APPENDIX I

NOISE IMPACT ASSESSMENT

UEM

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Noise Impact Assessment

Ninth Line (Regional Road 13) Transportation Corridor Improvements: Highway 407 to 10 Side Road (Regional Road 10)

May 2015

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Noise Impact Assessment

Ninth Line (Regional Road 13) Transportation Corridor Improvements

Prepared for:

Halton Region

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351003

Date:

May 2015

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1. Introduction

1.1 Project Overview

Halton Region has initiated a Class Environmental Assessment (Class EA) to evaluate options for the management of future traffic growth on Ninth Line (Regional Road 13), between Highway 407 and 10 Side Road in Halton Hills, Ontario (the Project). A preliminary review of options for improving the corridor was completed in January 2015, which evaluated several alternatives for widening Ninth Line to accommodate projected traffic growth, including widening about the existing centreline, widening towards the east, and widening towards the west. The preferred design was selected from this review, which consisted primarily of widening Ninth Line about the existing centerline, with several segments instead widened on the east or west side depending on the locations of homes in the area.

This Noise Impact Assessment has been prepared in support of the Class EA, and evaluates the potential for noise impacts associated with the preferred design in accordance with Halton Region and Provincial guidelines for transportation projects.

1.2 Summary of Assessment Approach

The first step in the assessment of potential noise impacts attributable to the Project was to establish the sound level criteria by which the predicted sound level increases due to the Project would be evaluated. This report reviews the relevant Municipal and Provincial noise assessment guidance applicable to this project. Noise assessment guidelines for regional transportation projects provided by Halton Region, and transportation noise assessment guidelines from the Ontario government are reviewed in Section 2 of this report.

The proposed widening of Ninth Line will result in a decrease in separation distance between many of the nearest sensitive receptors and the road alignment, which will in turn result in increased sound levels at these locations. In addition, the widening of Ninth Line is projected to result in increased traffic volumes, which would also be expected to increase sound levels at the receptors abutting the road. Sound levels have been predicted at the adjacent sensitive receptor locations for two future operating scenarios – one which assumes that the Project does not proceed, and Ninth Line remains in the current configuration (future no-build), and one which assumes that the Project does proceed (future build). The difference between these levels represents the incremental increase in sound level that is attributable to the Project.

The incremental increases and projected future sound levels are then compared to the assessment criteria to determine whether an evaluation of noise control is required.

All sound levels were predicted in accordance with the Ontario Ministry of the Environment and Climate Change (MOECC) Ontario Road Noise Analysis Method for Environment and Transportation (ORNAMENT) [1], as required by Halton Region and Ontario guidelines.

2. Regulatory Context

2.1 Municipal Guidance (Halton Region)

Halton Region outlines its requirements for the assessment of noise impacts from Regional Road Projects in Section 3.0 of the Noise Abatement Guidelines [2], which is part of a series of guidelines developed to assist in the implementation of policies outlined in the Halton Regional Official Plan (ROP). Regional Road Projects include road reconstruction and expansion projects adjacent to Noise Sensitive Areas (NSAs). The Noise Abatement Guideline indicates that the assessment of noise impacts due to Regional Road Projects is to account for projected future traffic volumes to the year 2031 [2].

Increases in sound level at an NSA due to a Regional Road Project are to be assessed at an Outdoor Living Area (OLA) within a 16-hr period representing the daytime hours (07:00 – 23:00). An OLA is defined as "*the part of an outdoor amenity area provided for the quiet enjoyment of the outdoor environment*." [2] Future sound levels due to traffic are to be calculated in accordance with prediction methodology developed by the MOECC (i.e., ORNAMENT [1]) both with and without the Project undertaking. Predicted increases in sound level due to the Project are to be evaluated in accordance with the following criteria:

- 0-5 dBA – no action required;
- Greater than 5 dBA – Investigate noise control measures within the right-of-way where a minimum attenuation of 5 dBA can be achieved.

If noise attenuation measures are not found to be a requirement, but existing noise levels are found to be in excess of 60 dBA, an application may be made to Halton Region under the Retrofit guideline for existing residential developments that abut Regional Road allowances. Such an application would require the applicant to meet the specific requirements of that policy.

2.2 Provincial Guidance

The MOECC has outlined a land use planning assessment approach for transportation noise sources on residential properties in its Environmental Noise Guideline Publication NPC-300. However, it is noted in Part A2 of NPC-300 that the sound level limits provided do not apply to "*new or expanded traffic corridors*" [3]. The intention of the sound level criteria in NPC-300 related to transportation sources is for application to the assessment of proposed sensitive land uses (e.g., residential developments) adjacent to existing transportation corridors. A 2011 draft guideline authored by the MOECC entitled "Guideline for Noise and Vibration Assessment of Transit Projects" is referenced in NPC-300 as the source of sound level criteria for transportation expansion projects; however, the MOECC indicated that it is not yet approved for use in assessments of this nature.

In 1986, the MOECC and Ontario Ministry of Transportation (MTO) authored a joint protocol for the assessment of noise impacts from provincial transportation projects, entitled the "Protocol for Dealing With Noise Concerns During the Preparation, Review and Evaluation of Provincial Highways Environmental Assessments" [4]; commonly referred to as the "MOE/MTO Joint Protocol". This document outlines the preferred MOECC approach to the assessment of noise impacts from road projects. While this guideline was developed for provincial highway projects, the criteria by which the requirement for noise control is evaluated are often applied to municipal transportation projects being evaluated under the Environmental Assessment Act, in the absence of a specific protocol from the MOECC.

