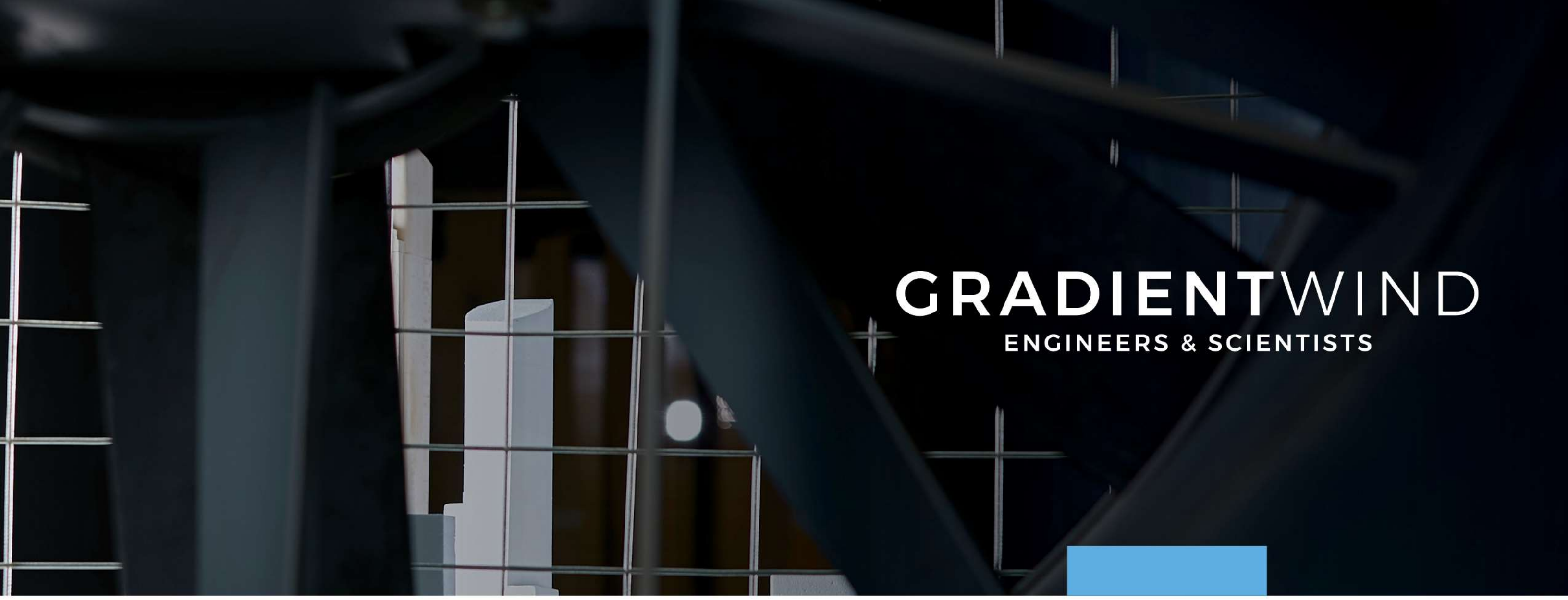
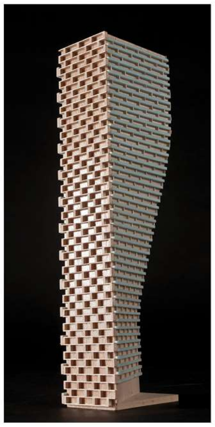
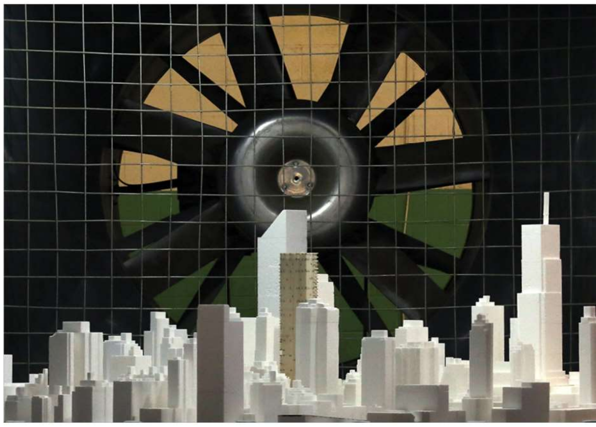


TRANSPORTATION NOISE & VIBRATION FEASIBILITY ASSESSMENT

21-51 Queen Street North
Mississauga, Ontario

REPORT: GW21-164-Noise & Vibration





August 18, 2021

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EXECUTIVE SUMMARY

This report describes a transportation noise and vibration feasibility assessment in support of an Official Plan Amendment (OPA) and Zoning By-Law Amendment (ZBA) application for the proposed development located at 21-51 Queen Street North in Mississauga, Ontario. For the purposes of this study, the elevation facing Queen Street North will be referred to as project west. The development comprises two nine-storey buildings oriented north-south on a shared rectangular two-storey podium with a four-storey connection on the west side. Spaces considered as Outdoor Living Areas (OLA) in this study comprise a 5th floor amenity on the west side, a 3rd floor central amenity, stepped terraces on the east elevations, and ground-level patios surrounding the east side of the development. Balconies extending less than 4 metres from the building façade do not require consideration as OLAs in this study.

Primary sources of transportation noise are vehicle traffic on Queen Street North and Britannia Road West as well as railway traffic through the Canadian Pacific Railway Corridor to the west. Canadian Pacific Railway freight trains and GO passenger trains (Milton Line) use this corridor. The Canadian Pacific Railway corridor is also a source of ground vibrations. Furthermore, the rail yard approximately 100 metres to the northwest was assessed as a source of stationary noise. Figure 1 illustrates a 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) requirements; (ii) architectural drawings prepared by A&Architects Inc. in July 2021; (iii) roadway traffic counts obtained from the Region of Peel; and (iv) train information assumed from Gradient Wind's previous experience and Metrolinx scheduling information.

