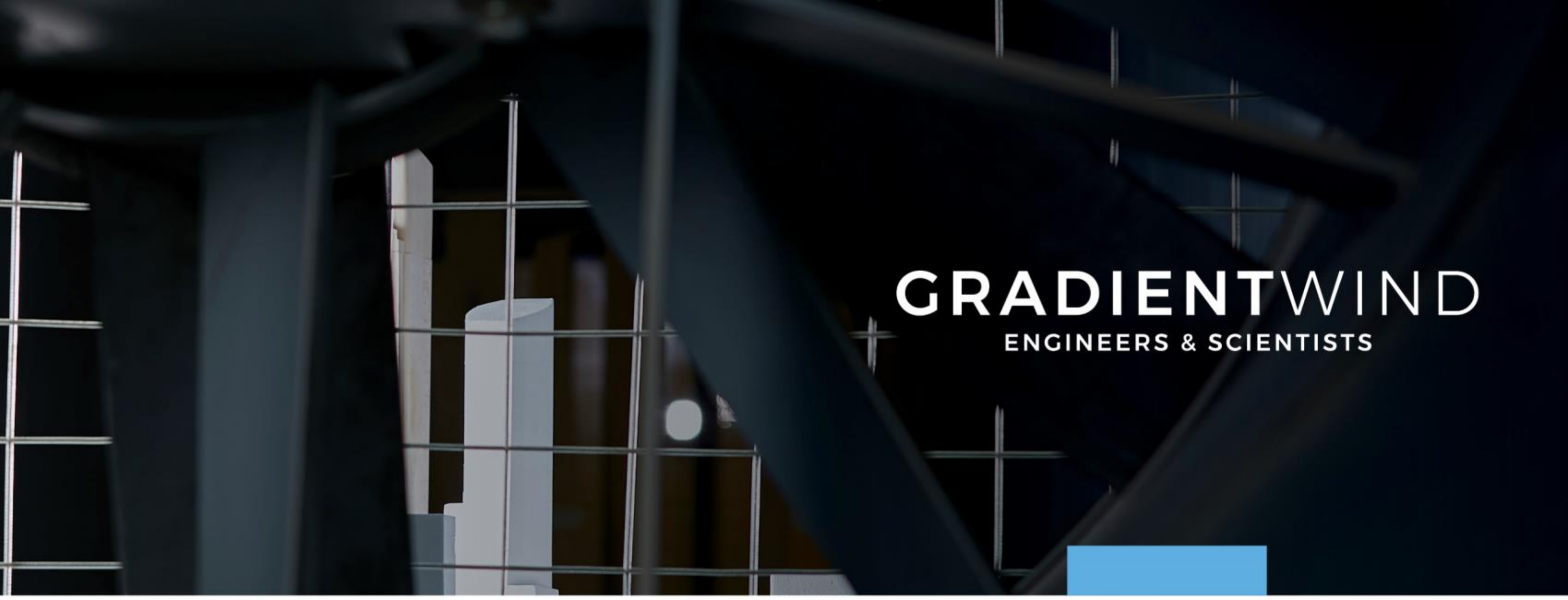
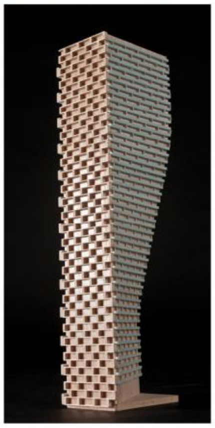
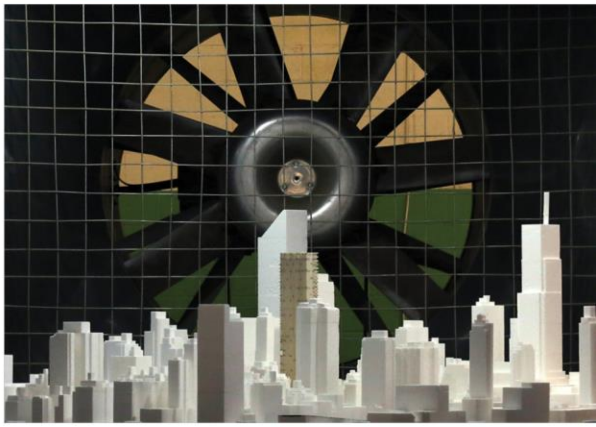