The MOECC approach involves identifying NSAs, and predicting the sound levels with and without the undertaking (i.e., future no-build and future build) at a 10 year horizon. The MOE/MTO Joint Protocol does not specifically outline a required time interval for the assessment of sound levels; however, based on other MOECC guidance (i.e., NPC-300, for the assessment of transportation noise on proposed developments), the sound levels for roads assessed at an OLA are to be calculated for a 16-hr period (daytime). The objective for outdoor sound levels from the MOE/MTO Protocol is the higher of 55 dBA or the existing ambient sound level. An investigation into noise control measures is required when the projected future sound level with the undertaking exceeds the objective level by more than 5 dBA. Noise control measures may only be implemented in the right-of-way. The MOECC criteria are summarized in Table 1.

Table 1 Summary Mitigation Effort (from [4])

Change in Noise Level Above Ambient	Mitigation Effort
0 – 5 dBA	• None
> 5 dBA	• Investigate noise control measures on right-of-way. • If project cost is not significantly affected introduce noise control measures within the right-of-way. • Noise control measures, where introduced, should achieve a minimum of 5 dBA attenuation, over first row receivers. • Mitigate to ambient, as administratively, economically, and technically feasible.

2.3 Summary of Assessment Criteria

The criteria in the Halton Region and MOECC/MTO guidelines are similar. The Halton Region guideline requires the use of ORNAMENT for prediction of future no-build and future build sound levels, based on a 16-hour daytime period at the OLA of the NSAs identified in the study area, which is consistent with the preferred MOECC approach. Both guidelines outline that noise controls are to be evaluated if the project causes receptor sound levels to increase by more than 5 dBA. If noise control is found to be required, both guidelines identify that mitigation measures within the right-of-way must be investigated and any adopted measure must achieve 5 dBA of attenuation.

In cases when noise mitigation is not required, but residents are exposed to existing sound levels exceeding 60 dBA, the Halton Region guideline allows residents to apply for retrofit noise abatement where the requirements of that process (separate from the EA process) are satisfied. The assessment criteria that has been adopted for this assessment is summarized in Table 2.

Table 2 Summary of Assessment Criteria

Condition	Mitigation Effort Required	Reference
<5 dBA	• None	Halton Region [2] MOECC [4]
≥ 5 dBA	• Investigate noise control measures on right-of-way. • Introduce noise control measures within right-of-way and mitigate to ambient if technically, economically and administratively feasible. • Noise control measures, where introduced, should achieve a minimum of 5 dBA attenuation, over first row receivers. • Mitigate to ambient, as administratively, economically, and technically feasible.	Halton Region [2] MOECC [4]

3. Study Area Description

Ninth Line is currently a two-lane roadway with a posted speed limit of 80 km/hr, and with gravel shoulders on either side. The land uses along the Ninth Line corridor between Highway 407 and 10 Side Road are primarily zoned for Agricultural use by the Town of Halton Hills [6], and are mainly used for farming and limited residential.

The preferred design for the widening of Ninth Line will result in an increase in the total number of lanes from two to four (i.e., two lanes in each direction), with northbound and southbound traffic separated by a painted island. The preferred design also includes on-road bicycle lanes and provision for multi-use paths on the boulevard, on either side of the roadway. The posted speed limit upon expansion is to remain at 80 km/hr. A typical cross-section of the proposed right-of-way is provided in Figure 1.

4. Noise Impact Assessment Methodology

4.1 Identification of Noise Sensitive Areas

The section of Ninth Line that is the subject of this assessment (between Highway 407 and 10 Side Road) is approximately 6.2 km in length. A detailed review of recent aerial photography was completed in order to identify the locations of all NSAs adjacent to the right-of-way. A total of 36 properties were identified as NSAs (all residential), and were considered as points of reception (PORs) in the noise impact assessment. The locations of these PORs are provided in Figure 1.

The Halton Region guideline and MOE/MTO Protocol each identify that sound levels in an NSA should be assessed at an outdoor space. The Halton Region guideline defines an outdoor living area (OLA) as:

> *The part of an outdoor amenity area provided for the quiet enjoyment of the outdoor environment. The OLA is typically an area at ground level accommodating outdoor living activities. This area may be situated on any side of a building. The usual distance from the dwelling unit wall is 3m. The vertical height is 1.5 meters above the existing ground surface. Where OLA location is unknown, the side closest to the roadway or transit way should be assumed to be the OLA. Paved areas for multiple dwelling residential units may not be defined as an OLA.* [2]

For purposes of this assessment, each NSA was assumed to have an OLA located at 3 m from the dwelling unit wall in the direction of Ninth Line, and were modelled at a height of 1.5 m for consistency with the Halton Region assessment approach.

4.2 Estimation of Traffic Volumes

Hourly traffic counts on Ninth Line and Steeles Avenue, inclusive of vehicle classification information, were provided by UEM for use in this study. UEM also provided traffic modelling data from Halton Region that provides the projected annual traffic growth rates for the Region, which accounts for planned Regional Road improvement projects. The hourly traffic count data was collected in 2013, and the annual growth rates from Halton Region were used to project these traffic volumes to the year at which operations commence (2016) and the horizon year for the assessment of noise impacts (2031).

Annual growth rates on Ninth Line and Steeles Avenue for a period prior to the commencement of operations (2011-2016) was applied to the project the hourly traffic volumes from 2013 to 2016. The future no-build traffic volumes were then estimated by continuing to use this annual growth rate to project traffic volumes in 2031. The future build traffic volumes were estimated using the Halton Region projected annual growth rate from 2016 to 2031, which accounts for the widening of Ninth Line. The 16-hr traffic volumes applied in the study are summarized in Table 3 and Table 4.