The results of the current analysis indicate that noise levels will range between 46 and 70 dBA at the Plane of Window during the daytime period (07:00-23:00) and between 48 and 70 dBA during the nighttime period (23:00-07:00). The highest noise levels (i.e. 70 dBA) occur along the west façade which is nearest and most exposed to the transportation noise sources. Noise levels at Outdoor Living Areas (OLA) range between 48 and 64 dBA during the daytime period.

The exterior noise levels predicted due to roadway and railway traffic exceed the criteria listed in Section 4.2 for upgraded building components. Therefore, upgraded building components will be required where exterior noise levels exceed 65 dBA. Furthermore, the building will require central air conditioning, allowing occupants to keep windows and doors closed and maintain a comfortable living environment. Warning clauses will be required in all Lease, Purchase and Sale agreements.

Noise levels at the Outdoor Living Areas (OLA) range between 48 and 64 dBA during the daytime period. Mitigation will be required where OLA noise levels exceed 60 dBA, and is recommended where noise levels exceed 55 dBA. OLA noise levels are expected to exceed 60 dBA at the level-5 amenity area on the west side of the building, and the ground-level patios on the north and south sides. Mitigation at OLA can be further explored at the time of site plan approval.

With respect to stationary noise, results indicate that impacts from the rail yard to the northwest of the study building exceed the NPC-300 stationary noise criteria. Stationary noise levels exceed the Class 1 criteria at multiple points of reception, on the façades most exposed to the rail yard. As source-based mitigation is not considered viable, upgraded building components will be required on the façades where exterior noise levels from the rail yard are elevated.

The development's own mechanical equipment has the potential to generate noise off-site at surrounding noise-sensitive (residential) developments. Any potential impacts can be minimized by judicious selection of the mechanical equipment and its location. It is preferable to locate large pieces of equipment, such as cooling towers and make up air units, on the roof of the towers or in mechanical penthouses. Once the mechanical design of the building has developed sufficiently, it should be reviewed by a qualified acoustical engineer to ensure compliance with NPC-300 sound level limits.

Estimated vibration levels due to the CP Railway corridor are expected to be 0.10 mm/s RMS (72 dBV) within the first floor of the building, based on the FTA protocol and a conservative offset distance of 64 m from the property line to the nearest railway track centerline. Details of the calculation are provided in Appendix A. Since predicted vibration levels do not exceed the criterion of 0.14 mm/s RMS first floor of the building, vibration mitigation will not be required. As vibration levels are acceptable, correspondingly, regenerated noise levels are also expected to be acceptable.

A detailed transportation and stationary noise study will be required at the time of site plan approval, to determine specific noise control measures for the development.

TABLE OF CONTENTS

1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Miss BJL Corp. to undertake a transportation noise and vibration assessment in support of an Official Plan Amendment (OPA) and Zoning By-Law Amendment (ZBA) application for the proposed development located at 21-51 Queen Street North in Mississauga, Ontario. This report summarizes the methodology, results, and recommendations related to a transportation noise and ground vibration assessment investigating exterior noise levels generated by stationary and transportation noise sources, as well as ground vibrations generated by local railway traffic.

The assessment was performed based on theoretical noise calculation methods conforming to the Ministry of the Environment, Conservation and Parks (MECP) NPC-300 guidelines. Noise calculations were based on architectural drawings prepared by A&Architects Inc. in July 2021, with future traffic volumes corresponding to roadway traffic counts obtained from the Region of Peel and train information assumed from Gradient Wind's previous experience and Metrolinx scheduling information.

2. TERMS OF REFERENCE

The focus of this transportation noise and vibration assessment is the two-tower mixed-use development located at 21-51 Queen Street North in Mississauga, Ontario. For the purposes of this study, the elevation facing Queen Street North will be referred to as project west. The study site is situated centrally on parcel of land bound by Matlock Avenue to the north, Queen Street North to the west, and Britannia Road West to the south.

The study building comprises two nine-storey buildings oriented north-south (referring to project north) on a shared rectangular two-storey podium with a four-storey connection on the west side. The ground floor consists of a residential lobby and lounge in the southwest corner, and retail space along the west elevation, all accessible from Queen Street North, residential units with adjacent private patios along the east and south elevations, and amenity space located centrally. A driveway along the north elevation provides access to a loading area and ramp to three levels of below-grade parking. Level 2 is largely open to areas below on the west side, with residential units on the east and south sides. At Level 3, the centre of the east elevation sets back to form a 'C'-shaped planform with a central outdoor amenity terrace, an indoor amenity in the southeast end and surrounding residential units. Levels 4 and above comprise exclusively residential units, and at Level 5 the west elevations setback to form two separate rectangular buildings with the short axis facing Queen Street North. Above Level 5, the buildings rise to full height with stepped terraces on the east elevations. Mechanical penthouses complete the development. Terraces or balconies that extend less than 4 metres from the building façade are not considered Outdoor Living Areas (OLA) in this study, as per NPC-300 guidelines.

The site is surrounded by low-rise in all directions, and the Canadian Pacific Railway (CP) corridor approximately 75 metres to the west. CP freight trains and GO passenger trains (Milton Line) use this corridor, with freight traffic branching off to the west on a main line, and north on a spur line. A small portion of freight trains travel northbound on the Orangeville-Brampton Railway (OBRY) spur line. The majority of freight train traffic is expected to follow the westbound CP corridor, parallel to the Milton Line GO trains. Primary sources of transportation noise are Queen Street North, Britannia Road West and the railway traffic. The Canadian Pacific Railway is also a source of ground vibrations. Furthermore, the rail yard approximately 100 metres to the northwest was assessed as a source of stationary noise. Figure 1 illustrates a site plan with surrounding context.

3. OBJECTIVES

The main goals of this work are to (i) calculate the future noise and vibration levels on the study building produced by local transportation and stationary sources, and (ii) determine whether noise and vibration levels exceed the allowable limits specified by the MECP Noise Control Guidelines – NPC-300 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, 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 NPC-300 guidelines specify that the recommended indoor noise limit range (that is relevant to this study) is 45 and 40 dBA for residence living rooms and sleeping quarters respectively, as listed in Table 1. However, to account for deficiencies in building construction and to control peak noise, these levels should be targeted toward 42 and 37 dBA. Indoor noise level criteria due to railway traffic are 5 dB lower.