TRANSPORTATION NOISE & VIBRATION FEASIBILITY ASSESSMENT

Petrie's Landing III
8600 Jeanne d'Arc Boulevard North
Ottawa, Ontario

Report: 23-056-Noise & Vibration





May 26, 2023

PREPARED FOR
11034936 Canada Inc.
98 rue Lois
Gatineau, QC J8Y 3R7

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

EXECUTIVE SUMMARY

This report describes a transportation noise & vibration feasibility assessment to satisfy concurrent Official Plan Amendment (OPA) and Zoning By-law Amendment (ZBLA) application requirements for the proposed multi-building development, referred to as “Petrie’s Landing III”, located at 8600 Jeanne d’Arc Boulevard North in Ottawa, Ontario. The proposed development comprises 11 buildings with a mixture of residential units and retail spaces. The major sources of transportation noise transportation noise are Jeanne-d’Arc Boulevard, Highway 174, and the future Light Rail Transit (LRT) Confederation line. Figure 1 illustrates a complete 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 roadway traffic volumes corresponding to the City of Ottawa’s Official Plan (OP) roadway classifications and LRT information based on previous project experience; (iv) architectural drawings prepared by Brigil, in May 2023; (v) satellite imagery; and (vi) Gradient Wind’s experience with similar projects.

The results of the current analysis indicate that noise levels will range between 62 and 77 dBA during the daytime period (07:00-23:00) and between 59 and 69 dBA during the nighttime period (23:00-07:00). The highest noise level (i.e. 77 dBA) occurs along the south façade D1, which is nearest and most exposed to Highway 174. Noise levels at the various amenity terraces tested exceed the 60 dBA upper criterion, and as such, investigation of noise screens is expected to be required. Amenity spaces classified as outdoor living areas should make use of building massing to provide blockage from transportation noise sources, where possible.

Building components with a higher Sound Transmission Class (STC) rating will be required where exterior noise levels exceed 65 dBA. Results of the calculations also indicate that building along Jeanne-d-Arc Boulevard and Highway 174 will require central air conditioning, which will allow occupants to keep windows closed and maintain a comfortable living environment. Buildings setback and sheltered from these sources will require forced air heating with provision for air conditioning. Furthermore, Warning Clauses will also be required to be placed on all Lease, Purchase and Sale Agreements.

Specific transportation noise control measures will be determined as part of a detailed transportation noise assessment conducted at a later stage as part of the requirements for a Site Plan Application.

Regarding stationary noise, impacts from the surroundings on the study building are expected to be minimal. Sources associated with surrounding residential properties are expected to be in compliance with the MECP's noise guideline NPC-216-Residential Air Conditioning.

Impacts from the development on the surroundings can be minimized by judicious placement of mechanical equipment such as its placement on a roof or in a mechanical penthouse, or the incorporation of silencers and noise screens as necessary. It is recommended that any large pieces of HVAC equipment be placed in the middle of the roof, avoiding the line of site with the surrounding residential dwellings. A detailed stationary noise assessment will be conducted for the development to ensure impacts at on-site and off-site locations are in compliance with the stationary noise criteria.

TABLE OF CONTENTS

1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by 11034936 Canada Inc. to undertake a transportation noise & vibration feasibility assessment to satisfy concurrent Official Plan Amendment (OPA) and Zoning By-law Amendment (ZBLA) application requirements for the proposed multi-building development, referred to as "Petrie's Landing III", located at 8600 Jeanne d'Arc Boulevard North in Ottawa, Ontario (hereinafter referred to as "subject site" or "proposed development"). This report summarizes the methodology, results, and recommendations related to a transportation noise & vibration feasibility assessment.

The present scope of work involves assessing exterior noise & vibration levels generated by local transportation sources. 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 architectural drawings prepared by Brigil in May 2023, with future roadway traffic volumes corresponding to the City of Ottawa's Official Plan (OP) roadway classifications and LRT information based on previous project experience.