Table 3 Summary of Traffic Data on Ninth Line (Regional Road 13)

Scenario	Year	Northbound Traffic			Southbound Traffic		
		Total	Commercial		Total	Commercial	
		(16-hr)	% Medium	% Heavy	(16-hr)	% Medium	% Heavy
Steeles Ave. to 5th Side Road							
Existing	2013	4,793	2.8%	4.5%	4,551	2.2%	4.5%
Commencement	2016	5,405	2.8%	4.5%	5,050	2.2%	4.5%
Future No-Build	2031	9,858	2.8%	4.5%	8,492	2.2%	4.5%
Future Build	2031	14,025	2.8%	4.5%	15,731	2.2%	4.5%
5th Side Road to 10th Side Road							
Existing	2013	5,280	2.2%	4.0%	4,900	2.1%	3.8%
Commencement	2016	5,954	2.2%	4.0%	5,437	2.1%	3.8%
Future No-Build	2031	10,859	2.2%	4.0%	9,143	2.1%	3.8%
Future Build	2031	15,449	2.2%	4.0%	16,936	2.1%	3.8%

Table 4 Summary of Traffic Data on Steeles Avenue (Regional Road 8)

Scenario	Year	Eastbound Traffic			Westbound Traffic		
		Total (16-hr)	Commercial		Total (16-hr)	Commercial	
			% Medium	% Heavy		% Medium	% Heavy
East of Ninth Line							
Existing	2013	9,043	2.8%	5.5%	8,137	2.5%	4.3%
Commencement	2016	9,700	2.8%	5.5%	8,076	2.5%	4.2%
Future No-Build	2031	13,774	2.8%	5.5%	7,780	2.5%	4.2%
Future Build	2031	15,475	2.8%	5.5%	11,367	2.5%	4.2%
West of Ninth Line							
Existing	2013	5,030	2.8%	5.3%	4,676	2.5%	4.3%
Commencement	2016	5,395	2.8%	5.3%	4,641	2.5%	4.3%
Future No-Build	2031	7,661	2.8%	5.3%	4,471	2.5%	4.3%
Future Build	2031	8,607	2.8%	5.3%	6,532	2.4%	4.3%

4.3 Traffic Noise Modelling

As per Halton Region and MOECC requirements, traffic noise predictions were completed using the MOECC ORNAMENT method. ARCADIS has developed a spreadsheet that implements the ORNAMENT calculation method, and provides identical results to calculations completed using STAMSON (the MOECC computerized version of ORNAMENT). This spreadsheet was applied to calculate the predicted sound levels at selected PORs for this study, and the detailed results are provided in Appendix A. A verification run that demonstrates identical results to those predicted by STAMSON is provided in Appendix B.

The traffic volume data provided in Table 3 and Table 4 were applied as input to the ORNAMENT calculations, as well as the posted speed limits for Ninth Line and Steeles Avenue and the pre- and post-project separation distances from the NSAs to Ninth Line and Steeles Avenue. These separation distances were determined using the scaled AutoCAD drawings of the preferred layout from UEM, and aerial photography of the existing road alignments. A total of five (5) receptors were selected for detailed modelling in ORNAMENT. The receptors that were selected were those with the greatest potential for noise impacts, based on current proximity to Ninth Line, and changes in separation distance to Ninth Line after widening.

In order to provide a summary of the degree to which each individual receptor in the study area is impacted by the project, additional ORNAMENT calculations were completed to determine the separation distance required to result in predicted sound levels of 45 to 75 dBA in 5 dBA increments for both the future no-build and future build scenarios. A total of 4 model runs were completed for each scenario, in order to properly account for the position of each receptor as being on either the east or west side of Ninth Line (i.e., exposed to northbound versus southbound traffic), and either north or south of 5th Side Road, as follows:

- Receptors west of Ninth Line and north of 5th Side Road;
- Receptors west of Ninth Line and south of 5th Side Road;
- Receptors east of Ninth Line and north of 5th Side Road; and
- Receptors east of Ninth Line and south of 5th Side Road.

The results of these generic runs were used to develop sound propagation equations for each of the above circumstances (for both the future no-build and future build scenarios), by plotting the calculated separation distance against the sound level and fitting a logarithmic trendline to the data. Each receptor was then assigned to one of the above four categories, and the appropriate trendline equation was applied to calculate future no-build and future build sound levels based on the setback to the nearest set of lanes (i.e., northbound or southbound) and typical distance between the nearest set of lanes and adjacent (further) set of lanes for opposite traffic flow.

5. Noise Impact Assessment

The results of the noise impact assessment for the five (5) receptors selected for detailed analysis are summarized in Table 5.

Table 5 Summary of Sound Level Predictions

POR ID	Distance from OLA to Centreline of Nearest Lane (m)			Predicted Sound Levels (dBA)		
	Existing	Future	Difference	Future No-Build	Future Build	Difference
POR1	57.1	52.8	+4.3	61.4	63.7	+2.3
POR11	22.0	18.8	+3.2	68.0	70.5	+2.5
POR15	39.3	34.0	+5.3	64.0	66.6	+2.4
POR19	23.5	20.4	+3.1	67.6	69.9	+2.3
POR34	166.3	151.3	+15.0	59.6	61.3	+1.7

The results show that the sound levels are not predicted to exceed the assessment criteria at these receptor locations. The results of the generic runs for all receptors in the study area were reviewed to confirm that the assessment criteria was not exceeded. The results of these runs are summarized in Table 6.

Table 6 Summary of Predicted Sound Level Changes for All Receptors

Range of Predicted Change in Sound Level (dBA)	Number of Receptors in Predicted Range
-5 to ≤0	12
>0 to ≤+5	24
>+5 to ≤+10	0
>+10 to ≤+15	0

Table 6 indicates that the majority of receptors are predicted to experience changes in sound level between 0 and 5 dBA, which does not require an assessment of noise controls per Halton Region and MOECC guidelines. The remaining receptors are predicted to experience reductions in sound levels. This is applicable to receptors on the west side of Ninth Line along a section north of Steeles, for which Ninth Line will be widened toward the east, thereby increasing the separation distance between these receptors and the road.

