ridge Blvd. was also included in noise study.

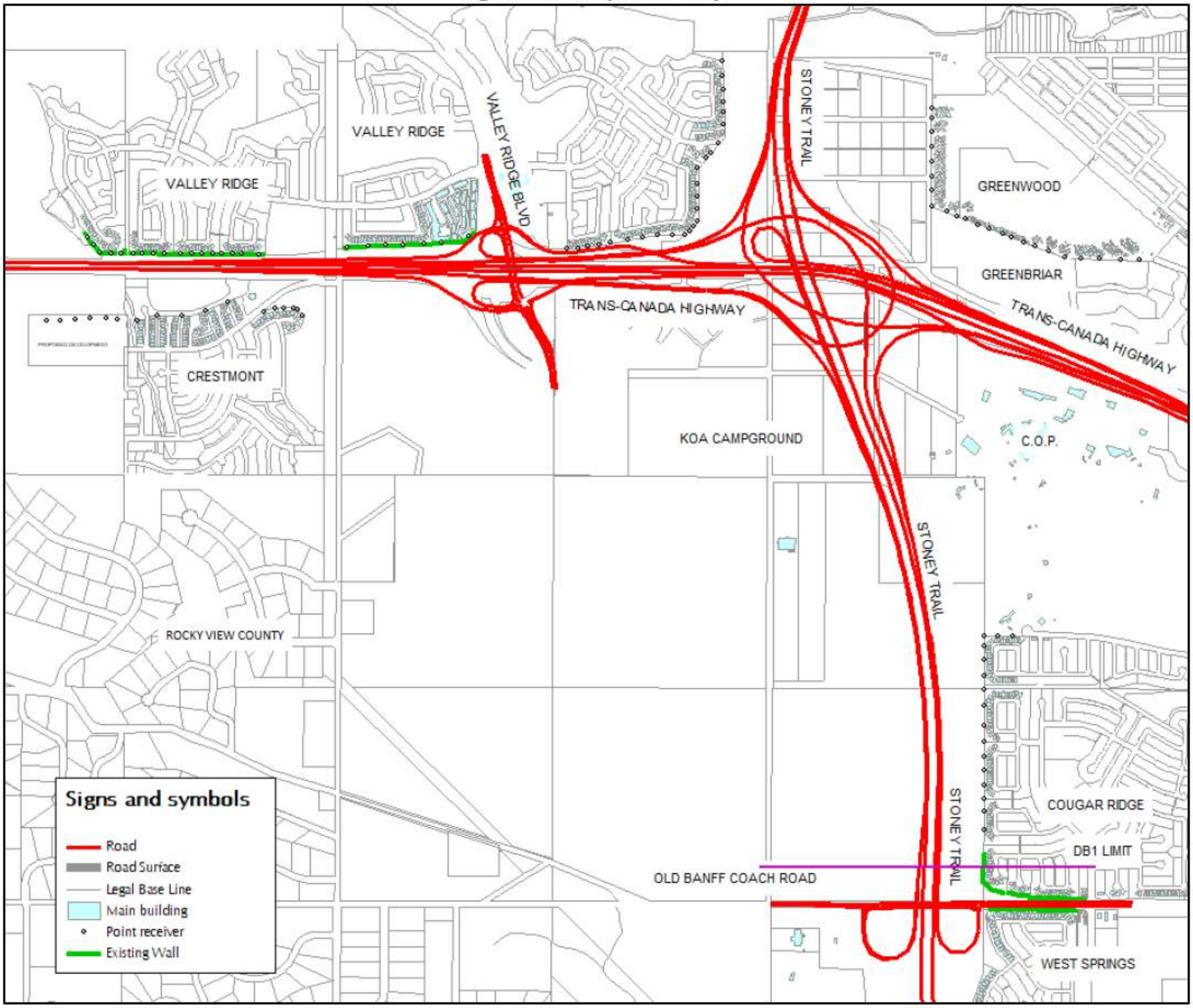
The study area includes the subject roadways, from Trans-Canada Highway to north of Old Banff Coach Road, and the first row residential developments adjacent to the subject roadways.

Receivers were modeled in a resident's yard at a location two metres inside the property line (away from the road right of way), at a height of 1.2 metres above the ground surface in this study.

There are existing noise barriers in the study area that have been considered in this assessment. There are also areas with existing, single panel wood fences along the property line of the housing adjacent to the subject roadways. Site visits have indicated that some of these fences have recognizable gaps or have deteriorated. Therefore, attenuation provided by existing single panel wood fences was not considered for this analysis.

Figure 1 shows a map of the study area. See Appendix C for more details.

Figure 1: Study Area Map



Noise Criteria

Sound is typically measured using the A-weighting scale and is commonly expressed as an L_{eq} value. The A-weighted equivalent-continuous sound level is the noise descriptor used in the Alberta Transportation Guideline. This index is an energy average of the varying sound level over a specified period. The use of this index permits the description of a varying sound level environment as a single number. As the L_{eq} is an "average" level, the measured sound level may exceed the criterion level, provided the duration is limited. The L_{eq} value considers both the sound level and the length of time that the sound level occurs. Appendix A provides a detailed explanation of the L_{eq} as well as other units and descriptors used in noise analysis.

The Alberta Transportation *Noise Attenuation Guidelines for Provincial Highways Under Provincial Jurisdiction within Cities and Urban Areas* (adopted 2002) specifies that a basic noise abatement threshold level of 65 dBA L_{eq} (24 Hours) may be received in a resident's yard at a location two metres inside the property line (away from the road right of way), at a height of 1.2 metres above the ground surface. Noise studies for Alberta Transportation are normally to be adjusted to the 10-year planning horizon.

For this study, PAAE was requested to examine the impact of traffic noise as per 2035 Year Horizon.

A copy of the Guideline document is found in Appendix F.

See Appendix A for a glossary of terms used in the report.

Method

The method used in the study follows the requirements set forth in the Alberta Transportation Noise Attenuation Guideline and follow the functional study (PAAE project: 5090-AT-WCRR-N-002) with the following noted differences;

- For this study, PAAE was requested to examine the impact of traffic noise based on the 2035-year volume projections.
- Traffic data provided by Associated Engineering gave the 2035-year horizon traffic volume projections and the classifications of vehicles. See Appendix B for the data.
- Geometry data based on the Ellis Don updated road design.

The modelling parameters used in this study are consistent with the functional study.

Results

Future Noise Level Predictions

Table 1 shows the range of predicted noise levels for the 2035-year horizon 24-hour periods with existing noise attenuation features. See Appendix C for drawings showing the receiver locations and tabled receiver results.

Table 1: Predicted L_{eq} (24Hr) Traffic Noise Levels for 2035
Existing Attenuation

Receiver Number	L_{eq} (24Hr) dBA	Receiver Number	L_{eq} (24Hr) dBA
Cougar Ridge Area	43.1-53.5	Valley Ridge Area	52.0-65.4
Crestmont Area	53.2-59.4	Greenwood Area (Including Receiver 9555 2 AV SW)	50.8-55.4

The modeled results indicate that the L_{eq} (24 Hours) noise levels without additional attenuation for the developments in the study area range from 43.1 to 65.4 dBA for the 2035-year horizon forecast in the WCRR north project study area. Most of the predicted results are within the 65 dBA L_{eq} (24 Hour) noise target except for a small area in the south edge of the community of Valley Ridge, and additional attenuation is required for this location.

Figures C01 to C03 in Appendix C depict the modeled receivers along with the existing attenuation and corresponding predicted noise levels. Figures C04 to C06 in Appendix C give a general depiction of the predicted noise levels adjacent to the upgraded roadway by plotting the locations of the 45.0 dBA to 95.0 dBA L_{eq} (24 Hours) noise contours at the 2035 Year horizon traffic forecast with the existing attenuation. Each figure also shows the location of the receivers, subdivisions and the subject roadways with existing attenuation or recommended attenuation.

Note: The contours are based on interpolation for a range of grid points. The predictions for individual locations are based on the specific data for each site and as such, the individual predicted levels should be taken as more accurate in the event of any discrepancies.

Future Conditions Sensitivity Analysis

As part of this noise study, a Sensitivity Analysis was performed to predict the noise impact of changing the parameters of traffic volume, traffic speed, and truck percentage on the subject roadways. The values of these parameters were increased and decreased to a reasonable amount given the possible error in long-term planning horizon, and the predicted results are listed in Table 2. The red and highlighted entries indicate receivers where the DNL is exceeded.

- The Traffic Volume Sensitivity Analysis predicted the impact of changing the current number of vehicles per day (VPD) to +/- 25%, as shown in Appendix E.
- The Traffic Speed Sensitivity Analysis predicted the impact of changing the current speed to +/- 10 km/h. as shown in Appendix E.
- The Truck Volume Sensitivity Analysis predicted the impact of changing the percentage of trucks, 25% increase (example: 25% of 10% trucks; with a min 1% total increase), or 25% decrease (min 1% total decrease) on all the subject roads, as shown in Appendix E .
- The Cumulative Sensitivity Analysis predicted the impact of increasing the traffic volume, speed, and truck percentages simultaneously, which is assumed traffic volumes 25% increase, speed 10 km/h increase, Truck percentage 25% increase (min 1% total increase); and traffic volumes 25% decrease, speed 10 km/h decrease, Truck percentage 25% decrease (min 1% total decrease) on all the subject roads, as shown in Appendix E.

See Appendix E for a sensitivity analysis, which predicts the impact of changing some of the parameters on the subject roadways.

Table 2: Sensitivity Analysis - Predicted L_{eq} (24Hr) Traffic for Year 2035

Change Type	Traffic Volume		Traffic Speed		Truck Percentage		Cumulative: -25% Vehicles -10 kph -25% Truck Percentage (dBA)	Cumulative: +25% Vehicles +10 kph +25% Truck Percentage (dBA)
	-25% (dBA)	+25% (dBA)	-10 kph (dBA)	+10 kph (dBA)	-25% (dBA)	+25% (dBA)		
Minimum change among all the receivers	-1.1	+0.9	-0.4	+0.4	-0.4	+0.3	-2.1	+1.8
Maximum change among all the receivers	-1.3	+1.1	-1.4	+1.2	-0.6	+0.6	-3.1	+2.5
Average change among all the receivers	-1.2	+1.0	-1.0	+0.9	-0.5	+0.4	-2.8	+2.3

The traffic volume analysis indicates that changing the traffic volume, the traffic speed, and the truck volume will change the levels to within +1.1 dBA and -1.3 dBA, to +1.2 dBA and -1.4 dBA, and to +0.6 dBA and -0.6 dBA of the current predicted levels, respectively.

The Cumulative Sensitivity Analysis indicates that simultaneous changes of the traffic volume, speed, and truck percentages will change the levels to within +2.5 dBA and -3.1 dBA of the current predicted levels. This suggests that the simultaneous changes of the traffic volume, speed, and truck percentages will produce a just noticeable impact at the receivers.

Proposed Attenuation Design

Adding some new barriers will be required to achieve the Guideline DNL for the south edge of the Valley Ridge community. Under the Guideline, noise barriers will be warranted at the 2035-year horizon traffic forecast. A minimum height of 1.8 metres (shown in Figure 2) was considered for the proposed barriers as the standard attenuation fence, as this is also the common height of a 'privacy' fence.

Schedule 18 states: "Noise attenuation shall be constructed at the locations shown in "*Noise Analysis Report – Alberta Transportation West Calgary Ring Road (WCRR) (TransCanada Hwy – Old Banff Coach Road),* Patching Associates Acoustical Engineering Ltd., October 2018"... Noise mitigation measures shall be a minimum height of 1.8m, measured from existing ground at the affected residence property line." This analysis confirms that a noise barrier is also warranted at the 2035 year horizon for the area of Valley Ridge (receivers 25, 25A, 25B).

Table 3 shows the predicted noise levels for the 2035-year horizon with existing and recommended noise attenuation features in this Valley Ridge area. See Appendix C for drawings showing the receiver locations.