2. TERMS OF REFERENCE

The subject site is located at 8600 Jeanne d'Arc Boulevard North in Ottawa, situated at the east intersection of Jeanne d'Arc Boulevard North and Parkrose Private, on a parcel of land bounded by Jeanne d'Arc Boulevard North to the north, Centre des métiers Minto educational institution to the east, Ottawa Regional Road 174 (hereinafter referred to as "Highway 174") to the south, and Taylor Creek and low-rise residential dwellings to the west. Internal public and private roads extending from Jeanne d'Arc Boulevard North and a future connection extending from the existing laneway situated to the east of the subject site divides the subject site into four blocks (identified as 'A', 'B', 'C', and 'D'). The proposed development comprises 11 buildings with a mixture of residential units and retail spaces. A park is situated to the west

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

of the subject site. Of note, the present study considers all podia roofs as potential common amenity terraces.

Block A is situated at the northwest corner of the subject site and includes buildings A1, A2, A3, and A4. Buildings A1, A2, and A4 comprise nominally rectangular planforms and building A3 comprises a nominally 'L'-shaped planform with its long axis-oriented along Jeanne d'Arc Boulevard North. Building A1 rises to four storeys while buildings A2, A3, and A4 rise to six storeys. A potential privately-owned publicly accessible space (P.O.P.S.) is provided at the southwest corner of building A3.

Block B is situated central to the subject site and includes buildings B1, B2, and B3. Buildings B1 and B2 both rise to nine storeys. Building B1 comprises a nominally 'U'-shaped planform and building B2 comprises a nominally 'L'-shaped planform, with their long and short axis-oriented along Jeanne d'Arc Boulevard North, respectively. Building B3 comprises a nominally rectangular 40-storey tower inclusive of a nominally trapezoidal six-storey podium. A potential P.O.P.S. is located at the southwest corner of building B2.

Block C is situated at the northeast corner of the subject site and includes buildings C1 and C2. Buildings C1 and C2 both comprise nominally rectangular planforms. Building C1 rises to nine storeys while building C2 comprises a 30-storey tower inclusive of a six-storey podium.

Block D is situated to the south of the subject site and includes buildings D1 and D2. Building D1 comprises two 30-storey towers above a common six-storey podium, while building D2 comprises a 30-storey tower above a nominally trapezoidal six-storey podium. A potential P.O.P.S. is provided at the northeast corner of building D2.

The near-field surroundings comprise green spaces in all compass directions with Highway 174 to the southeast, low-rise residential dwellings to the southwest, and Taylor Creek to the west. The major sources of transportation noise transportation noise are Jeanne-d'Arc Boulevard, Highway 174, and the future Light Rail Transit (LRT) Confederation line. Figure 1 illustrates a complete site plan with surrounding context.

3. OBJECTIVES

The main goals of this work are to (i) calculate the future noise levels on the development produced by local transportation and stationary sources, (ii) calculate the future vibration levels on the development produced by local LRT 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 vehicle traffic, 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 that 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 indoor noise limit range (that is relevant to this study) is 45 and 40 dBA for living rooms and sleeping quarters, respectively, as listed in Table 1.

However, to account for deficiencies in building construction and control peak noise, these levels should be targeted toward 42 and 37 dBA.

TABLE 1: INDOOR SOUND LEVEL CRITERIA (ROAD) [3]

Type of Space	Time Period	L_{eq} (dBA)
General offices, reception areas, retail stores, etc.	07:00 – 23:00	50
Living/dining/den areas of residences, hospitals, schools, **nursing/retirement homes**, day-care centres, theatres, places of worship, libraries, individual or semi-private offices, conference rooms, etc.	07:00 – 23:00	45
Sleeping quarters of hotels/motels	23:00 – 07:00	45
Sleeping quarters of residences, hospitals, **nursing/retirement homes**, etc.	23:00 – 07:00	40

Predicted noise levels at the plane of window (POW) dictate the action required to achieve the recommended sound levels. An open window is considered to provide a 10 dBA reduction in noise while a standard closed window is capable of providing a minimum 20 dBA noise reduction[4]. Therefore, where noise levels exceed 55 dBA daytime and 50 dBA nighttime, the ventilation for the building should consider the need for having windows and doors closed, which normally triggers the need for central air conditioning (or similar systems). Where noise levels exceed 65 dBA daytime and 60 dBA nighttime building components will require higher levels of sound attenuation[5].

The sound level criterion for outdoor living areas is 55 dBA, which applies during the daytime (07:00 to 23:00). However, given the location of the development, a daytime sound level of 60 dBA would be acceptable. When noise levels exceed 60 dBA, mitigation must be provided to reduce noise levels where technically and administratively feasible to acceptable levels at or below the criterion.