Based on the general predictions for the receptors in the study area, it is estimated that 27 out of the 36 receptors will experience sound levels greater than 60 dBA in the future no-build case, increasing to 29 in the future build scenario. Table 7 summarizes the predicted ranges of sound level for the future no-build and future build general runs. There is a predicted to be an increase in the number of receptors that experience sound levels that exceed 65 dBA under future build conditions, compared to future no-build conditions. One receptor (POR11) is predicted to have a future build sound level exceeding 70 dBA.

The locations with predicted sound levels exceeding 60 dBA may apply to Halton Region for retrofit noise barriers; however, this is unlikely to be successful as barriers are typically only considered for reverse frontage lots. As such, while an investigation of noise control is not strictly required by the Halton Region guideline, it should be considered to avoid excessive sound levels at houses with minimal setbacks.

Table 7 Summary of Predicted Sound Levels for All Receptors

Range of Predicted Change in Sound Level (dBA)	Number of Receptors in Predicted Range	
	Future No-Build	Future Build
45 to 50	0	0
50 to 55	4	1
55 to 60	5	6
60 to 65	19	15
65 to 70	8	13
70 to 75	0	1

6. Conclusions

Halton Region is proposing to widen Ninth Line (Regional Road 13), between Highway 407 and 10 Side Road in Halton Hills, Ontario (the Project) in order to manage future traffic growth. The noise impacts associated with the implementation of the preferred option was assessed through traffic noise modelling. The preferred option consisted of widening Ninth Line about the existing centerline, with several segments instead widened on the east or west side depending on the locations of homes in the area. The assessment of noise impacts was completed in accordance with Halton Region and Provincial guidelines for transportation projects.

Sound levels for the future no-build scenario (i.e., Project does not proceed) and future build scenario (i.e., Project does proceed) were predicted to estimate the impact of the Project. Traffic sound levels were estimated using the MOECC traffic noise modelling method, ORNAMENT, which has been adopted by Halton Region for traffic analysis. Guidelines from Halton Region and the MOECC indicate that noise controls be investigated in instances when the Project under assessment causes sound levels to increase by 5 dBA at any noise sensitive areas.

Sound levels were predicted to increase by less than 5 dBA at all receptors. 10 receptors were predicted to experience a reduction in sound level, as a result of the plans to widen Ninth Line to the east along a section with numerous receptors on the west side. As such, an investigation into noise control is not required per Halton Region and MOECC guidelines.

It should be noted that the number of receptors that experience sound levels exceeding 60 dBA (the threshold for consideration of retrofit noise barriers by Halton Region) is predicted to increase from 27 to 29. The number of receptors that experience sound levels greater than 65 dBA is predicted to increase from 8 to 14 with the Project in place. As applications for retrofit noise control are not likely to be successful since the properties are not reverse-frontage lots, it is recommended that some form of noise control be considered during the detailed design stage.

7. References

[1] Ontario Ministry of the Environment, "Ontario Road Noise Analysis Method for Environment and Transportation: Technical Document," 1989.

[2] Halton Region, "Noise Abatement Guidelines," Halton Region, Oakville, 2014.

[3] Ontario Ministry of the Environment, "Environmental Noise Guideline: Stationary and Transportation Sources - Approval and Planning Publication NPC-300," Queen's Printer for Ontario, 2013.

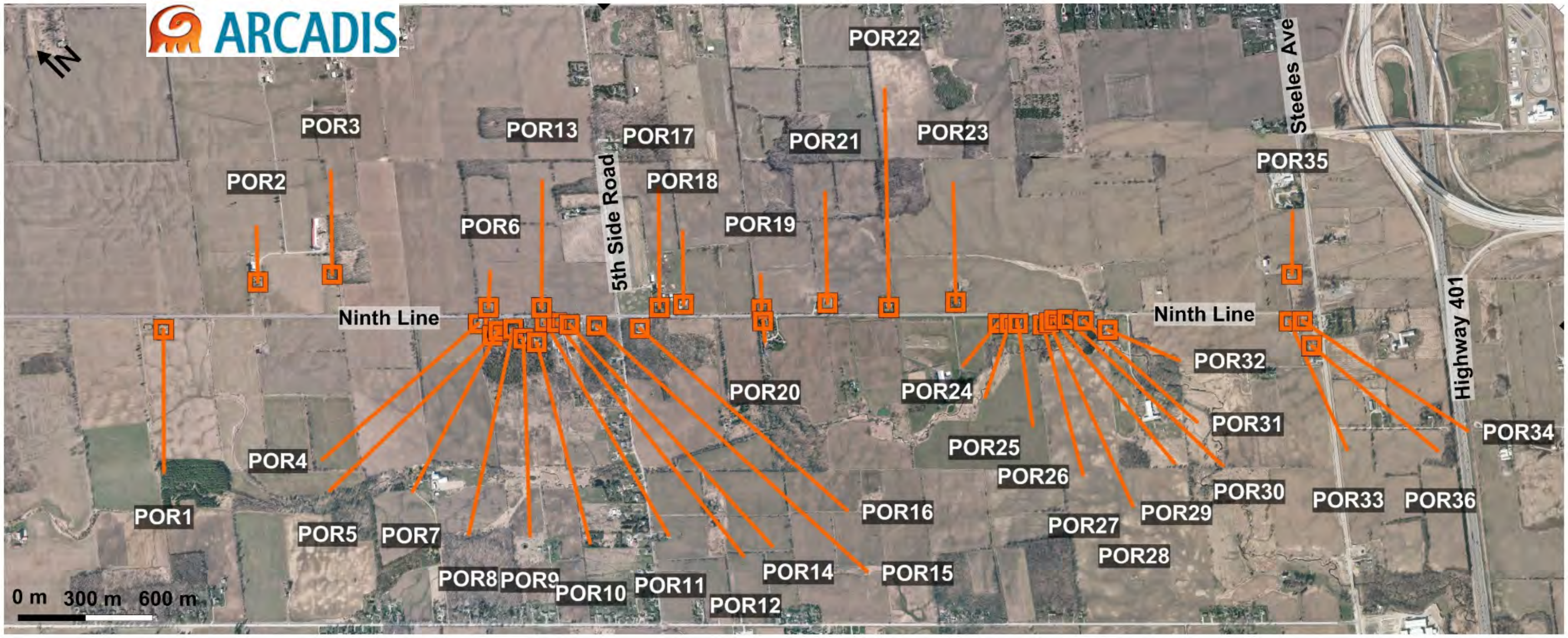
[4] Ontario Ministry of Transportation (MTO), "A Protocol for Dealing With Noise Concerns During the Preparation, Review and Evaluation of Provincial Highway Environmental Assessments," Queen's Printer for Ontario, 1986.