Table 3: Predicted L_{eq} (24Hr) Traffic Noise Levels for 2035 Within in the Valley Ridge Area

Receiver Number	SPL with Existing Attenuation	SPL with Upgraded Attenuation
Valley Ridge 22	63.9	62.6
Valley Ridge 23	64.6	60.7
Valley Ridge 23A	64.3	60.0
Valley Ridge 24	64.7	61.2
Valley Ridge 24A	64.7	60.4
Valley Ridge 24B	64.9	60.5
Valley Ridge 25	65.4	62.3
Valley Ridge 25A	65.3	62.6
Valley Ridge 25B	65.4	62.7
Valley Ridge 26	64.9	62.6
Valley Ridge 22	63.9	62.6
Valley Ridge 23	64.6	60.7

Figure 2 Proposed Barrier Required

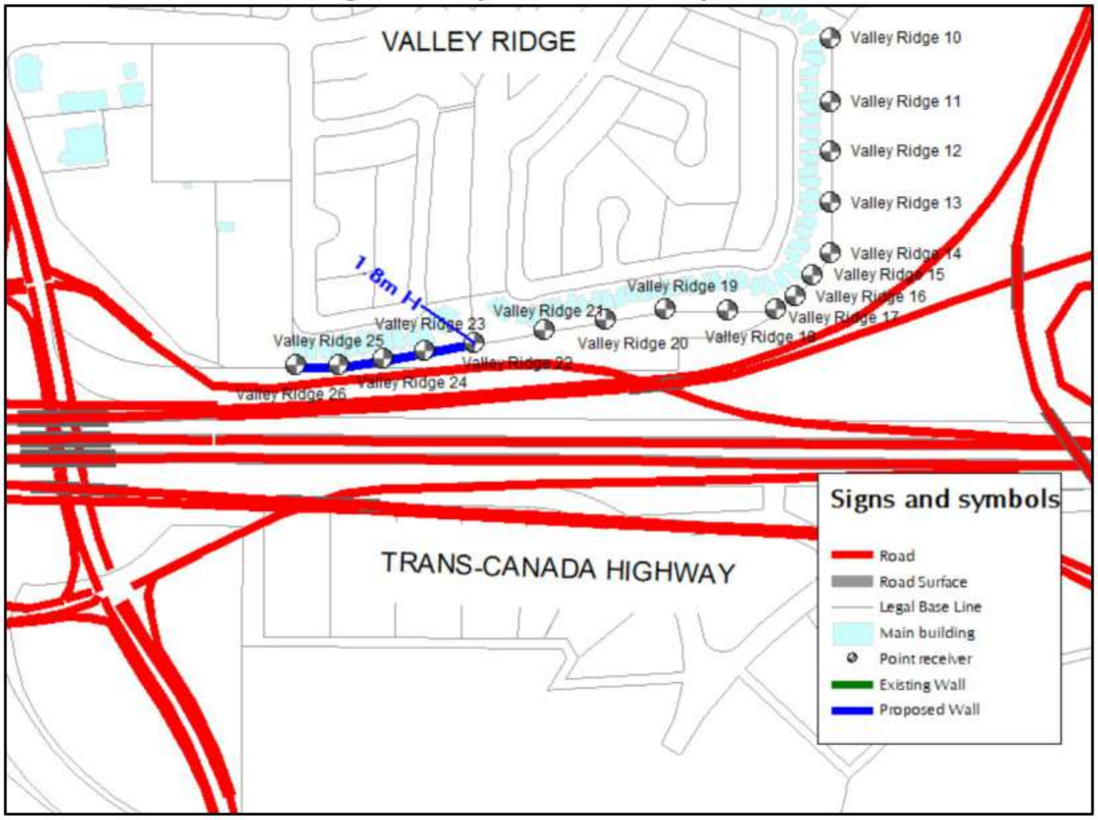


Table 4 gives a summary for the proposed noise barrier. See Appendix C for drawings showing the barrier locations. See Appendix D for tables giving details on the barrier segments.

Table 4: Barrier Design Summary (65 dBA Leq (24Hr)

Barrier Name	Status	Barrier Length (m)	Barrier Height (m)	Barrier Area (m^2)
Valley Ridge South	Proposed	168.83	1.8	303.89

Figure C04 in Appendix C also gives a general depiction of the predicted noise levels adjacent to the upgraded roadway by plotting the locations of the 45.0 dBA to 95.0 dBA L_{eq} (24 Hours) noise contours at the 2035 Year horizon traffic forecast with upgraded attenuation in this area.

Conclusion

Associated Engineering Alberta Ltd. retained Patching Associates Acoustical Engineering Ltd. on behalf of Alberta Transportation to conduct a noise study for the West Calgary Ring Road roadway network north project (DB1) from the TransCanada Hwy Interchange to north of Old Banff Coach Road Interchange based on the detailed road design by Ellis Don and AECOM. This study was conducted in accordance with the requirements of the Alberta Transportation guideline.

The modeled results indicate that the L_{eq} (24 Hours) noise levels without additional attenuation for the developments in the study area range from 43.1 to 65.4 dBA for the 2035-year horizon forecast. The majority of the predicted results are within the 65 dBA L_{eq} (24 Hour) noise target except for a small area in the south edge of the community of Valley Ridge, and additional attenuation is required for this area.

See Appendix D for details on the proposed barrier design.

The results of the sensitivity analysis indicate that a change traffic volume, traffic speed and truck percentage will not produce a significant impact respectively; but that a simultaneous change of the traffic volume, speed, and truck percentages will produce a noticeable impact at the receivers.

See Appendix G for general technical details on sound levels and analysis.

Appendix A: Glossary

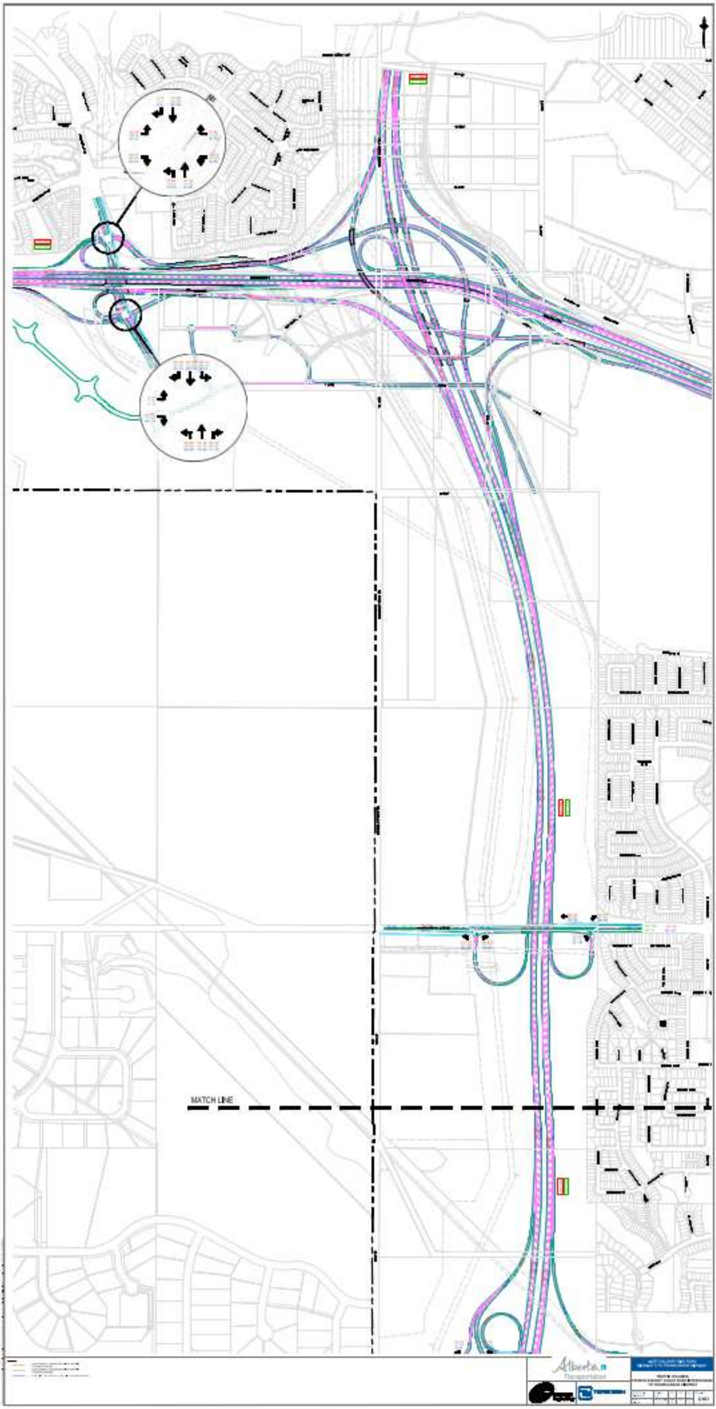
Table A: Glossary

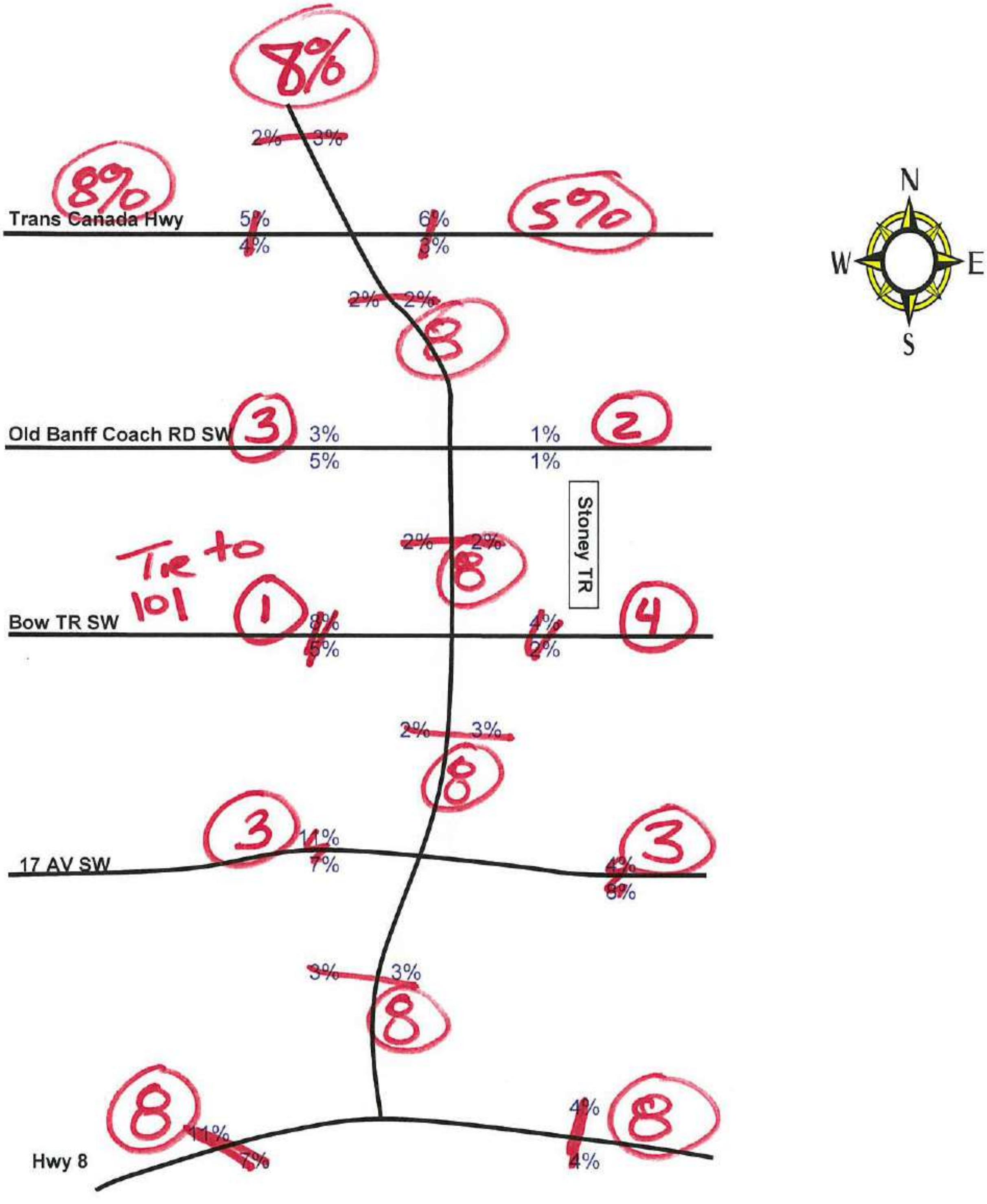
Term	Description
Automobiles	All vehicles with two axles and four tires -- primarily designed to carry nine or fewer people (passenger cars, vans) or cargo (vans, light trucks) -- generally with gross vehicle weight less than 4,500 kg (9,900 lb)
Average Annual Daily Traffic (AADT)	The total volume of vehicle traffic of a highway or road for a year divided by 365 days. This parameter is generally used to quantify the business of the road.
A-weighted sound level (dBA)	The sound level as measured on a sound level meter using a setting that emphasizes the middle frequency components similar to the frequency response of the human ear at levels typical of rural backgrounds in mid frequencies.
Daytime	Defined as the hours from 07:00 to 22:00 on the same days on weekdays, or 09:00 to 22:00 on the same days on a weekend.
Decibel (dB)	A logarithmic unit used to express here a sound level.
Dense-Graded Asphaltic Concrete (DGAC)	A composite material commonly used to surface roads, parking lots. Because of its coarse texture, it typically generates less noise at the tire-road interface than the PCC (Portland Cement Concrete) type pavement. According to FHWA policy, the recommended pavement type is the average of DGAC and PCC.
Design Noise Level (DNL)	A target noise level which value is deemed acceptable in residential areas.
Energy equivalent sound level (L_{eq})	The average weighted sound level over a specified period of time. It is a single-number representation of the cumulative acoustical energy measured over a time interval. The time interval used should be specified in brackets following the Leq—e.g., Leq (24) is a 24-hour average equivalent sound level. If a sound level is constant over the measurement period, the L_{eq} will equal the constant sound level.
Federal Highway Administration's Traffic Noise Model (FHWA TNM)	A methodology comprised of acoustic algorithms and computer architecture, for noise prediction, and barrier analysis and design.
Heavy Trucks	All cargo vehicles with three or more axles -- generally with gross vehicle weight more than 12,000 kg (26,400 lb).
Medium Trucks	All cargo vehicles with two axles and six tires -- generally with gross vehicle weight between 4,500 kg (9,900 lb) and 12,000 kg (26,400 lb).
Nighttime	Defined as the hours from 22:00 to 07:00 of the following day if the following day is a weekday, or from 22:00 to 09:00 of the following day if the following day is a weekend.
Noise	Generally associated with the unwanted portion of sound.
Noise Barrier	See the webpage below for guidelines on how to design a highway noise barrier that fits with its surroundings and performs its intended acoustical and structural functions: www.fhwa.dot.gov/environment/noise/noise_barriers
Non-truck routes	The City of Calgary designated roads where truck access are not allowed. For the City of Calgary, it means a highway so designated in Schedule "A" to the Bylaw Number 60M90. Some truck routes are restricted by time of day or by number of axles.
Outdoor Leisure Area for Standard Lot	A yard, patio or common area allocated outside a multi-residential building
Outdoor Leisure Area for Walkout Lot	A rear deck that is at the same elevation as the main floor
Portland Cement Concrete (PCC)	The most common type of cement in general use around the world as a basic ingredient of concrete, mortar, stucco, and non-specialty grout. It usually generates more noise than the DGAC type pavement.
Privacy fence	A residential fence designed to block the view to the residence but not to attenuation the sound.
Receiver	Point of reception for which the SPL is determined and compared with the Design Noise Level (DNL).
Sensitivity Analysis	A secondary analysis designed to predict the noise impact of changing calculation parameters given the possible error in long-term planning horizon. Such parameters include traffic volume, traffic speed, and truck percentage on the subject roadways.

