HIGHWAY 1 WIDENING AND 216 STREET INTERCHANGE PROJECT

ENVIRONMENTAL NOISE IMPACT ASSESSMENT

PREPARED FOR:

BINNIE

R.F. BINNIE & ASSOCIATES LTD.

MAY 2016

REVISION 1

BKL Consultants in Acoustics

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BKL Consultants in Acoustics

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EXECUTIVE SUMMARY

After being retained by R.F. Binnie & Associates Ltd. (Binnie), BKL Consultants Ltd. (BKL) conducted an environmental noise assessment for the proposed Highway 1 Widening and 216 Street Interchange Project (the Project). The Project includes adding an extra lane in each direction along Highway 1 between 202 Street and 216 Street and building an interchange at 216 Street. The Project is located in Langley, BC.

BKL's environmental noise assessment aimed to

- identify noise-sensitive land uses potentially impacted by Highway 1 traffic noise within the Project construction limits;
- evaluate existing noise conditions at potentially impacted noise-sensitive receivers;
- predict the future noise environment 10 years after Project completion;
- assess the noise impact of the Project according to criteria outlined in the *2014 Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways* (the Policy) published by the Ministry of Transportation and Infrastructure (MOTI);
- identify noise mitigation strategies as warranted by the Policy; and
- provide construction noise best management practices (BMPs).

To predict the attenuation of Project-related noise and assess the impacts of such noise against the Policy criteria, BKL created a 3-D noise model that included

- baseline noise measurements conducted in November 2014 and November 2015;
- existing and projected future traffic volumes, provided by MOTI and Binnie;
- the topography and ground conditions within the Project area, including an existing 3 metre high noise wall south of Highway 1 extending east from 208 Street; and
- the geometry of the new road and interchange alignment.

According to BKL's assessment, predictions and analysis, 187 of 212 residences in the Project area would be affected by Moderate noise impacts, as defined by the Policy criteria. Seven would be affected by Severe noise impacts. Three classrooms in Alex Hope Elementary School would be exposed to noise levels that exceed the maximum one hour equivalent noise levels outlined by the Policy.

In general, BKL predicts that the increase in noise due to the Project would be less than 2 dBA. Most of the predicted Moderate and Severe noise impacts are due to noise exposures that are already very noisy.

BKL recommends considering the following potential mitigation:

- extending the existing noise wall along the Highway 1 right of way to the east until 216 Street;
- building new 5 metre high noise walls along the northern edge of Highway 1 right of way from Yorkson Creek to 216 Street;
- quiet pavement or building facade improvements to offset noise increases and eliminate Severe impacts predicted at residences behind the existing noise wall; and
- building facade and ventilation system improvements at Alex Hope Elementary.

BKL believes that the above noise mitigation would meet the Policy's requirements, but additional analysis may be required to further develop the detailed design.

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List of Abbreviations and Acronyms

Abbreviation/Acronym	**Definition**
AADT	annual average daily traffic
ANSI	American National Standards Institute
μPa	micropascal
Binnie	R.F. Binnie & Associates Ltd.
BKL	BKL Consultants Ltd.
BMP	best management practice
dB	decibel
dBA	A-weighted decibel
ISO	International Standards Organization
km	kilometre
km/h	kilometres per hour
L_d	daytime (7 am to 10 pm) equivalent sound level
L_{dn}	day-night equivalent sound level
L_{eq}	equivalent sound level
L_{eq24}	24-hour equivalent sound level
L_n	nighttime (10 pm to 7 am) equivalent sound level
m	metre
MOTI	British Columbia Ministry of Transportation and Infrastructure
the Project	Highway 1 Widening and 216 Street Interchange Project
the Policy	*2014 Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways*

1 INTRODUCTION

BKL Consultants Ltd. (BKL) has been retained by R.F. Binnie & Associates Ltd. (Binnie) to provide an environmental noise assessment for the proposed Highway 1 Widening and 216 Street Interchange Project (the Project). The Project, being an upgrade of an existing numbered highway, requires a noise impact study to determine the potential need for mitigation according to *2014 Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways* (The Policy) published by the BC Ministry of Transportation and Infrastructure (MOTI).

This report documents existing noise exposure levels measured at several noise-sensitive receiver locations near the Project, the future noise climate predicted 10 years after the completion of the Project, noise impact assessment results and any required noise mitigation options.

2 PROJECT DESCRIPTION

The Project scope includes improvements along Highway 1 in Langley, BC, from 202 Street to 216 Street, a distance of approximately 3.5 km, and along 216 Street north and south of the highway. The area is mainly residential land use and agricultural land reserve with the exception of one school whose property line is adjacent to the highway right-of-way.

The proposed Project includes the widening of Highway 1 from four to six total travel lanes, the construction of a diamond interchange with 216 Street elevated as an overpass and 216 Street road improvements.

3 STUDY OBJECTIVES

BKL's environmental noise study aimed to

- identify noise-sensitive land uses potentially impacted by Highway 1 traffic noise emitting from within the Project construction limits;
- evaluate existing noise conditions at potentially impacted noise-sensitive receivers;
- predict the future noise environment 10 years after Project completion;
- assess the noise impact according to the Policy;
- specify noise mitigation options as warranted by the Policy; and
- provide construction noise best management practices (BMPs).

This study did not include an assessment of potential noise impacts from traffic on 216 Street or a construction noise and vibration impact assessment.

4 ASSESSMENT CRITERIA

The Policy outlines the required methodology for assessing the impact of traffic noise. It also describes mitigation considerations for noise-sensitive land uses adjacent to the new construction or upgrading of a numbered highway. According to the Policy, noise-sensitive land uses include residences; educational facilities, such as schools, preschools and commercial daycare centres;

hospitals; libraries; churches; museums; passive parks and other land uses where quiet and tranquility are essential attributes.

Eligible noise-sensitive land uses must predate the highway project by receiving planning approvals prior to the first public announcement of the highway project or designation (through gazetting) of the affected lands as potential future highway rights-of-way.

4.1 Residences

For residential receivers, the Policy sets noise impact thresholds to identify areas where noise mitigation consideration is warranted. The Policy quantifies its thresholds with the noise metric outdoor day-night average sound Level (L_{dn}). This metric is similar to the 24-hour equivalent sound level (L_{eq24}) but it applies a 10 dBA penalty to nighttime noise to account for the public's greater sensitivity to noise between 10 pm and 7 am.

Post-project (10 years after project completion) noise predictions are compared to pre-project levels in order to rate impacts at the noise-sensitive receivers as either Minor, Moderate, or Severe. Residential receivers within the Moderate and Severe impact zones are considered for mitigation.

4.2 Educational Facilities

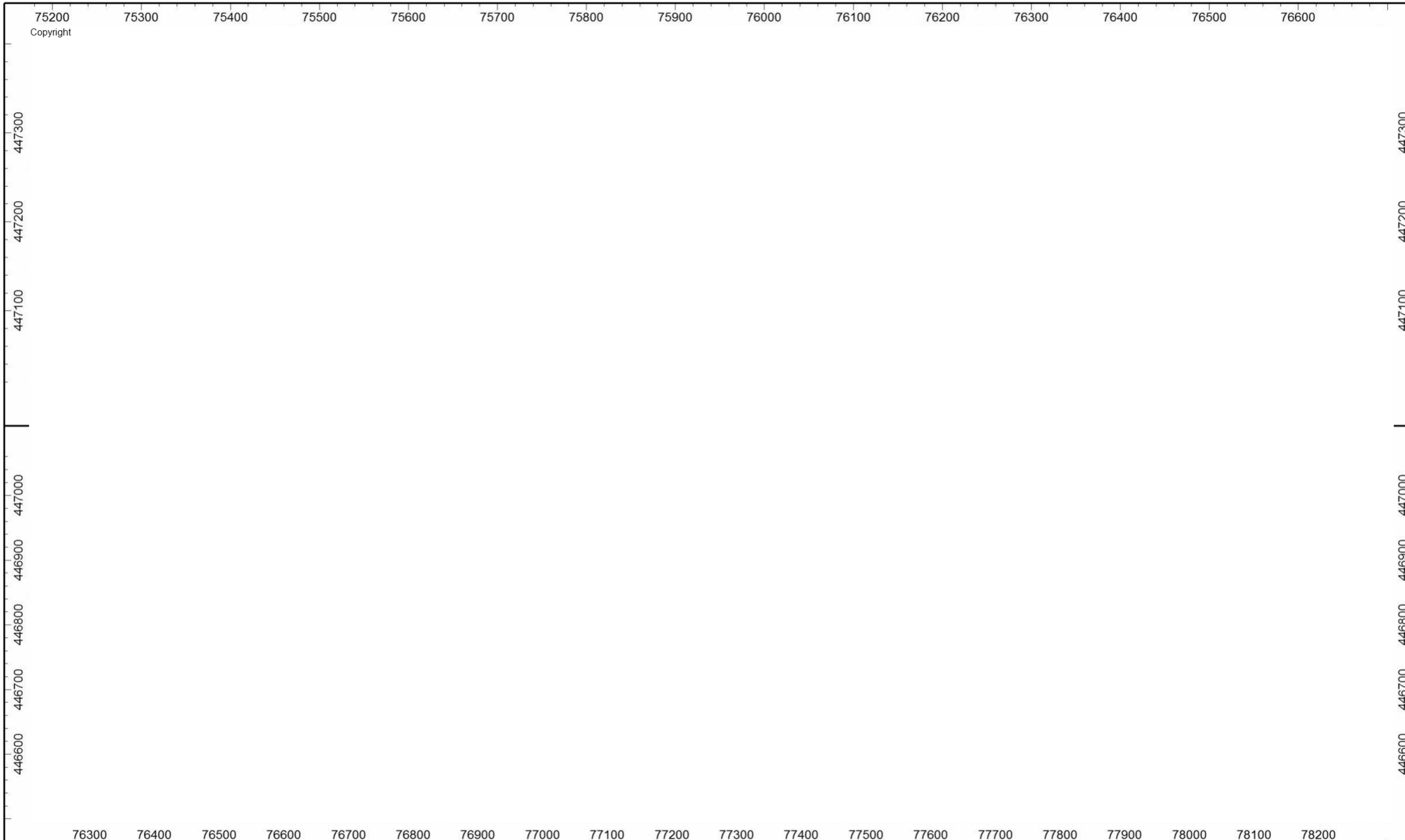
For educational receivers, the Policy sets a criterion based on the loudest one hour equivalent sound level, $L_{eq(max\text{-}hr)}$, inside classrooms. The Policy states:

> *Mitigation measures will be considered at educational facilities where it is anticipated that... the post-project traffic noise levels, ten years after the project completion, will reach Leq(max-hr) 40 dBA inside classrooms or other highly noise sensitive spaces.*

5 STUDY AREA

The study area extends from Yorkson Creek (east of 202 Street) along Highway 1 to 216 Street. Alex Hope Elementary School and the first row of residential houses adjacent to Highway 1 were considered in this assessment. The study area is shown in Figure 5-1.

Within the study area, there are over 200 noise-sensitive land uses, including residences and one school, which could potentially be affected by noise levels that approach or exceed the Policy criteria.



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Highway 1 Widening and 216 Street Interchange Project
Figure 5-1: Noise Impact Study Area

Date: May 2016

6 EXISTING NOISE CONDITIONS

Baseline noise monitoring was conducted to measure the noise exposure at locations along the extent of the Project from November 12-14, 2014. Additional baseline noise measurements were completed at Alex Hope Elementary from November 23-25, 2015.

The monitoring results were used to calibrate a noise model and predict the pre-project noise environment throughout the study area. Figure 6-1 Baseline Measurement Locations shows the locations where baseline monitoring was conducted. Results are presented in Table 6-1.

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Figure 6-1 Baseline Measurement Locations

Table 6-1 Baseline Measurement Results

Site	Location	Pre-Project Noise Level
B01	20617 86A Ave	L_{dn} 64 dBA
B02	20891 84A Ave	L_{dn} 73 dBA
B03	34-8515 209 St	L_{dn} 70 dBA
B04	21069 85 Ave	L_{dn} 61 dBA
B05	Alex Hope Elementary - Classroom S11	$L_{eq(max\text{-}hr)}$ 52 dBA
B06	Alex Hope Elementary - Classroom S15	$L_{eq(max\text{-}hr)}$ 52 dBA
B07	Alex Hope Elementary - Classroom W22	$L_{eq(max\text{-}hr)}$ 51 dBA
B08	8382 211B St	L_{dn} 70 dBA

Site	Location	Pre-Project Noise Level
B09	21464 83B Ave	L_{dn} 70 dBA
B10	21427 83 Ave	L_{dn} 71 dBA
B11	8298 216 St	L_{dn} 71 dBA
B12	8198 216 St	L_{dn} 74 dBA

7 NOISE PREDICTION METHODOLOGY

7.1 Acoustical Model

Transportation noise levels have been predicted using the French standard for road traffic noise prediction, NMPB-Routes-1996 (NMPB 1996), implemented in the outdoor sound propagation software Cadna/A, version 4.6. *The Good Practice Guide for Noise Mapping* points out that this standard is recommended by the European Commission as current best practice to obtain accurate prediction results (WG-AEN 2007).