TABLE 1: INDOOR SOUND LEVEL CRITERIA [1]

Type of Space	Time Period	Leq (dBA)	
		Road	Rail
General offices, reception areas, retail stores, etc.	07:00 – 23:00	50	45
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	40
Sleeping quarters of hotels/motels	23:00 – 07:00	45	40
Sleeping quarters of **residences**, hospitals, nursing/retirement homes, etc.	23:00 – 07:00	40	35

[1] Adapted from Table C-2, Part C, Section 3.2.3 of NPC-300

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[2]. 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[3].

For designated Outdoor Living Areas (OLAs), the sound level limit is 55 dBA during the daytime period. An excess above the limit is acceptable only in cases where the required noise control measures are not feasible for technical, economic or administrative reasons.

4.2.2 Roadway and Railway Traffic Volumes

NPC-300 dictates that noise calculations should consider future sound levels based on a roadway's classification at the mature state of development. Therefore, traffic volumes have been considered for the mature state of development based on traffic counts obtained from Peel Region and train information assumed based on Gradient Wind's experience and Metrolinx scheduling information[4]. Counts are then projected to 10 years in the future from the year of the project (2021) with a growth rate of 2% per year. Table 2 (below) summarizes the Annual Average Daily Traffic (AADT) values used for each roadway and railway line included in this assessment.

[2] Burberry, P.B. (2014). Mitchell's Environment and Services. Routledge, Page 125
[3] MECP, Environmental Noise Guidelines, NPC 300 – Part C, Section 7.1.3
[4] Metrolinx (2021), Milton Line GO Train Schedule

TABLE 2: ROADWAY AND RAILWAY TRAFFIC DATA

Segment	Roadway/Transit Class	Speed Limit (km/h)	Existing AADT Count	Year of Count	Projected 2031 AADT Count
Queen Street North	4-UAD	50	29,330	2019	**37,198**
Brittania Road W	4-UAD	50	17,540	2019	**22,245**
Canadian Pacific Railway	Northbound Freight	80	1/1*	2017	**1/1***
	Westbound Freight	80	9/6*	2017	**11/8***
	GO Passenger	97	9/1*	2021	**11/1***

* Daytime/nighttime volumes

4.2.3 Theoretical Transportation Noise Predictions

The impact of transportation noise sources on the development was determined by computer modelling. Transportation noise source modelling is based on the software program *Predictor-Lima* which utilizes the United States Federal Highway Administration's Traffic Noise Model (TNM) to represent the roadway line sources, and the International Standards Organization (ISO) standard 9613 Parts 1 and 2 to represent railway line sources. This computer program can represent three-dimensional surfaces and first reflections of sound waves over a suitable spectrum for human hearing. A set of comparative calculations were performed in the free field environment for comparisons to the current Ontario traffic noise prediction model STAMSON, which incorporates the calculation model 'Sound from Trains Environment Analysis Method' (STEAM). The STAMSON model is however older and requires each receptor to be calculated separately. STAMSON also does not accurately account for building reflections and multiple screening elements, and curved road geometry. Noise levels modelled in STAMSON were found to be within an imperceptible level of 0-3 dBA of those in Predictor. A total of 19 receptor locations were identified around the site, as illustrated in Figure 2.

Roadway and railway noise calculations were performed separately by treating each transportation segment as line sources of noise, and by using existing building locations as noise barriers. The impact from roadway and railway noise is then combined using a logarithmic addition at each point of reception and compared to the relevant criteria. 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.
- The daytime/nighttime traffic volume split was taken as 90% daytime and 10% nighttime.
- Reflective intermediate ground surfaces were assumed.
- Receptors were placed at heights of 27.2 metres for level 9; 21.3 metres for level 7; 15.4 metres for level 5; 11.9 m for level 4; 8.6 metres for level 3; and 1.5 m for the ground-level.
- Surrounding buildings were considered as noise barriers.
- Noise receptors were strategically placed at 19 locations around the study area (Figure 2).
- Freight trains were modeled with an average of 164 cars and 4 locomotives per train (80 km/h).
- GO passenger trains were modeled with an average 10 cars and 1 locomotive per train (97 km/h).
- Whistle events were excluded from analysis as the main line crossing is on a bridge, and the level-crossing for the spur line is expected to have infrequent whistle events due to minimal traffic.
- Railway tracks were assumed to be not welded, due to the number of turnouts in the area.

The noise generated from both on-road and railway traffic were combined for the 19 receptor locations identified in Figure 2. The combined outdoor noise levels from both road and rail were compared to the appropriate NPC-300 criteria stipulated in Table C-2.

4.3 Stationary Noise

Stationary sources are defined in NPC-300 as: "a source of sound or combination of sources of sound that are included and normally operated within the property lines of a facility and includes the premises of a person as one stationary source, unless the dominant source of sound on those premises is construction"[5]. Common stationary sources of noise include rail yards, HVAC equipment, emergency generators, cooling towers and exhaust fans, which are often found on industrial and commercial facilities. As stationary noise can cause an adverse effect, it is important to examine (i) the impact of existing stationary sources on the development, and (ii) impact of study building sources on the surrounding residences. The focus of this stationary noise assessment is on the impact of noise emanating from the rail yard located approximately 100 metres northwest of the proposed development.

[5] NPC – 300, page 16

4.3.1 Criteria for Stationary Noise

Noise criteria taken from the NPC-300 apply to all points of reception (POR). A POR is defined under NPC-300 as "any location on a noise sensitive land use where noise from a stationary source is received"[6]. A POR can be located on an existing or zoned for future use premises of permanent or seasonal residences, hotels/motels, nursing/retirement homes, rental residences, hospitals, campgrounds, and noise sensitive buildings such as schools and places of worship.

The study site is considered to be in a Class 1 area because it is located near the intersection of two arterial roadways. This condition indicates that the sound field is dominated by manmade sources. According to NPC-300, the exclusion limit sound levels for Plane of Window and Outdoor Points of Reception are shown in Table 3 below.