Table A: Glossary

Term	Description
Sound Power Level (PWL)	The decibel equivalent of the rate of energy (or power) emitted in the form of noise. The sound power level is given by: $PWL = 10 \times LOG_{10}\left(\frac{Sound\ as\ Power}{W_0}\right)$ where $W_0 = 10^{-12}$ watts (or 1 pW)
Sound Pressure Level (SPL)	The decibel equivalent of the pressure of sound waves at a specific location, which is measured with a microphone. The sound pressure level is given by: $SPL = 10 \times LOG_{10}\left(\frac{Sound\ as\ Pressure}{P_0}\right)$ where $P_0 = 2 \times 10^{-5}$ Pa (or 20 µPa)
Subject roadways	The roads which noise emissions are being assessed.
Truck-type vehicle	A vehicle or a group of attached vehicles, which shall be considered a single vehicle, intended for the conveyance of goods or materials of any kind and includes: (i) any assemblage of truck tractor and trailer; and (ii) mobile equipment of any kind.
Trucks	Trucks are defined as (i) A truck-type vehicle with a maximum weight in excess of 5,450 kilograms (ii) Any self-propelled vehicle, excluding buses and school buses, with a maximum weight in excess of 5,450 kilograms (iii) A tractor, grader, road building or road maintenance equipment or construction equipment (other than truck-type vehicles) regardless of weight (iv) A “school bus” by definition, only qualifies as a school bus, as long as it is actively engaged in the transport of pupils or for authorized school-related activities. Once the bus is no longer being operated in this manner (i.e. carrying passengers or completing the trip to/from the destination), it ceases to operate as a ”school bus” and is therefore subject to all the restrictions otherwise placed on trucks or truck-type vehicles. School buses are categorized as trucks when parked unless they are parked at a school, or a school-related destination, between the hours of 5 a.m. and 5 p.m., school days

Appendix B: Traffic Forecast


MATCH LINE
Transportation



8%
2% 3%
8%
Trans Canada Hwy
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6% 3%
5%
2% 2%
8
Old Banff Coach RD SW
3
3% 5%
1% 1%
2
Stoney TR
2% 2%
8
Tr to 101
Bow TR SW
1
8% 5%
4% 2%
4
2% 3%
8
17 AV SW
3
11% 7%
4% 8%
3
3% 3%
8
Hwy 8
8
11% 7%
4% 4%
8
N
W
E
S

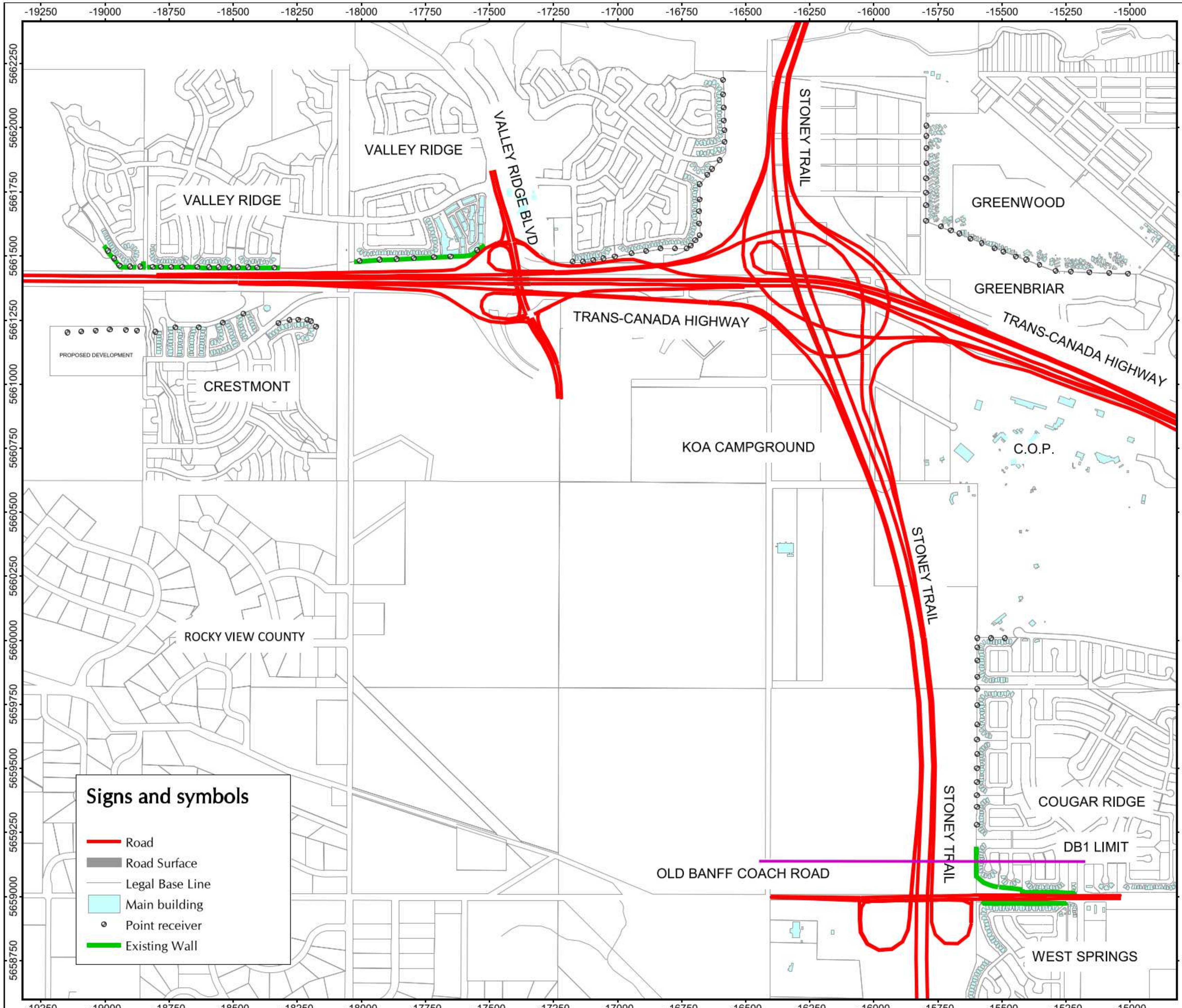
Appendix C: Study Area and Noise Results

Table C: Predicted L_{eq} (24Hr) Traffic Noise Levels for 2035
Existing Attenuation

Receiver Number	L_{eq} (24Hr) dBA	Receiver Number	L_{eq} (24Hr) dBA
Cougar Ridge 01	43.1	Valley Ridge 1	55.1
Cougar Ridge 02	52.7	Valley Ridge 2	56.0
Cougar Ridge 03	53.5	Valley Ridge 3	56.8
Cougar Ridge 04	50.2	Valley Ridge 4	56.9
Cougar Ridge 05	47.9	Valley Ridge 5	57.6
Cougar Ridge 06	49.2	Valley Ridge 6	57.1
Cougar Ridge 07	47.7	Valley Ridge 7	57.7
Cougar Ridge 08	46.7	Valley Ridge 8	59.2
Cougar Ridge 09	45.7	Valley Ridge 9	58.2
Cougar Ridge 10	45.3	Valley Ridge 10	57.4
Cougar Ridge 11	47.5	Valley Ridge 11	58.3
Cougar Ridge 12	47.5	Valley Ridge 12	58.3
Cougar Ridge 13	48.4	Valley Ridge 13	58.6
Cougar Ridge 14	48.6	Valley Ridge 14	59.6
Cougar Ridge 15	49.1	Valley Ridge 15	60.8
Cougar Ridge 16	53.1	Valley Ridge 16	62.4
Crestmont 1	54.1	Valley Ridge 17	61.7
Crestmont 2	55.1	Valley Ridge 18	62.0
Crestmont 3	54.5	Valley Ridge 19	62.2
Crestmont 4	54.9	Valley Ridge 20	62.1
Crestmont 5	55.6	Valley Ridge 21	62.7
Crestmont 6	59.4	Valley Ridge 22	63.9
Crestmont 7	53.2	Valley Ridge 23	64.6
Crestmont 8	57.7	Valley Ridge 23A	64.3
Crestmont 9	58.8	Valley Ridge 24	64.7
Crestmont 10	59.0	Valley Ridge 24A	64.7
Crestmont 11	57.6	Valley Ridge 24B	64.9
Crestmont 12	55.2	Valley Ridge 25	65.4
Crestmont W1	55.0	Valley Ridge 25A	65.3
Crestmont W2	55.6	Valley Ridge 25B	65.4
Crestmont W3	55.5	Valley Ridge 26	64.9
Crestmont W4	57.9	Valley Ridge 27	54.5
Crestmont W5	57.2	Valley Ridge 28	58.9
Crestmont W6	55.9	Valley Ridge 29	57.1
Greenwood 1	50.8	Valley Ridge 30	56.2
Greenwood 2	52.5	Valley Ridge 31	56.0
Greenwood 3	53.3	Valley Ridge 32	55.9
Greenwood 4	53.0	Valley Ridge 33	55.7
Greenwood 5	52.9	Valley Ridge 34	57.5
Greenwood 6	53.7	Valley Ridge 35	60.8
Greenwood 7	54.4	Valley Ridge 36	60.2

Table C: Predicted L_{eq} (24Hr) Traffic Noise Levels for 2035
Existing Attenuation

Receiver Number	L_{eq} (24Hr) dBA	Receiver Number	L_{eq} (24Hr) dBA
Greenwood 8	55.4	Valley Ridge 37	60.8
Greenwood 9	53.5	Valley Ridge 38	59.6
Greenwood 10	54.3	Valley Ridge 39	60.0
Greenwood 11	52.5	Valley Ridge 40	59.6
Greenwood 12	52.2	Valley Ridge 41	58.7
Greenwood 13	53.8	Valley Ridge 42	58.9
Greenwood 14	53.6	Valley Ridge 43	60.4
Greenwood 15	54.3	Valley Ridge 44	58.9
Greenwood 16	54.0	Valley Ridge 45	59.4
Greenwood 17	54.5	Valley Ridge 46	54.3
Greenwood 18	54.1	Valley Ridge 47	56.0
Greenwood 19	54.3	Valley Ridge 48	54.3
Greenwood 20	54.1	Valley Ridge 49	53.0
Greenwood 21	53.6	Valley Ridge 50	52.0
Greenwood 22	53.6		
Greenwood 23	52.6		
Receiver 9555 2 AV SW	51.6		



Customer:
Associated Engineering/Alberta Transportation
Project: Associated AT WCRR Rev DB1 Review
Project-No. 2018-5090

WCRR DB1 Noise Study

Traffic Horizon: 2035

Figure C00
Study Area DB1

Noise Criteria

Alberta Transportation Noise Limit:
Leq_{24}: 65 dBA

Signs and symbols

- Road
- Road Surface
- Legal Base Line
- Main building
- Point receiver
- Existing Wall