NMPB-Routes-96 specifies octave band sound power levels for roadways, dependant on traffic volumes, average travel speed, percentage of heavy vehicles (i.e., trucks, buses), road gradient and flow conditions (continuous, accelerating, decelerating vehicles). BKL has found that this standard provides a high level of agreement with traffic noise measurements conducted in BC.

First order reflections were considered in the acoustic model. Model calculations were performed in octave bands, considering ground cover, topography and shielding objects (see following sections).

7.1.1 Ground Absorption

The acoustic properties of the ground surface can have a considerable effect on the propagation of noise. Flat, non-porous surfaces such as concrete, asphalt, buildings, calm water, etc., are highly reflective to noise, and have a ground constant of G=0. Soft, porous surfaces such as foliage, loam, soft grass, fresh snow, etc., are highly absorptive to noise and have a ground constant of G=1.

In order to approximate the ground effect on sound propagation, the ground surface has been modelled as absorptive (G=1) throughout.

7.1.2 Meteorological Conditions

A temperature of 10 °C and relative humidity of 80 per cent were used in the model settings to best represent weather conditions based on the selection available in Cadna/A. Favourable sound propagation was assumed to occur for 50 per cent of the time during the day and 100 per cent of the time during the night.

Variations in temperature and humidity generally have little effect on the overall noise propagation.

7.1.3 Topography and Obstacles

The intervening terrain has been modelled by directly importing ground contours of the area provided by Binnie. Ground contours were imported at a 1 metre elevation resolution.

Building outlines were included in the model from the previous Port Mann / Highway 1 Project.

7.1.4 Roadway Geometry

The existing highway alignment was modelled using aerial photographs from the previous Port Mann / Highway 1 Project.

Future highway, ramp and 216 Street alignments were provided by Binnie.

7.1.5 Traffic Inputs

Pre-project highway traffic data was provided by MOTI and future highway and 216 Street traffic volume predictions were provided by Binnie. Pre-project 216 Street traffic volumes were estimated by BKL.

Table 7-1 lists the increases in annual average daily traffic (AADT) from 2014 to 10 years after the Project's completion date (2029) that were incorporated in the noise model. For modelling purposes, trucks have been conservatively defined as a vehicle of any size or weight with more than two axles.

Table 7-1 Increases from 2014 to 2029 in Annual Average Daily Traffic

Road	Section	2014 AADT	2029 AADT	% Trucks	Modelled speed (km/h)
Highway 1	200 St to 232 St	68464	91515	11	100
216 St	North of Highway 1	20	14420	10	50
	South of Highway 1	4590	17748	10	50
Highway 1 and 216 St Interchange Ramps	216 St to Highway 1 Eastbound on-ramp	-	6734	10	0 to 100
	Highway 1 to 216 St Eastbound off-ramp	-	7407	10	100 to 0
	216 St to Highway 1 Westbound on-ramp	-	5387	10	0 to 100
	Highway 1 to 216 St Westbound off-ramp	-	6060	10	100 to 0

New on- and off-ramps for the 216 Interchange were also included in the future 2029 noise model. Traffic volumes and geometries along the new 216 Street overpass and access to/from Highway 1 were provided by Binnie.

To account for speed variations along the on- and off-ramps, road traffic was corrected for either "accelerating" or "decelerating" noise emissions as traffic was entering or departing Highway 1 respectively. All other road traffic was modelled for "continuous flow" conditions. Roadways were modelled with standard asphaltic pavement, except for elevated roadways (e.g., bridges, overpasses) which were modelled with standard concrete pavement.

7.2 Model Calibration

The noise model was calibrated using the baseline location results described in Section 6. The major noise source is road traffic noise from Highway 1, and was modelled to show accurate correlation between the measurement and the noise model. Side streets and minor city roads were not included in the model. A scaling factor was used so the predicted existing noise levels in the model were within 1 dBA of the measured levels. This factor was also applied to the future traffic volumes.

7.3 Receivers

For all assessments, calculations were performed using point receivers at each noise-sensitive land use identified in the study area, e.g., residences and schools. The first floor receiver height was set at 1.5 metres above the ground for buildings without front walk-up steps, and 2 metres above the ground for buildings with front walk-up steps. Where buildings had more than one storey, a second receiver was placed 2.8 metres directly above the first floor receiver. A total of 391 residential receivers were included in this study, representing 212 distinct residences: 212 for the first floor and 179 for the second floor. Three receivers were placed outside the highest noise-exposed classrooms at Alex Hope Elementary.

Average noise contours were predicted on 10 metre by 10 metre grids at a height of 1.5 metres. Figure 7-1 shows an example 3-D view of receivers placed on building facades.

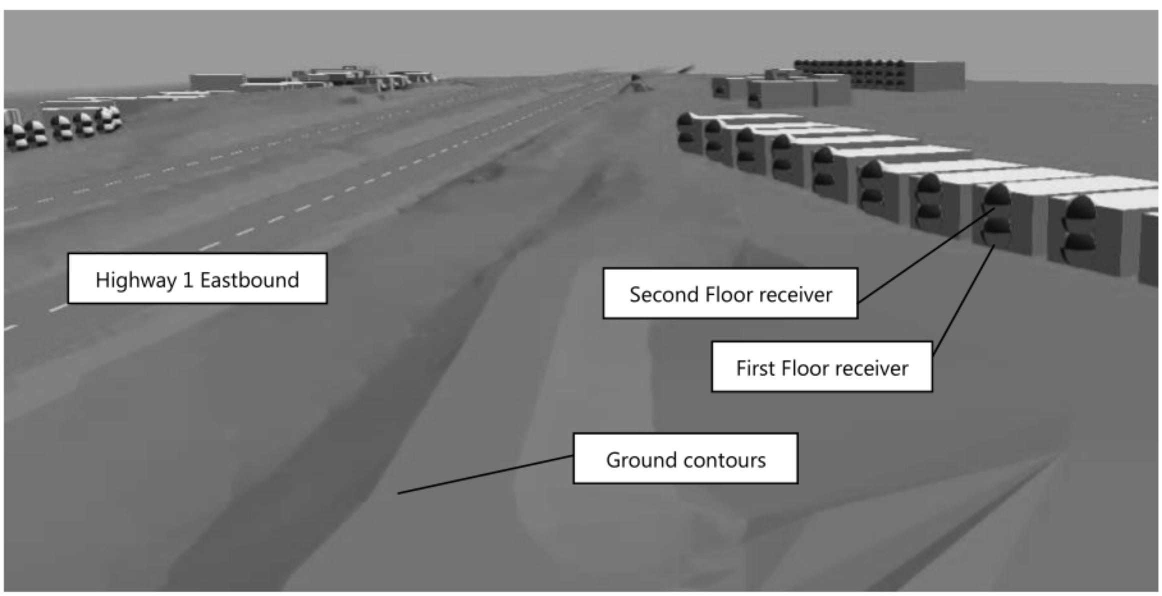

Figure 7-1 Example 3-D view of noise source, ground contours and receivers

8 EXISTING NOISE PREDICTION RESULTS

Figure 8-1 shows a contour plot of predicted existing L_{dn} traffic noise levels. Calculated results in tabulated form at individual receivers are available in Appendix D. The graphical contours are based on interpolation of predictions made on a 10 metre by 10 metre grid at a height of 1.5 metres above the ground. The predictions for individual receivers are based on specific coordinates of each point; therefore, the tabulated levels should be taken as more accurate in the event of any discrepancies.

75200 75300 75400 75500 75600 75700 75800 75900 76000 76100 76200 76300 76400 76500 76600

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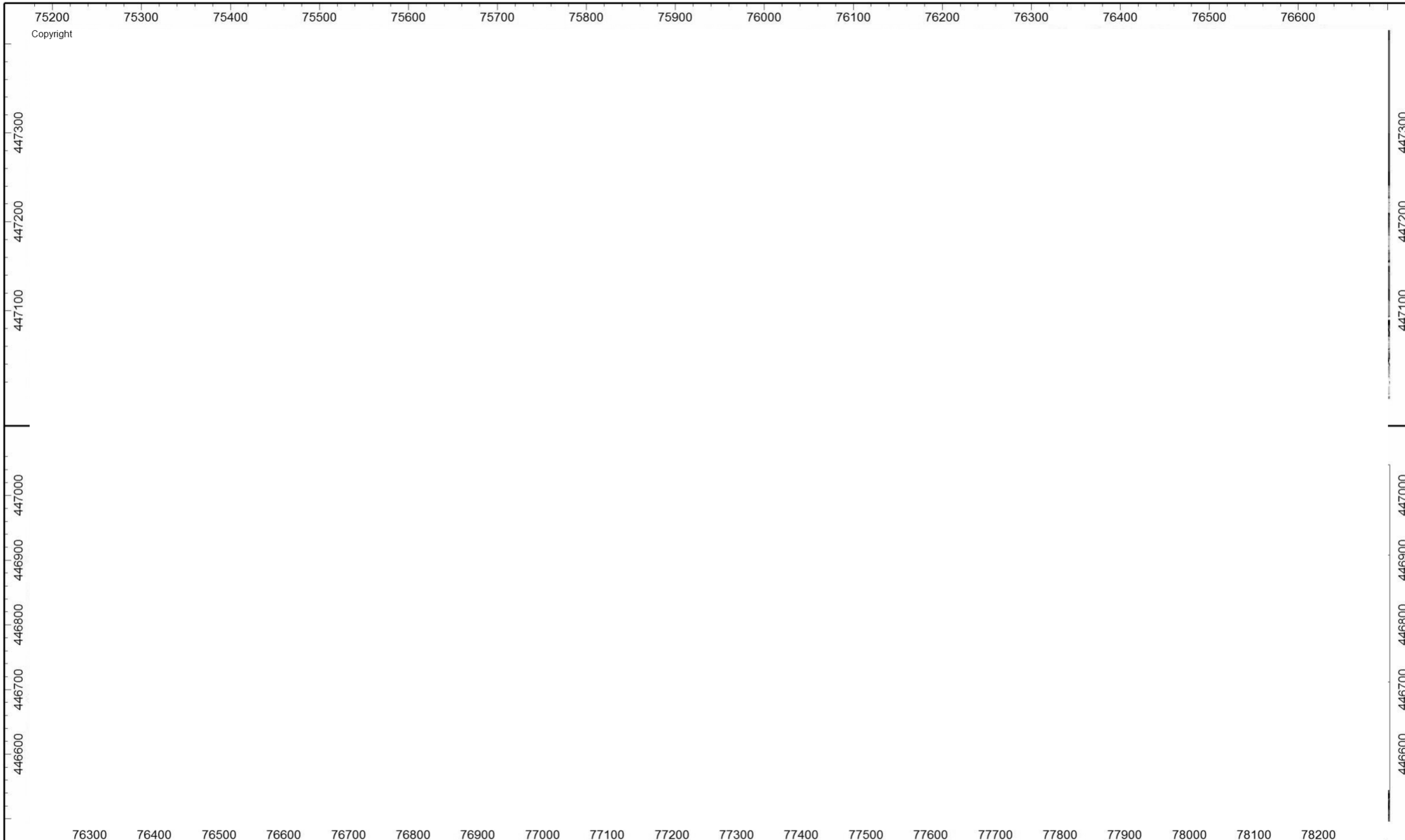
Highway 1 Widening and 216 Street Interchange Project
Figure 8-1: Predicted Existing Noise Contours

Date: May 2016

9 FUTURE NOISE PREDICTION RESULTS

Figure 9-1 shows a contour plot of predicted future L_{dn} traffic noise levels. Calculated results in tabulated form at individual receivers are available in Appendix D. The graphical contours are based on interpolation of predictions made on a 10 metre by 10 metre grid at a height of 1.5 metres above the ground. The predictions for individual receivers are based on specific coordinates of each point; therefore, the tabulated levels should be taken as more accurate in the event of any discrepancies.



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Highway 1 Widening and 216 Street Interchange Project

Figure 9-1: Predicted Future Noise Contours

Date: May 2016

10 NOISE IMPACT ASSESSMENT

10.1 Noise Impact Assessment at Residences

For the purpose of this noise impact assessment, the study area has been broken down into six separate zones, grouped geographically. Table 10-1 summarizes the number of residences and impacts in each assessment zone as indicated in Figure 5-1. Each residence has a first floor receiver, and, where applicable, second floor receiver. The charts in Figure 10-1 show a graphical comparison of project noise to the Policy in each zone. These figures offer an overview and allow for a quick comparison of the noise impact at the first floor versus the second floor. Appendix C breaks down the Policy into each assessment zone. Detailed tabulated results for each receiver are presented in Appendix D.

In general, the increase in total L_{dn} noise levels is less than 2 dBA. However, the Policy assigns a Moderate impact if the future noise environment is predicted to be 65 dBA or greater, regardless of any increase. Most of the Moderate impacts are a result of a predicted baseline L_{dn} of 65 dBA or greater.

The seven Severe impacts are located at the second floor of residences in zone RS2 behind the existing 3 metre noise wall. The predicted existing L_{dn} at these receivers is 74 dBA and the predicted future noise levels of 76 dBA constitute a Severe impact. It is noted that the existing noise wall was developed under the previous MOTI noise policy which only considered ground floor receivers and limited noise wall heights to 3 metres.