TABLE 3: EXCLUSION LIMIT FOR CLASS 1 AREA

Time of Day	Class 1	
	Outdoor Points of Reception	Plane of Window
07:00 – 19:00	50	50
19:00 – 23:00	50	50
23:00 – 07:00	N/A	45

4.3.2 Determination of Stationary Noise Source Power Levels

Stationary noise source power levels were based on Gradient Wind's experience with similar developments, and a protocol developed by the Federal Transit Administration (FTA) entitled: 'Transit Noise and Vibration Impact Assessment'[7]. The FTA protocol provides a general assessment and screening procedures for the computation of stationary noise impacts from rail yards. The general assessment has been based on noise source and land-use information previously mentioned.

[6] NPC – 300, page 14
[7] C. E. Hanson; D. A. Towers; and L. D. Meister, Transit Noise and Vibration Impact Assessment, Federal Transit Administration, May 2006

To determine the sound power level of the rail yard stationary noise based on the FTA protocol, the assessment begins with determining a reference Sound Exposure Level (SEL) at 50 feet (15 m). A value of 118 dBA is provided for rail yards. Next, the hourly L_{eq} can be calculated based on the average number of trains per hour during the day and night. It is assumed that the rail yard could experience a peak of 10 train activities per hour during both the daytime and nighttime periods, based on the train volumes indicated in section 4.2.2. A peak value is used, as specified in the *Guidelines for New Development in Proximity to Railway Operations*[8]. These parameters are used to determine the hourly L_{eq} sound pressure level at 15 m as summarized by Equation 1.

$$L_{eq}(h) = SEL_{ref} + \left(10log\left(\frac{N_T}{20}\right)\right) - 35.6 \qquad \text{(Eq.1)}$$

Where:

$L_{eq}(h)$ = Hourly L_{eq} Sound Pressure Level at 15 m (dBA)
SEL_{ref} = Source Reference Level at 15 m (dBA)
N_T = Number of train activities per hour

Equation 2 below was used to convert the sound pressure level of the rail yard to sound power level.

$$L_P = L_W - |10\log\left(\frac{Q}{4\pi r^2}\right)| \qquad \text{(Eq.2)}$$

Where:
L_w = Sound Power level (dBA)
L_p = Sound Pressure level (dBA)
Q = Directivity Factor (2)
r = Distance between Source and Receiver (m)

The resultant steady state sound power level of the rail yard based on Equation 2 was calculated to be 111 dBA (1 hour L_{eq}). This value is the same value published in The Canadian Transportation Agency's Railway Noise Measurement and Reporting Methodology[9].

[8] Dialog and J.E. Coulter Associates Limited, prepared for The Federation of Canadian Municipalities and The Railway Associated of Canada, May 2013
[9] Canadian Transportation Agency, Railway Noise Measurement and Reporting, August 2011

4.3.3 Stationary Noise Source Predictions

The impact of stationary noise sources on the proposed development was determined by computer modelling using the software program Predictor-Lima. The calculation method used for this section of the study was developed from the International Standards Organization (ISO) standard 9613 Parts 1 and 2. The methodology has been used on numerous assignments and has been accepted by the Ministry of the Environment, Conservation and Parks (MECP) as part of Environmental Compliance Approval applications.

A total of 19 receptor locations were chosen around the site, corresponding to the locations chosen in section 4.2.3. Figure 2 illustrates the location of all PORs used in this study. Table 4 below contains Predictor-Lima calculation settings. These are typical settings that have been based on ISO 9613 standards and guidance from the MECP. Figure 1 illustrates the boundaries of the rail yard, used to represent noise emanating from the rail yard as an area source in the Predictor model.

Ground absorption over the study area was determined based on topographical features (such as water, concrete, grassland, etc.). An absorption value of 0 is representative of hard ground, while a value of 1 represents grass and similar soft surface conditions. Existing and proposed buildings were added to the model to account for screening and reflection effects from building façades. A Predictor-Lima sample output and further modelling data is available upon request.

TABLE 4: CALCULATION SETTINGS

Parameter	Setting
Meteorological correction method	Single value for C0
Value C0	2.0
Default ground attenuation factor	0
Ground attenuation factor for roadways and paved areas	0
Temperature (K)	283.15
Pressure (kPa)	101.33
Air humidity (%)	70

4.3.4 Impacts on Surroundings

The development's own mechanical equipment has the potential to generate noise off-site at surrounding noise sensitive (residential) developments. Any potential impacts can be minimized by judicious selection of mechanical equipment and its location. It is preferable to locate large pieces of equipment, such as cooling towers and make up air units, on the roof of the towers or in mechanical penthouses. Once the mechanical design of the building has developed sufficiently, it should be reviewed by a qualified acoustical engineer to ensure compliance with NPC-300 sound level limits.

4.4 Ground Vibration & Ground-borne Noise

4.4.1 Background on Vibrations

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.

Similar to sound waves in air, ground vibrations also 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. The repetitive motion of steel 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 noise signature that is unique to that structure and soil combination.

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 measurement units of ground vibration are millimeters per second (mm/s) or inchs 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.

4.4.2 Ground Vibration Criteria

The Canadian Railway Association and Canadian Association of Municipalities have set standards for new sensitive land developments within 300 metres of a railway right-of-way, as published in their document *Guidelines for New Development in Proximity to Railway Operations*[10], which indicate 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.