Length scale 1:14300

0 50 100 200 300 400 m

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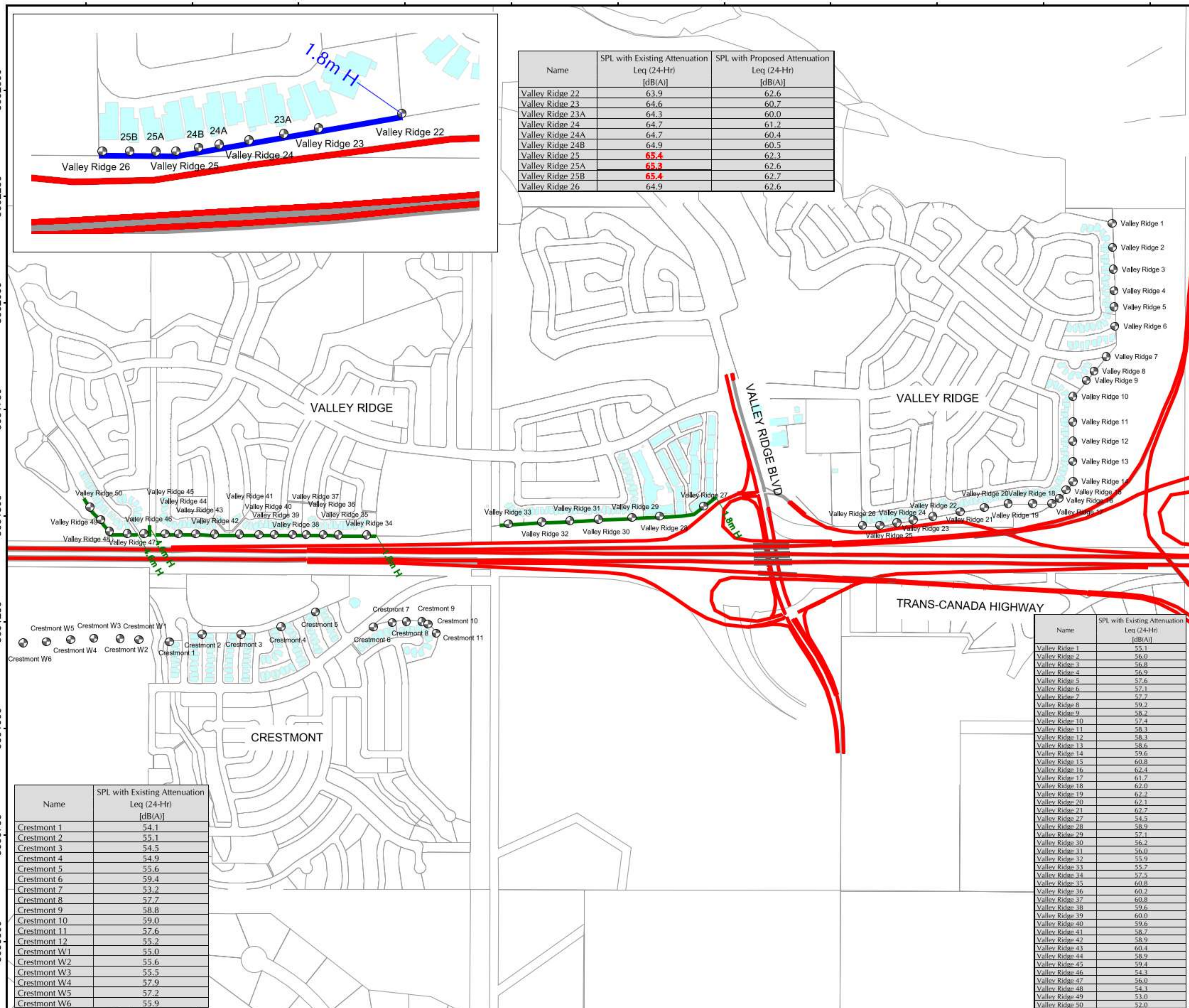

Name	SPL with Existing Attenuation Leq (24-Hr) [dB(A)]	SPL with Proposed Attenuation Leq (24-Hr) [dB(A)]
Valley Ridge 22	63.9	62.6
Valley Ridge 23	64.6	60.7
Valley Ridge 23A	64.3	60.0
Valley Ridge 24	64.7	61.2
Valley Ridge 24A	64.7	60.4
Valley Ridge 24B	64.9	60.5
Valley Ridge 25	65.4	62.3
Valley Ridge 25A	65.3	62.6
Valley Ridge 25B	65.4	62.7
Valley Ridge 26	64.9	62.6

Name	SPL with Existing Attenuation Leq (24-Hr) [dB(A)]
Valley Ridge 1	55.1
Valley Ridge 2	56.0
Valley Ridge 3	56.8
Valley Ridge 4	56.9
Valley Ridge 5	57.6
Valley Ridge 6	57.1
Valley Ridge 7	57.7
Valley Ridge 8	59.2
Valley Ridge 9	58.2
Valley Ridge 10	57.4
Valley Ridge 11	58.3
Valley Ridge 12	58.3
Valley Ridge 13	58.6
Valley Ridge 14	59.6
Valley Ridge 15	60.8
Valley Ridge 16	62.4
Valley Ridge 17	61.7
Valley Ridge 18	62.0
Valley Ridge 19	62.2
Valley Ridge 20	62.1
Valley Ridge 21	62.7
Valley Ridge 27	54.5
Valley Ridge 28	58.9
Valley Ridge 29	57.1
Valley Ridge 30	56.2
Valley Ridge 31	56.0
Valley Ridge 32	55.9
Valley Ridge 33	55.7
Valley Ridge 34	57.5
Valley Ridge 35	60.8
Valley Ridge 36	60.2
Valley Ridge 37	60.8
Valley Ridge 38	59.6
Valley Ridge 39	60.0
Valley Ridge 40	59.6
Valley Ridge 41	58.7
Valley Ridge 42	58.9
Valley Ridge 43	60.4
Valley Ridge 44	58.9
Valley Ridge 45	59.4
Valley Ridge 46	54.3
Valley Ridge 47	56.0
Valley Ridge 48	54.3
Valley Ridge 49	53.0
Valley Ridge 50	52.0

Name	SPL with Existing Attenuation Leq (24-Hr) [dB(A)]
Crestmont 1	54.1
Crestmont 2	55.1
Crestmont 3	54.5
Crestmont 4	54.9
Crestmont 5	55.6
Crestmont 6	59.4
Crestmont 7	53.2
Crestmont 8	57.7
Crestmont 9	58.8
Crestmont 10	59.0
Crestmont 11	57.6
Crestmont 12	55.2
Crestmont W1	55.0
Crestmont W2	55.6
Crestmont W3	55.5
Crestmont W4	57.9
Crestmont W5	57.2
Crestmont W6	55.9

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WCRR DB1 Noise Study

Traffic Horizon: 2035

Figure C01
Predicted Noise Levels
Valley Ridge and Crestmont Areas

Noise Criteria

Alberta Transportation Noise Limit:
Leq_{24}: 65 dBA

Signs and symbols

- Road
- Road Surface
- Legal Base Line
- Main building
- Point receiver
- Existing Wall
- Proposed Wall

Length scale 1:8901

0 50 100 200 300 400 m

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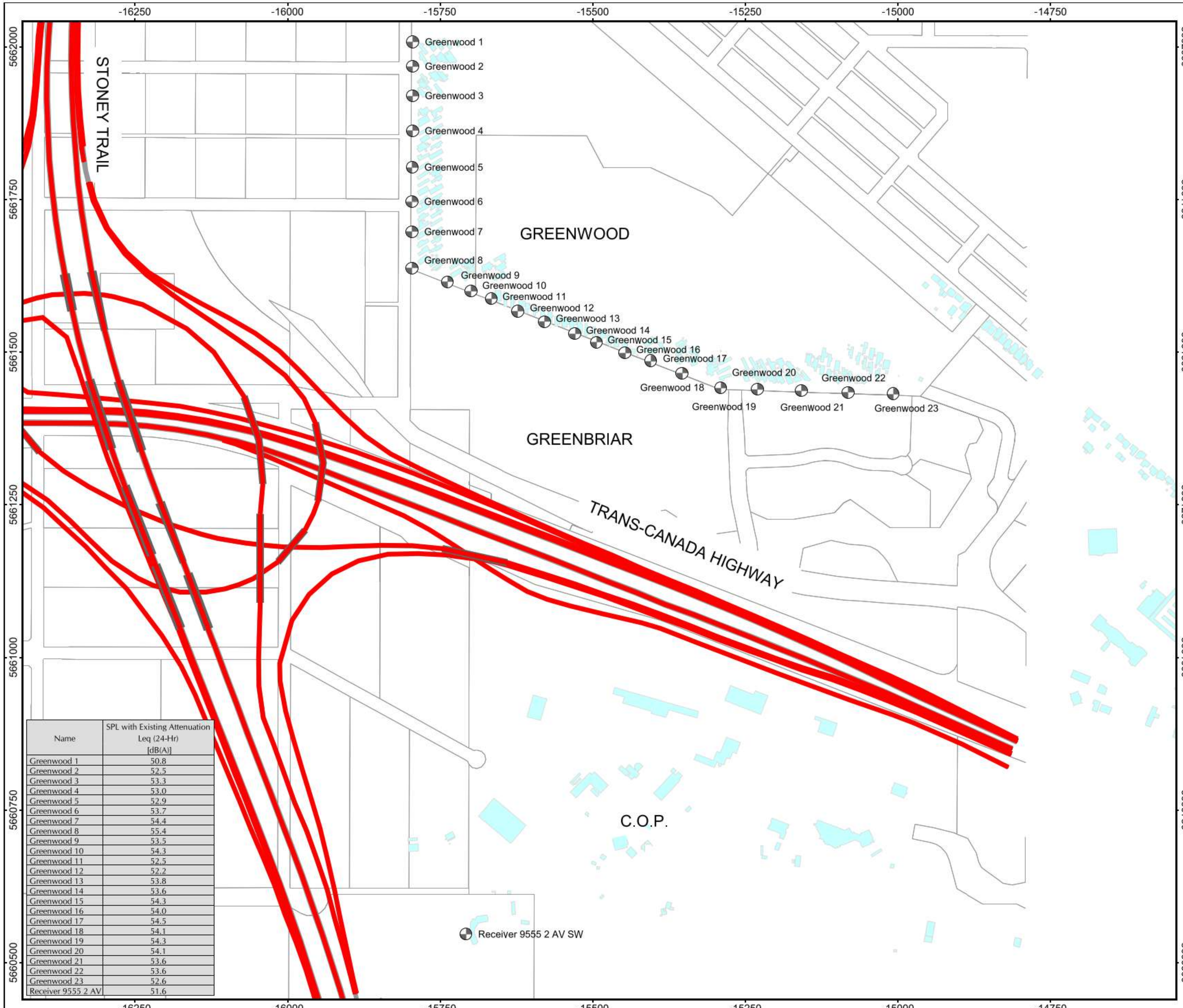

Name	SPL with Existing Attenuation Leq (24-Hr) [dB(A)]
Greenwood 1	50.8
Greenwood 2	52.5
Greenwood 3	53.3
Greenwood 4	53.0
Greenwood 5	52.9
Greenwood 6	53.7
Greenwood 7	54.4
Greenwood 8	55.4
Greenwood 9	53.5
Greenwood 10	54.3
Greenwood 11	52.5
Greenwood 12	52.2
Greenwood 13	53.8
Greenwood 14	53.6
Greenwood 15	54.3
Greenwood 16	54.0
Greenwood 17	54.5
Greenwood 18	54.1
Greenwood 19	54.3
Greenwood 20	54.1
Greenwood 21	53.6
Greenwood 22	53.6
Greenwood 23	52.6
Receiver 9555 2 AV	51.6