[5] Ontario Ministry of Transportation, "Environmental Guide for Noise (version 1.1)," Provincial and Environmental Planning Office, Ministry of Transportation, St. Catharines, Ontario, 2008.

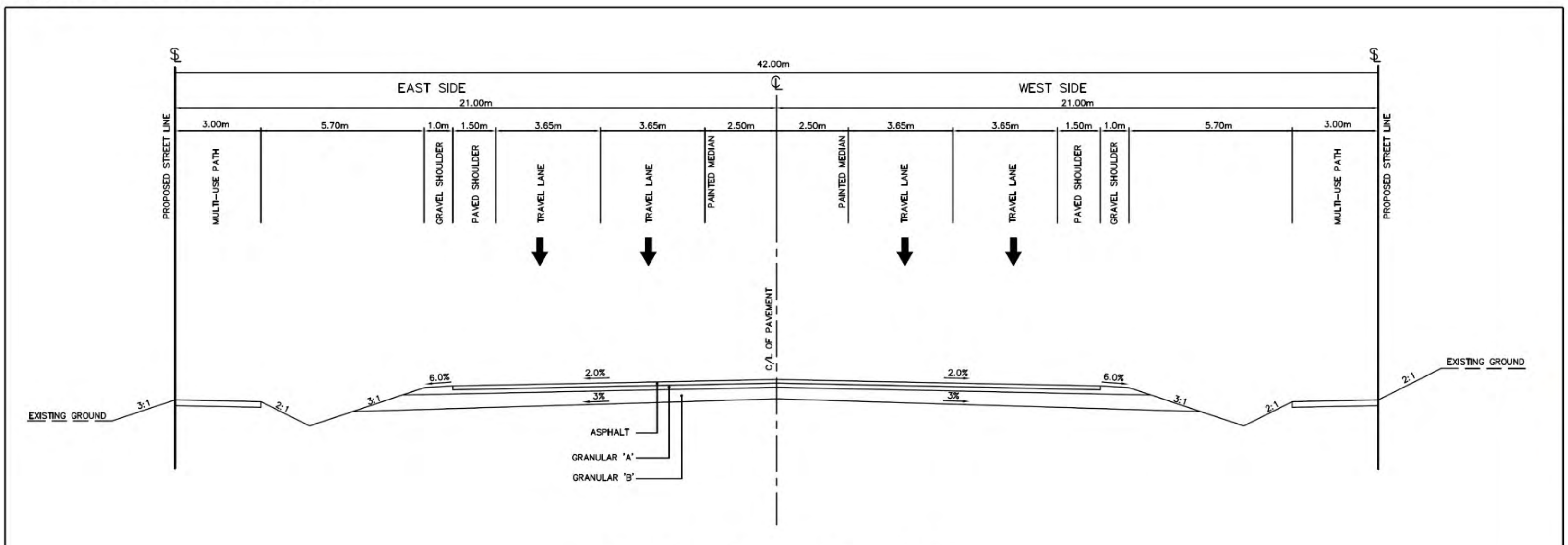
[6] Town of Halton Hills, "Town of Halton Hills Zoning By-Law 2010-0050," Halton Hills, Ontario, 2010 (rev. 2013).

Figures

Plan View



Typical Cross-Section



TYPICAL SECTION 42.0m R.O.W.

LEGEND:

Point of Reception (POR)

NOTES:

SCALE:

see individual drawings

REVISIONS:

No.	Date	By	Revision

REFERENCE:

ARCADIS

Halton Region

Plan and Cross-Sectional Views

Ninth Line (Regional Road 13)
Town of Halton Hills, Ontario

Drawn By:	Approved By:	Figure No.:
NZS	PLA	1
Date: Apr. 2015	Project No.: 351003	

Appendix A

ORNAMENT Calculations

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ORNAMENT Modelling (POR1)