Table 10-1 Noise Impact Assessment Summary for Residences

Zone	Extent	Number of Residences	Number of Moderate Impacts	Number of Severe Impacts
RN1	Residences north of Highway 1 and west of 208 Street overpass to 206 Street	26	25	0
RN2	Residences north of Highway 1 between 208 Street overpass and Alex Hope Elementary School	41	38	0
RN3	Residences north of Highway 1 between Alex Hope Elementary School and 216 Street	44	34	0
RS1	Residences south of Highway 1 and west of 208 Street overpass to 205B Street	27	27	0
RS2	Residences south of Highway 1 and east of 208 Street overpass behind existing 3 m high noise wall	69	59	7
RS3	Residences south of Highway 1 west of 216 Street not covered by existing noise wall	5	4	0
	Total	212	187	7

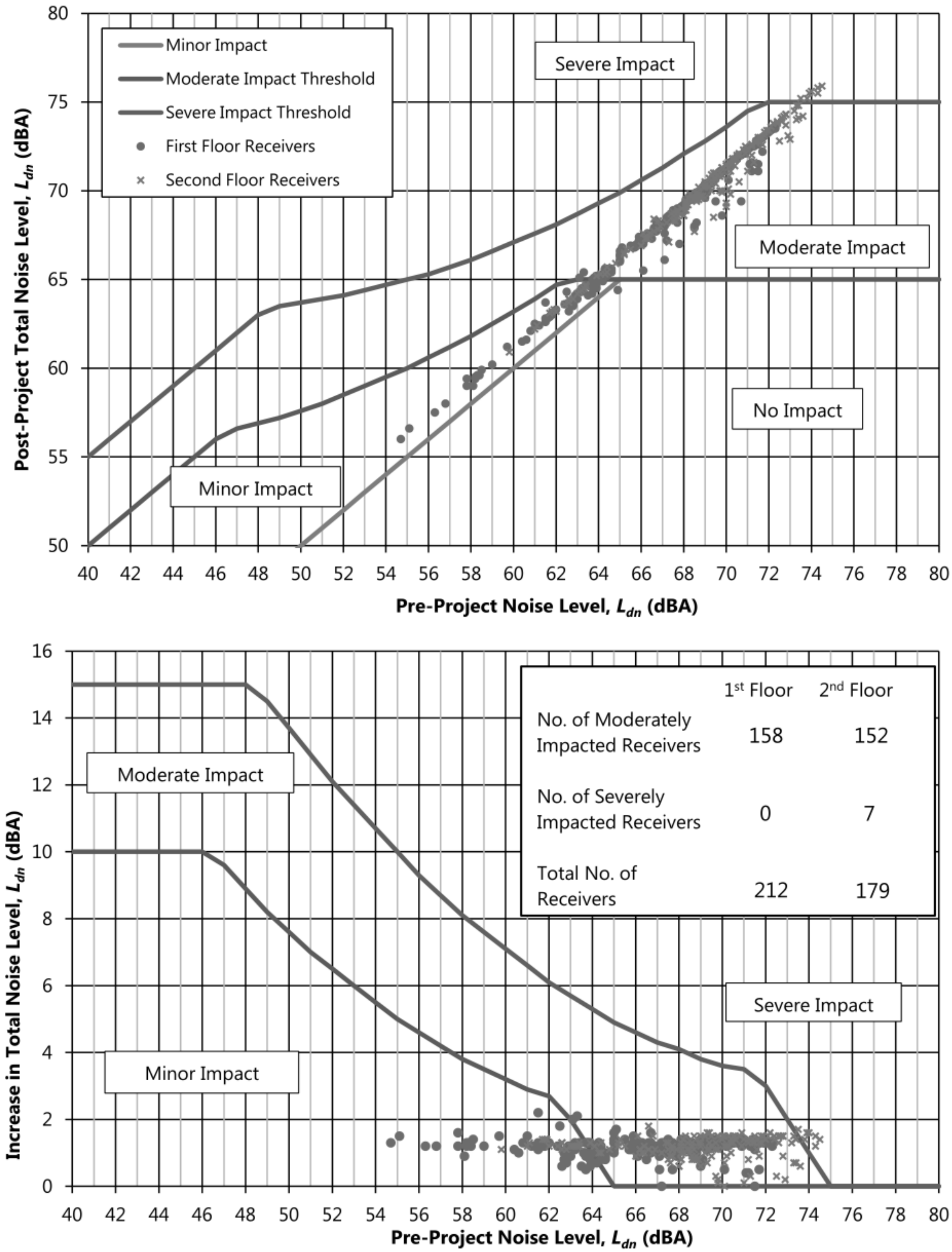

Figure 10-1 Comparison of Pre and Post Project Noise (top) and Increase in Noise (bottom)

10.2 Noise Impact Assessment at Schools

Table 10-2 summarizes the level of impact at the three classrooms identified as the most noise sensitive.

Table 10-2 Noise Impact Assessment at Alex Hope Elementary School

Classroom	Baseline $L_{eq(max\text{-}hr)}$ (dBA)	Predicted 2024 $L_{eq(max\text{-}hr)}$ (dBA)	Meets 40 dBA Criterion?	Exceedance (dBA)
S11	52	53	No	13
S15	52	53	No	13
W22	51	52	No	12

11 TRAFFIC NOISE MITIGATION STRATEGIES

According to the Policy, the main objective of noise mitigation is to reduce the total noise exposure at affected residences by at least 5 dBA and to reduce classroom noise levels to 40 dBA.

In general, noise mitigation options include

- constructing noise walls or earth berms;
- using low-noise/quiet pavements on roadways;
- controlling noise at the receiver by upgrading facades and/or windows where residential unit density is low;
- improving HVAC in classrooms to eliminate the need to open windows where open windows are currently required; and
- reducing vehicle speeds.

South of Highway 1 and east of 208 Street, there is an existing noise wall that is 3 metres high. BKL is not aware of any practical means of improving the performance of existing noise walls.

Binnie provided four preliminary noise wall alignments:

1. to the north of Highway 1 from Discovery Town Park to 208 Street;
2. to the south of Highway 1 between Yorkson Creek to 208 Street;
3. to the north of Highway 1 between 208 Street and 216 Street; and
4. an extension of the eastern edge of the existing noise wall toward the new off-ramp at 216 Street.

The Policy gives benchmark mitigation cost guidelines for residential units that are directly benefiting from the noise mitigation based on the noise impact situation for that unit. The Policy states:

> *[The] benchmark mitigation cost guideline … [is] $25,000 per directly-benefiting residential unit in Moderate noise impact situations, and $40,000 per directly-benefiting residential unit in Severe noise impact situations.*

The Policy also gives a height restriction of 5 metres on any noise wall constructed.

Based on Section 10, the total number of residential units in Moderate and Severe noise impact situations is 187 and 7 respectively, which gives a mitigation budget of $5 million. Assuming an installed cost of $300 per square metre of noise wall, 16,500 square metres of noise wall could be constructed while meeting the Policy's cost guideline.

Table 11-1 shows the noise wall geometry required in order to provide a noise benefit of at least 5 dBA at most ground floor receivers and resulting noise wall cost estimates.

Table 11-1 Proposed Noise Wall Summary

Wall No.	Benefiting Receiver Zone	Wall Length (m)	Modelled Wall Height (m)	Estimated Installed Cost	Average Noise Benefit at Fronting Residences	
					First Floor (dBA)	Second Floor (dBA)
1	RN1	550	5	$825,000	5	4
2	RS1	580	5	$870,000	4	2
3	RN2	1,660	5	$2.5 million	5	2
	RN3				7	4
4	RS3	500	3	$450,000	5	N/A

BKL's preliminary estimates show that building noise barriers would generally be effective for ground floor receivers, except at residences within zone RS1. For these residences, effective mitigation would likely be achievable if the noise wall alignment was outside the right of way along the existing multi-use path; otherwise, a noise wall west of 208 Street is not recommended and alternative measures could be pursued.

The existing residences in zone RS3 are either single storey houses, or otherwise behind the proposed 216 Street off-ramp, such that a 3 metre wall height should be sufficient to comply with the policy.

The proposed noise walls would not sufficiently limit noise levels for most upper level receivers. Figure 11-1 shows predicted noise contours at a height of 1.5 metres above the ground with the proposed noise walls in place.

The average predicted noise benefit at Alex Hope Elementary is 4 dBA. In the three worst-case classrooms, this benefit would result in a noise level of 48-49 dBA, which still exceeds the Policy's 40 dBA criterion. Therefore, additional facade improvements would be required to meet the Policy criterion. These improvements include

- eliminating the classroom wall vents; and
- providing mechanical ventilation so windows can stay closed during the summer.

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Highway 1 Widening and 216 Street Interchange Project
Figure 11-1: Predicted Future Noise Contours with Proposed Barriers

Date: May 2016

12 CONSTRUCTION NOISE BEST MANAGEMENT PRACTICES

Construction noise also has the potential to significantly affect the surrounding noise-sensitive land uses. Best management practices (BMPs) should be implemented to minimize the impact of construction noise during the Project. Noise impact minimization generally involves

- actively communicating with affected residents,
- managing and educating construction personnel to minimize noise emissions at the source.

The effectiveness of BMPs for construction activities depend on site-specific conditions and proposed construction methodologies. With this in mind, consider implementing as many BMPs as practical for the Project.

The following BMPs should be considered for the Project:

- Use equipment or processes that have additional noise control features, including high-performance mufflers and enclosures on diesel- or gas-powered equipment or exhaust silencers on air tools.
- Regularly maintain all equipment, including lubricating applicable components and replacing worn parts.
- Operate equipment at minimum engine speeds consistent with effective operation.
- Educate construction personnel (site supervisors, foremen, equipment operators, etc.) regarding particular noise issues and train workers to operate equipment as quietly as possible.
- Avoid unnecessary idling, revving, use of airbrakes and banging of tail gates and front end loader buckets.
- Turn off equipment when not in use.
- Where practicable, use alternative back-up warning systems such as white noise reversing alarms instead of tonal beepers.
- Where practicable, locate stationary work stations as far away as possible from noise-sensitive receivers.
- Schedule construction activities and limit equipment usage times to minimize noise, especially during nighttime hours and near sensitive receivers.
- Where possible, schedule periods of respite during noisy construction activities.
- Where noise-sensitive receivers are affected, install temporary noise barriers or enclosures to block construction equipment noise (would typically need to block line-of-sight from the top of the machine to affected residents to be effective), and/or take action to reduce noise at the source such as laying rubber matting on dump truck beds to minimize impact noise when loading rubble, etc.
- Develop a procedure to handle noise complaints that includes a plan to document and investigate complaints and target timeframes to respond to complaints.

- Develop and implement a community consultation and communication plan to ensure the community is aware of and prepared for scheduled construction activities and planned road closures.

13 CONCLUSIONS AND RECOMMENDATIONS

BKL Consultants Ltd. was retained by R.F. Binnie & Associates Ltd. to conduct a noise impact assessment for the Highway 1 Widening and 216 Street Interchange Project. The noise impact assessment was completed by performing a baseline noise survey, modelling baseline and future noise levels, rating future noise levels using the MOTI Policy and reviewing potential mitigation strategies.

The analysis concluded that out of 212 residences, there are 187 residences with a Moderate noise impact and seven with a Severe noise impact. Three classrooms in Alex Hope Elementary School were also shown to exceed the maximum one hour equivalent noise levels outlined by the Policy. In general, the increase in noise is predicted to be less than 2 dBA; all predicted noise impacts are due to noise exposures that are already very noisy.

Mitigation strategies include, but are not limited to

- building a noise wall that is 5 metres high and 550 metres long along the north side of Highway 1 between Discovery Town Park and 208 Street;
- building a noise wall that is 5 metres high and 1,660 metres long along the north side of Highway 1 between 208 Street and 216 Street;
- building a noise wall that is 3 metres high and 500 metres long, extending from the existing noise wall on the south side of Highway 1 to 216 Street;
- using quiet pavement;
- building facade improvements at residences; and
- building facade and ventilation system improvements at Alex Hope Elementary.

It appears that the above noise mitigation would meet the Policy's cost recommendations. A proposed 5 metre high noise wall alignment south of Highway 1 between Yorkson Creek and 208 Street was modelled but it did not demonstrate an adequate benefit to fronting residences and therefore is not recommended. Further analysis may be required to further develop the detailed design.

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APPENDIX A GLOSSARY

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

ambient/existing level – The pre-project noise or vibration levels.

critical ratio (CR) - The ratio between the power in the pure tone at threshold and the power per hertz (spectrum level) of the background noise.

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

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

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

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

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

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

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

metric – Measurement parameter or descriptor.

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

noise-sensitive receivers – A place occupied by species with a high sensitivity to noise.

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

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

sound power – The total sound energy radiated by a source per unit time.

