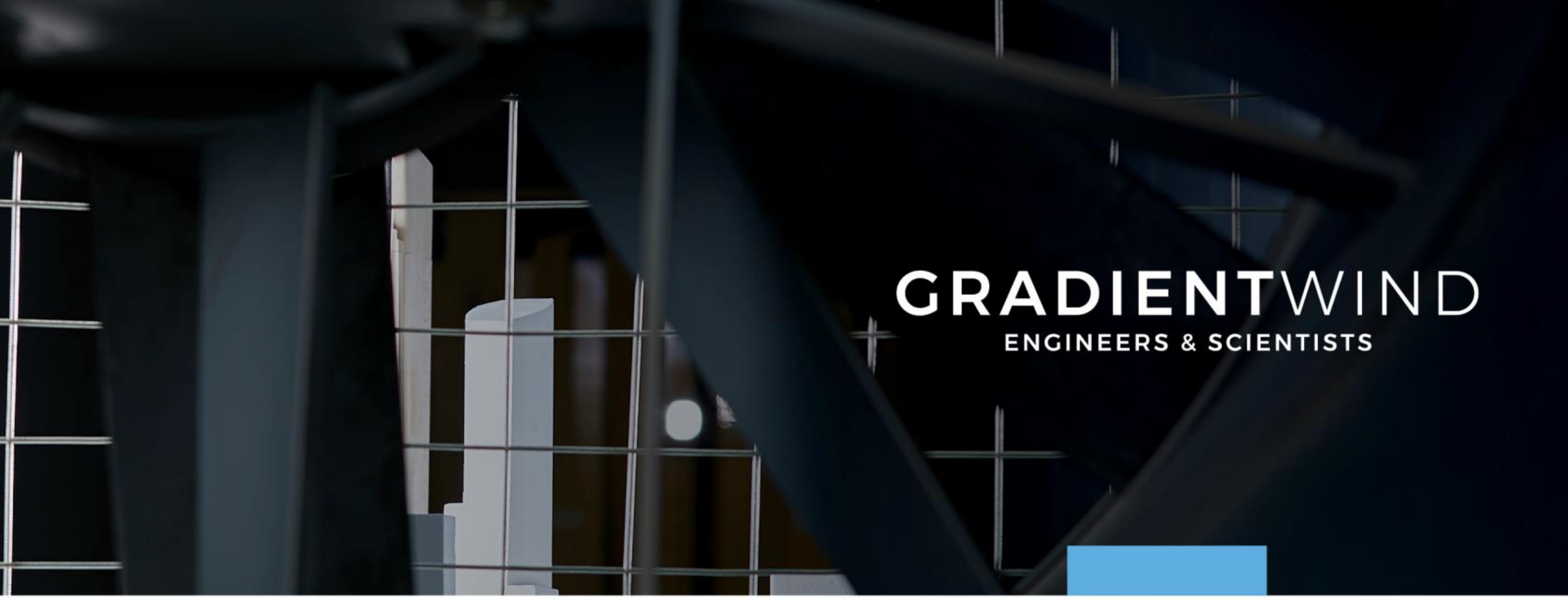
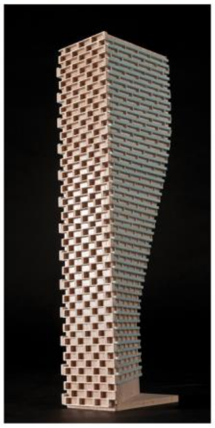


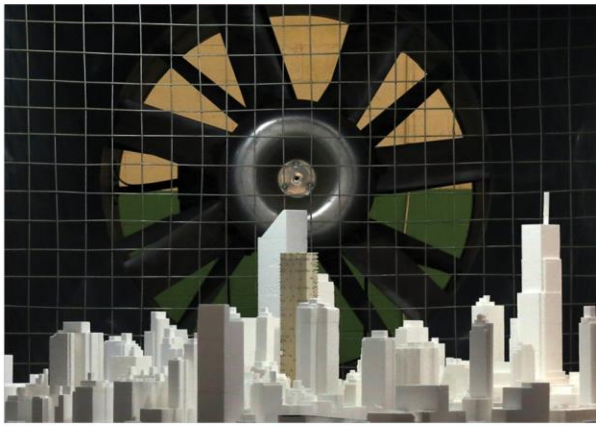
GRADIENTWIND
ENGINEERS & SCIENTISTS

TRANSPORTATION NOISE & VIBRATION FEASIBILITY ASSESSMENT

5907-6038 Ottawa Street
Ottawa, Ontario

REPORT: 20-262-Noise & Vibration Feasibility





November 16, 2020

PREPARED FOR
Taggart Richmond
3187 Albion Road South
Ottawa, ON
K1V 8Y3

PREPARED BY
Michael Lafortune, C.E.T., Environmental Scientist
Joshua Foster, P.Eng., Principal

EXECUTIVE SUMMARY

This report describes a transportation noise & vibration feasibility assessment undertaken in support of a rezoning and draft plan of subdivision application for a proposed residential subdivision located at 5907-6038 Ottawa Street in Ottawa, Ontario. The proposed development comprises an approximate "U-shaped" parcel of land bounded by Ottawa Street to the north, Eagleson Road to the east, McBean Street to west, and a VIA Rail line to the northwest. Industrial land uses are situated on the west side of the development (and upwards to the northwest). The development comprises 62 blocks with some blocks reserved for community parks, a school, commercial use, as well as a stormwater management facility. Major sources of noise impacting the site include roadway traffic along Eagleson Road, Ottawa Street, King Street and McBean Street. The VIA Rail line is a source of noise as well as ground vibrations. Figure 1 illustrates the site plan with surrounding context.

The assessment is based on (i) theoretical noise prediction methods that conform to the Ministry of the Environment, Conservation and Parks (MECP) and City of Ottawa requirements; (ii) noise level criteria as specified by the City of Ottawa's Environmental Noise Control Guidelines (ENCG); (iii) future vehicular traffic volumes based on the City of Ottawa's Official Plan roadway classifications; and (iv) draft site plan drawings provided by Annis, O'Sullivan, Collebekk Ltd.

The results of the current study indicate that noise levels due to roadway traffic over the site will range between approximately 45 and 70 dBA during the daytime period (07:00-23:00). The highest transportation noise levels will occur nearest to Eagleson Road. Results of the roadway traffic noise calculations indicate that dwellings exposed Eagleson Road, Ottawa Street and McBean Street will possibly require internal ventilation such as forced air heating or central air conditioning.

Results of the roadway traffic noise calculations also indicate that outdoor living areas on blocks adjacent to and having direct exposure to Eagleson Road, Ottawa Street and McBean Street will likely require noise control measures in the form of noise barriers. Mitigation measures are described in Section 5.2, with the aim to reduce the L_{eq} to as close to 55 dBA as technically, economically and administratively feasible. A detailed roadway traffic noise study will be required at the time of subdivision registration to determine specific noise control measures for the development.

There are a number of light industrial facilities located adjacent to the study site, along Ottawa Street and McBean Street. These facilities include a garden centre, a landscaping stone company, a storage facility and two automotive garages. Based on Gradient Wind's past experience with similar industries, the 50-100 m setback buffer created by the nearby creek/by-pass drain, and the background noise generated by the surrounding arterial and collector roadways, noise levels at the study site due to the light industrial facilities are expected to fall below the ENCG and NPC-300 noise criteria. Furthermore, several existing dwellings along Ottawa Street currently constrain operations of these industrial sites with equal or less offset distance.

Based on an offset distance of 65 metres between the VIA Rail line and the property line the estimated vibration level at the nearest possible point of reception is expected to be 0.12 mm/s RMS (73.5 dBV) based on the FTA protocol. Details of the calculation are provided in Appendix B. Since predicted vibration levels are below the criterion of 0.14 mm/s RMS, no mitigation will be required. Ground borne noise levels are also expected to be below the ground borne noise criteria of 35 dB.