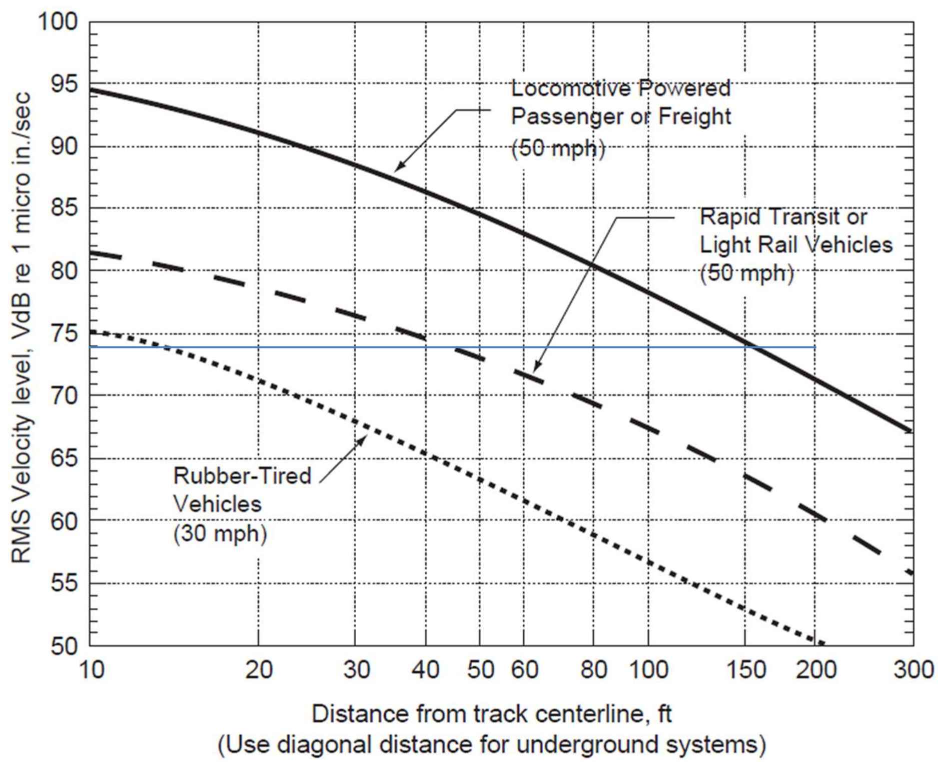
4.4.3 Theoretical Ground Vibration Prediction Procedure

Potential vibration impacts of the trains were predicted using the Federal Transit Authority's (FTA) Transit Noise and Vibration Impact Assessment[11] 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 on the following page, 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. The vibration impact on the building was determined using a set of curves for Locomotive Powered Passenger of Freight at a speed of 50 mph. Adjustment factors were considered based on the following information:

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

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

- The maximum operating speed of the freight trains near the study site is 80 km/h (50 mph)
- The distance between the property line of the development and the closest track is 64 m
- The vehicles are assumed to have soft primary suspensions
- Tracks are assumed to be jointed due to a number of turnouts in the area.
- Soil conditions do not efficiently propagate vibrations
- The building's foundation is large masonry on piles



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 5 below.

TABLE 5: EXTERIOR NOISE LEVELS DUE TO TRANSPORTATION SOURCES

Receptor Number	Receptor Location	Roadway Noise Level (dBA)		Railway Noise Level (dBA)		Total Noise Level (dBA)	
		Day	Night	Day	Night	Day	Night
	South Tower						
1	POW - Level 9 - South Façade	63	57	63	65	**66**	**66**
2	POW - Level 9 - West Façade	65	58	67	69	**69**	**69**
3	POW - Level 9 - North Façade	61	54	65	67	**66**	**67**
4	POW - Level 9 - East Façade	56	50	44	46	**56**	**51**
12	OLA - Level 9 - Terrace - East Side	55	N/A*	45	N/A*	**55**	**N/A***
13	OLA - Level 7 - Terrace - East Side	56	N/A*	43	N/A*	**56**	**N/A***
14	OLA - Level 5 - Terrace - East Side	56	N/A*	43	N/A*	**56**	**N/A***
	North Tower						
5	POW - Level 9 - South Façade	61	55	64	66	**66**	**66**
6	POW - Level 9 - West Façade	65	59	68	70	**70**	**70**
7	POW - Level 9 - North Façade	62	55	65	67	**67**	**67**
8	POW - Level 9 - East Façade	40	34	45	48	**46**	**48**
15	OLA - Level 9 - Terrace - East Side	46	N/A*	50	N/A*	**51**	**N/A***
16	OLA - Level 7 - Terrace - East Side	46	N/A*	50	N/A*	**51**	**N/A***
	Podium / Ground-Level						
9	POW - Level 4 - West Façade	66	60	67	69	**70**	**70**
10	OLA - Level 5 - West Amenity	54	N/A*	63	N/A*	**64**	**N/A***
11	OLA - Level 3 - Central Amenity	36	N/A*	48	N/A*	**48**	**N/A***
17	OLA - Ground-level Patio - North	52	N/A*	62	N/A*	**62**	**N/A***
18	OLA - Ground-level Patio - East	51	N/A*	46	N/A*	**52**	**N/A***
19	OLA - Ground-level Patio - South	56	N/A*	63	N/A*	**64**	**N/A***

* Nighttime noise levels not considered at OLA receptors, as per NPC-300 guidelines

The results of the current analysis indicate that noise levels will range between 46 and 70 dBA at the Plane of Window during the daytime period (07:00-23:00) and between 48 and 70 dBA during the nighttime period (23:00-07:00). The highest noise levels (i.e. 70 dBA) occur along the west façade which is nearest and most exposed to the transportation noise sources. Noise levels at Outdoor Living Areas range between 48 and 64 dBA during the daytime period. Transportation noise contours at 25 metres above grade for daytime and nighttime periods can be seen in Figures 3 and 4 respectively.

5.2 Stationary Noise Levels

The results of stationary noise calculations are summarized in Table 6 below.

TABLE 6: NOISE LEVELS FROM STATIONARY SOURCES

Receptor Number	Receptor Location	Rail Yard Noise Level (dBA)		MECP Class 1 Criteria		Meets Class 1 Criteria	
		Day	Night	Day	Night	Day	Night
South Tower							
1	POW - Level 9 - South Façade	36	36	50	45	YES	YES
2	POW - Level 9 - West Façade	56	56	50	45	**NO**	**NO**
3	POW - Level 9 - North Façade	56	56	50	45	**NO**	**NO**
4	POW - Level 9 - East Façade	29	29	50	45	YES	YES
12	OLA - Level 9 - Terrace - East Side	31	31	50	45	YES	YES
13	OLA - Level 7 - Terrace - East Side	30	30	50	45	YES	YES
14	OLA - Level 5 - Terrace - East Side	30	30	50	45	YES	YES
North Tower							
5	POW - Level 9 - South Façade	40	40	50	45	YES	YES
6	POW - Level 9 - West Façade	58	58	50	45	**NO**	**NO**
7	POW - Level 9 - North Façade	59	59	50	45	**NO**	**NO**
8	POW - Level 9 - East Façade	36	36	50	45	YES	YES
15	OLA - Level 9 - Terrace - East Side	40	40	50	45	YES	YES
16	OLA - Level 7 - Terrace - East Side	39	39	50	45	YES	YES