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WCRR DB1 Noise Study

Traffic Horizon: 2035

Figure C02
Predicted Noise Levels
Greenwood and COP Areas

Noise Criteria

Alberta Transportation Noise Limit:
Leq_{24}: 65 dBA

Signs and symbols

- Road
- Road Surface
- Legal Base Line
- Main building
- Point receiver

N

Length scale 1:6000

0 40 80 160 240

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WCRR DB1 Noise Study

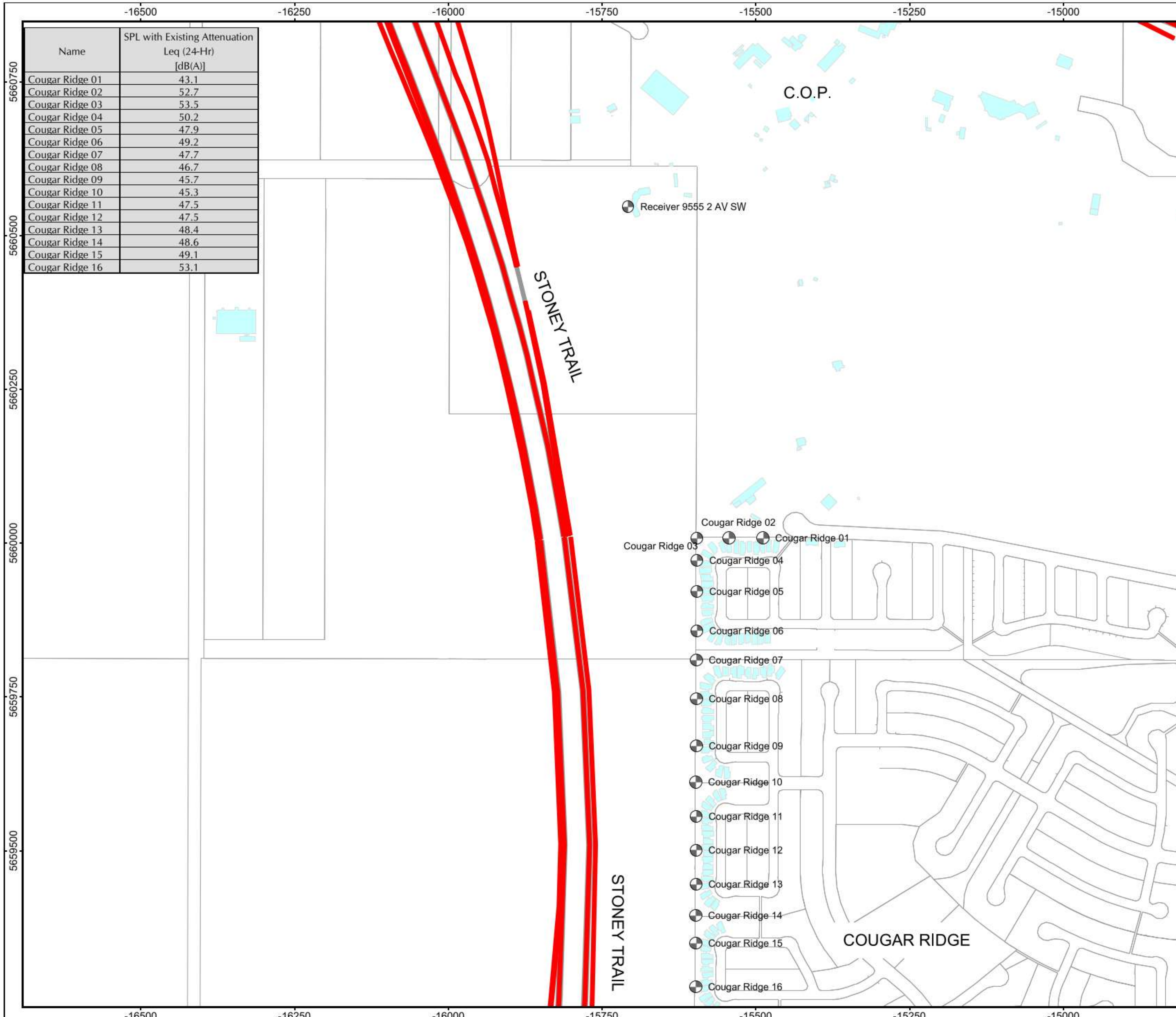
Traffic Horizon: 2035

Figure C03
Predicted Noise Levels
Cougar Ridge and West Springs Areas

Noise Criteria

Alberta Transportation Noise Limit:
Leq_{24}: 65 dBA

Name	SPL with Existing Attenuation Leq (24-Hr) [dB(A)]
Cougar Ridge 01	43.1
Cougar Ridge 02	52.7
Cougar Ridge 03	53.5
Cougar Ridge 04	50.2
Cougar Ridge 05	47.9
Cougar Ridge 06	49.2
Cougar Ridge 07	47.7
Cougar Ridge 08	46.7
Cougar Ridge 09	45.7
Cougar Ridge 10	45.3
Cougar Ridge 11	47.5
Cougar Ridge 12	47.5
Cougar Ridge 13	48.4
Cougar Ridge 14	48.6
Cougar Ridge 15	49.1
Cougar Ridge 16	53.1



Signs and symbols

- Road
- Road Surface
- Legal Base Line
- Main building
- Point receiver
- Existing Wall

Length scale 1:6000
0 35 70 140 210 280 m

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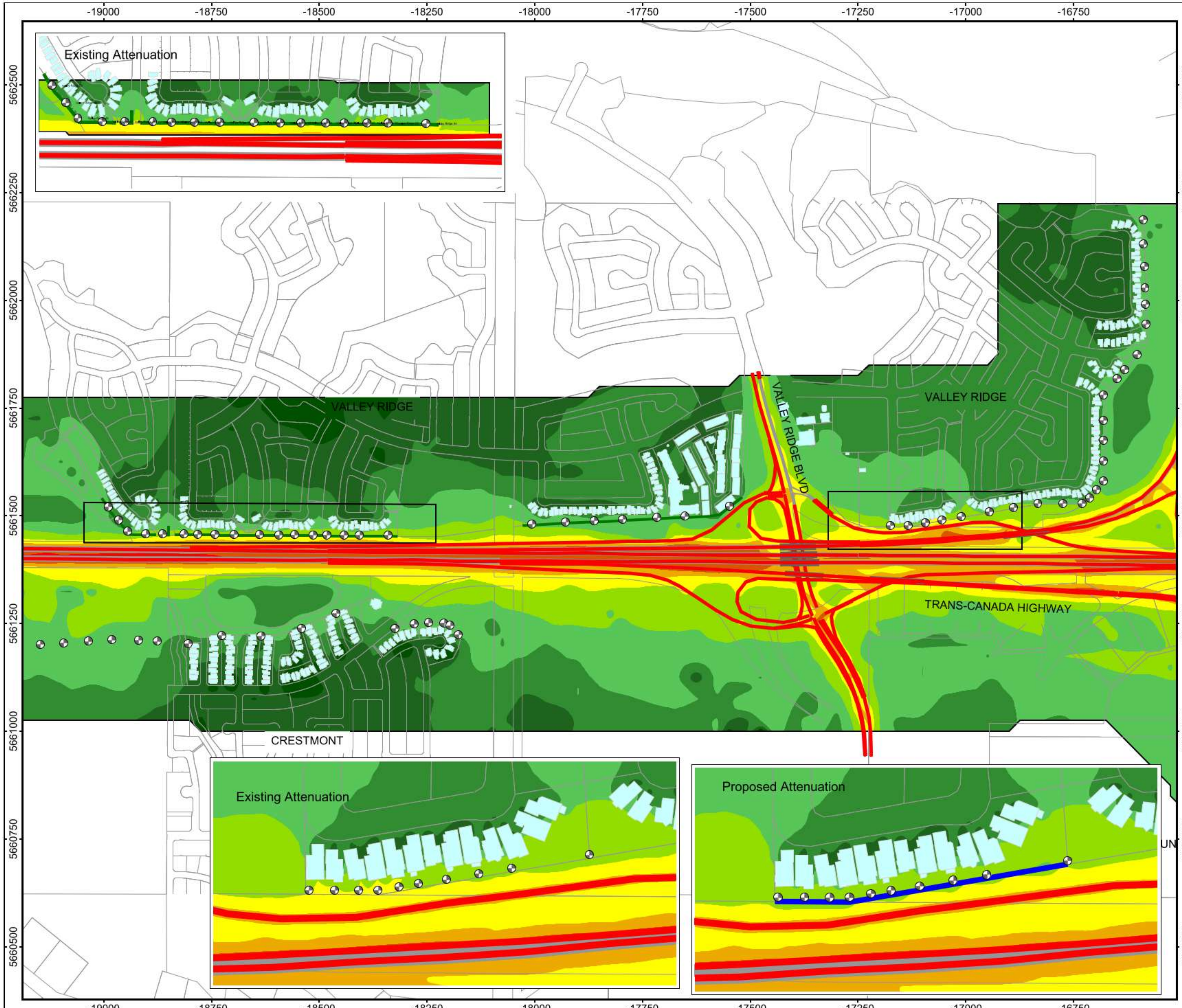

Customer:
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Project-No. 2018-5090

WCRR DB1 Noise Study

Traffic Horizon: 2035

Figure C04
Predicted Noise Contours
Valley Ridge and Crestmont Areas

Noise Criteria

Alberta Transportation Noise Limit:
Leq_{24}: 65 dBA

Signs and symbols

- Road
- Road Surface
- Legal Base Line
- Main building
- Point receiver
- Existing Wall
- Proposed Wall

Sound Levels
in dB(A)

<= 45.0
45.0 - 50.0
50.0 - 55.0
55.0 - 60.0
60.0 - 65.0
65.0 - 70.0
70.0 - 75.0
75.0 - 80.0
80.0 - 85.0
85.0 - 90.0
90.0 - 95.0
> 95.0

N

Length scale 1:8500
0 50 100 200 300 400 m

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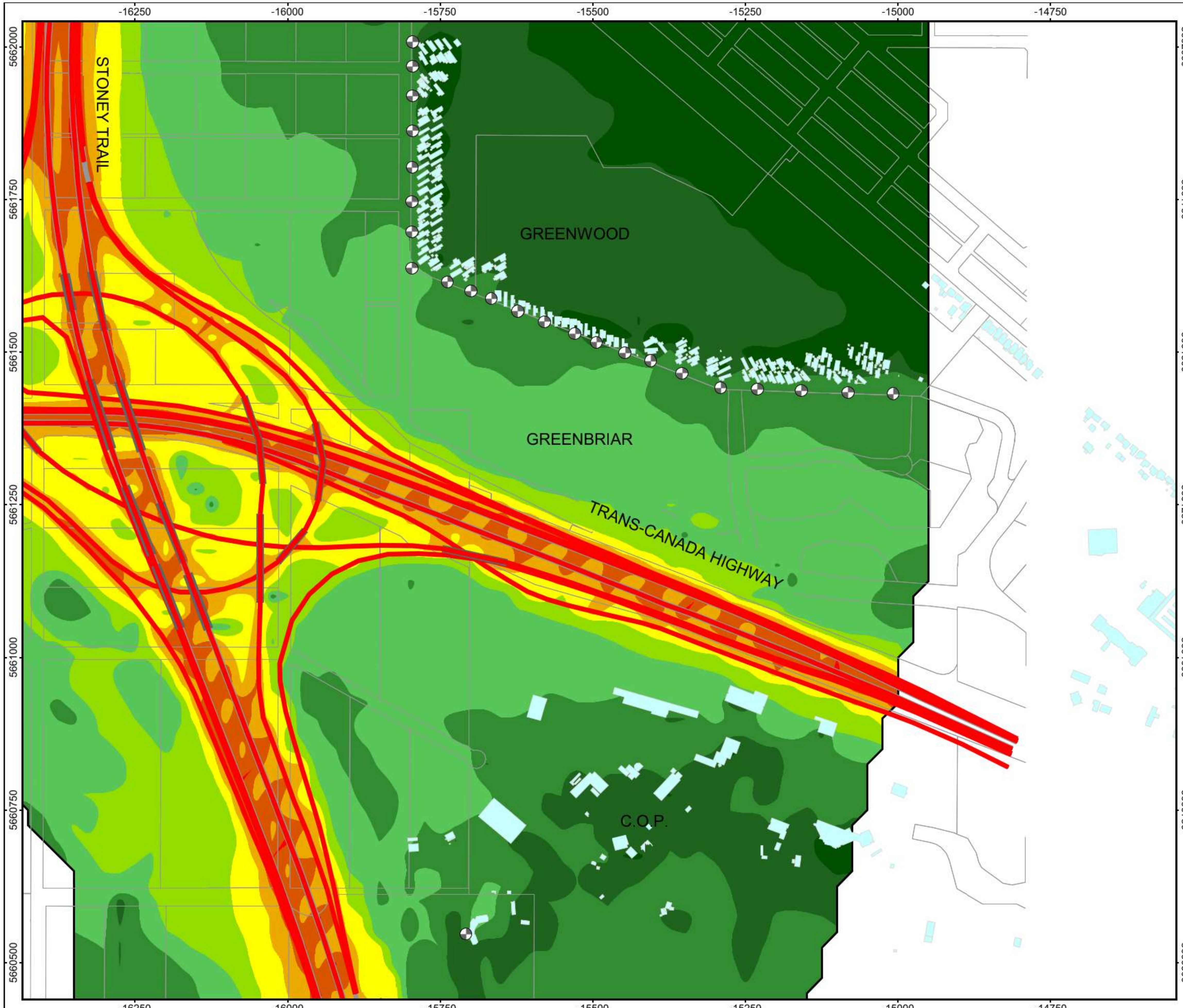
WCRR DB1 Noise Study

Traffic Horizon: 2035

Figure C05
Predicted Noise Contours
Greenwood and COP Areas



Noise Criteria

Alberta Transportation Noise Limit:
Leq_{24}: 65 dBA

Signs and symbols

- Road
- Road Surface
- Legal Base Line
- Main building
- Point receiver

Sound Levels
in dB(A)

<= 45.0
45.0 - 50.0
50.0 - 55.0
55.0 - 60.0
60.0 - 65.0
65.0 - 70.0
70.0 - 75.0
75.0 - 80.0
80.0 - 85.0
85.0 - 90.0
90.0 - 95.0
> 95.0