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TABLE OF CONTENTS

1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Taggart Richmond to undertake a transportation noise & vibration feasibility assessment in support of a draft plan of subdivision application for a proposed residential subdivision located at 5907-6038 Ottawa Street in Ottawa, Ontario. This report summarizes the methodology, results, and recommendations related to a transportation noise feasibility assessment and was prepared in consideration of the client's draft plan of subdivision application. Gradient Wind's scope of work involved assessing exterior noise and vibration levels throughout the site, generated by local roadway and railway traffic.

The assessment was performed on the basis of theoretical noise calculation methods conforming to the City of Ottawa[1] and Ministry of the Environment, Conservation and Parks (MECP)[2] guidelines. Noise calculations were based on draft site plan drawings provided by Annis, O'Sullivan, Collebekk Ltd., with future traffic volumes corresponding to the City of Ottawa's Official Plan (OP) roadway classifications.

2. TERMS OF REFERENCE

The proposed development comprises an approximate "U-shaped" parcel of land bounded by Ottawa Street to the north, Eagleson Road to the east, McBean Street to west, and a VIA Rail line to the northwest. Industrial land uses are situated on the west side of the development (and upwards to the northwest). The development comprises 62 blocks with some blocks reserved for community parks, a school, commercial use, as well as a stormwater management facility.

Major sources of noise impacting the site include roadway traffic along Eagleson Road, Ottawa Street, King Street and McBean Street. The VIA Rail line is a source of noise as well as ground vibrations. Figure 1 illustrates the site plan with surrounding context.

[1] City of Ottawa Environmental Noise Control Guidelines, January 2016
[2] Ontario Ministry of the Environment and Climate Change – Environmental Noise Guidelines, Publication NPC-300, Queens Printer for Ontario, Toronto, 2013

3. OBJECTIVES

The main goals of this work are to (i) calculate the future noise levels on the study site produced by local transportation sources, (ii) calculate the future vibration levels on the study site produced by local rail traffic, and (iii) ensure that interior noise levels and vibration levels do not exceed the allowable limits specified by the City of Ottawa's Environmental Noise Control Guidelines as outlined in Section 4 of this report.

4. METHODOLOGY

4.1 Background

Noise can be defined as any obtrusive sound. It is created at a source, transmitted through a medium, such as air, and intercepted by a receiver. Noise may be characterized in terms of the power of the source or the sound pressure at a specific distance. While the power of a source is characteristic of that particular source, the sound pressure depends on the location of the receiver and the path that the noise takes to reach the receiver. Measurement of noise is based on the decibel unit, dBA, which is a logarithmic ratio referenced to a standard noise level (2×10^{-5} Pascals). The 'A' suffix refers to a weighting scale, which better represents how the noise is perceived by the human ear. With this scale, a doubling of power results in a 3 dBA increase in measured noise levels and is just perceptible to most people. An increase of 10 dBA is often perceived to be twice as loud.

4.2 Transportation Noise

4.2.1 Criteria for Transportation Noise

For surface roadway traffic noise, the equivalent sound energy level, L_{eq}, provides a measure of the time varying noise levels, which is well correlated with the annoyance of sound. It is defined as the continuous sound level, which has the same energy as a time varying noise level over a period of time. For roadways, the L_{eq} is commonly calculated on the basis of a 16-hour (L_{eq16}) daytime (07:00-23:00) / 8-hour (L_{eq8}) nighttime (23:00-07:00) split to assess its impact on residential buildings. The City of Ottawa's Environmental Noise Control Guidelines (ENCG) specifies that the recommended Outdoor Living Area (OLA) noise limit is 55 dBA during the daytime period. OLA do not need to be considered during the nighttime period.

Predicted noise levels at the OLA dictate the action required to achieve the recommended sound levels. According to the ENCG, if an area is to be used as an OLA, noise control measures are required to reduce the L_{eq} to 55 dBA. This is typically done with noise control measures outlined in Section 5.2. When noise levels at these areas exceed the criteria, specific Warning Clause requirements may apply. As this is a preliminary assessment, noise control recommendations are of a general nature. Specific mitigation requirements would be the work of a future study.

4.2.2 Theoretical Transportation Noise Predictions

Noise predictions were determined by computer modelling using two programs. To provide a general sense of noise across the site, the employed software program was Predictor-Lima (TNM calculation), which incorporates the United States Federal Highway Administration's (FHWA) Transportation Noise Model (TNM) 2.5. This computer program is capable of representing three-dimensional surface and first reflections of sound waves over a suitable spectrum for human hearing. A receptor grid with 5 × 5 m spacing was placed across the study site, along with a number of discrete receptors at key sensitive areas.

Although this program outputs noise contours, it is not the approved model for roadway predictions by the City of Ottawa. Therefore, the results were confirmed by performing discrete noise calculations with the Ministry of the Environment, Conservations and Parks (MECP) computerized noise assessment program, STAMSON 5.04, at key receptor locations coinciding with receptor locations in Predictor as shown in Figure 2, as well as receptor distances. Appendix A includes the STAMSON 5.04 input and output data.

Roadway noise calculations were performed by treating each road segment as separate line sources of noise. In addition to the traffic volumes summarized in Table 1 below, theoretical noise predictions were based on the following parameters:

- Truck traffic on all roadways was taken to comprise 5% heavy trucks and 7% medium trucks, as per ENCG requirements for noise level predictions.
- The day/night split was taken to be 92% / 8% respectively for all streets.
- Receptor heights taken to be 1.5 m above grade.
- Absorptive and reflective intermediate ground surfaces based on specific source-receiver path ground characteristics.

- The study site was treated as having flat or gently sloping topography.
- Massing associated with the study site was not considered as potential noise screening elements.
- Roadways exceeding a distance of 500 m from a discrete receptor were omitted.
- VIA Rail trains modeled with 1 locomotive and 4 cars.
- VIA Rail tracks assumed to not be welded.
- Train whistle included in VIA Rail calculations due to at grade crossings near the study site.
- Three (3) receptors were strategically placed throughout the study area for STAMSON correlation.
- Receptor distances and exposure angles are illustrated in Figure 2 and 3.

4.2.3 Roadway and Railway Traffic Volumes

The ENCG dictates that noise calculations should consider future sound levels based on a roadway's classification at the mature state of development. Therefore, traffic volumes are based on the roadway classifications outlined in the City of Ottawa's Official Plan (OP) and Transportation Master Plan[3] which provide additional details on future roadway expansions. Average Annual Daily Traffic (AADT) volumes are then based on data in Table B1 of the ENCG for each roadway classification. As for the VIA Rail line, volumes were used based on train schedules obtained from VIA Rail. Table 1 (below) summarizes the AADT values used for each roadway included in this assessment.

TABLE 1: ROADWAY TRAFFIC DATA

Roadway	Roadway Traffic Data	Speed Limit (km/h)	Traffic Volumes
Eagleson Road	2-Lane Rural Arterial Undivided	80	**15,000**
Ottawa Street	2-Lane Collector Undivided	50	**8,000**
McBean Street	2-Lane Rural Arterial Undivided	70	**15,000**
King Street	2-Lane Collector Undivided	40	**8,000**
VIA Rail	Railway	150	**24/1***

* Daytime and nighttime volumes project to 2030

[3] City of Ottawa Transportation Master Plan, November 2013

4.3 Ground Vibration & Ground-borne Noise

Transit systems and heavy vehicles on roadways can produce perceptible levels of ground vibrations, especially when they are in close proximity to residential neighbourhoods or vibration-sensitive buildings. Similar to sound waves in air, vibrations in solids are generated at a source, propagated through a medium, and intercepted by a receiver. In the case of ground vibrations, the medium can be uniform, or more often, a complex layering of soils and rock strata. Also, similar to sound waves in air, ground vibrations produce perceptible motions and regenerated noise known as 'ground-borne noise' when the vibrations encounter a hollow structure such as a building. Ground-borne noise and vibrations are generated when there is excitation of the ground, such as from a train. Repetitive motion of the wheels on the track or rubber tires passing over an uneven surface causes vibrations to propagate through the soil. When they encounter a building, vibrations pass along the structure of the building beginning at the foundation and propagating to all floors. Air inside the building excited by the vibrating walls and floors represents regenerated airborne noise. Characteristics of the soil and the building are imparted to the noise, thereby creating a unique noise signature.

