October 4, 2021

Stillwater Station Limited
c/o The Properties Group
236 Metcalfe Street
Ottawa, ON K2P 1R3

Re: Noise Feasibility Brief
1987 Robertson Road, Ottawa
Gradient Wind File # 21-308-Noise Brief

1. INTRODUCTION AND TERMS OF REFERENCE

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Stillwater Station Limited to undertake a noise brief assessment for a Secondary Plan submission for a conceptual residential development located at 1987 Roberston Road in Ottawa, Ontario. The nearest source of transportation noise is the freight rail line to the north. All collector/arterial roadways and highways are located beyond 100 and 500 metres (m) from the development, respectively, therefore are considered insignificant. The CN freight rail line is also a source of ground vibrations. Furthermore, noise impacts from potential sources of stationary noise, such as nearby existing roof top units, were also investigated.

The noise 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, and Gradient Wind's experience on previous projects. Our study was based on a concept plan drawing prepared by RLA Architecture, railway volumes based on Gradient Wind's experience along similar railway lines, as well as satellite imagery provided by the City of Ottawa.

The current development concept comprises a number of residential blocks ranging from 6-20 storeys. There are a number of ground-level amenity spaces throughout the study site. The study site is bound by the CN freight rail line to the north, the General Dynamics campus to the east, and trailer park (residential)

[1] City of Ottawa – Environmental Noise Control Guidelines, January 2016
[2] Ministry of the Environment and Climate Change (MOECC) – Environmental Noise Guideline, Publication NPC-300, August 2013

properties to the south and west. There as a light-industrial park to the northwest, along Menten Place. Figure 1 illustrates the current concept plan and surrounding context.

2. OBJECTIVES

The main goals of this work are to: (i) calculate the future noise levels on the study building produced by local railway traffic, and (ii) qualitatively assess potential impacts from nearby stationary noise sources.

3. METHODOLOGY

3.1 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.

3.2 Transportation Noise

3.2.1 Criteria for Railway Traffic Noise

For railway 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, 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.

Predicted noise levels at the plane of window (POW) and outdoor living area (OLA) dictate the action required to achieve the recommended indoor and OLA sound levels, as specified in the ENCG. When noise levels at these areas meet or exceed the ENCG objective limit of 55 dBA, specific outdoor, ventilation and

Warning Clause requirements may apply. In addition, where noise levels exceed 65 dBA, upgraded building components must be designed to ensure indoor sound level limits can be met.

3.2.2 Railway Traffic Volumes

Table 1 (below) summarizes the railway traffic volumes used for the assessment, based on Gradient Wind's experience with other CN Rail and the Kanata LRT EA. All collector/arterial roadways and highways are located beyond 100 and 500 metres (m) from the development, respectively, therefore are considered insignificant.

TABLE 1: ROADWAY TRAFFIC DATA

Roadway	Roadway Class	Speed Limit (km/h)	AADT
CN Rail Line	Freight Line	80	**1/1***

* - Daytime/nighttime volumes

3.2.3 Theoretical Railway Traffic Noise Predictions

Calculations were performed for a sample receptor representative as a worst-case location for the development (Minimum setback and maximum exposure to CN Rail line) with the assistance of the (MECP) rail and road noise analysis program STAMSON 5.04, which incorporates the calculation model '*Sound from Trains Environment Analysis Method*' (STEAM). The impact from railway noise is then combined with roadway predictions using a logarithmic addition at each point of reception and compared to the relevant criteria.

The railway line was treated as a single line source of noise which used existing and proposed building locations as noise barriers. In addition to the railway volumes summarized in Table 1, theoretical noise predictions were also based on the following parameters:

- For freight trains, four locomotives were modelled per train, with an average of 100 cars per train.
- Whistle events were not considered, because there are no level crossings in the area
- Rail lines were assumed not to be welded, due to the number of turnouts in the area

3.3 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.

3.3.1 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[3]. 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[4], 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 LRT lines, 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.

3.3.2 Theoretical Ground Vibration Prediction Procedure

Potential vibration impacts of the rail line was predicted using the FTA's Transit Noise and Vibration Impact Assessment[5] 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 freight and light rail trains at 50 miles per hour (mph). Details of the vibration calculations are presented in Appendix B.