TABLE 6: NOISE FROM STATIONARY SOURCES (CONTINUED)

Receptor Number	Receptor Location	Rail Yard Noise Level (dBAI)		MECP Class 1 Criteria		Meets Class 1 Criteria	
		Day	Night	Day	Night	Day	Night
Podium / Ground-Level							
9	POW - Level 4 - West Façade	57	57	50	45	**NO**	**NO**
10	OLA - Level 5 - West Amenity	54	54	50	N/A*	**NO**	N/A*
11	OLA - Level 3 - Central Amenity	37	37	50	N/A*	YES	N/A*
17	OLA - Ground-level Patio - North	55	55	50	N/A*	**NO**	N/A*
18	OLA - Ground-level Patio - East	36	36	50	N/A*	YES	N/A*
19	OLA - Ground-level Patio - South	32	32	50	N/A*	YES	N/A*

*Nighttime noise levels not considered at OLA receptors, as per NPC-300

Stationary noise levels exceed NPC-300 Class 1 criteria at multiple points of reception. The west and north façades are most effected by rail yard noise, as they are nearest and most exposed to the source. Figure 5 illustrates stationary noise contours at a height of 25 metres above grade.

5.3 Ground Vibrations & Ground-Borne Noise Levels

Estimated vibration levels due to the CP Railway corridor are expected to be 0.101 mm/s RMS (72 dBV) within the first floor of the building, based on the FTA protocol and a conservative offset distance of 64 m from the property line to the nearest railway track centerline. Details of the calculation are provided in Appendix A. Since predicted vibration levels do not exceed the criterion of 0.14 mm/s RMS first floor of the building, vibration mitigation will not be required. As vibration levels are acceptable, correspondingly, regenerated noise levels are also expected to be acceptable.

6. CONCLUSIONS AND RECOMMENDATIONS

The results of the current analysis indicate that noise levels will range between 46 and 70 dBA at the Plane of Window during the daytime period (07:00-23:00) and between 48 and 70 dBA during the nighttime period (23:00-07:00). The highest noise levels (i.e. 70 dBA) occur along the west façade which is nearest and most exposed to the transportation noise sources. Noise levels at Outdoor Living Areas (OLA) range between 48 and 64 dBA during the daytime period.

The exterior noise levels predicted due to roadway and railway traffic exceed the criteria listed in Section 4.2 for upgraded building components. Therefore, upgraded building components will be required where exterior noise levels exceed 65 dBA, to attenuate noise to acceptable indoor levels. Furthermore, the building will require central air conditioning, allowing occupants to keep windows and doors closed and maintain a comfortable living environment. Warning clauses will be required in all Lease, Purchase and Sale agreements.

Noise levels at the Outdoor Living Areas (OLA) range between 48 and 64 dBA during the daytime period. Mitigation will be required where OLA noise levels exceed 60 dBA, and is recommended where noise levels exceed 55 dBA. OLA noise levels are expected to exceed 60 dBA at the level-5 amenity area on the west side of the building, and the ground-level patios on the north and south sides. Mitigation at OLA can be further explored at the time of site plan approval.

With respect to stationary noise, results indicate that impacts from the rail yard to the northwest of the study building exceed the NPC-300 stationary noise criteria. Stationary noise levels exceed the Class 1 criteria at multiple points of reception, on the façades most exposed to the rail yard. As source-based mitigation is not considered viable, upgraded building components will be required on the façades where exceedances occur.

The development's own mechanical equipment has the potential to generate noise off-site at surrounding noise-sensitive (residential) developments. Any potential impacts can be minimized by judicious selection of the mechanical equipment and its location. It is preferable to locate large pieces of equipment, such as cooling towers and make up air units, on the roof of the towers or in mechanical penthouses. Once the mechanical design of the building has developed sufficiently, it should be reviewed by a qualified acoustical engineer to ensure compliance with NPC-300 sound level limits.

Estimated vibration levels due to the CP Railway corridor are expected to be 0.101 mm/s RMS (72 dBV) within the first floor of the building, based on the FTA protocol and a conservative offset distance of 64 m from the property line to the nearest railway track centerline. Details of the calculation are provided in Appendix A. Since predicted vibration levels do not exceed the criterion of 0.14 mm/s RMS first floor of the building, vibration mitigation will not be required. As vibration levels are acceptable, correspondingly, regenerated noise levels are also expected to be acceptable.

A detailed transportation noise and stationary noise study will be required at the time of site plan approval, to determine specific noise control measures for the development.