Human response to ground vibrations is dependent on the magnitude of the vibrations, which is measured by the root mean square (RMS) of the movement of a particle on a surface. Typical units of ground vibration measures are millimeters per second (mm/s), or inch per second (in/s). Since vibrations can vary over a wide range, it is also convenient to represent them in decibel units, or dBV. In North America, it is common practice to use the reference value of one micro-inch per second (µin/s) to represent vibration levels for this purpose. The threshold level of human perception to vibrations is about 0.10 mm/s RMS or about 72 dBV. Although somewhat variable, the threshold of annoyance for continuous vibrations is 0.5 mm/s RMS (or 85 dBV), five times higher than the perception threshold, whereas the threshold for significant structural damage is 10 mm/s RMS (or 112 dBV), at least one hundred times higher than the perception threshold level.

4.3.1 Ground Vibration Criteria

In the United States, the Federal Transportation Authority (FTA) has set vibration criteria for sensitive land uses next to transit corridors. Similar standards have been developed by a partnership between the MECP and the Toronto Transit Commission[4]. These standards indicate that the appropriate criteria for residential buildings is 0.10 mm/s RMS for vibrations. For main line railways, a document titled Guidelines for New Development in Proximity to Railway Operations[5], indicates that vibration conditions should not exceed 0.14 mm/s RMS averaged over a one second time-period at the first floor and above of the proposed building. As the main vibration source is due to the VIA Rail line, which will have infrequent events, the 0.14 mm/s RMS (75 dBV) vibration criteria and 35 dBA ground borne noise criteria were adopted for this study.

4.3.2 Theoretical Ground Vibration Prediction Procedure

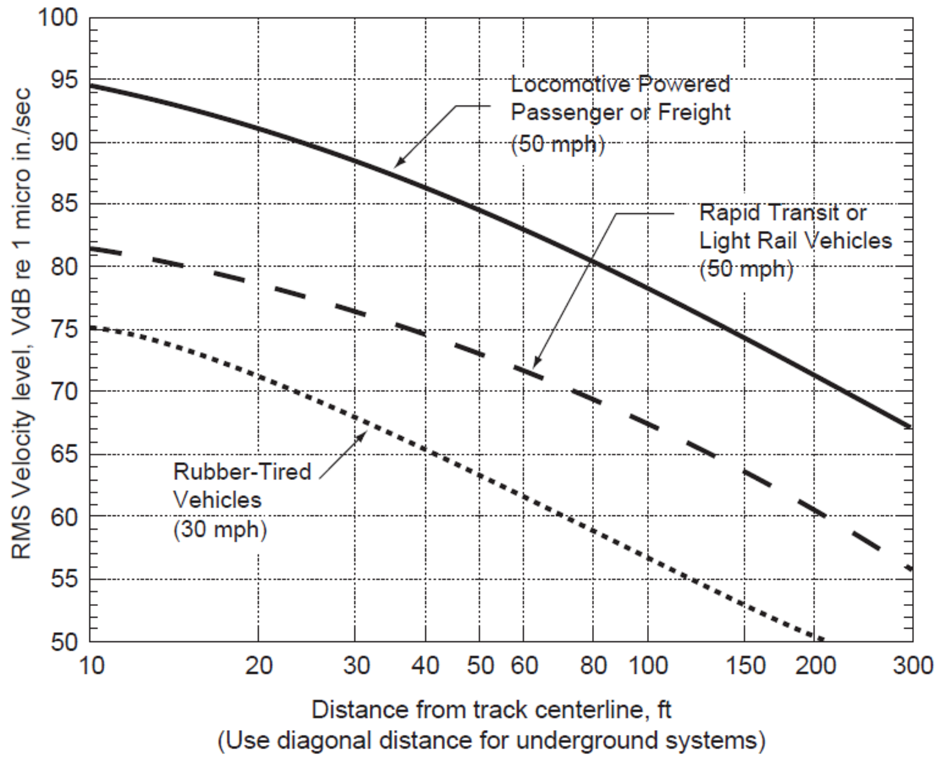
Potential vibration impacts of the future Confederation LRT rail line, currently under construction, were predicted using the FTA's Transit Noise and Vibration Impact Assessment[6] protocol. The FTA general vibration assessment is based on an upper bound generic set of curves that show vibration level attenuation with distance. These curves, illustrated in the figure below, are based on ground vibration measurements at various transit systems throughout North America. Vibration levels at points of reception are adjusted by various factors to incorporate known characteristics of the system being analyzed, such as operating speed of vehicle, conditions of the track, construction of the track and geology, as well as the structural type of the impacted building structures. Based on the setback distance of the closest building, initial vibration levels were deduced from a curve for light rail trains at 50 miles per hour (mph) and applying an adjustment factor of +3.5 dBV to account for an operational speed of 60 mph (150 km/h). The track was assumed to be jointed with no welds. Details of the vibration calculations are presented in Appendix B.

---

[4] MECP/TTC Protocol for Noise and Vibration Assessment for the Proposed Yonge-Spadina Subway Loop, June 16, 1993

[5] Dialog and J.E. Coulter Associates Limited, prepared for The Federation of Canadian Municipalities and The Railway Association of Canada, May 2013

[6] C. E. Hanson; D. A. Towers; and L. D. Meister, Transit Noise and Vibration Impact Assessment, Federal Transit Administration, May 2006.



FTA GENERALIZED CURVES OF VIBRATION LEVELS VERSUS DISTANCE (ADOPTED FROM FIGURE 10-1, FTA TRANSIT NOISE AND VIBRATION IMPACT ASSESSMENT)

5. RESULTS AND DISCUSSION

5.1 Transportation Noise Levels

The results of the roadway traffic noise calculations for the daytime period, covering the entire study site, are shown in Figure 4-6. Discrete receptors were also placed at ground level at key locations throughout the site. The noise contours were generated using TNM and verified with discrete receptors using STAMSON 5.04, as shown in Figure 1, and summarized in Table 2 below. Appendix A contains the complete set of input and output data from all STAMSON 5.04 calculations.

TABLE 2: EXTERIOR NOISE LEVELS DUE TO ROAD AND RAIL TRAFFIC

Receptor Number	Receptor Height Above Grade (m)	Receptor Location	STAMSON 5.04 Noise Level (dBA)	Predictor-Lima Noise Level (dBA)
			Day	Day
1	1.5	OLA – Grade Level – Block 10	70	69
2	1.5	OLA – Grade Level – Block 10	57	57
3	1.5	OLA – Grade Level – Block 50	64	64

As shown above, the results calculated from TNM have good correlation with calculations performed in STAMSON 5.04. A tolerance of 3 dBA between models is generally considered acceptable given human hearing cannot detect a change in sound level of less than 3 dBA. As stated in Section 4.2.2, massing elements within the development were conservatively ignored as potential screening elements. Results of the roadway traffic noise calculations also indicate that outdoor living areas on blocks adjacent to and having direct exposure to Eagleson Road, Ottawa Street and McBean Street will likely require noise control measures. These measures are briefly described in Section 5.2, with the aim to reduce the L_{eq} to as close to 55 dBA as technically, economically and administratively feasible. A detailed roadway traffic noise study will be required at the time of subdivision registration to determine specific noise control measures for the development.

5.1.1 Noise Control Measures

The noise levels predicted due to roadway traffic, at a number of receptors, exceed the criteria listed in the ENCG for outdoor living areas, as discussed in Section 4.2. Therefore, noise control measures as described below, subscribing to Table 2.3a in the ENCG and listed in order of preference, will be required to reduce the L_{eq} to 55 dBA:

- Distance setback with soft ground
- Insertion of noise insensitive land uses between the source and sensitive points of reception
- Orientation of buildings to provide sheltered zones in rear yards
- Shared outdoor amenity areas
- Earth berms (sound barriers)

- Acoustic barriers

Based on expected noise levels, blocks in the dark red region in Figure 5 will likely require upgraded building components and central air conditioning. Blocks in the dark orange and red regions in Figure 5 will require forced air heating with provisions for central air conditioning. Warning Clauses will also be required on purchase, sale, and lease agreements. Specific mitigation will be determined during the detailed design assessment.