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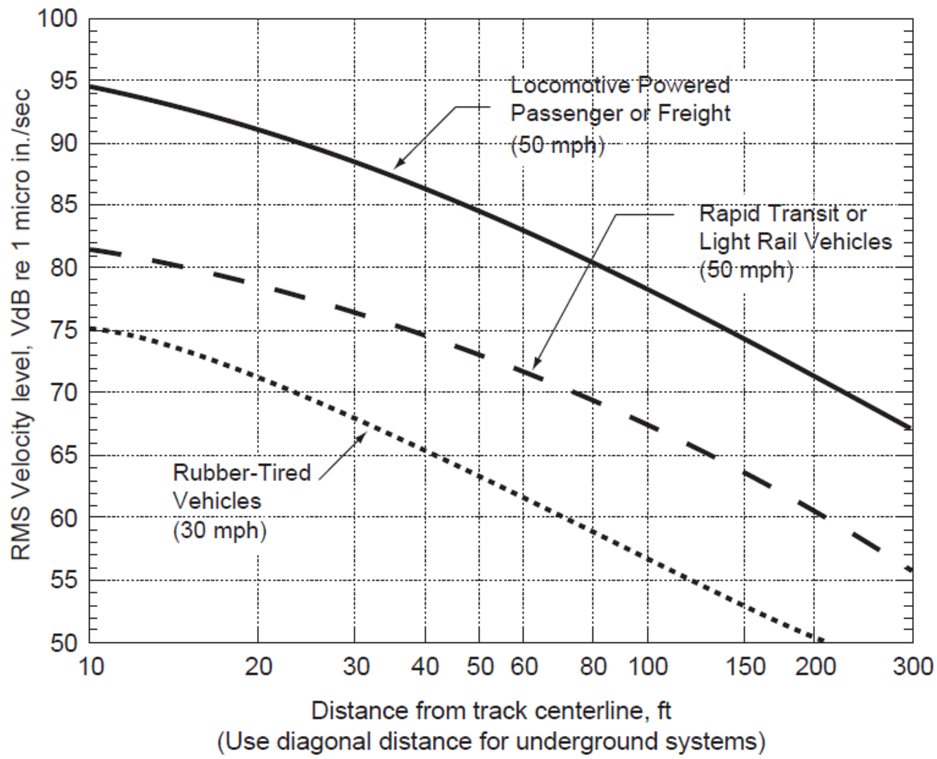
[3] MECP/TTC Protocol for Noise and Vibration Assessment for the Proposed Yonge-Spadina Subway Loop, June 16, 1993

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

[5] 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)

4. RESULTS AND CONCLUSIONS

4.1 Transportation Noise

The results of the roadway traffic noise calculations are summarized in Table 2 below. A complete set of input and output data from all STAMSON 5.04 calculations are available in Appendix A.

TABLE 2: EXTERIOR NOISE LEVELS DUE TO ROADWAY TRAFFIC SOURCES

Receptor Number	Plane of Window Receptor Location	Train Type	Noise Level (dBA)	
			Day	Night
1	POW – 20 m above grade North Façade Tower B1	Freight	57	60

The results of the current study indicate that noise levels are expected to reach 57 dBA during the daytime period (07:00-23:00) and 60 dBA during the nighttime period (23:00-07:00). The highest noise levels will occur along the north façades, which are nearest and most exposed to the CN Rail line. Noise levels may exceed the ENCG objective limit of 55 dBA, triggering the requirement for forced air heating and provisions for air conditioning, and the corresponding warning clauses. Ground level amenity spaces are favorably located to make use of building massing to provide blockage from the CN Rail line. Specific noise control measures will be determined as part of future studies for site plan control applications.

4.2 Stationary Noise

Potential impacts from proposed rooftop mechanical equipment on nearby noise-sensitive buildings can be controlled with judicial selection and placement of equipment. A more detailed stationary noise analysis would be conducted once the mechanical design develops.