APPENDIX B INTRODUCTION TO SOUND AND ENVIRONMENTAL NOISE ASSESSMENT

B.1 General Noise Theory

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

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

B.2 Basic Sound Metrics

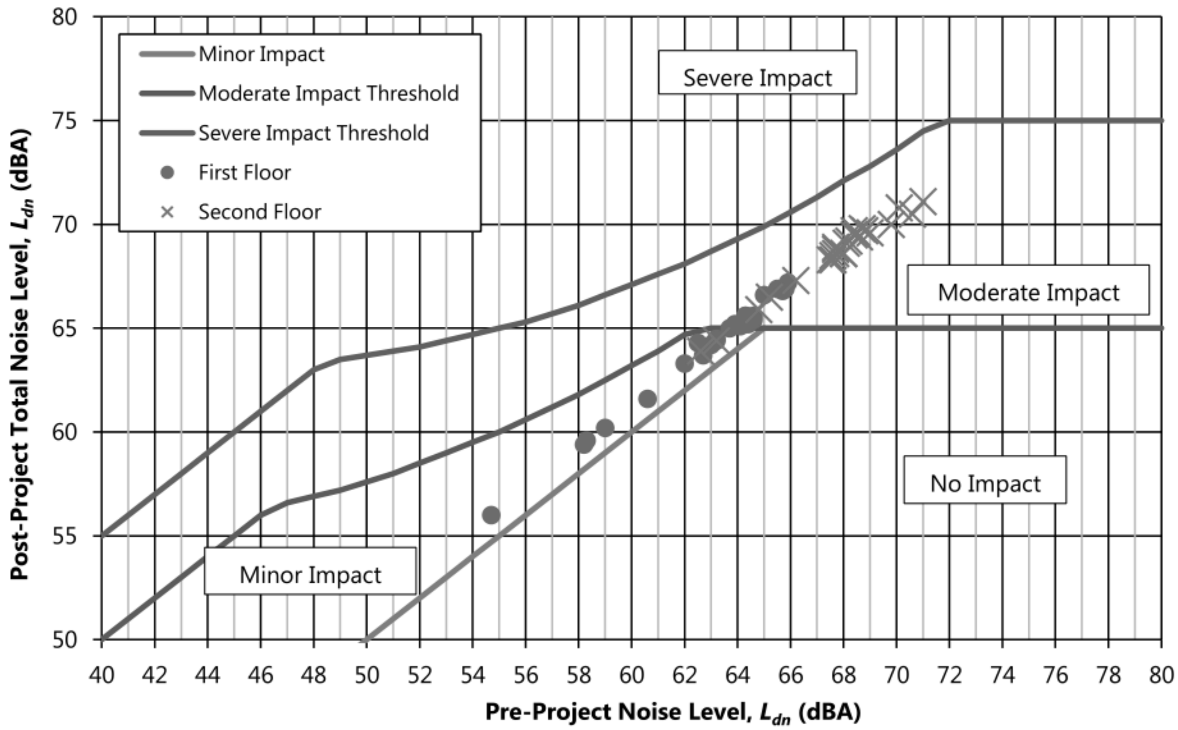
While the decibel, or A-weighted decibel, is the basic unit used for noise measurement, other indices are also used to describe environmental noise. The equivalent sound level, abbreviated L_{eq}, is commonly used to indicate the average sound level over a period of time. The L_{eq} represents the steady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

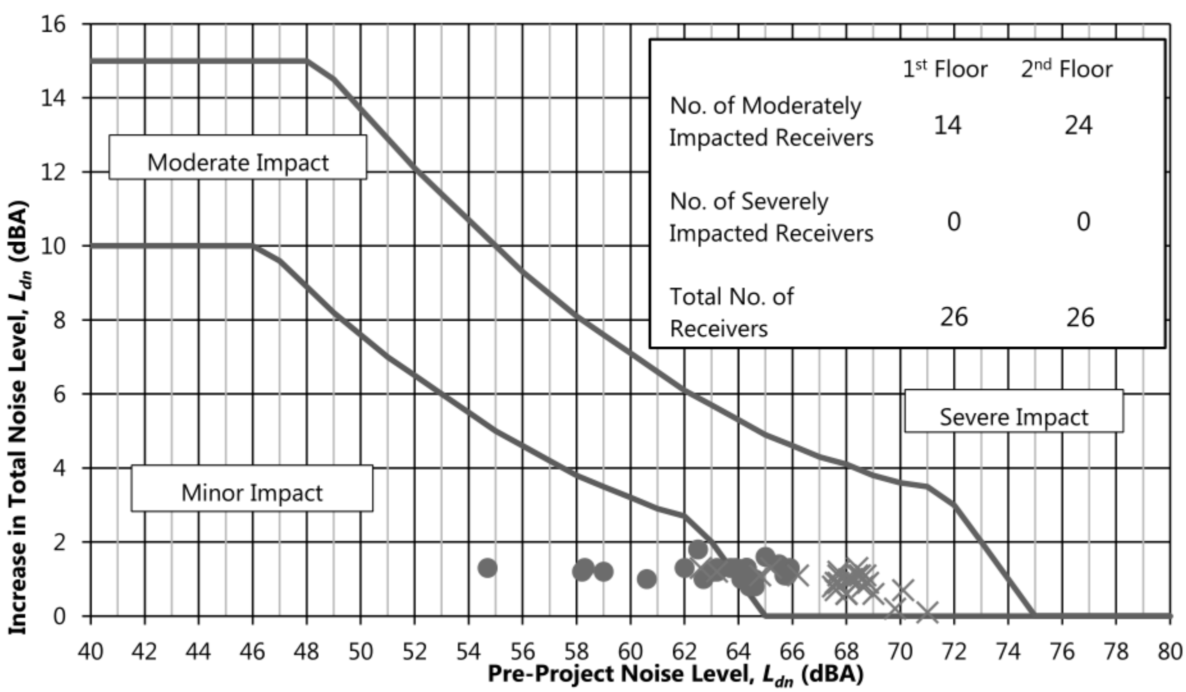
The L_{eq} can be measured over any period of time using an integrating sound level meter. Some common time periods used are 24 hours, noted as the L_{eq24}, daytime hours (7 am to 10 pm), noted as the L_d, and nighttime hours (10 pm to 7 am), noted as the L_n. As the impact of noise on people is judged differently during the day and during the night, 24-hour noise metrics have been developed that reflect this.

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

APPENDIX C NOISE IMPACT ASSESSMENT CHART DETAILS

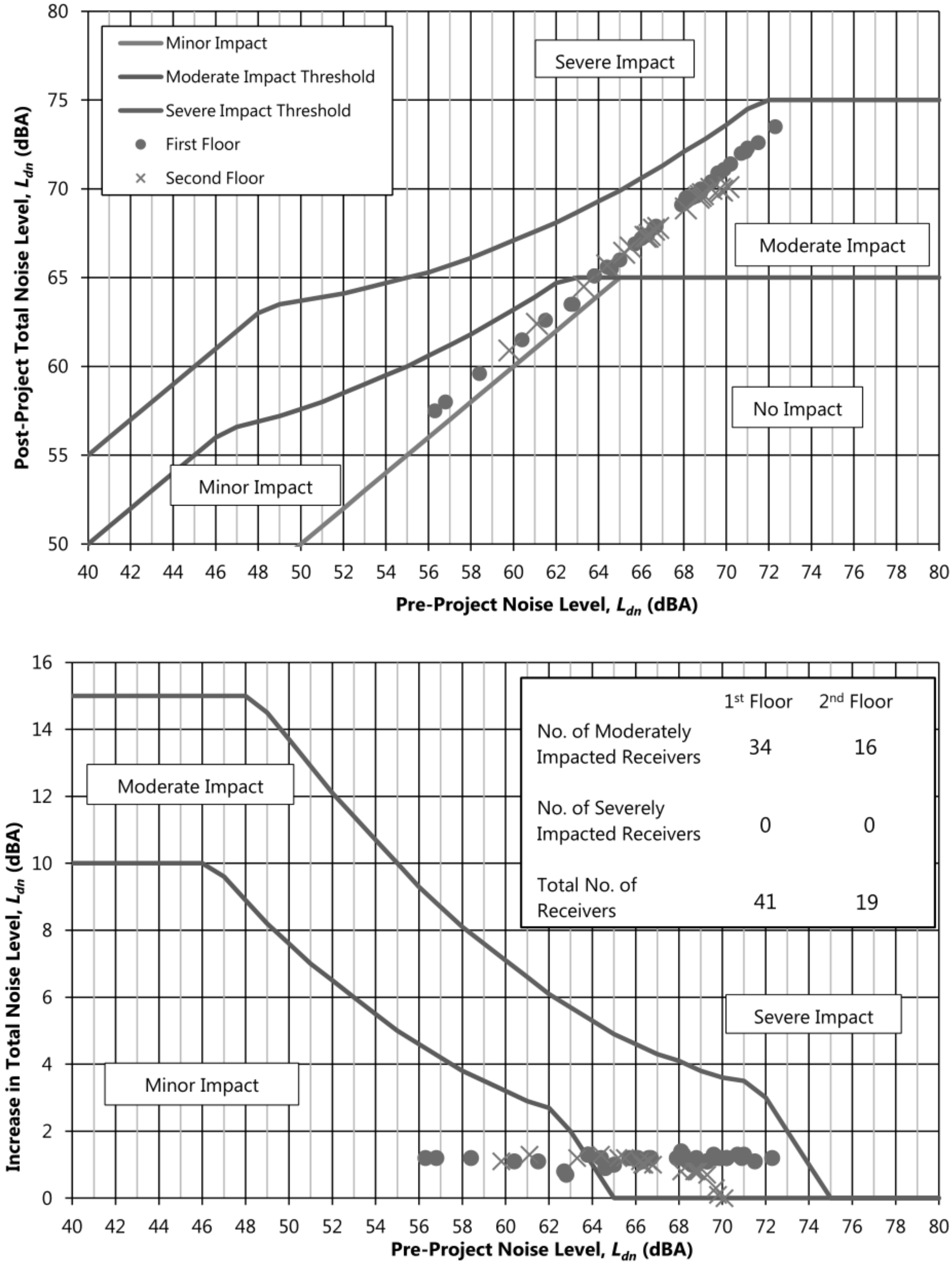
The following charts compare pre and post project road traffic noise at receivers in each assessment zone as described in Figure 5-1.





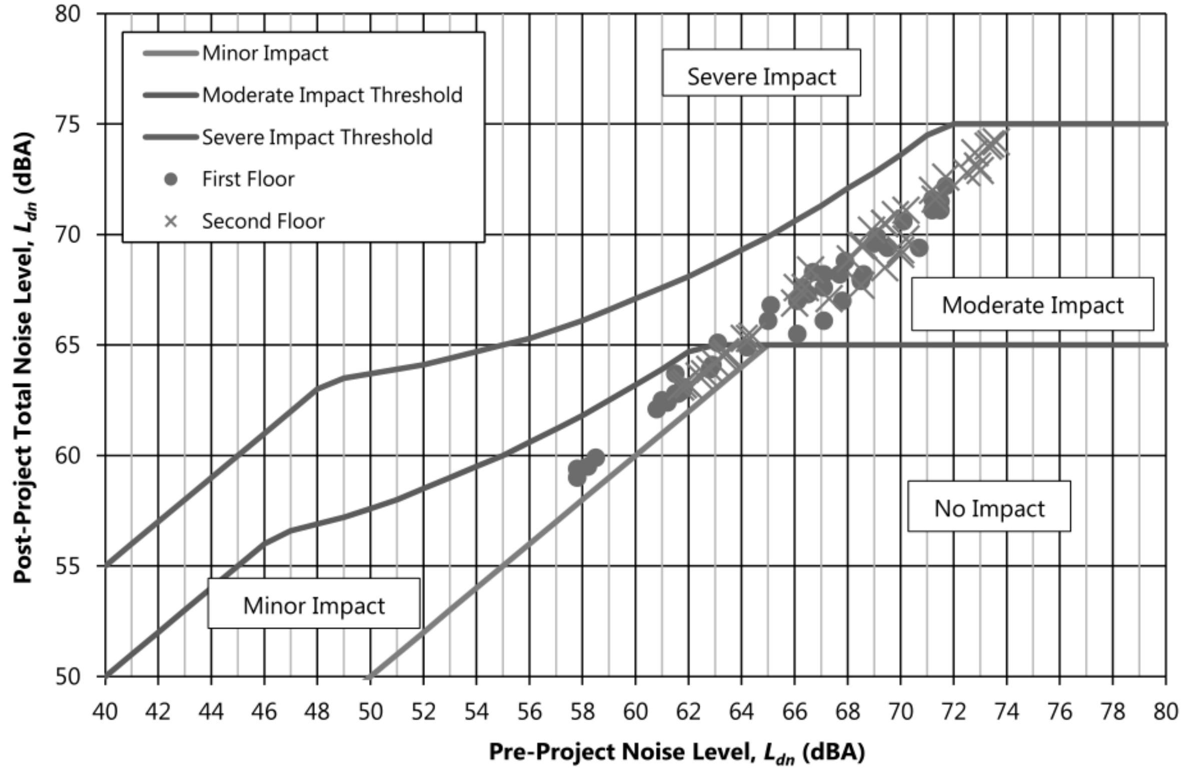
	1st Floor	2nd Floor
No. of Moderately Impacted Receivers	14	24
No. of Severely Impacted Receivers	0	0
Total No. of Receivers	26	26