[3] Adapted from ENCG 2016 – Tables 2.2b and 2.2c
[4] Burberry, P.B. (2014). Mitchell's Environment and Services. Routledge, Page 125
[5] MECP, Environmental Noise Guidelines, NPC 300 – Part C, Section 7.1.3

4.2.2 Roadway and LRT 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[6] 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. Table 2 (below) summarizes the AADT values used for each roadway and LRT line included in this assessment.

TABLE 2: ROADWAY AND LRT TRAFFIC DATA

Segment	Roadway Traffic Data	Speed Limit (km/h)	Traffic Volume
Jeanne-d'Arc Boulevard	2-Lane Major Collector	60	**12,000**
Highway 174	6-Lane Highway	100	**110,000**
Confederation Line	LRT	70	**540/60***

* Daytime / nighttime volumes

4.2.3 Theoretical Transportation Noise Predictions

Noise predictions were performed with the aid of the MECP computerized noise assessment program, STAMSON 5.04, for road and rail analysis. Appendix A includes the STAMSON 5.04 input and output data.

Roadway noise calculations were performed by treating each road segment as a separate line source of noise. In addition to the traffic volumes summarized in Table 2, 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.
- Ground surfaces were taken to be reflective due to the presence of hard (paved) ground.

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

- The site is assumed to have flat or gently sloping topography.
- The future LRT system was modelled using 4-car SRT vehicle type in STAMSON.
- Surrounding buildings and the study buildings themselves were considered as noise barriers, as applicable, partially or fully obstructing exposure to the source.
- Noise receptors were strategically placed at six (6) locations around the study area (see Figure 2).

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[7]. 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[8], 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 future LRT Confederation line, which will have frequent events, the 0.10 mm/s RMS (72 dBV) vibration criteria and 35 dBA ground borne noise criteria were adopted for this study.

4.3.2 Theoretical Ground Vibration Prediction Procedure

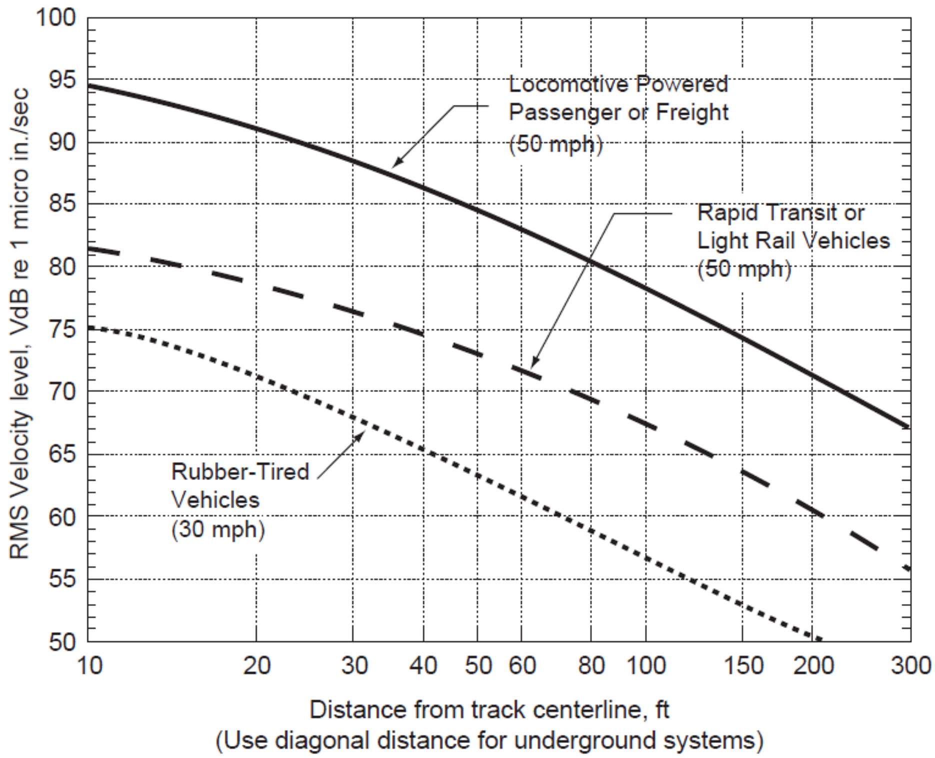
At the time of this study, the Confederation Line in the area of the site has not yet been constructed, therefore theoretical calculations were used to assess vibrations. Potential vibration impacts of the future Confederation LRT rail line, currently planned, were predicted using the FTA's Transit Noise and Vibration Impact Assessment[9] 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 -1 dBV to account for an operational speed of 43.4 mph (70 km/h). The track was assumed to have welded joints. Details of the vibration calculations are presented in Appendix B.