Parameter	Unit	Future No-Build (2031) R.R. 13 NB	Future No-Build (2031) R.R. 13 SB	Future Build (2031) R.R. 13 NB	Future Build (2031) R.R. 13 SB
Assessment Period Information					
Time Period for Assessment	hours	16	16	16	16
Assessment Period Adjustment	**dBA**	**-12.04**	**-12.04**	**-12.04**	**-12.04**
Traffic Volume Information					
Automobiles (vehicles/Time Period)	-	10,193	8,603	14,502	15,936
Medium Trucks (vehicles/Time Period)	-	235	192	335	355
Heavy Trucks (vehicles/Time Period)	-	432	346	615	642
Posted Speed Limit	km/hr	80	80	80	80
Road Gradient	%	0	0	0	0
Reference Sound Level Calculations					
Reference Sound Level - adjusted	**dBA**	**70.17**	**69.30**	**71.70**	**71.98**
Topographical Information					
Topography Scenario (*select*; see notes below)	-	1	1	1	1
1 - flat/gentle slope bewteen source and receiver, no barrier					
Effective Source Height	m	1.41	1.39	1.41	1.40
Receiver Height	m	1.5	1.5	1.5	1.5
Total Effective Height	m	2.9	2.9	2.9	2.9
Distance Adjustment					
Source-Receiver Distance	m	60.7	57.1	65.1	52.8
Intermediate surface type (*select*)	-	Absorptive	Absorptive	Absorptive	Absorptive
Absorption coefficient - alpha	-	0.66	0.66	0.66	0.66
Distance Adjustment - A_d	**dBA**	**-10.08**	**-9.64**	**-10.58**	**-9.07**
Finite Segment Adjustment					
Segment subtend angle 1	deg.	-90	-90	-90	-90
Segment subtend angle 2	deg.	90	90	90	90
Finite Segement Adjustment - A_f	**dBA**	**-1.46**	**-1.46**	**-1.46**	**-1.46**
Pavement Adjustment					
Pavement Surface Type (*select*; see notes below)	-	1	1	1	1
1 - typical asphalt or concrete (use by default)					
Pavement Adjustment	**dBA**	**0.00**	**0.00**	**0.00**	**0.00**
Total Noise from Segment					
Segment Leq	**dBA**	**58.63**	**58.20**	**59.65**	**61.44**
Total Leq for Scenario:		**61.43**		**63.65**	
		Impact of the Project:		2.22	

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ORNAMENT Modelling (POR11)

Parameter	Unit	Future No-Build (2031) R.R. 13 NB	Future No-Build (2031) R.R. 13 SB	Future Build (2031) R.R. 13 NB	Future Build (2031) R.R. 13 SB
Assessment Period Information					
Time Period for Assessment	hours	16	16	16	16
Assessment Period Adjustment	**dBA**	**-12.04**	**-12.04**	**-12.04**	**-12.04**
Traffic Volume Information					
Automobiles (vehicles/Time Period)	-	10,193	8,603	14,502	15,936
Medium Trucks (vehicles/Time Period)	-	235	192	335	355
Heavy Trucks (vehicles/Time Period)	-	432	346	615	642
Posted Speed Limit	km/hr	80	80	80	80
Road Gradient	%	0	0	0	0
Reference Sound Level Calculations					
Reference Sound Level - adjusted	**dBA**	**70.17**	**69.30**	**71.70**	**71.98**
Topographical Information					
Topography Scenario (*select* ; see notes below)	-	1	1	1	1
1 - flat/gentle slope bewteen source and receiver, no barrier					
Effective Source Height	m	1.41	1.39	1.41	1.40
Receiver Height	m	1.5	1.5	1.5	1.5
Total Effective Height	m	2.9	2.9	2.9	2.9
Distance Adjustment					
Source-Receiver Distance	m	25.6	22	28.8	18.8
Intermediate surface type (*select*)	-	Absorptive	Absorptive	Absorptive	Absorptive
Absorption coefficient - alpha	-	0.66	0.66	0.66	0.66
Distance Adjustment - A_d	**dBA**	**-3.85**	**-2.76**	**-4.70**	**-1.63**
Finite Segment Adjustment					
Segment subtend angle 1	deg.	-90	-90	-90	-90
Segment subtend angle 2	deg.	90	90	90	90
Finite Segement Adjustment - A_f	**dBA**	**-1.46**	**-1.46**	**-1.46**	**-1.46**
Pavement Adjustment					
Pavement Surface Type (*select* ; see notes below)	-	1	1	1	1
1 - typical asphalt or concrete (use by default)					
Pavement Adjustment	**dBA**	**0.00**	**0.00**	**0.00**	**0.00**
Total Noise from Segment					
Segment Leq	**dBA**	**64.85**	**65.07**	**65.53**	**68.89**
	Total Leq for Scenario:	**67.97**		**70.54**	
		Impact of the Project:		**2.56**	

ORNAMENT Modelling (POR15)

Parameter	Unit	Future No-Build (2031) RR13 N of 5th NB	Future No-Build (2031) RR13 N of 5th SB	Future No-Build (2031) RR13 S of 5th NB	Future No-Build (2031) RR13 S of 5th SB	Future Build (2031) RR13 N of 5th NB	Future Build (2031) RR13 N of 5th SB	Future Build (2031) RR13 S of 5th NB	Future Build (2031) RR13 S of 5th SB
Assessment Period Information									
Time Period for Assessment	hours	16	16	16	16	16	16	16	16
Assessment Period Adjustment	**dBA**	**-12.04**	**-12.04**	**-12.04**	**-12.04**	**-12.04**	**-12.04**	**-12.04**	**-12.04**
Traffic Volume Information									
Automobiles (vehicles/Time Period)	-	10,193	8,603	9,146	7,917	14,502	15,936	13,013	14,665
Medium Trucks (vehicles/Time Period)	-	235	192	272	190	335	355	387	352
Heavy Trucks (vehicles/Time Period)	-	432	346	440	385	615	642	625	713
Posted Speed Limit	km/hr	80	80	80	80	80	80	80	80
Road Gradient	%	0	0	0	0	0	0	0	0
Reference Sound Level Calculations									
Reference Sound Level - adjusted	**dBA**	**70.17**	**69.30**	**70.11**	**69.41**	**71.70**	**71.98**	**71.64**	**72.09**
Topographical Information									
Topography Scenario (*select* ; see notes below)	-	1	1	1	1	1	1	1	1
1 - flat/gentle slope bewteen source and receiver, no barrier									
Effective Source Height	m	1.41	1.39	1.45	1.46	1.41	1.40	1.45	1.46
Receiver Height	m	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Total Effective Height	m	2.9	2.9	3.0	3.0	2.9	2.9	3.0	3.0
Distance Adjustment									
Source-Receiver Distance	m	43	39.3	43	39.3	46.3	34	46.3	34
Intermediate surface type (*select*)	-	Absorptive	Absorptive	Absorptive	Absorptive	Absorptive	Absorptive	Absorptive	Absorptive
Absorption coefficient - alpha	-	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Distance Adjustment - A_d	**dBA**	**-7.59**	**-6.94**	**-7.59**	**-6.94**	**-8.13**	**-5.90**	**-8.13**	**-5.90**
Finite Segment Adjustment									
Segment subtend angle 1	deg.	-90	-90	65	65	-90	-90	65	65
Segment subtend angle 2	deg.	65	65	90	90	65	65	90	90
Finite Segement Adjustment - A_f	**dBA**	**-1.77**	**-1.77**	**-13.19**	**-13.19**	**-1.77**	**-1.77**	**-13.19**	**-13.19**
Pavement Adjustment									
Pavement Surface Type (*select* ; see notes below)	-	1	1	1	1	1	1	1	1
1 - typical asphalt or concrete (use by default)									
Pavement Adjustment	**dBA**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Total Noise from Segment									
Segment Leq	**dBA**	**60.81**	**60.59**	**49.33**	**49.27**	**61.81**	**64.31**	**50.32**	**52.99**
Total Leq for Scenario:		**64.01**				**66.55**			
						Impact of the Project:		**2.54**	