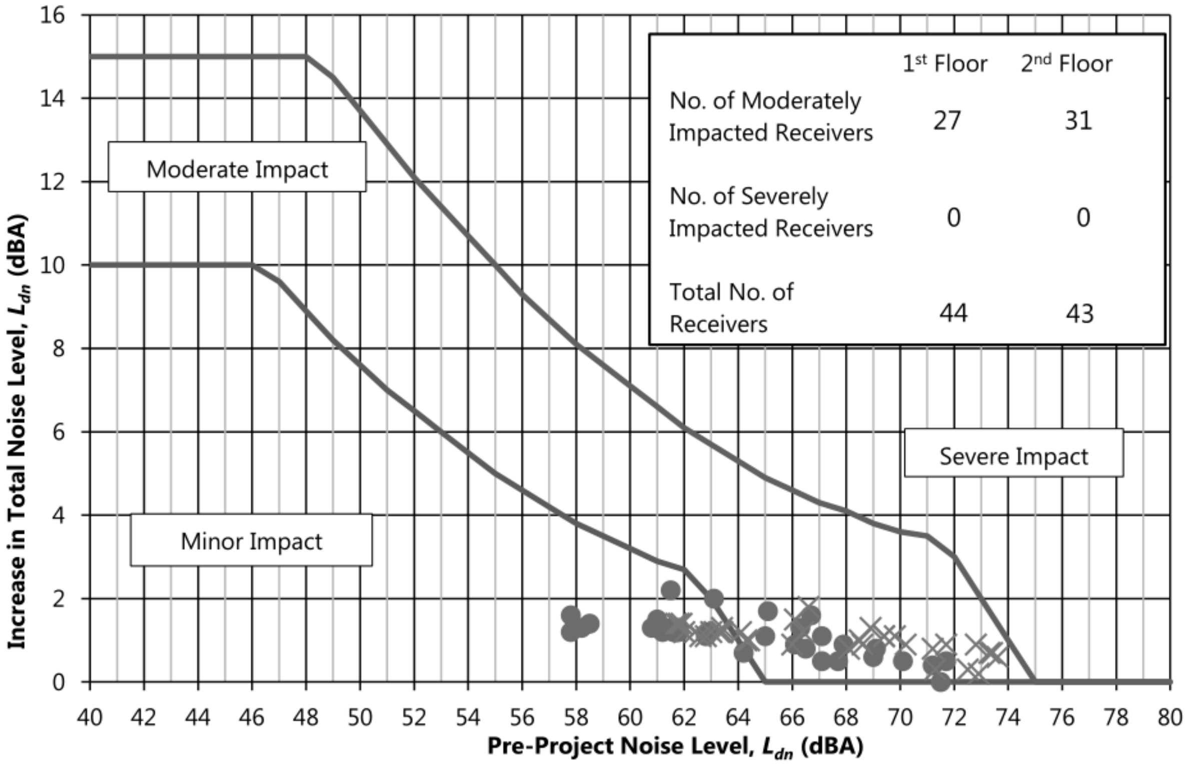
RN1 Comparison of Pre and Post Project Noise (top) and Increase in Noise (bottom)



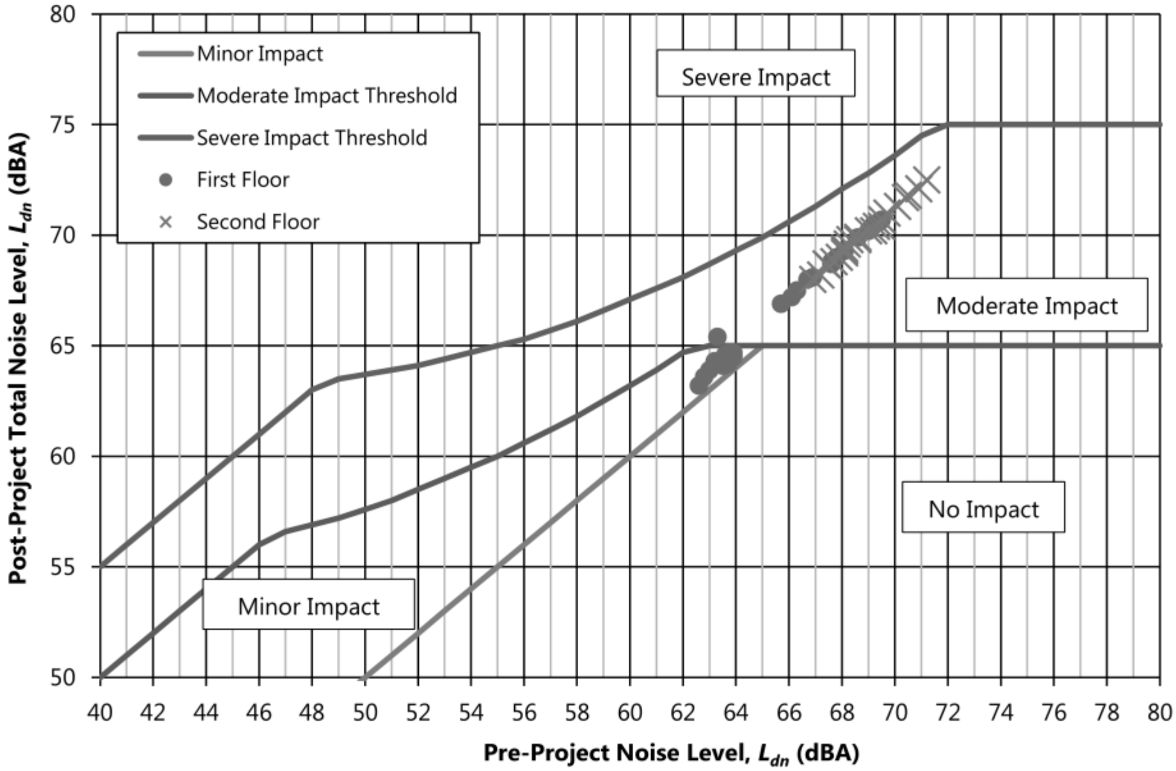
	1st Floor	2nd Floor
No. of Moderately Impacted Receivers	34	16
No. of Severely Impacted Receivers	0	0
Total No. of Receivers	41	19

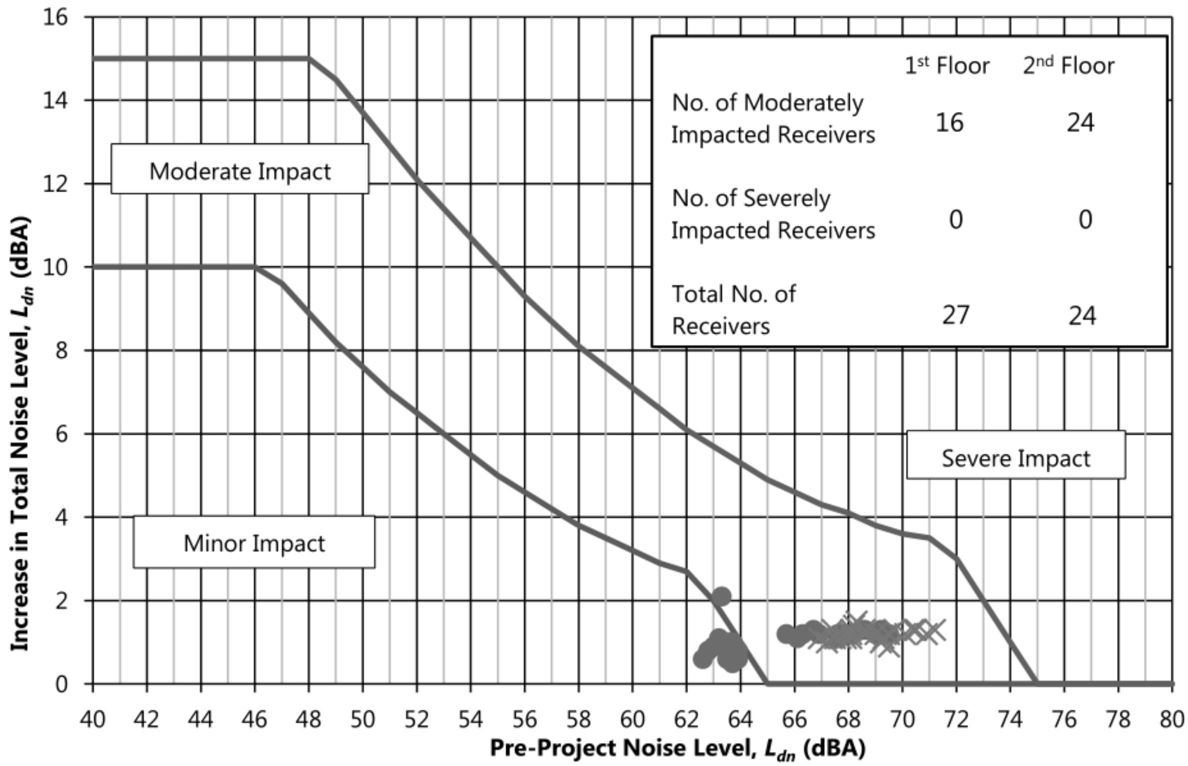
RN2 Comparison of Pre and Post Project Noise (top) and Increase in Noise (bottom)



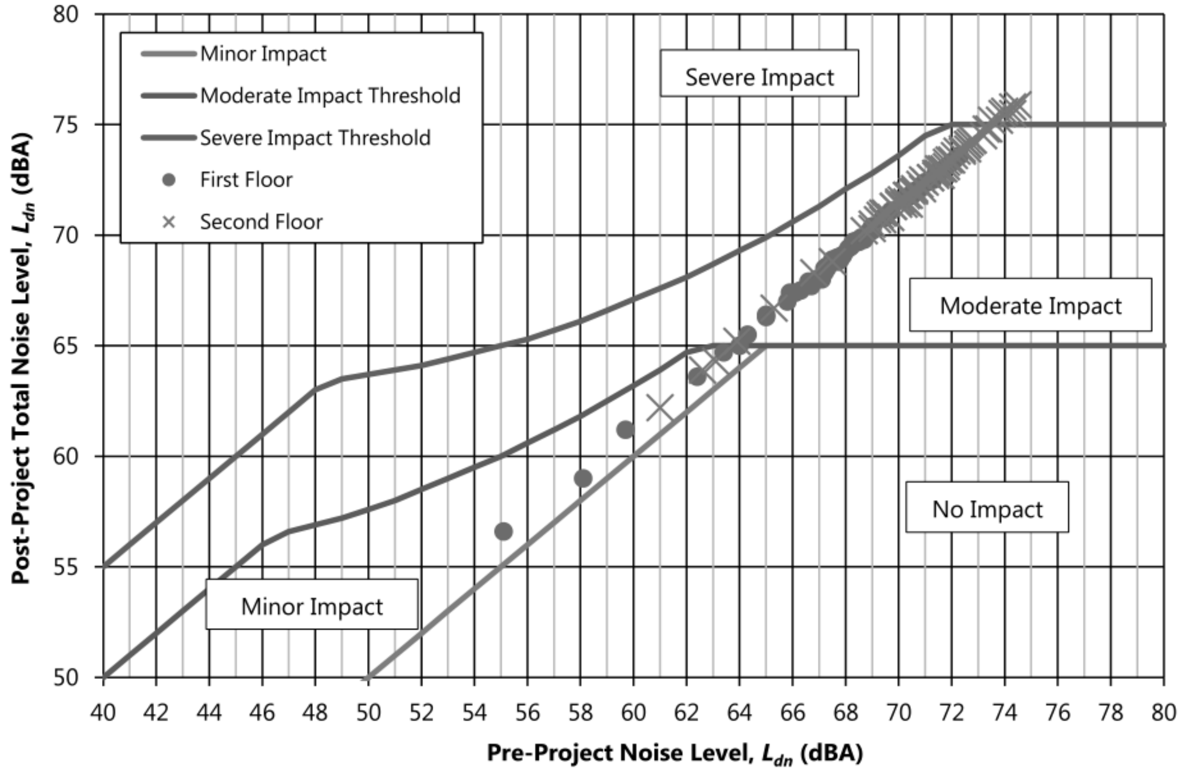


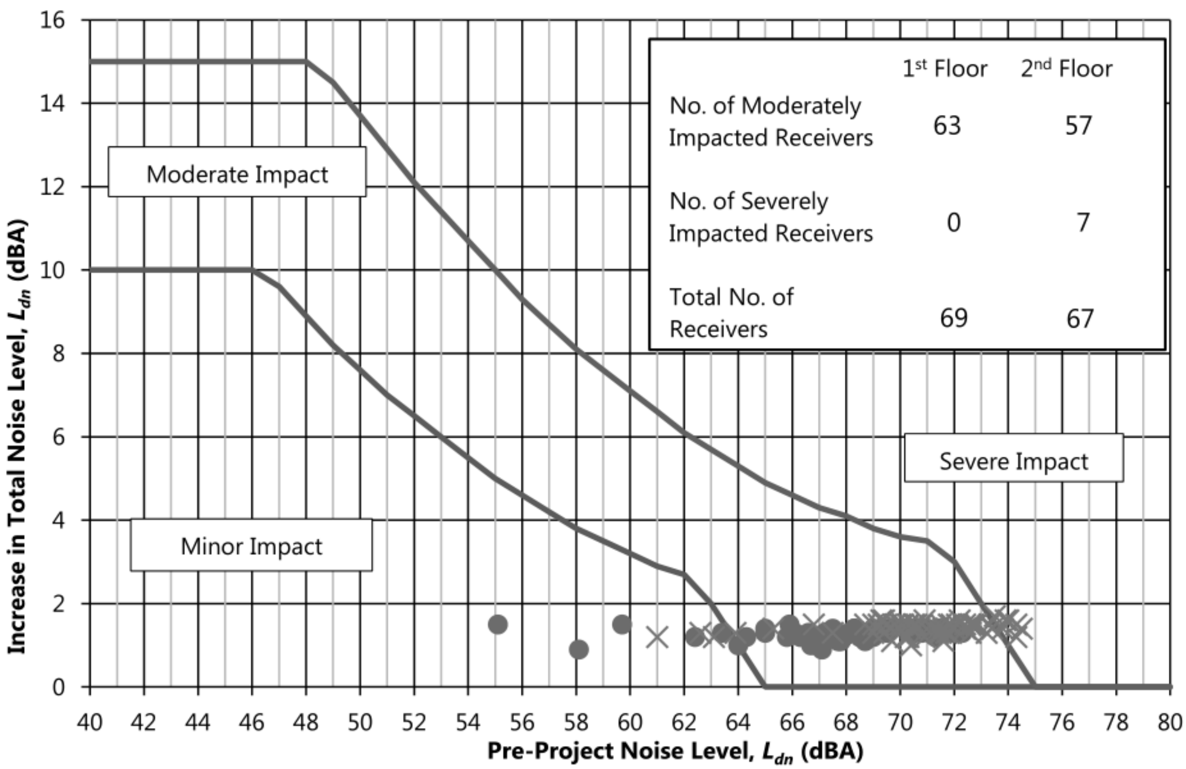
RN3 Comparison of Pre and Post Project Noise (top) and Increase in Noise (bottom)