---

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

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

[9] 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 transportation noise calculations are summarized in Table 6 below. A complete set of input and output data from all STAMSON 5.04 calculations are available in Appendix A.

TABLE 6: EXTERIOR NOISE LEVELS DUE TO TRANSPORTATION SOURCES

Receptor Number	Height above Local Grade/Roof (metres)	Receptor Location	Predictor-Lima Noise Level (dBA)		STAMSON 5.04 Noise Level (dBA)	
			Day	Night	Day	Night
1	4.5	POW – D1 South Façade	77	69	78	70
2	4.5	POW – A3 North Façade	67	59	68	61
3	1.5	OLA – D1 Podium Terrace	66	N/A	N/A	N/A
4	1.5	OLA – D2 Podium Terrace	66	N/A	N/A	N/A
5	1.5	OLA – C2 Podium Terrace	64	N/A	N/A	N/A
6	1.5	OLA – D1 POPS	62	N/A	N/A	N/A

*Noise levels at the OLAs during the nighttime period do not need to be considered as per the ENCG.

The results of the current analysis indicate that noise levels will range between 62 and 77 dBA during the daytime period (07:00-23:00) and between 59 and 69 dBA during the nighttime period (23:00-07:00). The highest noise level (i.e. 77 dBA) occurs along the south façade D1, which is nearest and most exposed to Highway 174. The noise impacts from the future LRT system are insignificant compared to the impacts from Highway 174, therefore roadway traffic noise will dictate the indoor noise level criteria. Figure 3 and 4 illustrate daytime and nighttime noise contours throughout the study site at grade.

5.2 Ground Vibrations & Ground-borne Noise Levels

Based on an offset distance of 55 m between the Confederation line railway centerline and the nearest building foundation, the estimated vibration level at the nearest point of reception is expected to be 0.014 mm/s RMS (55 dBV) based on the FTA protocol. Details of the calculation are provided in Appendix B. Since predicted vibration levels are below the criterion of 0.10 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 35 dB from the velocity vibration level in dBV. Since measured vibration levels were found to be less than 0.10 mm/s peak partial velocity (ppv), 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 analysis indicate that noise levels will range between 62 and 77 dBA during the daytime period (07:00-23:00) and between 59 and 69 dBA during the nighttime period (23:00-07:00). The highest noise level (i.e. 77 dBA) occurs along the south façade D1, which is nearest and most exposed to Highway 174. Noise levels at the various amenity terraces tested exceed the 60 dBA upper criterion, and as such, investigation of noise screens is expected to be required. Amenity spaces classified as outdoor living areas should make use of building massing to provide blockage from transportation noise sources, where possible.

Building components with a higher Sound Transmission Class (STC) rating will be required where exterior noise levels exceed 65 dBA. Results of the calculations also indicate that building along Jeanne-d-Arc Boulevard and Highway 174 will require central air conditioning, which will allow occupants to keep windows closed and maintain a comfortable living environment. Buildings setback and sheltered from these sources will require forced air heating with provision for air conditioning. Furthermore, Warning Clauses will also be required to be placed on all Lease, Purchase and Sale Agreements.

Specific transportation noise control measures will be determined as part of a detailed transportation noise assessment conducted at a later stage as part of the requirements for a Site Plan Application.

Regarding stationary noise, impacts from the surroundings on the study building are expected to be minimal. Sources associated with surrounding residential properties are expected to be in compliance with the MECP's noise guideline NPC-216-Residential Air Conditioning.

Impacts from the development on the surroundings can be minimized by judicious placement of mechanical equipment such as its placement on a roof or in a mechanical penthouse, or the incorporation of silencers and noise screens as necessary. It is recommended that any large pieces of HVAC equipment be placed in the middle of the roof, avoiding the line of site with the surrounding residential dwellings. A detailed stationary noise assessment will be conducted for the development to ensure impacts at on-site and off-site locations are in compliance with the stationary noise criteria.