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ORNAMENT Modelling (POR19)

Parameter	Unit	Future No-Build (2031) R.R. 13 NB	Future No-Build (2031) R.R. 13 SB	Future Build (2031) R.R. 13 NB	Future Build (2031) R.R. 13 SB
Assessment Period Information					
Time Period for Assessment	hours	16	16	16	16
Assessment Period Adjustment	**dBA**	**-12.04**	**-12.04**	**-12.04**	**-12.04**
Traffic Volume Information					
Automobiles (vehicles/Time Period)	-	9,146	7,917	13,013	14,665
Medium Trucks (vehicles/Time Period)	-	272	190	387	352
Heavy Trucks (vehicles/Time Period)	-	440	385	625	713
Posted Speed Limit	km/hr	80	80	80	80
Road Gradient	%	0	0	0	0
Reference Sound Level Calculations					
Reference Sound Level - adjusted	**dBA**	**70.11**	**69.41**	**71.64**	**72.09**
Topographical Information					
Topography Scenario (*select* ; see notes below)	-	1	1	1	1
1 - flat/gentle slope bewteen source and receiver, no barrier					
Effective Source Height	m	1.45	1.46	1.45	1.46
Receiver Height	m	1.5	1.5	1.5	1.5
Total Effective Height	m	3.0	3.0	3.0	3.0
Distance Adjustment					
Source-Receiver Distance	m	23.5	27.2	20.4	30.4
Intermediate surface type (*select*)	-	Absorptive	Absorptive	Absorptive	Absorptive
Absorption coefficient - alpha	-	0.66	0.66	0.66	0.66
Distance Adjustment - A_d	**dBA**	**-3.24**	**-4.29**	**-2.22**	**-5.09**
Finite Segment Adjustment					
Segment subtend angle 1	deg.	-90	-90	-90	-90
Segment subtend angle 2	deg.	90	90	90	90
Finite Segement Adjustment - A_f	**dBA**	**-1.46**	**-1.46**	**-1.46**	**-1.46**
Pavement Adjustment					
Pavement Surface Type (*select* ; see notes below)	-	1	1	1	1
1 - typical asphalt or concrete (use by default)					
Pavement Adjustment	**dBA**	**0.00**	**0.00**	**0.00**	**0.00**
Total Noise from Segment					
Segment Leq	**dBA**	**65.41**	**63.65**	**67.96**	**65.53**
Total Leq for Scenario:		**67.63**		**69.92**	
		Impact of the Project:		**2.29**	

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ORNAMENT Modelling (POR35)