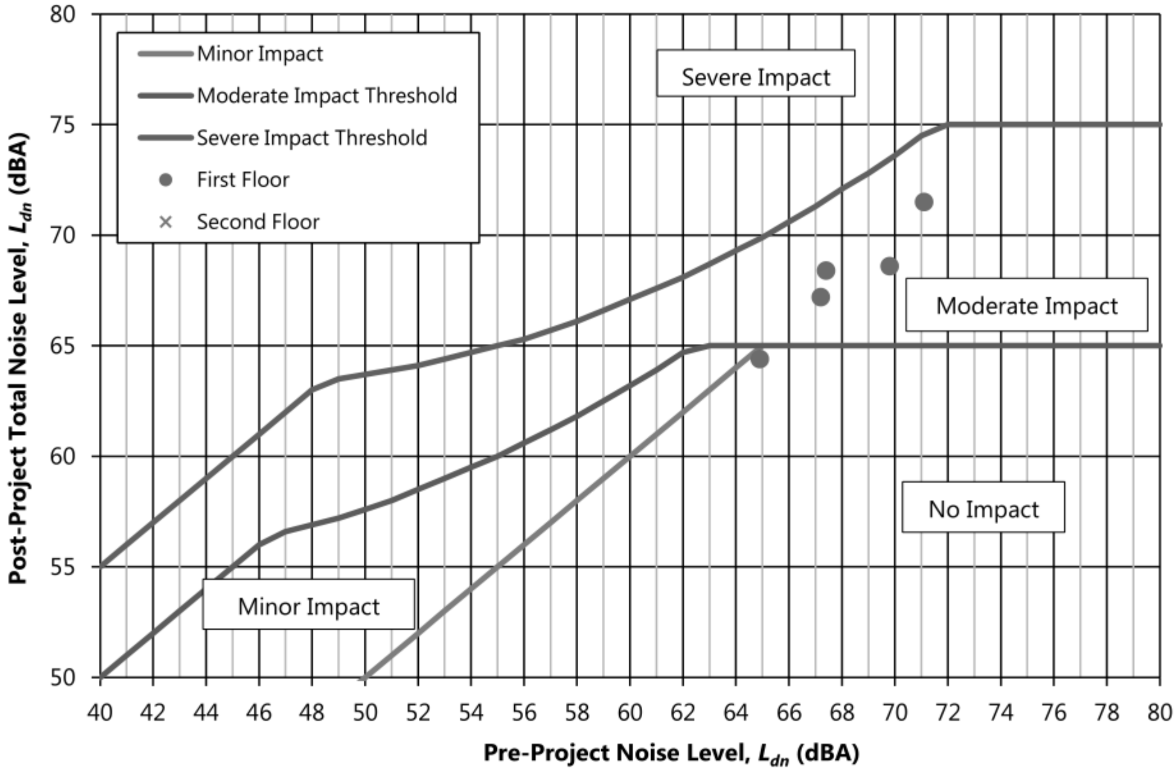


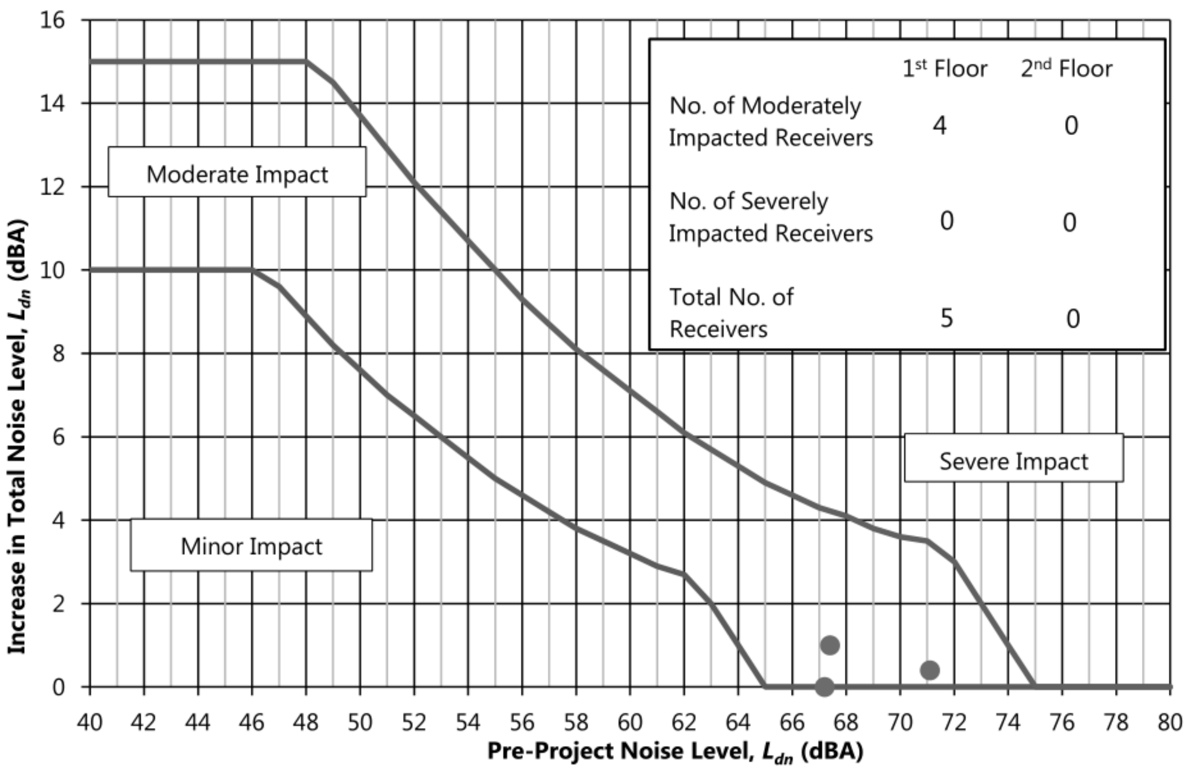
RS1 Comparison of Pre and Post Proejct Noise (top) and Increase in Noise (bottom)





RS2 Comparison of Pre and Post Project Noise (top) and Increase in Noise (bottom)





RS3 Comparison of Pre and Post Project Noise (top) and Increase in Noise (bottom)

APPENDIX D NOISE IMPACT ASSESSMENT RESULT TABLE

Names of residences are grouped according to zones as shown in Figure 5-1 and counted starting from west to east.

Name	L_{dn} (dBA) 1st Floor		L_{dn} (dBA) 2nd Floor		Allowable Increase in L_{dn} 1st Floor (dBA)		1st Floor Predicted Change (dBA)	Allowable Increase in L_{dn} 2nd Floor (dBA)		2nd Floor Predicted Change (dBA)	Noise Impact	
	Pre-Project	Post-Project	Pre-Project	Post-Project	Moderate Impact	Severe Impact		Moderate Impact	Severe Impact		1st Floor	2nd Floor
RN1-01	65.5	66.9	68.6	69.4	0.0	4.6	1.4	0.0	3.8	0.8	Moderate	Moderate
RN1-02	65.7	66.8	68.8	69.7	0.0	4.6	1.1	0.0	3.8	0.9	Moderate	Moderate
RN1-03	65	66.6	68.7	69.8	0.0	4.9	1.6	0.0	3.8	1.1	Moderate	Moderate
RN1-04	64.4	65.2	68.5	69.6	1.0	5.3	0.8	0.0	3.8	1.1	Moderate	Moderate
RN1-05	64.2	65.3	68.4	69.7	1.0	5.3	1.1	0.0	4.1	1.3	Moderate	Moderate
RN1-06	62.5	64.3	68.1	69.1	2.0	5.7	1.8	0.0	4.1	1.0	Minor	Moderate
RN1-07	64.1	65.1	67.7	68.6	1.0	5.3	1.0	0.0	4.1	0.9	Moderate	Moderate
RN1-08	64.6	65.6	67.7	68.8	0.0	4.9	1.0	0.0	4.1	1.1	Moderate	Moderate
RN1-09	65.9	67.2	71	71.1	0.0	4.6	1.3	0.0	3.5	0.1	Moderate	Moderate
RN1-10	63.2	64.5	68.2	69.2	2.0	5.7	1.3	0.0	4.1	1.0	Minor	Moderate
RN1-11	64.3	65.6	70.1	70.8	1.0	5.3	1.3	0.0	3.6	0.7	Moderate	Moderate
RN1-12	64.3	65.6	68.4	69.5	1.0	5.3	1.3	0.0	4.1	1.1	Moderate	Moderate
RN1-13	63.9	65.2	67.5	68.3	1.0	5.3	1.3	0.0	4.1	0.8	Moderate	Moderate
RN1-14	65.8	66.9	70.6	70.5	0.0	4.6	1.1	0.0	3.5	-0.1	Moderate	Moderate
RN1-15	64.6	65.4	69.8	70	0.0	4.9	0.8	0.0	3.6	0.2	Moderate	Moderate
RN1-16	64.2	65.2	69	69.6	1.0	5.3	1.0	0.0	3.8	0.6	Moderate	Moderate
RN1-17	63.7	65	68	68.6	1.0	5.3	1.3	0.0	4.1	0.6	Minor	Moderate
RN1-18	60.6	61.6	66.2	67.3	2.9	6.6	1.0	0.0	4.6	1.1	Minor	Moderate
RN1-19	58.2	59.4	62.6	63.9	3.8	8.1	1.2	2.0	5.7	1.3	Minor	Minor
RN1-20	63	64.2	68	68.6	2.0	5.7	1.2	0.0	4.1	0.6	Minor	Moderate
RN1-21	62.7	63.7	67.6	68.3	2.0	5.7	1.0	0.0	4.1	0.7	Minor	Moderate
RN1-22	63.2	64.4	67.6	68.5	2.0	5.7	1.2	0.0	4.1	0.9	Minor	Moderate
RN1-23	62	63.3	67.7	68.9	2.7	6.1	1.3	0.0	4.1	1.2	Minor	Moderate
RN1-24	58.3	59.6	64.8	65.9	3.8	8.1	1.3	0.0	4.9	1.1	Minor	Moderate