This concludes our traffic noise 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.

Michael Lafortune, C.E.T.
Environmental Scientist

Joshua Foster, P.Eng.
Lead Engineer

Gradient Wind File #23-056-Noise & Vibration

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

PROJECT PETRIE'S LANDING III - 8600 JEANNE D'ARC BLVD N, OTTAWA TRANSPORTATION NOISE & VIBRATION FEASIBILITY ASSESSMENT		DESCRIPTION FIGURE 1: SITE PLAN AND SURROUNDING CONTEXT
SCALE 1:3000 (APPROX.)	DRAWING NO. GW23-056-1	
DATE MAY 25, 2023	DRAWN BY M.L.	

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PROJECT PETRIE'S LANDING III - 8600 JEANNE D'ARC BLVD N, OTTAWA TRANSPORTATION NOISE & VIBRATION FEASIBILITY ASSESSMENT		DESCRIPTION FIGURE 2: RECEPTOR LOCATIONS
SCALE 1:3000 (APPROX.)	DRAWING NO. GW23-056-2	
DATE MAY 25, 2023	DRAWN BY M.L.	

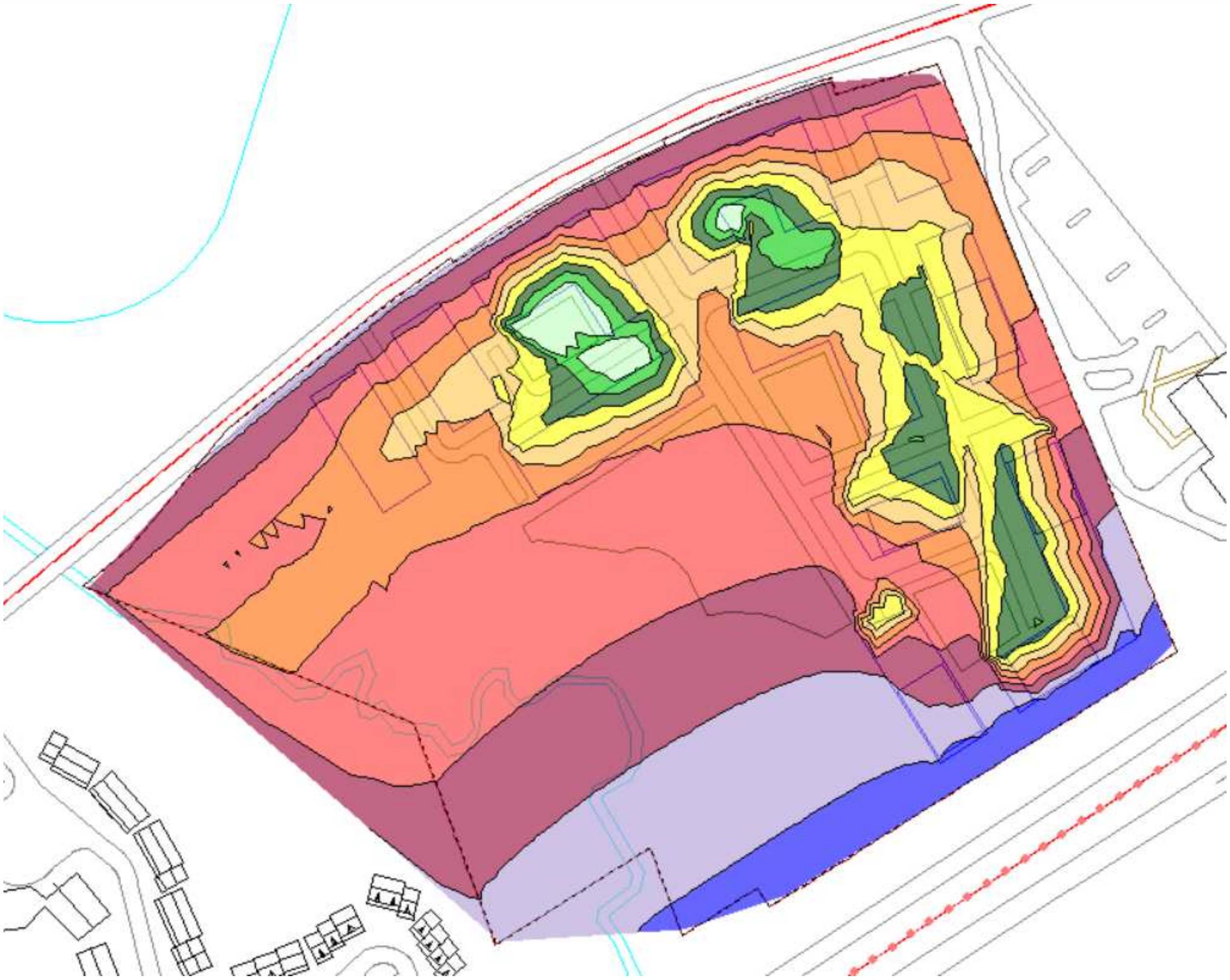
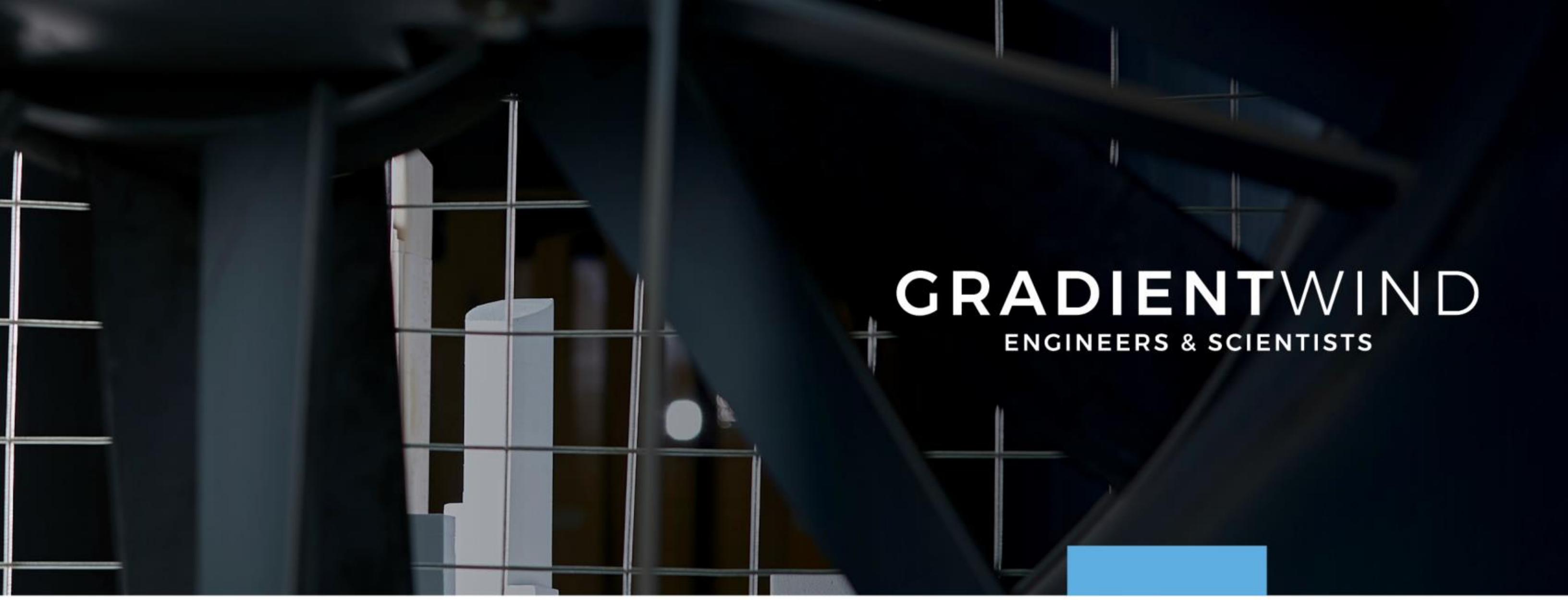


FIGURE 3: NOISE CONTOURS 1.5 M ABOVE GRADE (DAYTIME PERIOD)