5.2 Ground Vibrations & Ground-borne Noise Levels

Based on an offset distance of 65 metres between the VIA Rail line and the property line the estimated vibration level at the nearest possible point of reception is expected to be 0.12 mm/s RMS (73.5 dBV) based on the FTA protocol. Details of the calculation are provided in Appendix B. Since predicted vibration levels are below the criterion of 0.14 mm/s RMS, no mitigation will be required.

According to the United States Federal Transit Authority's vibration assessment protocol, ground borne noise can be estimated by subtracting 50 dB from the velocity vibration level in dBV. Since measured vibration levels were found to be 73.5 dBV, ground borne noise levels are also expected to be below the ground borne noise criteria of 35 dB.

6. CONCLUSIONS AND RECOMMENDATIONS

The results of the current study indicate that noise levels due to roadway traffic over the site will range between approximately 45 and 70 dBA during the daytime period (07:00-23:00). The highest transportation noise levels will occur nearest to Eagleson Road. Results of the roadway traffic noise calculations indicate that dwellings exposed Eagleson Road, Ottawa Street and McBean Street will possibly require internal ventilation such as forced air heating or central air conditioning.

Results of the roadway traffic noise calculations also indicate that outdoor living areas on blocks adjacent to and having direct exposure to Eagleson Road, Ottawa Street and McBean Street will likely require noise control measures in the form of noise barriers. Mitigation measures are described in Section 5.2, with the aim to reduce the L_{eq} to as close to 55 dBA as technically, economically and administratively feasible. A detailed roadway traffic noise study will be required at the time of subdivision registration to determine specific noise control measures for the development.

There are a number of light industrial facilities located adjacent to the study site, along Ottawa Street and McBean Street. These facilities include a garden centre, a landscaping stone company, a storage facility and two automotive garages. Based on Gradient Wind's past experience with similar industries, the 50-100 m setback buffer created by the nearby creek/by-pass drain, and the background noise generated by the surrounding arterial and collector roadways, noise levels at the study site due to the light industrial facilities are expected to fall below the ENCG and NPC-300 noise criteria. Furthermore, several existing dwellings along Ottawa Street currently constrain operations of these industrial sites with equal or less offset distance.

Based on an offset distance of 65 metres between the VIA Rail line and the property line the estimated vibration level at the nearest possible point of reception is expected to be 0.12 mm/s RMS (73.5 dBV) based on the FTA protocol. Details of the calculation are provided in Appendix B. Since predicted vibration levels are below the criterion of 0.14 mm/s RMS, no mitigation will be required. Ground borne noise levels are also expected to be below the ground borne noise criteria of 35 dB.

This concludes our transportation noise & vibration feasibility assessment and report. If you have any questions or wish to discuss our findings, please advise us. In the interim, we thank you for the opportunity to be of service.

Sincerely,

Gradient Wind Engineering Inc.

LICENSED PROFESSIONAL ENGINEER
J. R. FOSTER
100155655
Nov 16, 2022
PROVINCE OF ONTARIO

Michael Lafortune, C.E.T.
Environmental Scientist

Joshua Foster, P.Eng.
Principal

Gradient Wind File #20-262-Noise & Vibration Feasibility

GRADIENTWIND
ENGINEERS & SCIENTISTS
127 WALGREEN ROAD , OTTAWA, ON
613 836 0934 • GRADIENTWIND.COM

PROJECT: 5907-6038 OTTAWA STREET, OTTAWA TRANSPORTATION NOISE FEASIBILITY ASSESSMENT		DESCRIPTION: FIGURE 1: SUBDIVISION PLAN, SURROUNDING CONTEXT AND RECEPTOR LOCATIONS
SCALE: 1:4000 (APPROX.)	DRAWING NO.: GW20-262-1	
DATE: NOVEMBER 12, 2020	DRAWN BY: M.L.	

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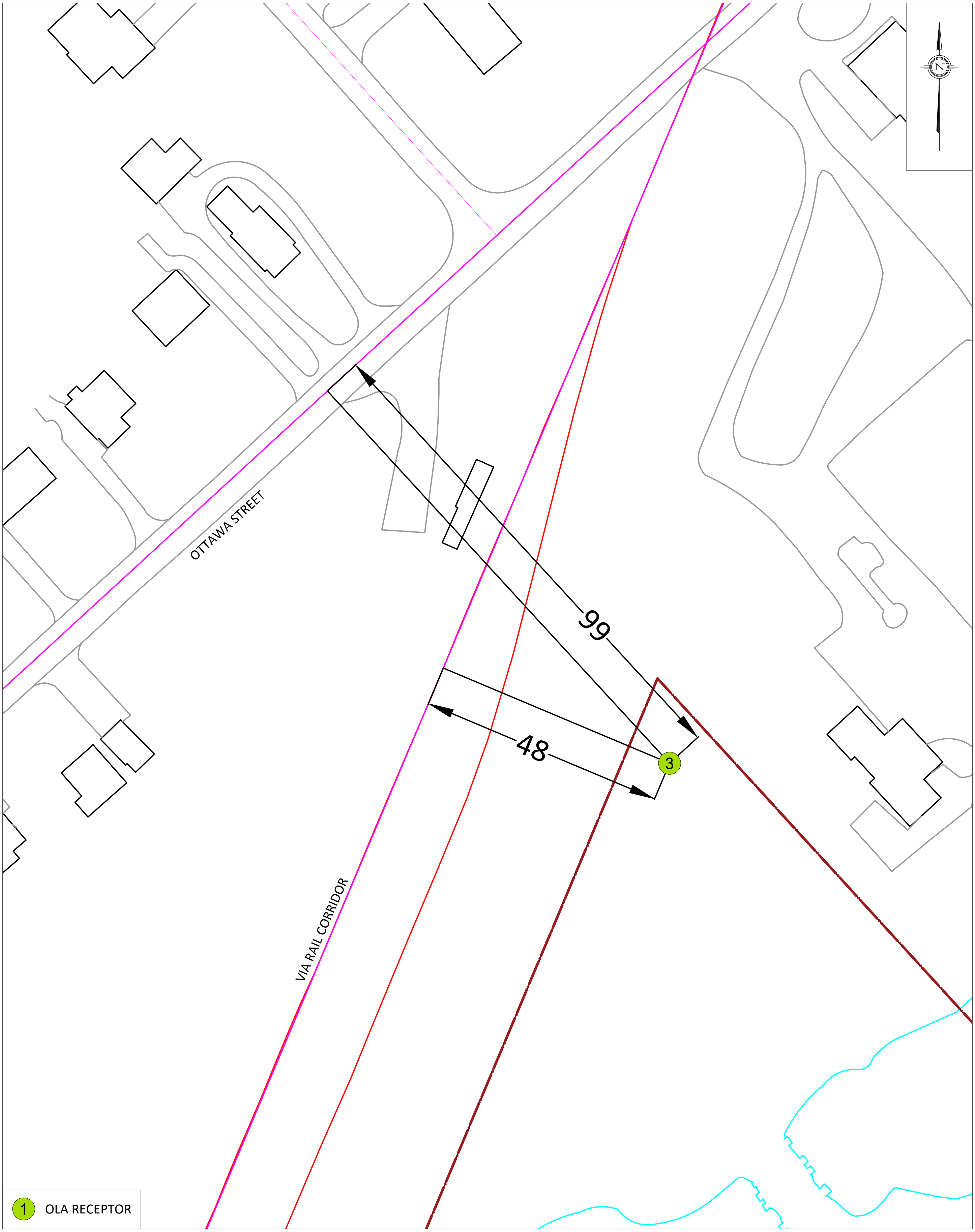
PROJECT	5907-6038 OTTAWA STREET, OTTAWA TRANSPORTATION NOISE FEASIBILITY ASSESSMENT		
SCALE	1:1000 (APPROX.)	DRAWING NO.	GWE20-262-2
DATE	NOVEMBER 12, 2020	DRAWN BY	M.L.

DESCRIPTION

FIGURE 2:
STAMSON INPUT PARAMETERS



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PROJECT	5907-6038 OTTAWA STREET, OTTAWA TRANSPORTATION NOISE FEASIBILITY ASSESSMENT		
SCALE	1:1000 (APPROX.)	DRAWING NO.	GWE20-262-3
DATE	NOVEMBER 12, 2020	DRAWN BY	M.L.