N

Length scale 1:6000
0 40 80 160 240

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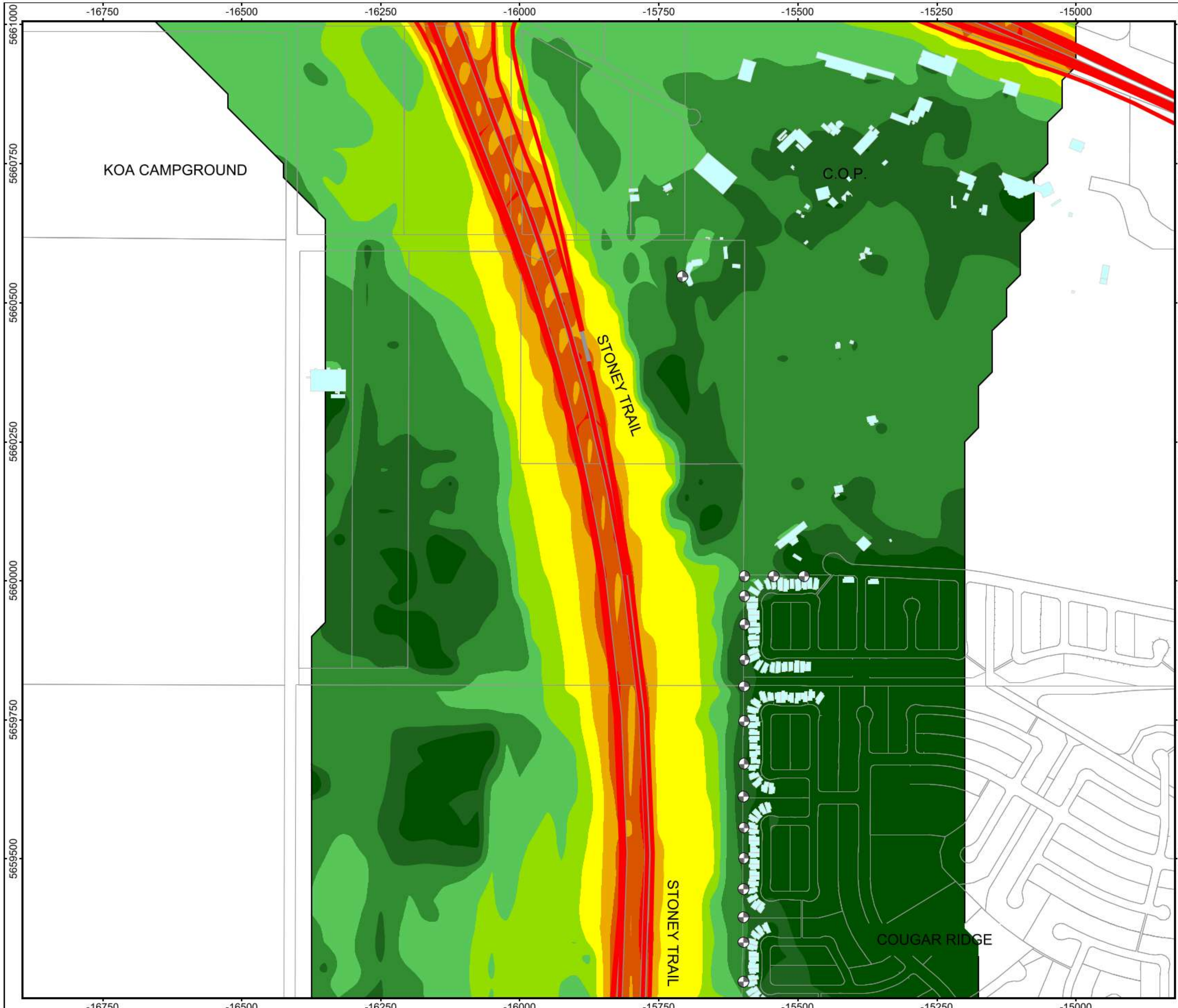

Customer:
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Project: Associated AT WCRR Rev DB1 Review
Project-No. 2018-5090

WCRR DB1 Noise Study

Traffic Horizon: 2035

Figure C06
Predicted Noise Contours
Cougar Ridge and West Springs Areas

Noise Criteria

Alberta Transportation Noise Limit:
Leq_{24}: 65 dBA

Signs and symbols

- Road
- Road Surface
- Legal Base Line
- Main building
- Point receiver
- Existing Wall

Sound Levels
in dB(A)

<=	45.0
45.0 -	50.0
50.0 -	55.0
55.0 -	60.0
60.0 -	65.0
65.0 -	70.0
70.0 -	75.0
75.0 -	80.0
80.0 -	85.0
85.0 -	90.0
90.0 -	95.0
>	95.0

N

Length scale 1:6580

0 40 80 160 240 320 m

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Appendix D: Barrier Segment Details

Table D below gives the segment details of all the barriers in the study area. Geodetic coordinates are shown as no station numbers were provided.

Table D: Barrier Design Segment Details

Barrier Name	Type	X	Y	Base Elevation	Height	Top Elevation
Valley Ridge S	Proposed	-17009.92	5661496.0	1130.0	1.8	1131.8
		-17055.16	5661488.0	1130.0	1.8	1131.8
		-17093.8	5661482.0	1131.0	1.8	1132.8
		-17134.22	5661475.0	1132.0	1.8	1133.8
		-17176.86	5661475.0	1133.0	1.8	1134.8
Valley Ridge Barrier 1	Existing	-17519.00	5661543.03	1133.13	1.8	1134.93
		-17571.00	5661503.02	1135.90	1.8	1137.70
		-17600.00	5661498.98	1137.16	1.8	1138.96
		-17640.00	5661497.00	1139.79	1.8	1141.59
		-17684.00	5661495.02	1142.40	1.8	1144.20
		-17737.00	5661491.97	1143.38	1.8	1145.18
		-17785.00	5661489.99	1143.42	1.8	1145.22
		-17834.00	5661487.02	1144.49	1.8	1146.29
		-17884.00	5661485.04	1147.16	1.8	1148.96
		-17933.00	5661482.98	1149.35	1.8	1151.15
		-17983.00	5661480.01	1151.99	1.8	1153.79
		-18007.00	5661478.52	1154.09	1.8	1155.89
		-18031.00	5661477.04	1156.63	1.8	1158.43
		-18060.75	5661473.07	1159.63	1.8	1161.43
		-18090.50	5661469.10	1160.60	1.8	1162.40
		-18118.35	5661465.31	1160.86	1.8	1162.66
		-18146.19	5661461.52	1161.01	1.8	1162.81
		-18181.91	5661456.85	1162.57	1.8	1164.37
		-18217.63	5661452.19	1164.11	1.8	1165.91
		-18242.70	5661452.28	1165.00	1.8	1166.80
		-18267.77	5661452.37	1165.39	1.8	1167.19
		-18292.84	5661452.47	1166.28	1.8	1168.08
		-18317.91	5661452.56	1167.59	1.8	1169.39
Valley Ridge Barrier 2	Existing	-18317.91	5661452.56	1167.59	1.8	1169.39
		-18339.72	5661452.68	1168.60	1.8	1170.40
		-18361.53	5661452.79	1169.34	1.8	1171.14
		-18383.34	5661452.91	1169.71	1.8	1171.51
		-18405.15	5661453.03	1169.81	1.8	1171.61
		-18426.96	5661453.14	1169.66	1.8	1171.46
		-18448.77	5661453.26	1169.82	1.8	1171.62
		-18470.58	5661453.37	1169.70	1.8	1171.50
		-18492.39	5661453.49	1169.21	1.8	1171.01
		-18513.84	5661453.61	1168.64	1.8	1170.44
		-18535.29	5661453.73	1168.44	1.8	1170.24
		-18556.74	5661453.85	1168.57	1.8	1170.37
		-18578.19	5661453.97	1168.61	1.8	1170.41
		-18599.64	5661454.09	1168.50	1.8	1170.30

Table D: Barrier Design Segment Details

Barrier Name	Type	X	Y	Base Elevation	Height	Top Elevation
Valley Ridge S	Proposed	-17009.92	5661496.0	1130.0	1.8	1131.8
		-17055.16	5661488.0	1130.0	1.8	1131.8
		-17093.8	5661482.0	1131.0	1.8	1132.8
		-17134.22	5661475.0	1132.0	1.8	1133.8
		-17176.86	5661475.0	1133.0	1.8	1134.8
		-18621.09	5661454.22	1168.59	1.8	1170.39
		-18642.54	5661454.34	1168.03	1.8	1169.83
		-18664.00	5661454.46	1167.78	1.8	1169.58
		-18685.38	5661454.58	1167.25	1.8	1169.05
		-18706.76	5661454.70	1167.65	1.8	1169.45
		-18728.14	5661454.82	1167.46	1.8	1169.26
		-18749.52	5661454.94	1167.77	1.8	1169.57
		-18770.91	5661455.06	1168.00	1.8	1169.80
		-18792.29	5661455.18	1168.00	1.8	1169.80
		-18813.67	5661455.30	1169.60	1.8	1171.40
		-18835.05	5661455.42	1170.33	1.8	1172.13
Valley Ridge Barrier 3	Existing	-18849.95	5661477.74	1169.00	4.6	1173.60
		-18850.05	5661455.54	1169.92	4.6	1174.52
		-18871.37	5661455.66	1169.00	4.6	1173.60
Valley Pointe South Barrier 4	Existing	-18878.40	5661455.41	1168.76	4.6	1173.36
		-18901.73	5661455.84	1167.83	4.6	1172.43
		-18910.81	5661455.87	1167.18	4.6	1171.78
		-18927.39	5661456.00	1166.58	4.6	1171.18
		-18941.68	5661456.31	1166.03	4.6	1170.63
		-18946.30	5661464.33	1165.46	4.6	1170.06
		-18949.68	5661468.61	1165.08	4.6	1169.68
		-18958.03	5661479.18	1166.09	4.6	1170.69
		-18966.28	5661489.36	1164.45	4.6	1169.05
		-18975.00	5661498.83	1163.94	4.6	1168.54
		-18975.00	5661498.83	1163.94	4.6	1168.54
		-18983.71	5661508.29	1163.59	4.6	1168.19
		-18985.38	5661510.11	1163.52	4.6	1168.12
		-18990.77	5661519.05	1163.21	4.6	1167.81
		-18998.02	5661531.06	1163.12	4.6	1167.72
		-19003.73	5661540.52	1163.02	4.6	1167.62
Crestmont North Barrier	Existing	-18796.25	5661362.97	1170.00	2.4	1172.40
		-18782.45	5661362.80	1170.11	2.4	1172.51
		-18782.45	5661362.80	1170.11	2.4	1172.51
		-18763.03	5661362.68	1169.27	2.4	1171.67
		-18708.04	5661362.38	1169.73	2.4	1172.13
		-18677.22	5661362.21	1169.69	2.4	1172.09
		-18648.77	5661362.04	1169.08	2.4	1171.48
		-18602.11	5661361.78	1169.67	2.4	1172.07
		-18556.13	5661361.52	1169.74	2.4	1172.14

Table D: Barrier Design Segment Details

Barrier Name	Type	X	Y	Base Elevation	Height	Top Elevation
Valley Ridge S	Proposed	-17009.92	5661496.0	1130.0	1.8	1131.8
		-17055.16	5661488.0	1130.0	1.8	1131.8
		-17093.8	5661482.0	1131.0	1.8	1132.8
		-17134.22	5661475.0	1132.0	1.8	1133.8
		-17176.86	5661475.0	1133.0	1.8	1134.8
		-18528.02	5661361.36	1169.48	2.4	1171.88
		-18504.80	5661361.23	1169.22	2.4	1171.62
		-18487.46	5661361.13	1169.51	2.4	1171.91
		-18469.55	5661361.00	1170.35	2.4	1172.75
		-18444.18	5661360.88	1171.71	2.4	1174.11
		-18422.54	5661360.76	1172.00	2.4	1174.40
		-18409.11	5661360.68	1172.07	2.4	1174.47
		-18394.86	5661360.60	1173.22	2.4	1175.62
		-18380.82	5661360.50	1172.89	2.4	1175.29
		-18339.37	5661360.14	1174.12	2.4	1176.52
		-18313.23	5661360.13	1174.53	2.4	1176.93
		-18285.07	5661360.11	1174.39	2.4	1176.79
		-18254.37	5661359.58	1173.91	2.4	1176.31
		-18238.57	5661359.58	1173.30	2.4	1175.70
		-18217.90	5661359.67	1172.22	2.4	1174.62

Appendix E: Sensitivity Analysis

As part of this noise study, a Sensitivity Analysis was performed to predict the noise impact of changing the parameters of traffic volume, traffic speed, and truck percentage on the subject roadways. The values of these parameters were increased and decreased to a reasonable amount given the possible error in long-term planning horizon, as follows:

- The Traffic Volume Sensitivity Analysis predicted the impact of changing the current number of vehicles per day (VPD) to +/- 25%.
- The Traffic Speed Sensitivity Analysis predicted the impact of changing the current speed to +/- 10 km/h.
- The Percentage Truck Sensitivity Analysis predicted the impact of changing the percentage of trucks, 25% increase (min 1% total increase), or 25% decrease (min 1% total decrease) on all the subject roads.
- The Cumulative Sensitivity Analysis predicted the impact of increasing the traffic volume, speed, and truck percentages simultaneously, which is assumed traffic volumes 25% increase, speed 10 km/h increase, Truck percentage 25% increase (min 1% total increase); and traffic volumes 25% decrease, speed 10 km/h decrease, Truck percentage 25% decrease (min 1% total decrease) on all the subject roads.