Name	L_{dn} (dBA) 1st Floor		L_{dn} (dBA) 2nd Floor		Allowable Increase in L_{dn} 1st Floor (dBA)		1st Floor Predicted Change (dBA)	Allowable Increase in L_{dn} 2nd Floor (dBA)		2nd Floor Predicted Change (dBA)	Noise Impact	
	Pre-Project	Post-Project	Pre-Project	Post-Project	Moderate Impact	Severe Impact		Moderate Impact	Severe Impact		1st Floor	2nd Floor
RN1-25	59	60.2	65.2	66.5	3.5	7.6	1.2	0.0	4.9	1.3	Minor	Moderate
RN1-26	54.7	56	63.2	64.4	5.0	10.0	1.3	2.0	5.7	1.2	Minor	Minor
RN2-01	56.3	57.5	-	-	4.6	9.3	1.2	-	-	-	Minor	-
RN2-02	68.7	69.8	-	-	0.0	3.8	1.1	-	-	-	Moderate	-
RN2-03	68.8	69.8	-	-	0.0	3.8	1.0	-	-	-	Moderate	-
RN2-04	68.1	69.5	-	-	0.0	4.1	1.4	-	-	-	Moderate	-
RN2-05	68.4	69.5	-	-	0.0	4.1	1.1	-	-	-	Moderate	-
RN2-06	68.6	69.6	-	-	0.0	3.8	1.0	-	-	-	Moderate	-
RN2-07	68.2	69.5	-	-	0.0	4.1	1.3	-	-	-	Moderate	-
RN2-08	69.3	70.4	-	-	0.0	3.8	1.1	-	-	-	Moderate	-
RN2-09	69.3	70.4	-	-	0.0	3.8	1.1	-	-	-	Moderate	-
RN2-10	69.6	70.9	-	-	0.0	3.6	1.3	-	-	-	Moderate	-
RN2-11	70.7	72	-	-	0.0	3.5	1.3	-	-	-	Moderate	-
RN2-12	71	72.3	-	-	0.0	3.5	1.3	-	-	-	Moderate	-
RN2-13	72.3	73.5	-	-	0.0	3.0	1.2	-	-	-	Moderate	-
RN2-14	70.9	72.1	-	-	0.0	3.5	1.2	-	-	-	Moderate	-
RN2-15	70.2	71.4	-	-	0.0	3.6	1.2	-	-	-	Moderate	-
RN2-16	71.5	72.6	-	-	0.0	3.0	1.1	-	-	-	Moderate	-
RN2-17	69.7	70.9	-	-	0.0	3.6	1.2	-	-	-	Moderate	-
RN2-18	67.9	69.1	-	-	0.0	4.1	1.2	-	-	-	Moderate	-
RN2-19	68	69.2	-	-	0.0	4.1	1.2	-	-	-	Moderate	-
RN2-20	70.2	71.4	-	-	0.0	3.6	1.2	-	-	-	Moderate	-
RN2-21	69.9	71.1	-	-	0.0	3.6	1.2	-	-	-	Moderate	-
RN2-22	68.8	70	-	-	0.0	3.8	1.2	-	-	-	Moderate	-
RN2-23	68.2	69.4	70.1	70.1	0.0	4.1	1.2	0.0	3.6	0.0	Moderate	Moderate
RN2-24	68	69.2	69.8	69.9	0.0	4.1	1.2	0.0	3.6	0.1	Moderate	Moderate
RN2-25	66.7	67.9	69.7	70	0.0	4.3	1.2	0.0	3.6	0.3	Moderate	Moderate
RN2-26	66.6	67.8	69.3	70	0.0	4.3	1.2	0.0	3.8	0.7	Moderate	Moderate

Name	L_{dn} (dBA) 1st Floor		L_{dn} (dBA) 2nd Floor		Allowable Increase in L_{dn} 1st Floor (dBA)		1st Floor Predicted Change (dBA)	Allowable Increase in L_{dn} 2nd Floor (dBA)		2nd Floor Predicted Change (dBA)	Noise Impact	
	Pre-Project	Post-Project	Pre-Project	Post-Project	Moderate Impact	Severe Impact		Moderate Impact	Severe Impact		1st Floor	2nd Floor
RN2-27	66	67.2	68.9	69.7	0.0	4.6	1.2	0.0	3.8	0.8	Moderate	Moderate
RN2-28	66.1	67.3	68.8	69.6	0.0	4.6	1.2	0.0	3.8	0.8	Moderate	Moderate
RN2-29	66.3	67.4	68.7	69.5	0.0	4.6	1.1	0.0	3.8	0.8	Moderate	Moderate
RN2-30	65.7	66.9	68.1	68.9	0.0	4.6	1.2	0.0	4.1	0.8	Moderate	Moderate
RN2-31	63.8	65.1	66.2	67.3	1.0	5.3	1.3	0.0	4.6	1.1	Moderate	Moderate
RN2-32	63.8	65.1	66.8	67.8	1.0	5.3	1.3	0.0	4.3	1.0	Moderate	Moderate
RN2-33	64.4	65.6	66.6	67.7	1.0	5.3	1.2	0.0	4.3	1.1	Moderate	Moderate
RN2-34	65	66	66.3	67.3	0.0	4.9	1.0	0.0	4.6	1.0	Moderate	Moderate
RN2-35	64.6	65.5	66.4	67.4	0.0	4.9	0.9	0.0	4.6	1.0	Moderate	Moderate
RN2-36	62.8	63.5	65.5	66.7	2.0	5.7	0.7	0.0	4.6	1.2	Minor	Moderate
RN2-37	62.7	63.5	65.2	66.4	2.0	5.7	0.8	0.0	4.9	1.2	Minor	Moderate
RN2-38	61.5	62.6	64.4	65.7	2.7	6.1	1.1	1.0	5.3	1.3	Minor	Moderate
RN2-39	60.4	61.5	63.3	64.5	3.2	7.1	1.1	2.0	5.7	1.2	Minor	Minor
RN2-40	58.4	59.6	61.1	62.4	3.8	8.1	1.2	2.9	6.6	1.3	Minor	Minor
RN2-41	56.8	58	59.8	60.9	4.2	8.7	1.2	3.2	7.1	1.1	Minor	Minor
RN3-01	57.8	59	61.8	63.2	3.8	8.1	1.2	2.7	6.1	1.4	Minor	Minor
RN3-02	58.2	59.5	61.7	63.1	3.8	8.1	1.3	2.7	6.1	1.4	Minor	Minor
RN3-03	58.5	59.9	61.9	63.3	3.5	7.6	1.4	2.7	6.1	1.4	Minor	Minor
RN3-04	61	62.5	63	64.2	2.9	6.6	1.5	2.0	5.7	1.2	Minor	Minor
RN3-05	61.8	63.1	63.4	64.7	2.7	6.1	1.3	2.0	5.7	1.3	Minor	Minor
RN3-06	61.8	63	64.1	65.3	2.7	6.1	1.2	1.0	5.3	1.2	Minor	Moderate
RN3-07	61.6	62.8	63.4	64.6	2.7	6.1	1.2	2.0	5.7	1.2	Minor	Minor
RN3-08	61.7	62.9	63.4	64.6	2.7	6.1	1.2	2.0	5.7	1.2	Minor	Minor
RN3-09	61.2	62.4	62	63.2	2.9	6.6	1.2	2.7	6.1	1.2	Minor	Minor
RN3-10	60.8	62.1	62.4	63.6	2.9	6.6	1.3	2.7	6.1	1.2	Minor	Minor
RN3-11	61.5	62.8	62.6	63.7	2.7	6.1	1.3	2.0	5.7	1.1	Minor	Minor
RN3-12	61.7	62.9	62.8	63.9	2.7	6.1	1.2	2.0	5.7	1.1	Minor	Minor
RN3-13	62.8	63.9	64.3	65.3	2.0	5.7	1.1	1.0	5.3	1.0	Minor	Moderate

Name	L_{dn} (dBA) 1st Floor		L_{dn} (dBA) 2nd Floor		Allowable Increase in L_{dn} 1st Floor (dBA)		1st Floor Predicted Change (dBA)	Allowable Increase in L_{dn} 2nd Floor (dBA)		2nd Floor Predicted Change (dBA)	Noise Impact	
	Pre-Project	Post-Project	Pre-Project	Post-Project	Moderate Impact	Severe Impact		Moderate Impact	Severe Impact		1st Floor	2nd Floor
RN3-14	62.9	64.1	64.4	65.4	2.0	5.7	1.2	1.0	5.3	1.0	Minor	Moderate
RN3-15	65	66.1	66.1	67.6	0.0	4.9	1.1	0.0	4.6	1.5	Moderate	Moderate
RN3-16	63.1	65.1	66.6	68.4	2.0	5.7	2.0	0.0	4.3	1.8	Moderate	Moderate
RN3-17	65.1	66.8	68.9	70.2	0.0	4.9	1.7	0.0	3.8	1.3	Moderate	Moderate
RN3-18	64.2	64.9	66	66.9	1.0	5.3	0.7	0.0	4.6	0.9	Minor	Moderate
RN3-19	61.5	63.7	66.4	67.6	2.7	6.1	2.2	0.0	4.6	1.2	Minor	Moderate
RN3-20	66.3	67.6	69.8	70.9	0.0	4.6	1.3	0.0	3.6	1.1	Moderate	Moderate
RN3-21	66.7	68.3	70.2	71.1	0.0	4.3	1.6	0.0	3.6	0.9	Moderate	Moderate
RN3-22	57.8	59.4	63.3	64.5	3.8	8.1	1.6	2.0	5.7	1.2	Minor	Minor
RN3-23	66.5	67.3	68.1	68.9	0.0	4.3	0.8	0.0	4.1	0.8	Moderate	Moderate
RN3-24	67.9	68.8	69.4	70.5	0.0	4.1	0.9	0.0	3.8	1.1	Moderate	Moderate
RN3-25	67.1	68.2	69.4	70.5	0.0	4.3	1.1	0.0	3.8	1.1	Moderate	Moderate
RN3-26	67.1	67.6	68.6	69.5	0.0	4.3	0.5	0.0	3.8	0.9	Moderate	Moderate
RN3-27	66.1	67	68.5	69.5	0.0	4.6	0.9	0.0	3.8	1.0	Moderate	Moderate
RN3-28	69	69.6	71.7	72.6	0.0	3.8	0.6	0.0	3.0	0.9	Moderate	Moderate
RN3-29	67.7	68.2	71.2	72	0.0	4.1	0.5	0.0	3.5	0.8	Moderate	Moderate
RN3-30	69.1	69.9	72.8	73.7	0.0	3.8	0.8	0.0	2.0	0.9	Moderate	Moderate
RN3-31	71.7	72.2	73.4	74.1	0.0	3.0	0.5	0.0	2.0	0.7	Moderate	Moderate
RN3-32	71.2	71.6	73.6	74.2	0.0	3.5	0.4	0.0	1.0	0.6	Moderate	Moderate
RN3-33	70.1	70.6	73.3	74	0.0	3.6	0.5	0.0	2.0	0.7	Moderate	Moderate
RN3-34	69.5	69.4	71.3	71.6	0.0	3.6	-0.1	0.0	3.5	0.3	Moderate	Moderate
RN3-35	71.2	71.1	72.5	72.8	0.0	3.5	-0.1	0.0	2.0	0.3	Moderate	Moderate
RN3-36	71.5	71.5	72.9	73.1	0.0	3.0	0.0	0.0	2.0	0.2	Moderate	Moderate
RN3-37	71.5	71.1	73	72.9	0.0	3.0	-0.4	0.0	2.0	-0.1	Moderate	Moderate
RN3-38	68.6	68.2	70.2	69.8	0.0	3.8	-0.4	0.0	3.6	-0.4	Moderate	Moderate
RN3-39	68.5	68	70	69.3	0.0	3.8	-0.5	0.0	3.6	-0.7	Moderate	Moderate
RN3-40	68.5	67.9	70	69.1	0.0	3.8	-0.6	0.0	3.6	-0.9	Moderate	Moderate
RN3-41	67.8	67	69.4	68.5	0.0	4.1	-0.8	0.0	3.8	-0.9	Moderate	Moderate

Name	L_{dn} (dBA) 1st Floor		L_{dn} (dBA) 2nd Floor		Allowable Increase in L_{dn} 1st Floor (dBA)		1st Floor Predicted Change (dBA)	Allowable Increase in L_{dn} 2nd Floor (dBA)		2nd Floor Predicted Change (dBA)	Noise Impact	
	Pre-Project	Post-Project	Pre-Project	Post-Project	Moderate Impact	Severe Impact		Moderate Impact	Severe Impact		1st Floor	2nd Floor
RN3-42	67.1	66.1	68.5	67.7	0.0	4.3	-1.0	0.0	3.8	-0.8	Moderate	Moderate
RN3-43	66.1	65.5	67.3	67.1	0.0	4.6	-0.6	0.0	4.3	-0.2	Moderate	Moderate
RN3-44	70.7	69.4	-	-	0.0	3.5	-1.3	-	-	-	Moderate	-
RS1-01	69.4	70.6	-	-	0.0	3.8	1.2	-	-	-	Moderate	-
RS1-02	65.7	66.9	67.4	68.7	0.0	4.6	1.2	0.0	0.0	0.0	Moderate	Moderate
RS1-03	66.3	67.5	68.1	69.3	0.0	4.6	1.2	0.0	4.3	1.3	Moderate	Moderate
RS1-04	66.9	68.1	68.6	69.8	0.0	4.3	1.2	0.0	4.1	1.2	Moderate	Moderate
RS1-05	67.6	68.7	69	70.2	0.0	4.1	1.1	0.0	3.8	1.2	Moderate	Moderate
RS1-06	67.6	68.8	69.3	70.4	0.0	4.1	1.2	0.0	3.8	1.2	Moderate	Moderate
RS1-07	67.8	69	69.5	70.7	0.0	4.1	1.2	0.0	3.8	1.1	Moderate	Moderate
RS1-08	68.1	69.3	69.7	71	0.0	4.1	1.2	0.0	3.6	1.2	Moderate	Moderate
RS1-09	68.6	69.9	70.1	71.3	0.0	3.8	1.3	0.0	3.6	1.3	Moderate	Moderate
RS1-10	69.2	70.5	70.4	71.7	0.0	3.8	1.3	0.0	3.6	1.2	Moderate	Moderate
RS1-11	69.1	70.3	70.5	71.8	0.0	3.8	1.2	0.0	3.6	1.3	Moderate	Moderate
RS1-12	69.5	70.7	70.9	72.1	0.0	3.6	1.2	0.0	3.5	1.3	Moderate	Moderate
RS1-13	69	70.2	71.2	72.5	0.0	3.8	1.2	0.0	3.5	1.2	Moderate	Moderate
RS1-14	66.1	67.2	-	-	0.0	4.6	1.1	-	-	-	Moderate	-
RS1-15	66.7	68	-	-	0.0	4.3	1.3	-	-	-	Moderate	-
RS1-16	62.6	63.2	66.9	68	2.0	5.7	0.6	0.0	0.0	0.0	Minor	Moderate
RS1-17	62.8	63.6	67.2	68.2	2.0	5.7	0.8	0.0	4.3	1.1	Minor	Moderate
RS1-18	63	63.9	67.5	68.6	2.0	5.7	0.9	0.0	4.3	1.0	Minor	Moderate
RS1-19	63.5	64.1	67.7	68.8	1.0	5.3	0.6	0.0	4.1	1.1	Minor	Moderate
RS1-20	63.7	64.2	67.9	69	1.0	5.3	0.5	0.0	4.1	1.1	Minor	Moderate
RS1-21	63.9	64.5	68.1	69.2	1.0	5.3	0.6	0.0	4.1	1.1	Minor	Moderate
RS1-22	63.7	64.6	68.1	69.4	1.0	5.3	0.9	0.0	4.1	1.1	Minor	Moderate
RS1-23	63.7	64.7	68.2	69.6	1.0	5.3	1.0	0.0	4.1	1.3	Minor	Moderate
RS1-24	63.9	64.7	68.3	69.8	1.0	5.3	0.8	0.0	4.1	1.4	Minor	Moderate
RS1-25	63.3	65.4	68.6	69.9	2.0	5.7	2.1	0.0	4.1	1.5	Moderate	Moderate