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,

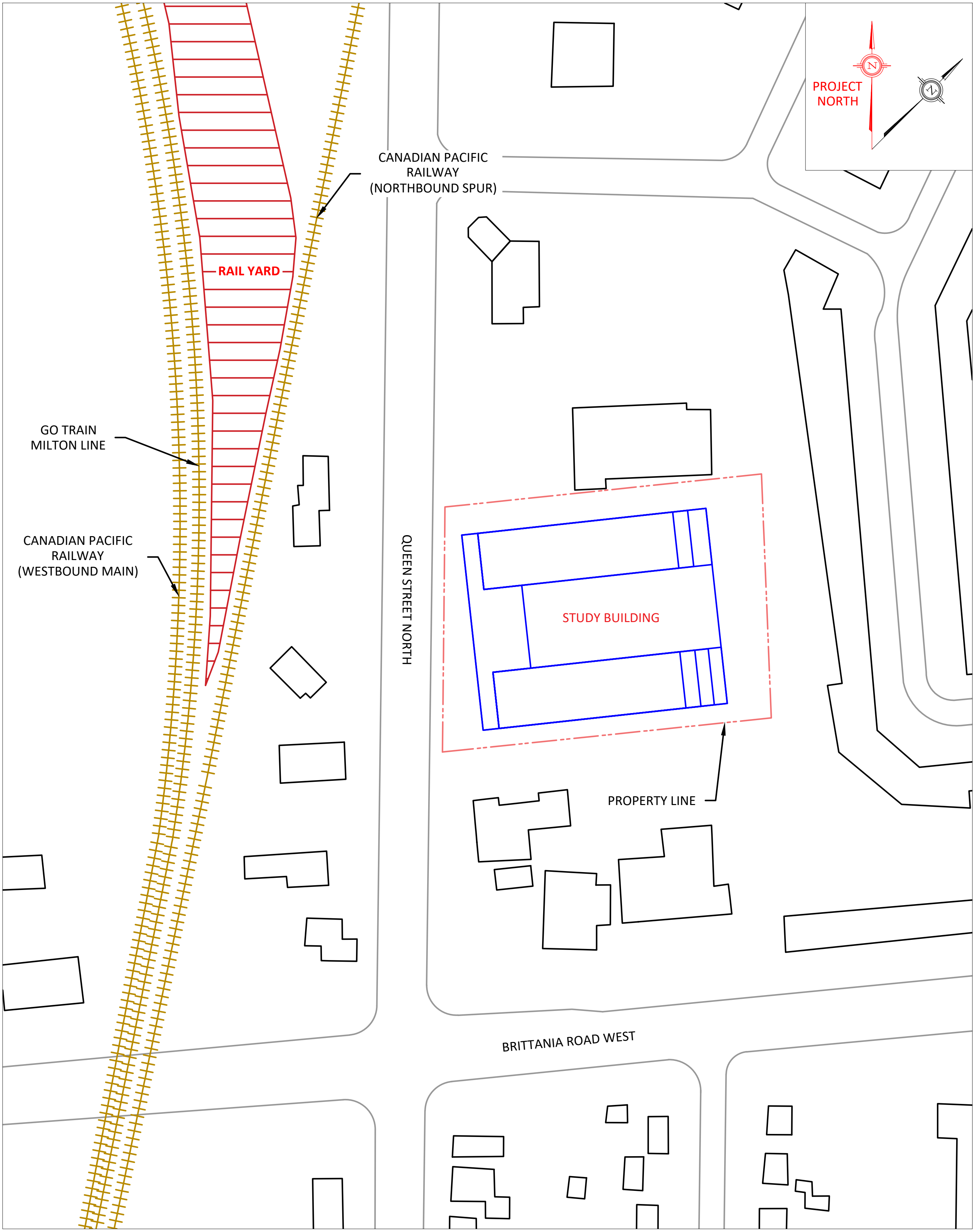
Gradient Wind Engineering Inc.

LICENSED PROFESSIONAL ENGINEER
J. R. FOSTER
100155655
Aug 18, 2021
PROVINCE OF ONTARIO

Tanyon Matheson-Fitchett, B.Eng.
Junior Environmental Scientist

Joshua Foster, P.Eng.
Principal

Gradient Wind File #21-164-Noise & Vibration



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PROJECT: 21-51 QUEEN STREET NORTH, MISSISSAUGA TRANSPORTATION NOISE AND VIBRATION FEASIBILITY ASSESSMENT		DESCRIPTION: FIGURE 1: SITE PLAN AND SURROUNDING CONTEXT
SCALE: 1:2000 (APPROX.)	DRAWING NO.: GW21-164-01	
DATE: AUGUST 10, 2021	DRAWN BY: T.M.F.	

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PROJECT		DESCRIPTION
21-51 QUEEN STREET NORTH, MISSISSAUGA TRANSPORTATION NOISE AND VIBRATION FEASIBILITY ASSESSMENT		FIGURE 2: NOISE SOURCE AND RECEPTOR LOCATIONS
SCALE 1:1250 (APPROX.)	DRAWING NO. GW21-164-02	
DATE AUGUST 10, 2021	DRAWN BY T.M.F.	

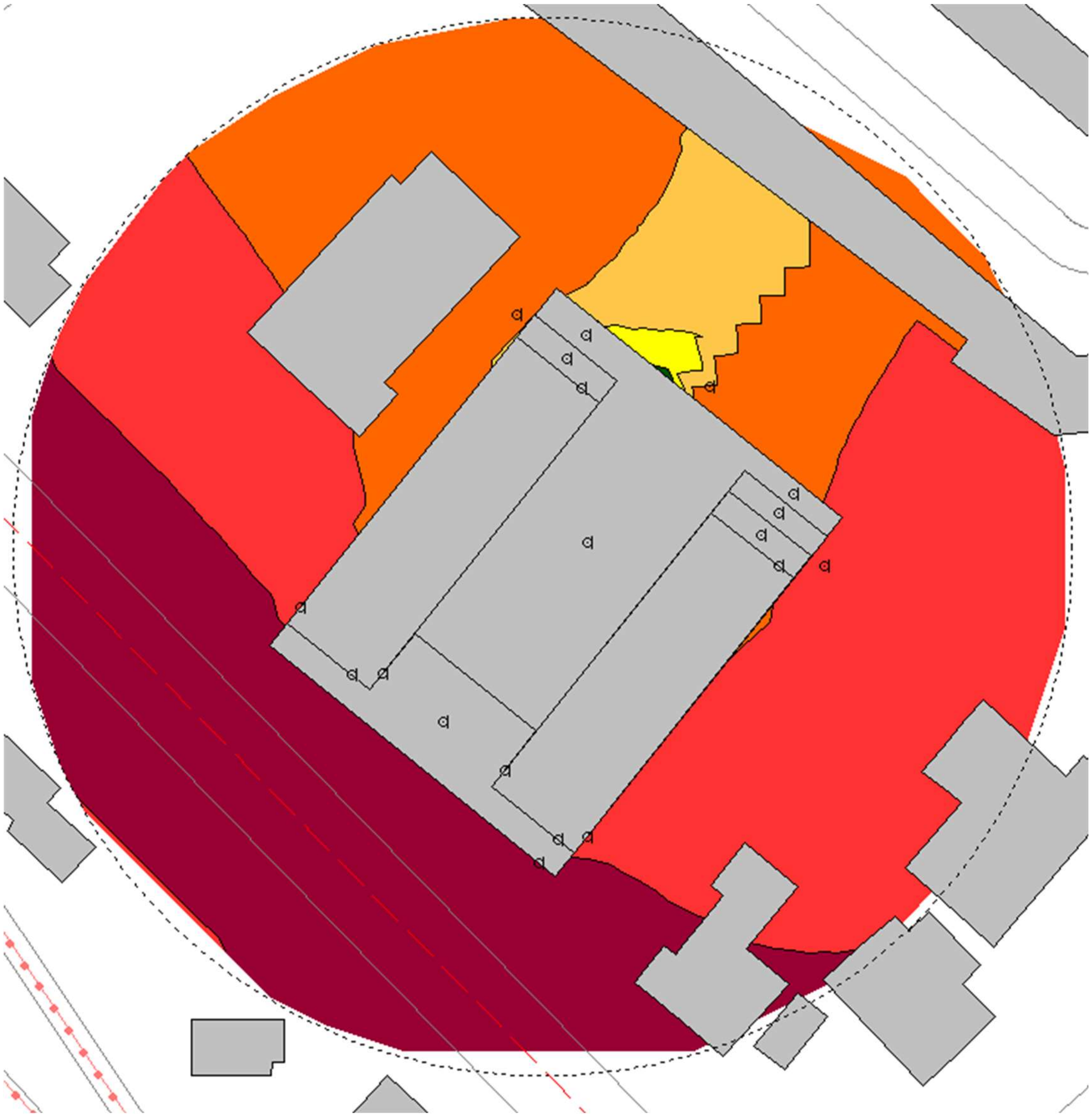
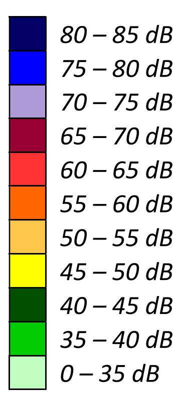