The table below summarizes the results of the sensitivity analysis for the traffic volume, the traffic speed, the percentage of heavy trucks, and the cumulative effect of the three analyses.

Table E: Predicted L_{eq} (24Hr) Traffic Noise Levels for 2035

Receiver Area	Current Parameters (dBA)	Traffic Volume		Traffic Speed		Truck Volume		Cumulative: -25% Vehicles -10 kph -25% Truck Percentage (dBA)	Cumulative: +25% Vehicles +10 kph +25% Truck Percentage (dBA)
		-25% (dBA)	+25% (dBA)	-10 kph (dBA)	+10 kph (dBA)	-25% (dBA)	+25% (dBA)		
Cougar Ridge 01	43.1	41.9	44.1	42.7	43.5	42.6	43.6	40.9	44.9
Cougar Ridge 02	52.7	51.4	53.6	51.7	53.6	52.3	53.1	50.0	55.0
Cougar Ridge 03	53.5	52.2	54.4	52.4	54.5	53.1	53.8	50.7	55.8
Cougar Ridge 04	50.2	48.9	51.1	49.3	51.0	49.7	50.6	47.6	52.4
Cougar Ridge 05	47.9	46.7	48.9	47.3	48.5	47.4	48.3	45.5	49.8
Cougar Ridge 06	49.2	48.0	50.2	48.6	49.8	48.8	49.7	46.9	51.2
Cougar Ridge 07	47.7	46.6	48.7	47.1	48.3	47.2	48.2	45.4	49.7
Cougar Ridge 08	46.7	45.6	47.7	46.1	47.2	46.2	47.2	44.4	48.6
Cougar Ridge 09	45.7	44.5	46.7	45.2	46.1	45.2	46.1	43.5	47.5
Cougar Ridge 10	45.3	44.1	46.2	44.8	45.7	44.8	45.7	43.2	47.1
Cougar Ridge 11	47.5	46.3	48.4	47.0	48.0	47.0	47.9	45.3	49.3
Cougar Ridge 12	47.5	46.3	48.5	46.9	48.0	47.0	48.0	45.2	49.4
Cougar Ridge 13	48.4	47.2	49.4	47.8	49.0	47.9	48.9	46.1	50.4
Cougar Ridge 14	48.6	47.5	49.6	48.0	49.3	48.1	49.1	46.2	50.7
Cougar Ridge 15	49.1	47.9	50.1	48.4	49.7	48.6	49.6	46.7	51.1
Cougar Ridge 16	53.1	51.9	54.1	52.3	54.0	52.6	53.6	50.6	55.4
Crestmont 1	54.1	52.9	55.1	52.9	55.0	53.6	54.6	51.1	56.4
Crestmont 2	55.1	53.9	56.1	54.0	56.0	54.5	55.7	52.1	57.5
Crestmont 3	54.5	53.3	55.5	53.4	55.4	53.9	55.1	51.6	56.9
Crestmont 4	54.9	53.7	55.9	53.8	55.8	54.3	55.5	52.0	57.3
Crestmont 5	55.6	54.4	56.5	54.6	56.4	55.0	56.1	52.7	57.9
Crestmont 6	59.4	58.2	60.4	58.6	60.4	58.9	60.0	56.7	61.8
Crestmont 7	53.2	51.9	54.1	52.3	54.0	52.6	53.7	50.5	55.5

Table E: Predicted L_{eq} (24Hr) Traffic Noise Levels for 2035

Receiver Area	Current Parameters (dBA)	Traffic Volume		Traffic Speed		Truck Volume		Cumulative: -25% Vehicles -10 kph -25% Truck Percentage (dBA)	Cumulative: +25% Vehicles +10 kph +25% Truck Percentage (dBA)
		-25% (dBA)	+25% (dBA)	-10 kph (dBA)	+10 kph (dBA)	-25% (dBA)	+25% (dBA)		
Crestmont 8	57.7	56.5	58.7	56.6	58.8	57.2	58.1	54.9	60.1
Crestmont 9	58.8	57.6	59.8	57.7	60.0	58.4	59.2	56.0	61.3
Crestmont 10	59.0	57.7	59.9	57.8	60.1	58.6	59.3	56.1	61.5
Crestmont 11	57.6	56.3	58.6	56.4	58.7	57.2	58.0	54.7	60.1
Crestmont 12	55.2	54.0	56.2	54.2	56.4	54.8	55.6	52.4	57.7
Crestmont W1	55.0	53.8	56.0	53.7	56.1	54.5	55.5	52.0	57.5
Crestmont W2	55.6	54.4	56.6	54.4	56.7	55.2	56.1	52.6	58.1
Crestmont W3	55.5	54.3	56.5	54.2	56.5	55.0	56.0	52.4	57.9
Crestmont W4	57.9	56.6	58.8	56.5	59.0	57.4	58.3	54.8	60.3
Crestmont W5	57.2	55.9	58.1	55.9	58.3	56.7	57.6	54.1	59.6
Crestmont W6	55.9	54.7	56.9	54.7	56.9	55.4	56.3	53.0	58.3
Greenwood 1	50.8	49.6	51.8	50.0	51.7	50.4	51.3	48.2	53.1
Greenwood 2	52.5	51.2	53.4	51.5	53.3	52.0	52.8	49.8	54.7
Greenwood 3	53.3	52.0	54.3	52.5	54.1	52.8	53.9	50.6	55.5
Greenwood 4	53.0	51.8	54.0	52.1	53.9	52.5	53.5	50.4	55.3
Greenwood 5	52.9	51.7	53.9	52.0	53.8	52.4	53.4	50.2	55.2
Greenwood 6	53.7	52.5	54.7	52.9	54.6	53.2	54.2	51.0	56.0
Greenwood 7	54.4	53.2	55.4	53.5	55.3	53.9	54.9	51.7	56.7
Greenwood 8	55.4	54.1	56.4	54.5	56.3	54.9	55.9	52.6	57.7
Greenwood 9	53.5	52.3	54.5	52.6	54.3	53.0	53.9	50.8	55.7
Greenwood 10	54.3	53.0	55.3	53.5	55.0	53.8	54.7	51.7	56.5
Greenwood 11	52.5	51.3	53.5	51.7	53.3	52.0	53.0	49.9	54.7
Greenwood 12	52.2	51.0	53.2	51.4	53.1	51.8	52.7	49.6	54.4
Greenwood 13	53.8	52.6	54.8	52.9	54.7	53.4	54.3	51.1	56.1
Greenwood 14	53.6	52.4	54.6	52.7	54.5	53.2	54.1	50.9	55.9
Greenwood 15	54.3	53.0	55.3	53.3	55.2	53.8	54.7	51.5	56.5
Greenwood 16	54.0	52.7	54.9	53.0	54.8	53.4	54.4	51.2	56.3
Greenwood 17	54.5	53.3	55.5	53.5	55.5	54.0	55.0	51.7	56.9
Greenwood 18	54.1	52.9	55.1	53.1	55.0	53.6	54.6	51.3	56.4
Greenwood 19	54.3	53.1	55.3	53.3	55.3	53.9	54.8	51.5	56.7
Greenwood 20	54.1	52.9	55.1	53.0	55.1	53.7	54.6	51.3	56.5
Greenwood 21	53.6	52.4	54.6	52.5	54.6	53.2	54.1	50.8	56.0
Greenwood 22	53.6	52.4	54.7	52.5	54.7	53.2	54.1	50.8	56.1
Greenwood 23	52.6	51.4	53.6	51.5	53.7	52.2	53.1	49.8	55.0
Receiver 9555 2 AV SW	51.6	50.4	52.6	50.7	52.4	51.2	52.0	49.0	53.8
Valley Ridge 1	55.1	53.9	56.1	54.2	56.1	54.7	55.6	52.4	57.5
Valley Ridge 2	56.0	54.8	57.0	55.2	56.9	55.5	56.6	53.3	58.4
Valley Ridge 3	56.8	55.5	57.7	55.9	57.7	56.2	57.3	54.0	59.1
Valley Ridge 4	56.9	55.6	57.9	56.0	57.8	56.3	57.4	54.1	59.3
Valley Ridge 5	57.6	56.4	58.6	56.7	58.5	57.0	58.1	54.8	60.0
Valley Ridge 6	57.1	55.9	58.1	56.2	58.1	56.6	57.6	54.3	59.6
Valley Ridge 7	57.7	56.5	58.7	56.7	58.7	57.2	58.2	54.9	60.2
Valley Ridge 8	59.2	57.9	60.1	58.1	60.2	58.7	59.6	56.3	61.6

Table E: Predicted L_{eq} (24Hr) Traffic Noise Levels for 2035

Receiver Area	Current Parameters (dBA)	Traffic Volume		Traffic Speed		Truck Volume		Cumulative: -25% Vehicles -10 kph -25% Truck Percentage (dBA)	Cumulative: +25% Vehicles +10 kph +25% Truck Percentage (dBA)
		-25% (dBA)	+25% (dBA)	-10 kph (dBA)	+10 kph (dBA)	-25% (dBA)	+25% (dBA)		
Valley Ridge 9	58.2	56.9	59.2	57.1	59.2	57.6	58.7	55.3	60.7
Valley Ridge 10	57.4	56.2	58.4	56.3	58.5	56.9	57.9	54.5	59.9
Valley Ridge 11	58.3	57.1	59.3	57.2	59.4	57.8	58.8	55.4	60.8
Valley Ridge 12	58.3	57.1	59.3	57.2	59.4	57.8	58.8	55.4	60.8
Valley Ridge 13	58.6	57.4	59.6	57.4	59.8	58.2	59.1	55.7	61.1
Valley Ridge 14	59.6	58.4	60.6	58.5	60.7	59.1	60.1	56.7	62.1
Valley Ridge 15	60.8	59.5	61.7	59.6	61.9	60.3	61.2	57.9	63.3
Valley Ridge 16	62.4	61.2	63.4	61.3	63.6	62.0	62.9	59.6	64.9
Valley Ridge 17	61.7	60.5	62.7	60.7	62.8	61.2	62.2	58.9	64.1
Valley Ridge 18	62.0	60.7	63.0	60.9	63.0	61.5	62.5	59.1	64.4
Valley Ridge 19	62.2	60.9	63.1	61.1	63.2	61.7	62.6	59.3	64.5
Valley Ridge 20	62.1	60.8	63.0	61.0	63.0	61.5	62.5	59.2	64.4
Valley Ridge 21	62.7	61.5	63.7	61.6	63.8	62.2	63.2	59.8	65.1
Valley Ridge 22	63.9	62.6	64.9	62.5	64.9	63.4	64.3	60.8	66.2
Valley Ridge 23	64.6	63.3	65.6	63.2	65.5	64.1	65.0	61.5	66.8
Valley Ridge 23A	64.3	63.0	65.2	62.9	65.2	63.8	64.7	61.2	66.5
Valley Ridge 24	64.7	63.4	65.7	63.4	65.7	64.2	65.2	61.7	67.1
Valley Ridge 24A	64.7	63.4	65.7	63.4	65.8	64.2	65.1	61.7	67.1
Valley Ridge 24B	64.9	63.6	65.9	63.7	66.0	64.4	65.4	61.9	67.4
Valley Ridge 25	65.4	64.1	66.4	64.2	66.5	64.9	65.8	62.4	67.8
Valley Ridge 25A	65.3	64.1	66.3	64.1	66.4	64.9	65.8	62.4	67.8
Valley Ridge 25B	65.4	64.1	66.4	64.2	66.5	64.9	65.8	62.4	67.8
Valley Ridge 26	64.9	63.6	65.9	63.7	66.0	64.4	65.3	61.9	67.4
Valley Ridge 27	54.5	53.3	55.5	53.5	55.5	54.0	55.0	51.7	56.9
Valley Ridge 28	58.9	57.7	59.9	57.9	59.9	58.4	59.3	56.1	61.2
Valley Ridge 29	57.1	55.8	58.0	56.1	58.0	56.5	57.5	54.3	59.5
Valley Ridge 30	56.2	55.0	57.2	55.3	57.1	55.7	56.7	53.5	58.6
Valley Ridge 31	56.0	54.7	56.9	55.0	56.9	55.4	56.5	53.2	58.4
Valley Ridge 32	55.9	54.6	56.8	54.9	56.8	55.3	56.4	53.1	58.3
Valley Ridge 33	55.7	54.5	56.7	54.8	56.6	55.3	56.2	53.1	58.0
Valley Ridge 34	57.5	56.3	58.5	56.9	58.3	57.0	57.9	55.1	59.7
Valley Ridge 35	60.8	59.6	61.8	59.9	61.7	60.3	61.3	58.1	63.1
Valley Ridge 36	60.2	59.0	61.2	59.3	61.1	59.7	60.7	57.5	62.5
Valley Ridge 37	60.8	59.6	61.8	59.8	61.7	60.3	61.2	58.0	63.1
Valley Ridge 38	59.6	58.3	60.5	58.5	60.4	59.1	60.0	56.8	61.8
Valley Ridge 39	60.0	58.8	61.0	58.9	60.9	59.5	60.5	57.2	62.3
Valley Ridge 40	59.6	58.4	60.6	58.6	60.6	59.1	60.1	56.8	62.0
Valley Ridge 41	58.7	57.5	59.7	57.8	59.6	58.2	59.2	56.0	61.0
Valley Ridge 42	58.9	57.7	59.9	58.0	59.7	58.4	59.4	56.2	61.1