DESCRIPTION

FIGURE 3:
STAMSON INPUT PARAMETERS

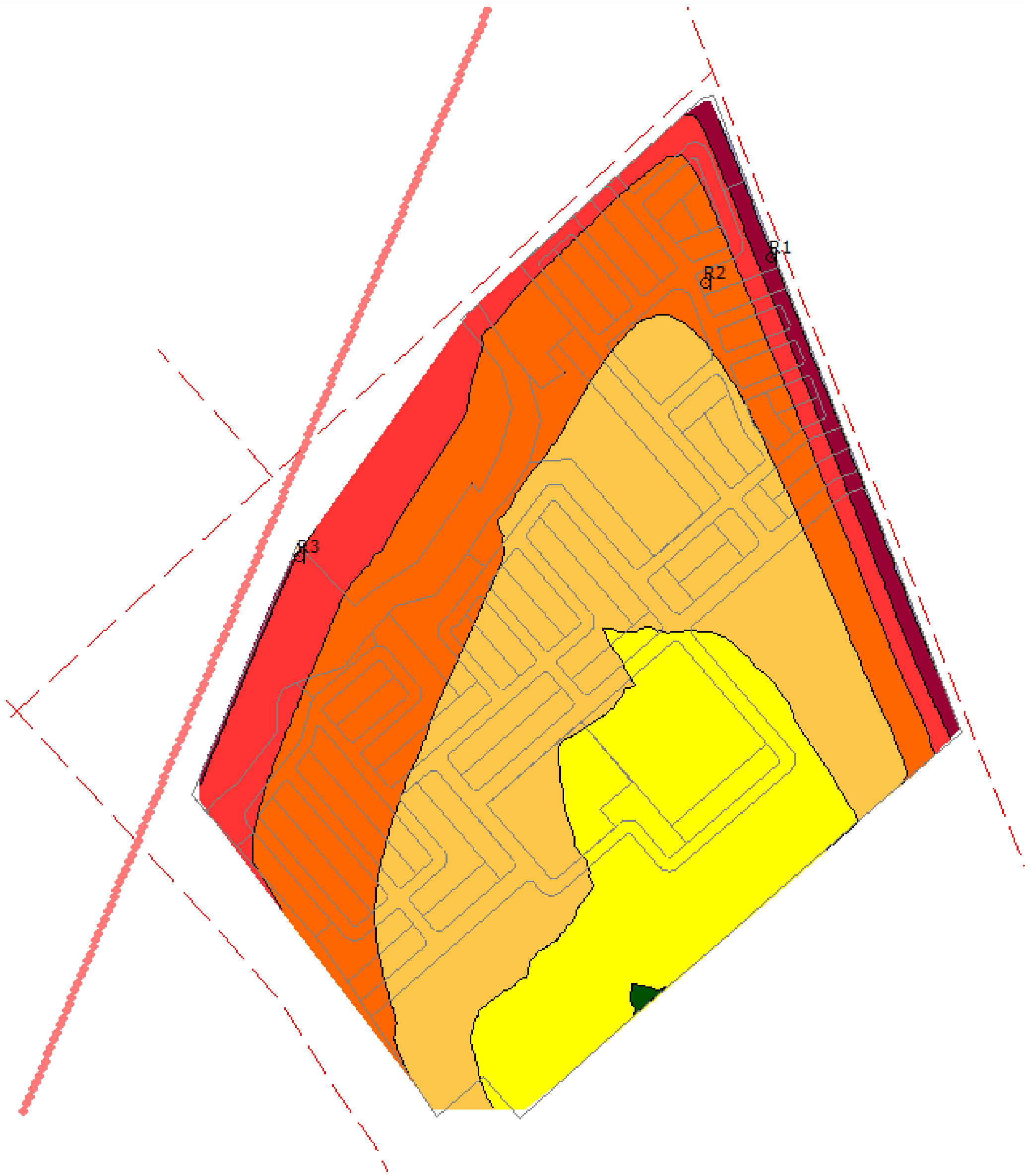


FIGURE 4: GROUND LEVEL NOISE CONTOURS FOR THE SITE (DAYTIME PERIOD)

80 – 85 dB
75 – 80 dB
70 – 75 dB
65 – 70 dB
60 – 65 dB
55 – 60 dB
50 – 55 dB
45 – 50 dB
40 – 45 dB
35 – 40 dB
0 – 35 dB

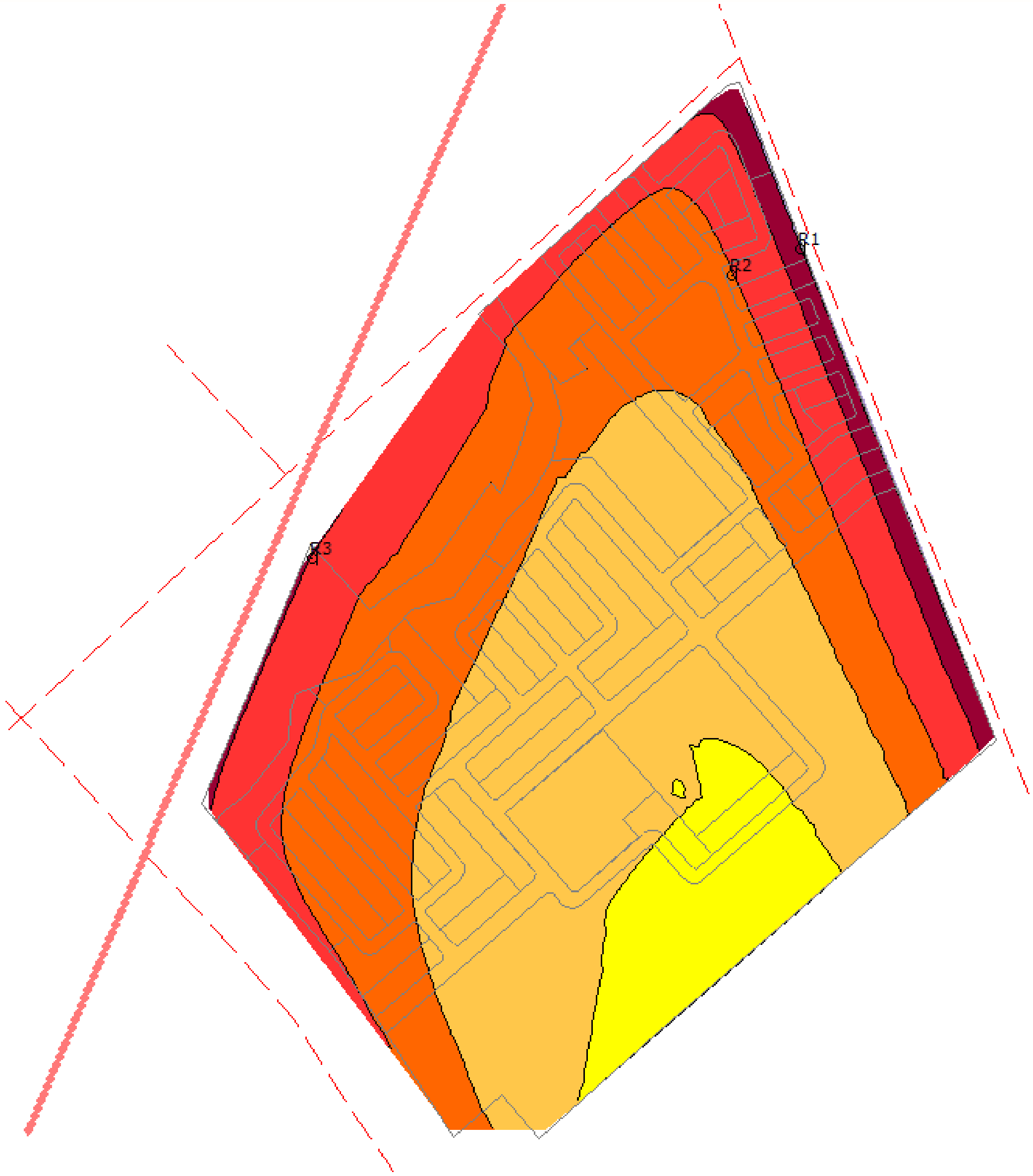


FIGURE 5: 4.5 M NOISE CONTOURS FOR THE SITE (DAYTIME PERIOD)