	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 4: NOISE CONTOURS 1.5 M ABOVE GRADE (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 AND SUPPORTING INFORMATION

```
STAMSON 5.0        NORMAL REPORT        Date: 25-05-2023 15:55:58
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: 174 (day/night)
---------------------------------------
Car traffic volume  : 89056/7744  veh/TimePeriod  *
Medium truck volume :  7084/616   veh/TimePeriod  *
Heavy truck volume  :  5060/440   veh/TimePeriod  *
Posted speed limit  :   100 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): 110000
    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: 174 (day/night)
-------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  54.00 / 54.00  m
Receiver height           :   4.50 / 4.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Results segment # 1: 174 (day)
------------------------------

Source height = 1.50 m

ROAD (0.00 + 77.59 + 0.00) = 77.59 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.00  83.16   0.00  -5.56   0.00   0.00   0.00   0.00
77.59
--------------------------------------------------------------------------
--

Segment Leq : 77.59 dBA

Total Leq All Segments: 77.59 dBA


Results segment # 1: 174 (night)
--------------------------------

Source height = 1.50 m

ROAD (0.00 + 70.00 + 0.00) = 70.00 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.00  75.56   0.00  -5.56   0.00   0.00   0.00   0.00
70.00
--------------------------------------------------------------------------
--

Segment Leq : 70.00 dBA

Total Leq All Segments: 70.00 dBA
```

```
RT/Custom data, segment # 1: LRT (day/night)
--------------------------------------------
1 - 4-car SRT:
Traffic volume     :   540/60    veh/TimePeriod
Speed              :    80  km/h

Data for Segment # 1: LRT (day/night)
-------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  54.00 / 54.00  m
Receiver height           :   4.50 / 4.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

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

Source height = 0.50 m

RT/Custom (0.00 + 59.03 + 0.00) = 59.03 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.00  64.60  -5.56   0.00   0.00   0.00   0.00  59.03
----------------------------------------------------------------------

Segment Leq : 59.03 dBA

Total Leq All Segments: 59.03 dBA


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

Source height = 0.50 m

RT/Custom (0.00 + 52.50 + 0.00) = 52.50 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.00  58.07  -5.56   0.00   0.00   0.00   0.00  52.50
----------------------------------------------------------------------

Segment Leq : 52.50 dBA

Total Leq All Segments: 52.50 dBA



TOTAL Leq FROM ALL SOURCES (DAY): 77.65
                         (NIGHT): 70.08
```

```
STAMSON 5.0        NORMAL REPORT        Date: 25-05-2023 15:56:03
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Jeanne (day/night)
------------------------------------------
Car traffic volume  :  9715/845   veh/TimePeriod  *
Medium truck volume :   773/67    veh/TimePeriod  *
Heavy truck volume  :   552/48    veh/TimePeriod  *
Posted speed limit  :    60 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):  12000
    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: Jeanne (day/night)
----------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  18.00 / 18.00  m
Receiver height           :   4.50 / 4.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

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Results segment # 1: Jeanne (day)
---------------------------------

Source height = 1.50 m

ROAD (0.00 + 68.24 + 0.00) = 68.24 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.00  69.03   0.00  -0.79   0.00   0.00   0.00   0.00
68.24
--------------------------------------------------------------------------
--

Segment Leq : 68.24 dBA

Total Leq All Segments: 68.24 dBA


Results segment # 1: Jeanne (night)
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Source height = 1.50 m

ROAD (0.00 + 60.64 + 0.00) = 60.64 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.00  61.43   0.00  -0.79   0.00   0.00   0.00   0.00
60.64
--------------------------------------------------------------------------
--

Segment Leq : 60.64 dBA

Total Leq All Segments: 60.64 dBA




TOTAL Leq FROM ALL SOURCES (DAY): 68.24
                         (NIGHT): 60.64
```

APPENDIX B

FTA VIBRATION CALCULATIONS

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

GW23-056 26-May-23

Possible Vibration Impacts on Petrie's Landing III
Perdicted using FTA General Assesment

Train Speed 70 km/h 43.5 mph

	Distance from C/L	
	(m)	(ft)
LRT	55.0	180.4

	Vibration	
From FTA Manual Fig 10-1		
Vibration Levels at distance from track	62	dBV re 1 micro in/sec
Adjustment Factors FTA Table 10-1		
Speed reference 50 mph	-1	Speed Limit of 88 km/h (55 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	61	0.028
Coupling to Building Foundation	-10	Large Massonry on Piles
Floor to Floor Attenuation	-2.0	Ground Floor Ocupied
Amplification of Floor and Walls	6	
Total Vibration Level	55	dBV or 0.014 mm/s
Noise Level in dBA	20	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.