Name	L_{dn} (dBA) 1st Floor		L_{dn} (dBA) 2nd Floor		Allowable Increase in L_{dn} 1st Floor (dBA)		1st Floor Predicted Change (dBA)	Allowable Increase in L_{dn} 2nd Floor (dBA)		2nd Floor Predicted Change (dBA)	Noise Impact	
	Pre-Project	Post-Project	Pre-Project	Post-Project	Moderate Impact	Severe Impact		Moderate Impact	Severe Impact		1st Floor	2nd Floor
RS1-26	63.6	64.6	69.2	70.2	1.0	5.3	1.0	0.0	3.8	1.3	Minor	Moderate
RS1-27	63.2	64.3	69.5	70.4	2.0	5.7	1.1	0.0	3.8	1.0	Minor	Moderate
RS2-01	55.1	56.6	61	62.2	5.0	10.0	1.5	2.9	6.6	1.2	Minor	Minor
RS2-02	63.4	64.7	65.3	66.7	2.0	5.7	1.3	0.0	4.9	1.4	Minor	Moderate
RS2-03	65	66.4	66.8	68.3	0.0	4.9	1.4	0.0	4.3	1.5	Moderate	Moderate
RS2-04	67.2	68.5	68.7	70.2	0.0	4.3	1.3	0.0	3.8	1.5	Moderate	Moderate
RS2-05	67.5	68.8	69	70.5	0.0	4.1	1.3	0.0	3.8	1.5	Moderate	Moderate
RS2-06	67.7	69	69.3	70.9	0.0	4.1	1.3	0.0	3.8	1.6	Moderate	Moderate
RS2-07	67.9	69.1	69.4	71	0.0	4.1	1.2	0.0	3.8	1.6	Moderate	Moderate
RS2-08	68.1	69.4	69.8	71.3	0.0	4.1	1.3	0.0	3.6	1.5	Moderate	Moderate
RS2-09	68.2	69.5	70	71.5	0.0	4.1	1.3	0.0	3.6	1.5	Moderate	Moderate
RS2-10	68.3	69.7	70.3	71.8	0.0	4.1	1.4	0.0	3.6	1.5	Moderate	Moderate
RS2-11	68.4	69.7	70.5	72	0.0	4.1	1.3	0.0	3.5	1.5	Moderate	Moderate
RS2-12	68.5	69.8	70.8	72.3	0.0	3.8	1.3	0.0	3.5	1.5	Moderate	Moderate
RS2-13	68.3	69.7	71	72.4	0.0	4.1	1.4	0.0	3.5	1.4	Moderate	Moderate
RS2-14	68.3	69.7	71.2	72.6	0.0	4.1	1.4	0.0	3.5	1.4	Moderate	Moderate
RS2-15	66.6	67.9	70.1	71.6	0.0	4.3	1.3	0.0	3.6	1.5	Moderate	Moderate
RS2-16	69.5	70.8	72	73.4	0.0	3.6	1.3	0.0	3.0	1.4	Moderate	Moderate
RS2-17	68.6	69.9	71.4	72.8	0.0	3.8	1.3	0.0	3.5	1.4	Moderate	Moderate
RS2-18	67.3	68.6	69.2	70.7	0.0	4.3	1.3	0.0	3.8	1.5	Moderate	Moderate
RS2-19	67.5	68.9	69.5	71	0.0	4.1	1.4	0.0	3.6	1.5	Moderate	Moderate
RS2-20	69	70.4	70.3	71.8	0.0	3.8	1.4	0.0	3.6	1.5	Moderate	Moderate
RS2-21	69.4	70.8	70.6	72.1	0.0	3.8	1.4	0.0	3.5	1.5	Moderate	Moderate
RS2-22	69.7	71.1	70.9	72.5	0.0	3.6	1.4	0.0	3.5	1.6	Moderate	Moderate
RS2-23	70.2	71.6	71.5	73	0.0	3.6	1.4	0.0	3.0	1.5	Moderate	Moderate
RS2-24	70.2	71.6	71.6	73	0.0	3.6	1.4	0.0	3.0	1.4	Moderate	Moderate
RS2-25	70.5	71.8	71.8	73.3	0.0	3.5	1.3	0.0	3.0	1.5	Moderate	Moderate
RS2-26	70.5	71.9	71.9	73.4	0.0	3.5	1.4	0.0	3.0	1.5	Moderate	Moderate

Name	L_{dn} (dBA) 1st Floor		L_{dn} (dBA) 2nd Floor		Allowable Increase in L_{dn} 1st Floor (dBA)		1st Floor Predicted Change (dBA)	Allowable Increase in L_{dn} 2nd Floor (dBA)		2nd Floor Predicted Change (dBA)	Noise Impact	
	Pre-Project	Post-Project	Pre-Project	Post-Project	Moderate Impact	Severe Impact		Moderate Impact	Severe Impact		1st Floor	2nd Floor
RS2-27	70.6	72	72.1	73.6	0.0	3.5	1.4	0.0	3.0	1.5	Moderate	Moderate
RS2-28	71.4	72.8	72.8	74.3	0.0	3.5	1.4	0.0	2.0	1.5	Moderate	Moderate
RS2-29	71	72.4	72.6	74.1	0.0	3.5	1.4	0.0	2.0	1.5	Moderate	Moderate
RS2-30	70.9	72.3	72.6	74.1	0.0	3.5	1.4	0.0	2.0	1.5	Moderate	Moderate
RS2-31	70.2	71.6	72.4	73.9	0.0	3.6	1.4	0.0	3.0	1.5	Moderate	Moderate
RS2-32	70.8	72.1	72.8	74.3	0.0	3.5	1.3	0.0	2.0	1.5	Moderate	Moderate
RS2-33	71.5	72.9	73.4	74.8	0.0	3.0	1.4	0.0	2.0	1.4	Moderate	Moderate
RS2-34	71.7	73	73.3	74.8	0.0	3.0	1.3	0.0	2.0	1.5	Moderate	Moderate
RS2-35	71.9	73.2	73.8	75.2	0.0	3.0	1.3	0.0	1.0	1.4	Moderate	Severe
RS2-36	72	73.3	73.9	75.5	0.0	3.0	1.3	0.0	1.0	1.6	Moderate	Severe
RS2-37	72.3	73.6	74.3	75.8	0.0	3.0	1.3	0.0	1.0	1.5	Moderate	Severe
RS2-38	72.1	73.4	74	75.6	0.0	3.0	1.3	0.0	1.0	1.6	Moderate	Severe
RS2-39	71.6	72.9	73.5	75.2	0.0	3.0	1.3	0.0	1.0	1.7	Moderate	Severe
RS2-40	71.1	72.4	72.7	74.2	0.0	3.5	1.3	0.0	2.0	1.5	Moderate	Moderate
RS2-41	70.2	71.6	72.2	73.8	0.0	3.6	1.4	0.0	3.0	1.6	Moderate	Moderate
RS2-42	68.9	70.2	70.4	71.8	0.0	3.8	1.3	0.0	3.6	1.4	Moderate	Moderate
RS2-43	71.7	73	73.2	74.5	0.0	3.0	1.3	0.0	2.0	1.3	Moderate	Moderate
RS2-44	71.3	72.5	74.5	75.9	0.0	3.5	1.2	0.0	0.0	1.4	Moderate	Severe
RS2-45	70.5	71.8	74.3	75.5	0.0	3.5	1.3	0.0	1.0	1.2	Moderate	Severe
RS2-46	66.7	67.7	69.8	71.3	0.0	4.3	1.0	0.0	3.6	1.5	Moderate	Moderate
RS2-47	67.1	68	70.2	71.4	0.0	4.3	0.9	0.0	3.6	1.2	Moderate	Moderate
RS2-48	67.6	68.9	71.2	72.6	0.0	4.1	1.3	0.0	3.5	1.4	Moderate	Moderate
RS2-49	69	70.3	72.4	73.8	0.0	3.8	1.3	0.0	3.0	1.4	Moderate	Moderate
RS2-50	62.4	63.6	63.1	64.3	2.7	6.1	1.2	2.0	5.7	1.2	Minor	Minor
RS2-51	68.2	69.5	71.8	73.1	0.0	4.1	1.3	0.0	3.0	1.3	Moderate	Moderate
RS2-52	69	70.2	72.6	73.9	0.0	3.8	1.2	0.0	2.0	1.3	Moderate	Moderate
RS2-53	68.5	69.7	71.7	73	0.0	3.8	1.2	0.0	3.0	1.3	Moderate	Moderate
RS2-54	68.7	69.8	-	-	0.0	3.8	1.1	-	-		Moderate	-

Name	L_{dn} (dBA) 1st Floor		L_{dn} (dBA) 2nd Floor		Allowable Increase in L_{dn} 1st Floor (dBA)		1st Floor Predicted Change (dBA)	Allowable Increase in L_{dn} 2nd Floor (dBA)		2nd Floor Predicted Change (dBA)	Noise Impact	
	Pre-Project	Post-Project	Pre-Project	Post-Project	Moderate Impact	Severe Impact		Moderate Impact	Severe Impact		1st Floor	2nd Floor
RS2-55	67.3	68.5	70.6	72	0.0	4.3	1.2	0.0	3.5	1.4	Moderate	Moderate
RS2-56	59.7	61.2	63.9	65.2	3.2	7.1	1.5	1.0	5.3	1.3	Minor	Moderate
RS2-57	58.1	59	62.6	63.9	3.8	8.1	0.9	2.0	5.7	1.3	Minor	Minor
RS2-58	66.3	67.5	70	71.4	0.0	4.6	1.2	0.0	3.6	1.4	Moderate	Moderate
RS2-59	65	66.3	69.4	70.7	0.0	4.9	1.3	0.0	3.8	1.3	Moderate	Moderate
RS2-60	66.1	67.4	-	-	0.0	4.6	1.3	-	-	-	Moderate	-
RS2-61	64.3	65.5	69	70.3	1.0	5.3	1.2	0.0	3.8	1.3	Moderate	Moderate
RS2-62	65.9	67.4	70.3	71.5	0.0	4.6	1.5	0.0	3.6	1.2	Moderate	Moderate
RS2-63	66.9	68	70.9	72.1	0.0	4.3	1.1	0.0	3.5	1.2	Moderate	Moderate
RS2-64	67.8	68.9	71.6	72.7	0.0	4.1	1.1	0.0	3.0	1.1	Moderate	Moderate
RS2-65	67.7	68.8	71.4	72.7	0.0	4.1	1.1	0.0	3.5	1.3	Moderate	Moderate
RS2-66	67.9	69.1	71.5	72.8	0.0	4.1	1.2	0.0	3.0	1.3	Moderate	Moderate
RS2-67	67.2	68.3	70.4	71.4	0.0	4.3	1.1	0.0	3.6	1.0	Moderate	Moderate
RS2-68	65.8	67	69.7	70.8	0.0	4.6	1.2	0.0	3.6	1.1	Moderate	Moderate
RS2-69	64	65	67.5	68.8	1.0	5.3	1.0	0.0	4.1	1.3	Minor	Moderate
RS3-01	64.9	64.4	-	-	0.0	4.9	-0.5	-	-	-	Minor	-
RS3-02	67.2	67.2	-	-	0.0	4.3	0.0	-	-	-	Moderate	-
RS3-03	71.1	71.5	-	-	0.0	3.5	0.4	-	-	-	Moderate	-
RS3-04	67.4	68.4	-	-	0.0	4.3	1.0	-	-	-	Moderate	-
RS3-05	69.8	68.6	-	-	0.0	3.6	-1.2	-	-	-	Moderate	-