80 – 85 dB
75 – 80 dB
70 – 75 dB
65 – 70 dB
60 – 65 dB
55 – 60 dB
50 – 55 dB
45 – 50 dB
40 – 45 dB
35 – 40 dB
0 – 35 dB

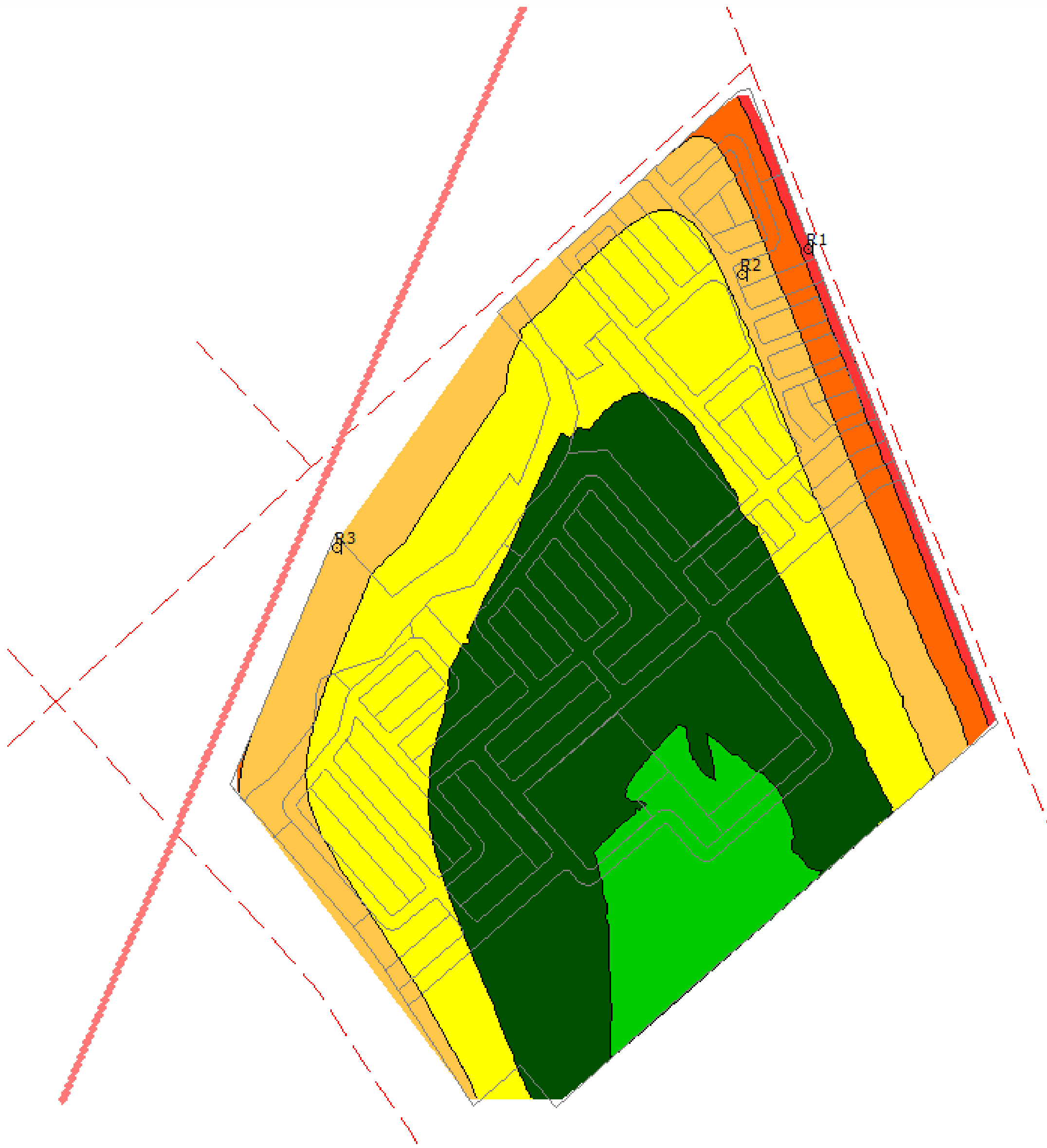
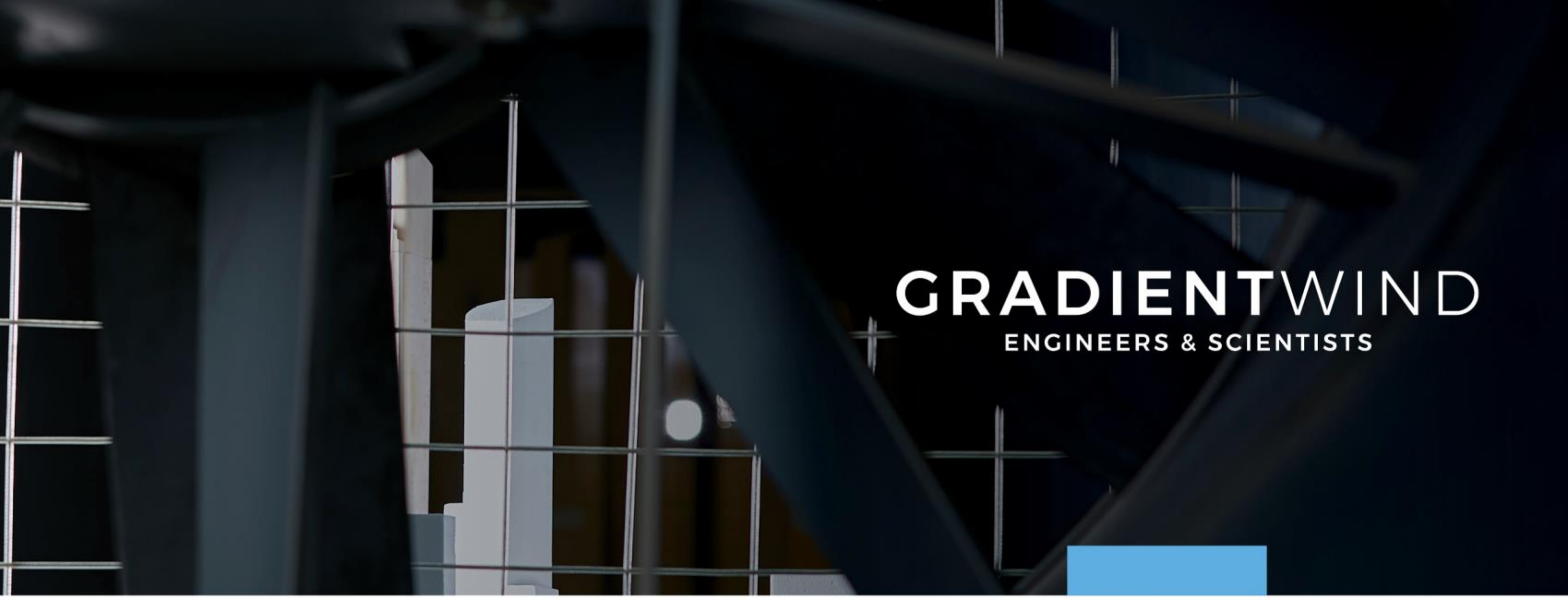


FIGURE 6: 4.5 M NOISE CONTOURS FOR THE SITE (NIGHTTIME PERIOD)

- *80 – 85 dB*
- *75 – 80 dB*
- *70 – 75 dB*
- *65 – 70 dB*
- *60 – 65 dB*
- *55 – 60 dB*
- *50 – 55 dB*
- *45 – 50 dB*
- *40 – 45 dB*
- *35 – 40 dB*
- *0 – 35 dB*