Impacts from existing stationary noise sources surrounding the study site are expected to be minimal. There are no existing significant sources, such as rooftop mechanical equipment associated with the surrounding industrial and office buildings, withing 100 m of the study site. Future sources on proposed buildings would be appropriately designed. As a result, the proposed development is expected to be compatible with the future proposed noise sensitive land uses.

4.3 Ground Vibrations & Ground-borne Noise Levels

Based on an offset distance of 54 metres between the CN Rail line and the nearest building foundation, the estimated vibration level at the nearest point of reception is expected to be 0.057 mm/s RMS (67 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.

This concludes our 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
Oct 4, 2021
PROVINCE OF ONTARIO

Michael Lafortune, C.E.T.
Environmental Scientist

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Principal

Gradient Wind File #21-308-Noise Brief

GRADIENTWIND
ENGINEERS & SCIENTISTS
127 WALGREEN ROAD , OTTAWA, ON
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PROJECT	1987 ROBERTSON ROAD, OTTAWA TRANSPORTATION NOISE BRIEF
SCALE	1:2000 (APPROX.)
DRAWING NO.	GW21-308-1
DATE	SEPTEMBER 9, 2021
DRAWN BY	M.L.
DESCRIPTION	FIGURE 1: CONCEPT PLAN AND SURROUNDING CONTEXT STAMSON INPUT PARAMETERS

APPENDIX A

STAMSON 5.04 – INPUT AND OUTPUT DATA, SUPPORTING INFORMATION

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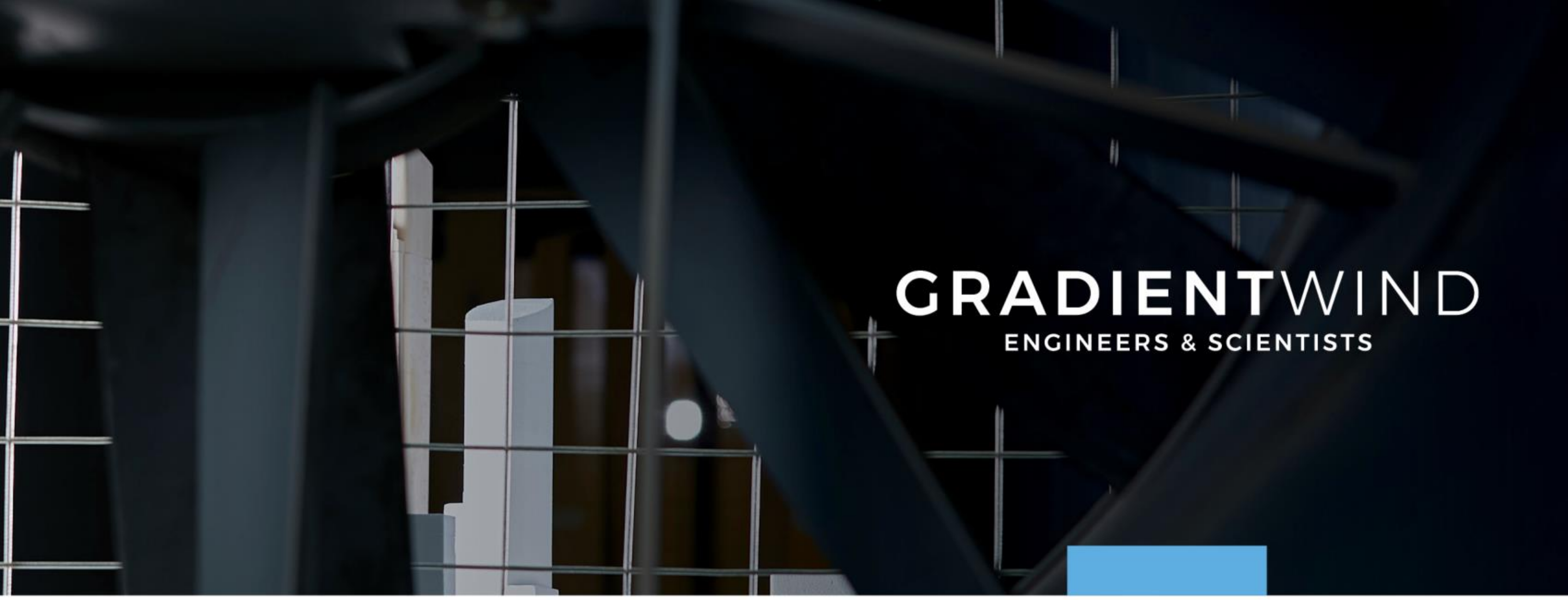
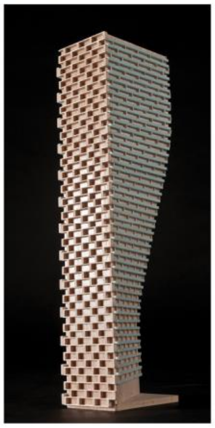
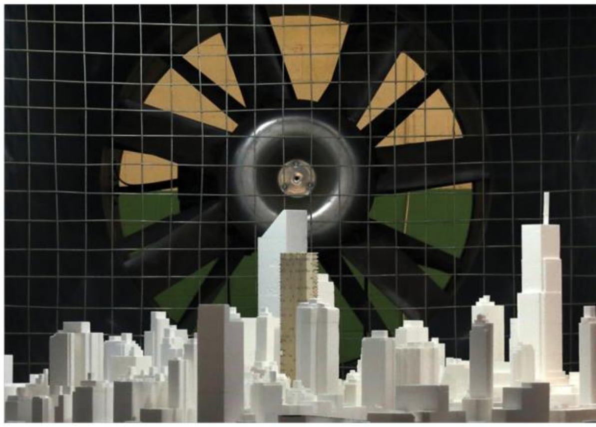
```
STAMSON 5.0        NORMAL REPORT        Date: 09-09-2021 15:25:02
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Rail data, segment # 1: Freight (day/night)
-------------------------------------------
Train            ! Trains       ! Speed !# loc !# Cars! Eng  !Cont
Type             !              !(km/h) !/Train!/Train! type !weld
-----------------+--------------+-------+------+------+------+----
  1.             !   1.0/1.0    !  80.0 !  4.0 !100.0 !Diesel!  No

Data for Segment # 1: Freight (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            :  20.00 / 20.00  m
Topography                 :      1       (Flat/gentle slope; no barrier)
No Whistle
Reference angle            :   0.00
```