		Future No-Build (2031)						Future Build (2031)									
Parameter	**Unit**	**RR13 NB**	**RR13 SB**	**RR8 E of RR13 EB**	**RR8 E of RR13 WB**	**RR8 W of RR13 EB**	**RR8 W of RR13 WB**	**RR13 NB**	**RR13 SB**	**RR8 E of RR13 EB1**	**RR8 E of RR13 EB2**	**RR8 E of RR13 EB3**	**RR8 E of RR13 WB**	**RR8 W of RR13 EB1**	**RR8 W of RR13 EB2**	**RR8 W of RR13 EB3**	**RR8 W of RR13 WB**
Assessment Period Information																	
Time Period for Assessment	hours	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Assessment Period Adjustment	**dBA**	**-12.04**	**-12.04**	**-12.04**	**-12.04**	**-12.04**	**-12.04**	**-12.04**	**-12.04**	**-12.04**	**-12.04**	**-12.04**	**-12.04**	**-12.04**	**-12.04**	**-12.04**	**-12.04**
Traffic Volume Information																	
Automobiles (vehicles/Time Period)	-	9,146	7,917	12,630	7,253	7,040	4,169	13,013	14,665	14,190	14,190	14,190	10,597	7,910	7,910	7,910	6,092
Medium Trucks (vehicles/Time Period)	-	272	190	392	197	216	110	387	352	440	440	440	287	242	242	242	160
Heavy Trucks (vehicles/Time Period)	-	440	385	751	330	405	193	625	713	844	844	844	483	455	455	455	281
Posted Speed Limit	km/hr	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
Road Gradient	%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reference Sound Level Calculations																	
Reference Sound Level - adjusted	**dBA**	**70.11**	**69.41**	**72.06**	**68.93**	**69.43**	**66.55**	**71.64**	**72.09**	**72.56**	**72.56**	**72.56**	**70.58**	**69.93**	**69.93**	**69.93**	**68.19**
Topographical Information																	
Topography Scenario (*select*; see notes below)	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1 - flat/gentle slope bewteen source and receiver, no barrier																	
Effective Source Height	m	1.45	1.46	1.53	1.44	1.52	1.44	1.45	1.46	1.53	1.53	1.53	1.44	1.52	1.52	1.52	1.44
Receiver Height	m	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Total Effective Height	m	3.0	3.0	3.0	2.9	3.0	2.9	3.0	3.0	3.0	3.0	3.0	2.9	3.0	3.0	3.0	2.9
Distance Adjustment																	
Source-Receiver Distance	m	166.3	170.0	103.4	98.0	103.9	97.7	151.3	163.6	92.6	92.1	90.2	98.0	87.0	82.7	94.3	103.1
Intermediate surface type (*select*)	-	Absorptive	Absorptive	Absorptive	Absorptive	Absorptive	Absorptive	Absorptive	Absorptive	Absorptive	Absorptive	Absorptive	Absorptive	Absorptive	Absorptive	Absorptive	Absorptive
Absorption coefficient - alpha	-	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Distance Adjustment - A_d	**dBA**	**-17.34**	**-17.50**	**-13.91**	**-13.53**	**-13.95**	**-13.51**	**-16.66**	**-17.23**	**-13.12**	**-13.08**	**-12.93**	**-13.53**	**-12.67**	**-12.30**	**-13.25**	**-13.90**
Finite Segment Adjustment																	
Segment subtend angle 1	deg.	-55	-55	-90	-90	61	61	-55.0	-55.0	-90.0	-12.6	24.2	-90.0	61.6	76.7	78.4	60.9
Segment subtend angle 2	deg.	90	90	61	61	90	90	90.0	90.0	-9.4	21.3	60.3	60.7	76.0	79.8	90.0	90.0
Finite Segement Adjustment - A_f	**dBA**	**-2.00**	**-2.00**	**-1.85**	**-1.85**	**-12.13**	**-12.14**	**-2.00**	**-2.00**	**-5.15**	**-7.33**	**-7.90**	**-1.86**	**-13.91**	**-22.20**	**-18.69**	**-12.11**
Pavement Adjustment																	
Pavement Surface Type (*select*; see notes below)	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1 - typical asphalt or concrete (use by default)																	
Pavement Adjustment	**dBA**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Total Noise from Segment																	
Segment Leq	**dBA**	**50.77**	**49.91**	**56.29**	**53.55**	**43.35**	**40.90**	**52.98**	**52.86**	**54.30**	**52.16**	**51.74**	**55.19**	**43.36**	**35.43**	**37.99**	**42.18**
	Total Leq for Scenario:	59.56						61.31									
														Impact of the Project:		1.75	

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Appendix B

STAMSON Output for POR1
(Comparison)

```
STAMSON 5.0        NORMAL REPORT       Date: 24-04-2015 10:49:54
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: POR1_FNB.te            Time Period: 16 hours
Description:                     POR1 Future No Build


Road data, segment # 1: NB
--------------------------
Car traffic volume  : 10193 veh/TimePeriod
Medium truck volume :   235 veh/TimePeriod
Heavy truck volume  :   432 veh/TimePeriod
Posted speed limit  :    80 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

Data for Segment # 1: NB
------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  60.70 m
Receiver height           :   1.50 m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

♀
Road data, segment # 2: SB
--------------------------
Car traffic volume  :  8603 veh/TimePeriod
Medium truck volume :   192 veh/TimePeriod
Heavy truck volume  :   346 veh/TimePeriod
Posted speed limit  :    80 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

Data for Segment # 2: SB
------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  57.10 m
Receiver height           :   1.50 m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

♀
Results segment # 1: NB
-----------------------

Source height = 1.41 m

ROAD (0.00 + 58.63 + 0.00) = 58.63 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-----------------------------------------------------------------------------
   -90     90   0.66  70.17   0.00 -10.08  -1.46   0.00   0.00   0.00  58.63
-----------------------------------------------------------------------------

Segment Leq : 58.63 dBA

♀
```

Results segment # 2: SB

Source height = 1.39 m

ROAD (0.00 + 58.20 + 0.00) = 58.20 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	90	0.66	69.30	0.00	-9.64	-1.46	0.00	0.00	0.00	58.20

Segment Leq : 58.20 dBA

Total Leq All Segments: 61.43 dBA

♀

TOTAL Leq FROM ALL SOURCES: 61.43

♀
♀

```
STAMSON 5.0        NORMAL REPORT        Date: 24-04-2015 10:53:20
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: POR1_FB.te            Time Period: 16 hours
Description:                    POR1 - Future Build


Road data, segment # 1: NB
--------------------------
Car traffic volume  : 14502 veh/TimePeriod
Medium truck volume :   335 veh/TimePeriod
Heavy truck volume  :   615 veh/TimePeriod
Posted speed limit  :    80 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

Data for Segment # 1: NB
------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  65.10 m
Receiver height           :   1.50 m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

♀
Road data, segment # 2: SB
--------------------------
Car traffic volume  : 15936 veh/TimePeriod
Medium truck volume :   355 veh/TimePeriod
Heavy truck volume  :   642 veh/TimePeriod
Posted speed limit  :    80 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

Data for Segment # 2: SB
------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  52.80 m
Receiver height           :   1.50 m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

♀
Results segment # 1: NB
-----------------------

Source height = 1.41 m

ROAD (0.00 + 59.66 + 0.00) = 59.66 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------------
   -90     90   0.66  71.70   0.00 -10.58  -1.46   0.00   0.00   0.00  59.66
----------------------------------------------------------------------------

Segment Leq : 59.66 dBA

♀
```

Results segment # 2: SB

Source height = 1.40 m

ROAD (0.00 + 61.45 + 0.00) = 61.45 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	90	0.66	71.98	0.00	-9.07	-1.46	0.00	0.00	0.00	61.45

Segment Leq : 61.45 dBA

Total Leq All Segments: 63.66 dBA

♀

TOTAL Leq FROM ALL SOURCES: 63.66

♀

♀