APPENDIX A

STAMSON 5.04 – INPUT AND OUTPUT DATA FOR PREDICTED BRT

```
STAMSON 5.0        NORMAL REPORT        Date: 11-11-2020 14:22:53
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r1.te                Time Period: Day/Night 16/8 hours
Description:


Road data, segment # 1: Eagleson (day/night)
--------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    80 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT):  15000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 1: Eagleson (day/night)
------------------------------------------
Angle1   Angle2            : -90.00 deg   90.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      1       (Absorptive ground surface)
Receiver source distance   :  17.00 / 17.00  m
Receiver height            :   1.50 / 1.50   m
Topography                 :      1       (Flat/gentle slope; no barrier)
Reference angle            :   0.00
```

```
Results segment # 1: Eagleson (day)
-----------------------------------

Source height = 1.50 m

ROAD (0.00 + 70.13 + 0.00) = 70.13 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.66  72.49   0.00  -0.90  -1.46   0.00   0.00   0.00
70.13
--------------------------------------------------------------------------
--

Segment Leq : 70.13 dBA

Total Leq All Segments: 70.13 dBA


Results segment # 1: Eagleson (night)
-------------------------------------

Source height = 1.50 m

ROAD (0.00 + 62.53 + 0.00) = 62.53 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.66  64.89   0.00  -0.90  -1.46   0.00   0.00   0.00
62.53
--------------------------------------------------------------------------
--

Segment Leq : 62.53 dBA

Total Leq All Segments: 62.53 dBA




TOTAL Leq FROM ALL SOURCES (DAY): 70.13
                         (NIGHT): 62.53
```

```
STAMSON 5.0        NORMAL REPORT        Date: 11-11-2020 14:22:58
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r2.te               Time Period: Day/Night 16/8 hours
Description:


Road data, segment # 1: Eagleson (day/night)
--------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    80 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT):  15000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 1: Eagleson (day/night)
------------------------------------------
Angle1   Angle2            : -90.00 deg   90.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      1       (Absorptive ground surface)
Receiver source distance   : 108.00 / 108.00 m
Receiver height            :   1.50 / 1.50   m
Topography                 :      1       (Flat/gentle slope; no barrier)
Reference angle            :   0.00
```

```
Results segment # 1: Eagleson (day)
-----------------------------------

Source height = 1.50 m

ROAD (0.00 + 56.80 + 0.00) = 56.80 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.66  72.49   0.00 -14.23  -1.46   0.00   0.00   0.00
56.80
--------------------------------------------------------------------------
--

Segment Leq : 56.80 dBA

Total Leq All Segments: 56.80 dBA


Results segment # 1: Eagleson (night)
-------------------------------------

Source height = 1.50 m

ROAD (0.00 + 49.20 + 0.00) = 49.20 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.66  64.89   0.00 -14.23  -1.46   0.00   0.00   0.00
49.20
--------------------------------------------------------------------------
--

Segment Leq : 49.20 dBA

Total Leq All Segments: 49.20 dBA




TOTAL Leq FROM ALL SOURCES (DAY): 56.80
                         (NIGHT): 49.20
```

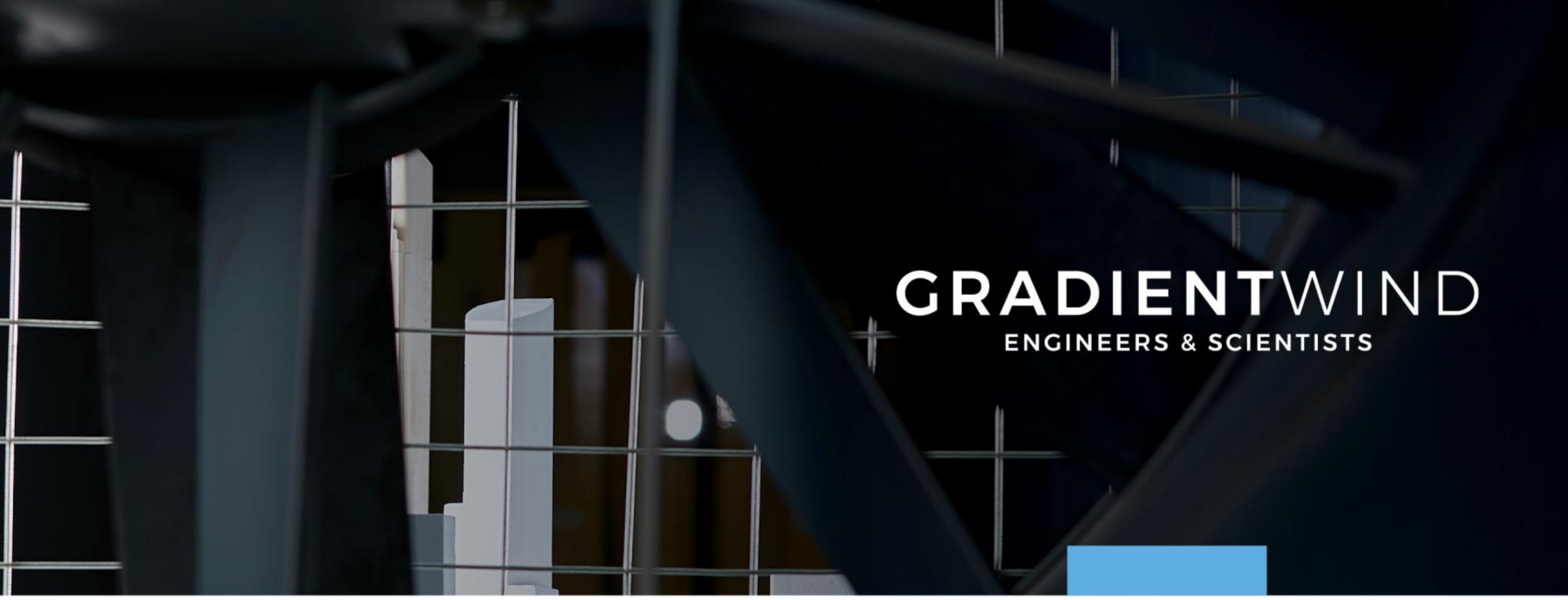
```
STAMSON 5.0        NORMAL REPORT        Date: 16-11-2020 14:30:07
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r3.te                Time Period: Day/Night 16/8 hours
Description:


Rail data, segment # 1: VIA (day/night)
---------------------------------------
Train            ! Trains       ! Trains       ! Speed !# loc !# Cars! Eng
!Cont
Type             !  (Left)      !  (Right)     !(km/h) !/Train!/Train! type
!weld
-----------------+-------------+-------------+-------+------+------+------
+----
  1.             !  12.0/0.5    !  12.0/0.5    ! 150.0 !  1.0 !  4.0
!Diesel!  No

Data for Segment # 1: VIA (day/night)
-------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  48.00 / 48.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Whistle Angle             :      0 deg   Track 1
Reference angle           :   0.00
```

```
Results segment # 1: VIA (day)
------------------------------

LOCOMOTIVE (0.00 + 60.40 + 0.00) = 60.40 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.58  69.74  -8.01  -1.33   0.00   0.00   0.00  60.40
----------------------------------------------------------------------

WHEEL (0.00 + 52.98 + 0.00) = 52.98 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.66  62.82  -8.39  -1.46   0.00   0.00   0.00  52.98
----------------------------------------------------------------------

LEFT WHISTLE (0.00 + 58.26 + 0.00) = 58.26 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -83      0   0.58  70.69  -8.01  -4.42   0.00   0.00   0.00  58.26
----------------------------------------------------------------------

RIGHT WHISTLE (0.00 + 58.26 + 0.00) = 58.26 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
     0     83   0.58  70.69  -8.01  -4.42   0.00   0.00   0.00  58.26
----------------------------------------------------------------------

Segment Leq : 64.21 dBA

Total Leq All Segments: 64.21 dBA
```

```
Results segment # 1: VIA (night)
--------------------------------

LOCOMOTIVE (0.00 + 49.61 + 0.00) = 49.61 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.58  58.95  -8.01  -1.33   0.00   0.00   0.00  49.61
----------------------------------------------------------------------

WHEEL (0.00 + 42.18 + 0.00) = 42.18 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.66  52.03  -8.39  -1.46   0.00   0.00   0.00  42.18
----------------------------------------------------------------------

LEFT WHISTLE (0.00 + 47.47 + 0.00) = 47.47 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -83      0   0.58  59.90  -8.01  -4.42   0.00   0.00   0.00  47.47
----------------------------------------------------------------------

RIGHT WHISTLE (0.00 + 47.47 + 0.00) = 47.47 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
     0     83   0.58  59.90  -8.01  -4.42   0.00   0.00   0.00  47.47
----------------------------------------------------------------------

Segment Leq : 53.42 dBA

Total Leq All Segments: 53.42 dBA
```

```
Road data, segment # 1: Ottawa (day/night)
------------------------------------------
Car traffic volume  :  6477/563   veh/TimePeriod  *
Medium truck volume :   515/45    veh/TimePeriod  *
Heavy truck volume  :   368/32    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT):   8000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 1: Ottawa (day/night)
----------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  99.00 / 99.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Results segment # 1: Ottawa (day)
---------------------------------

Source height = 1.50 m

ROAD (0.00 + 50.69 + 0.00) = 50.69 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.66  65.75   0.00 -13.60  -1.46   0.00   0.00   0.00
50.69
--------------------------------------------------------------------------
--

Segment Leq : 50.69 dBA

Total Leq All Segments: 50.69 dBA


Results segment # 1: Ottawa (night)
-----------------------------------

Source height = 1.50 m

ROAD (0.00 + 43.10 + 0.00) = 43.10 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.66  58.16   0.00 -13.60  -1.46   0.00   0.00   0.00
43.10
--------------------------------------------------------------------------
--

Segment Leq : 43.10 dBA

Total Leq All Segments: 43.10 dBA




TOTAL Leq FROM ALL SOURCES (DAY): 64.40
                         (NIGHT): 53.81
```