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

LOCOMOTIVE (0.00 + 55.86 + 0.00) = 55.86 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.00  61.42  -5.56   0.00   0.00   0.00   0.00  55.86
----------------------------------------------------------------------

WHEEL (0.00 + 52.35 + 0.00) = 52.35 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.00  57.91  -5.56   0.00   0.00   0.00   0.00  52.35
----------------------------------------------------------------------

Segment Leq : 57.46 dBA

Total Leq All Segments: 57.46 dBA


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

LOCOMOTIVE (0.00 + 58.87 + 0.00) = 58.87 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.00  64.43  -5.56   0.00   0.00   0.00   0.00  58.87
----------------------------------------------------------------------

WHEEL (0.00 + 55.36 + 0.00) = 55.36 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.00  60.92  -5.56   0.00   0.00   0.00   0.00  55.36
----------------------------------------------------------------------

Segment Leq : 60.47 dBA

Total Leq All Segments: 60.47 dBA




TOTAL Leq FROM ALL SOURCES (DAY): 57.46
                         (NIGHT): 60.47
```







APPENDIX B

FTA VIBRATION CALCULATIONS

127 WALGREEN ROAD, OTTAWA, ON, CANADA K0A 1L0 | 613 836 0934
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GW21-308 9-Sep-21

Possible Vibration Impacts on 1987 Robertson Road
Perdicted using FTA General Assesment

Train Speed 80 km/h 50 mph

	Distance from C/L	
	(m)	(ft)
CN	54.0	177.2

	Vibration	
From FTA Manual Fig 10-1		
Vibration Levels at distance from track	73	dBV re 1 micro in/sec
Adjustment Factors FTA Table 10-1		
Speed reference 50 mph	0	Speed Limit of 95 km/h (60 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	73	0.113
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	67	dBV or 0.057 mm/s
Noise Level in dBA	32	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.