Table E: Predicted L_{eq} (24Hr) Traffic Noise Levels for 2035

Receiver Area	Current Parameters (dBA)	Traffic Volume		Traffic Speed		Truck Volume		Cumulative: -25% Vehicles -10 kph -25% Truck Percentage (dBA)	Cumulative: +25% Vehicles +10 kph +25% Truck Percentage (dBA)
		-25% (dBA)	+25% (dBA)	-10 kph (dBA)	+10 kph (dBA)	-25% (dBA)	+25% (dBA)		
Valley Ridge 43	60.4	59.1	61.3	59.3	61.2	59.9	60.8	57.5	62.6
Valley Ridge 44	58.9	57.7	59.8	57.8	59.6	58.4	59.3	56.1	61.0
Valley Ridge 45	59.4	58.2	60.4	58.3	60.2	58.9	59.9	56.6	61.6
Valley Ridge 46	54.3	53.1	55.3	53.2	55.2	53.9	54.8	51.5	56.6
Valley Ridge 47	56.0	54.8	57.0	54.9	56.9	55.6	56.5	53.2	58.2
Valley Ridge 48	54.3	53.1	55.3	53.3	55.0	53.8	54.8	51.6	56.4
Valley Ridge 49	53.0	51.7	53.9	51.9	53.7	52.5	53.4	50.1	55.1
Valley Ridge 50	52.0	50.8	53.0	50.9	52.7	51.5	52.4	49.2	54.1
Minimum change among all the receivers		-1.1	+0.9	-0.4	+0.4	-0.4	+0.3	-2.1	+1.8
Maximum change among all the receivers		-1.3	+1.1	-1.4	+1.2	-0.6	+0.6	-3.1	+2.5
Average change among all the receivers		-1.2	+1.0	-1.0	+0.9	-0.5	+0.5	-2.8	+2.3

The results of the sensitivity analysis indicate that additional noise barriers may be warranted for the Valley Ridge area, if there were an increase in traffic volume, traffic speed, or truck percentage:

The traffic volume analysis indicates that changing the volume will change the levels to within +1.1 dBA and -1.3 dBA of the current predicted levels. This suggests that changing the traffic volume will not produce a significant impact at the receivers.

The traffic speed analysis indicates that changing the speed will change the levels to within +1.2 dBA and -1.4 dBA of the current predicted levels. This suggests that changing the traffic speed will not produce a significant impact at the receivers.

The truck percentage analysis indicates that changing the percentage of trucks will change the levels to within +0.6 dBA and -0.6 dBA of the current predicted levels. This suggests that changing the truck percentage will not produce a significant impact at the receivers.

The Cumulative Sensitivity Analysis indicates that simultaneous changes of the traffic volume, speed, and truck percentages will change the levels to within +2.5 dBA and -3.1 dBA of the current predicted levels. This suggests that the simultaneous changes of the traffic volume, speed, and truck percentages will produce a just perceptible change at the receivers.

Appendix F: Noise Attenuation Guidelines for Provincial Highways Under Provincial Jurisdiction within Cities and Urban Areas

NOISE ATTENUATION GUIDELINES FOR PROVINCIAL HIGHWAYS UNDER PROVINCIAL JURISDICTION WITHIN CITIES AND URBAN AREAS

Definition:

Noise is defined as the sounds generated by vehicles operating on the highway. It includes but is not limited to engine/exhaust sounds and road contact sounds.

Guidelines:

- For construction or improvements of highways through cities and other urban areas, Alberta Transportation will adopt a noise level of 65 dBA Leq_{24} * measured 1.2 metres above ground the level and 2 metres inside the property line (outside the highway right-of-way). The measurements should be adjusted to the 10 year planning horizon value, as a threshold to consider noise mitigation measures.
- The mitigation of noise issues could include constructing noise walls and/or berms. The decision to implement noise mitigation must consider whether mitigation is cost-effective, technically practical, broadly supported by the affected residents, and fits into overall provincial priorities.
- Any accepted noise mitigation measures consistent with this guideline will be the responsibility of Alberta Transportation. Where established local noise mitigation policies are more stringent than this guideline, the local policy may be considered on a shared responsibility basis.
- Alberta Transportation will be responsible for noise attenuation, in accordance with this guideline, in areas where Alberta Transportation is undertaking widening (by at lease one lane width) or major realignment of an existing road or constructing a new road adjacent to an existing residential development. .
- In areas where a residential subdivision is constructed adjacent to an existing roadway, the development proponent will be responsible for noise attenuation consistent with these guidelines.
- In areas where a residential subdivision is constructed adjacent to a designated highway that has not been constructed, Alberta Transportation will request that the development proponent and approving authority address future noise concerns consistent with these guidelines.

* Noise level expressed in decibels (dB) is taken to mean the A-weighted 24-hour equivalent sound level.

Alberta
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Appendix G: Technical Details

Sound is the phenomena of vibrations transmitted through air, or other medium such as water or a building structure. The range of pressure amplitudes, intensities, and frequencies of the sound energy is very wide, and many specialized fields have developed using different ranges of these variables, such as room acoustics and medical ultrasound.

Due to the wide range of intensities, which are perceived as sound, standard engineering units become inconvenient. Sound levels are commonly measured on a logarithmic scale, with the level (in decibels, or dB) being proportional to ten times the common logarithm of the sound energy or intensity. Normal human hearing covers a range of about twelve to fourteen orders of magnitude in energy, from the threshold of hearing to the threshold of pain. On the decibel scale, the threshold of hearing is set as zero, written as 0 dB, while the threshold of pain varies between 120 to 140 dB. The most usual measure of sound is the sound pressure level (SPL), with 0 dB SPL set at 2.0 X 10^{-5} N/m^2 (also written 20 μPa), which corresponds to a sound intensity of 10^{-12} Watts/m^2 (or 1 picoWatt/m^2, written 1 pW/m^2).

Normal human hearing spans a frequency range from about 20 Hertz (Hz, or cycles per second) to about 20,000 Hz (written 20 kHz). However, the sensitivity of human hearing is not the same at all frequencies. To accommodate the variation in sensitivity, various frequency-weighting scales have been developed. The most common is the A-weighting scale, which is based on the sensitivity of human hearing at moderate levels; this scale reflects the low sensitivity to sounds of very high or very low frequencies. Sound levels measured on the A-weighted scale are written in A-weighted decibels, commonly shown as dBA or dB(A).

Human hearing becomes more sensitive to lower frequency sounds as the level of the sound increases. For this purpose, the C-weighing scale was developed to assess reaction to higher levels sounds. Although the C-weighting scale, or the sound level in dBC, is seldom used on its own, the levels in dBC and dBA are often used together to assess the significance of the low-frequency components of sound. In some cases, a limit is placed on the dBC level at a location in order to limit the amount of low-frequency noise.

When sound is measured using the A-weighting scale, the reading is often called the "Noise level", to confirm that human sensitivity and reactions are being addressed. A table of some common noise sources and their associated noise levels are shown in the table below.

When the A-weighting scale is not used, the measurement is said to have a "linear" weighting, or to be unweighted, and may be called a "linear" level. As the linear reading is an accurate measurement of the physical (sound) pressure, the term "Sound Pressure Level", or SPL, is usually (but not universally) reserved for unweighted measurements.

Noise is usually defined as "unwanted sound", which indicates that it is not just the physical sound that is important, but also the human reaction to the sound that leads to the perception of sound as noise. It implies a judgment of the quality or quantity of sound experienced. As a human reaction to sound is involved, noise levels are usually given in A-weighted decibels (dBA). However, use of the C-weighting scale, usually in combination with the dBA level, is becoming more common as well. An alternate definition of noise is "sound made by somebody else", which emphasizes that the ability to control the level of the sound alters the perception of noise.

Noise Levels of Familiar Sources

Source Or Environment	Noise Level (dBA)
High Pressure Steam Venting To Atmosphere (3 m)	121
Steam Boiler (2 m)	90-95
Drilling Rig (10 m)	80-90
Pneumatic Drill (15 m)	85
Pump Jack (10 m)	68-72
Truck (15 m)	65-70
Business Office	65
Conversational Speech (1 m)	60
Light Auto Traffic (30 m)	50
Living Room	40
Library	35
Soft Whisper (5 m)	20-35

The single number A-weighted level is often inadequate for engineering purposes, although it does supply a good estimate of people's reaction to a noise environment. As noise sources, control measures, and materials differ in the frequency dependence of their noise responses or production, sound is measured with a narrower frequency bandwidth; the specific methodology varies with the application. For most work, the acoustic frequency range is divided into frequency bands where the center frequency of each band is twice the frequency of the next lower band; these are called "Octave" bands, as their frequency relation is called an "Octave" in music, where the field of acoustics has its roots. For more detailed work, the octave bands, and certain standard octave and 1/3 octave bands have been specified by international agreements.

Where the noise at the receiver is steady, it is easy to assess the noise level. However, both the production of noise at the source and the transmission of noise can vary with time; most noise levels are not constant, either because of the motion of the noise source (as in traffic noise), because the noise source itself varies, or because the transmission of sound to the receiver location is not steady as over long distances. This is almost always the case for environmental noise studies. Several single number descriptors have been developed and are used to assess noise in these conditions.

The most common is the measurement of the "equivalent continuous" sound level, or L_{eq}, which is the level of a hypothetical source of a constant level which would give the same total sound energy as is measured during the sampling period. This is the "energy" average noise level. Typical sampling periods are one hour, nighttime (9 hours) or one day (24 hours); the sampling period used must be reported when using this unit.

The greatest value of the L_{eq} is that the contributions of different sources to the total noise level can be assessed, or in a case where a new noise source is to be added to an existing environment, the total noise level from new and old sources can be easily calculated. It is also sensitive to short term high noise levels.

Statistical noise levels are sometimes used to assess an unsteady noise environment. They indicate the levels that are exceeded a fixed percentage of the measurement time period measured. For example, the 10^{th} percentile level, written L_{10}, is the levels exceeded 10% of the time; this level is a good measure of frequent noisy occurrences such as steady road traffic. The 90% level, L_{90}, is the level exceeded 90% of the time, and is the background level, or noise floor. A steady noise source will modify the background level, while an intermittent noise source such as road or rail traffic will affect the short-term levels only.

One disadvantage with the L_{eq} measure, when used alone, is that nearby loud sources (e.g. dogs barking, or birds singing) can confuse the assessment of the situation when it is the noise from a distant plant that is the concern. For this reason, the equivalent level and the statistical levels can be used together to better understand the noise environment. One such indication is the difference between the L_{eq} and the L_{90} levels. A large difference between the L_{eq} and L_{90}, greater than 10 dB, indicates the intrusion of short-term noise events on the general background level. A small difference, less than 5 dB, indicates a very steady noise environment. If the L_{eq} value exceeds the L_{10} value this indicates the presence of significant short-term loud events.

For most noise measurement, instruments are adjusted so that the time response of the instrument is similar to the response of the human ear; this is the "Fast" setting. Measurement with the "Fast" setting therefore assesses the sound environment according to the way humans would hear it and react to it. Where the noise level varies substantially and an average level is wanted without the complexity of and L_{eq} or statistical measurement, the "Slow" setting is used on the sound level meter. The "Slow" setting is also typically used in industrial settings where hearing damage is a concern. Where the noise level changes very rapidly, for example due to impacts or detonations, the "Fast" and "Slow" settings do not respond quickly enough to assess the maximum levels, and the "Impulse" meter setting us used.

The Sound Power Level (abbreviated L_w, SWL or PWL) is the decibel equivalent of the total energy emitted from a source in the form of noise. The reference level for the sound power is 10^{-12} Watts, or 1 picoWatt (abbreviated pW). The sound power level is given by:

$$L_w\text{, SWL, PWL} = 10 \times \log_{10} (\text{Emitted Power} / 1\text{ pW})\text{ dB}$$

Therefore, a source emitting 1 Watt of power in the form of sound would have a sound power level of 120 dB. Sound power levels can be expressed in terms of frequency bands, an overall linear-weighted level or A-weighted, as is the case for sound pressure levels. However, sound power levels are inherent to the source of noise, whereas the sound pressure level is dependant on the source, but also on the distance from the source and other environmental factors.

Note that according to the acoustical literature (E.g. Noise Control Engineering from Bies and Hanson), the subjective effect of changes in SPL is as follows:

- A 3 dB change is "just perceptible".
- A 5 dB change is "clearly noticeable".
- A 10 dB change is "twice as loud or half as loud".
- A 20 dB change is "much louder or much quieter".