APPENDIX B

FTA VIBRATION CALCULATIONS

127 WALGREEN ROAD, OTTAWA, ON, CANADA K0A 1L0 | 613 836 0934
GRADIENTWIND.COM

GW20-262 16-Nov-20

Possible Vibration Impacts on 5907-6038 Ottawa Street
Perdicted using FTA General Assesment

Train Speed 150 km/h 90 mph

	Distance from C/L	
	(m)	(ft)
VIA	65.0	213.3

		Vibration	
From FTA Manual Fig 10-1			
	Vibration Levels at distance from track	71	dBV re 1 micro in/sec
Adjustment Factors FTA Table 10-1			
	Speed reference 50 mph	4	Speed Limit of 150 km/h (90 mph)
	Vehicle Parameters	0	Assume Soft primary suspension, Weels run true
	Track Condition	0	None
	Track Treatments	0	None
	Type of Transit Structure	0	None
	Efficient vibration Propagation	0	Propagation through rock
	Vibration Levels at Fdn	75	0.135
	Coupling to Building Foundation	-5	Wood frame houses
	Floor to Floor Attenuation	-2.0	Ground Floor Ocupied
	Amplification of Floor and Walls	6	
	Total Vibration Level	73.5	dBV or 0.120 mm/s
	Noise Level in dBA	38.5	dBA

Table 10-1. Adjustment Factors for Generalized Predictions of Ground-Borne Vibration and Noise

Factors Affecting Vibration Source				
Source Factor	**Adjustment to Propagation Curve**			**Comment**
		Reference Speed		
Speed	Vehicle Speed	50 mph	30 mph	Vibration level is approximately proportional to 20*log(speed/speed$_{ref}$). Sometimes the variation with speed has been observed to be as low as 10 to 15 log(speed/speed$_{ref}$).
	60 mph	+1.6 dB	+6.0 dB	
	50 mph	0.0 dB	+4.4 dB	
	40 mph	-1.9 dB	+2.5 dB	
	30 mph	-4.4 dB	0.0 dB	
	20 mph	-8.0 dB	-3.5 dB	
Vehicle Parameters (not additive, apply greatest value only)				
Vehicle with stiff primary suspension	+8 dB			Transit vehicles with stiff primary suspensions have been shown to create high vibration levels. Include this adjustment when the primary suspension has a vertical resonance frequency greater than 15 Hz.
Resilient Wheels	0 dB			Resilient wheels do not generally affect ground-borne vibration except at frequencies greater than about 80 Hz.
Worn Wheels or Wheels with Flats	+10 dB			Wheel flats or wheels that are unevenly worn can cause high vibration levels. This can be prevented with wheel truing and slip-slide detectors to prevent the wheels from sliding on the track.
Track Conditions (not additive, apply greatest value only)				
Worn or Corrugated Track	+10 dB			If both the wheels and the track are worn, only one adjustment should be used. Corrugated track is a common problem. Mill scale on new rail can cause higher vibration levels until the rail has been in use for some time.
Special Trackwork	+10 dB			Wheel impacts at special trackwork will significantly increase vibration levels. The increase will be less at greater distances from the track.
Jointed Track or Uneven Road Surfaces	+5 dB			Jointed track can cause higher vibration levels than welded track. Rough roads or expansion joints are sources of increased vibration for rubber-tire transit.
Track Treatments (not additive, apply greatest value only)				
Floating Slab Trackbed	-15 dB			The reduction achieved with a floating slab trackbed is strongly dependent on the frequency characteristics of the vibration.
Ballast Mats	-10 dB			Actual reduction is strongly dependent on frequency of vibration.
High-Resilience Fasteners	-5 dB			Slab track with track fasteners that are very compliant in the vertical direction can reduce vibration at frequencies greater than 40 Hz.

Table 10-1. Adjustment Factors for Generalized Predictions of Ground-Borne Vibration and Noise (Continued)		
Factors Affecting Vibration Path		
Path Factor	**Adjustment to Propagation Curve**	**Comment**
Resiliently Supported Ties	-10 dB	Resiliently supported tie systems have been found to provide very effective control of low-frequency vibration.
Track Configuration (not additive, apply greatest value only)		
Type of Transit Structure	Relative to at-grade tie & ballast: Elevated structure -10 dB Open cut 0 dB	The general rule is the heavier the structure, the lower the vibration levels. Putting the track in cut may reduce the vibration levels slightly. Rock-based subways generate higher-frequency vibration.
	Relative to bored subway tunnel in soil: Station -5 dB Cut and cover -3 dB Rock-based - 15 dB	
Ground-borne Propagation Effects		
Geologic conditions that promote efficient vibration propagation	Efficient propagation in soil +10 dB	Refer to the text for guidance on identifying areas where efficient propagation is possible.
	Propagation in rock layer — **Dist.** / **Adjust.**: 50 ft +2 dB 100 ft +4 dB 150 ft +6 dB 200 ft +9 dB	The positive adjustment accounts for the lower attenuation of vibration in rock compared to soil. It is generally more difficult to excite vibrations in rock than in soil at the source.
Coupling to building foundation	Wood Frame Houses -5 dB 1-2 Story Masonry -7 dB 3-4 Story Masonry -10 dB Large Masonry on Piles -10 dB Large Masonry on Spread Footings -13 dB Foundation in Rock 0 dB	The general rule is the heavier the building construction, the greater the coupling loss.
Factors Affecting Vibration Receiver		
Receiver Factor	**Adjustment to Propagation Curve**	**Comment**
Floor-to-floor attenuation	1 to 5 floors above grade: -2 dB/floor 5 to 10 floors above grade: -1 dB/floor	This factor accounts for dispersion and attenuation of the vibration energy as it propagates through a building.
Amplification due to resonances of floors, walls, and ceilings	+6 dB	The actual amplification will vary greatly depending on the type of construction. The amplification is lower near the wall/floor and wall/ceiling intersections.
Conversion to Ground-borne Noise		
Noise Level in dBA	Peak frequency of ground vibration: Low frequency (<30 Hz): -50 dB Typical (peak 30 to 60 Hz): -35 dB High frequency (>60 Hz): -20 dB	Use these adjustments to estimate the A-weighted sound level given the average vibration velocity level of the room surfaces. See text for guidelines for selecting low, typical or high frequency characteristics. Use the high-frequency adjustment for subway tunnels in rock or if the dominant frequencies of the vibration spectrum are known to be 60 Hz or greater.