FIGURE 3: DAYTIME TRANSPORTATION NOISE CONTOURS (25 METRES ABOVE GRADE)



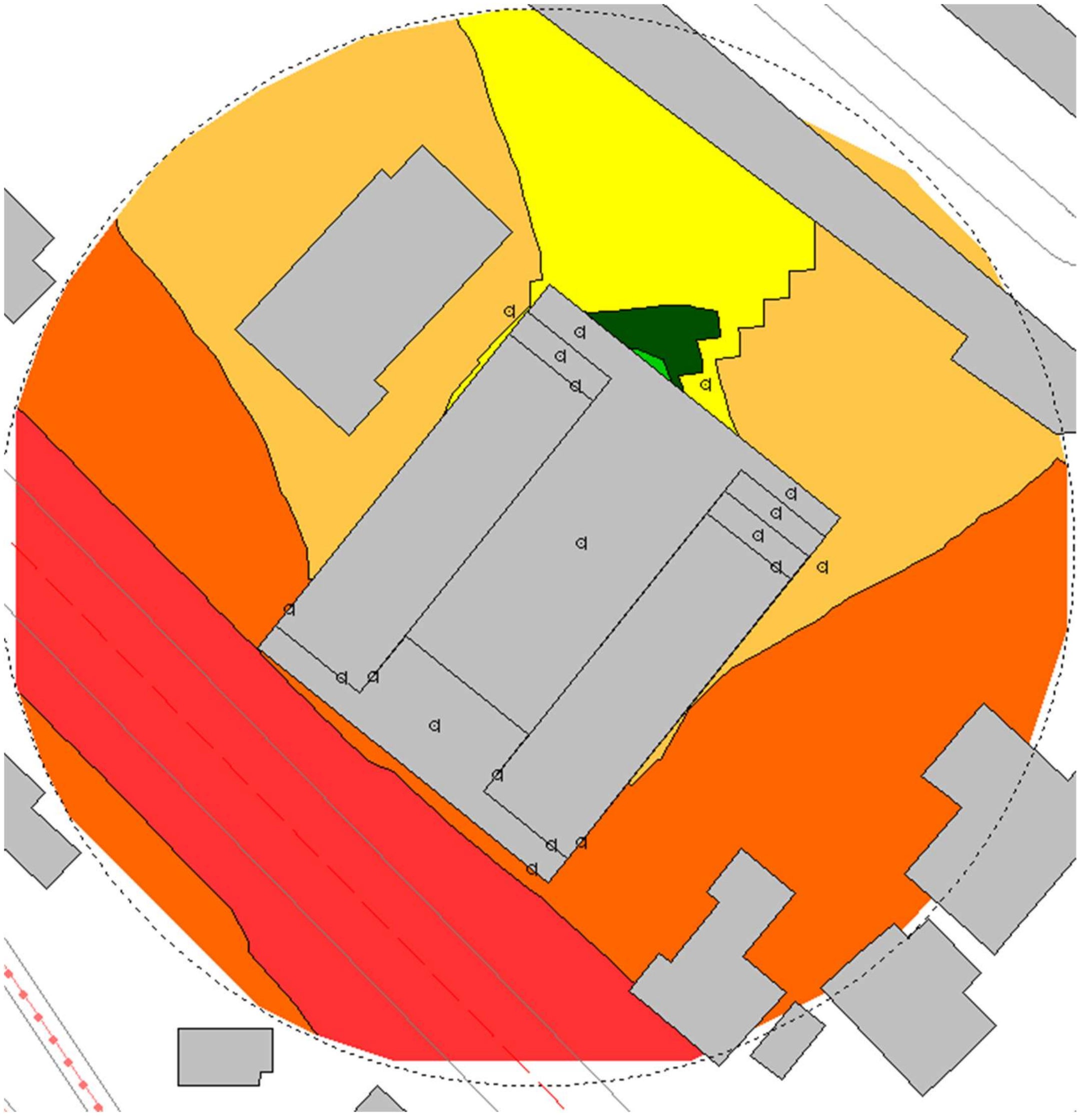
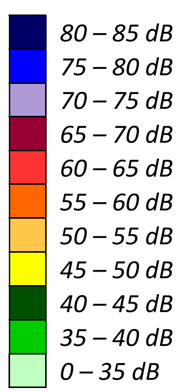


FIGURE 4: NIGHTTIME TRANSPORTATION NOISE CONTOURS (25 METRES ABOVE GRADE)



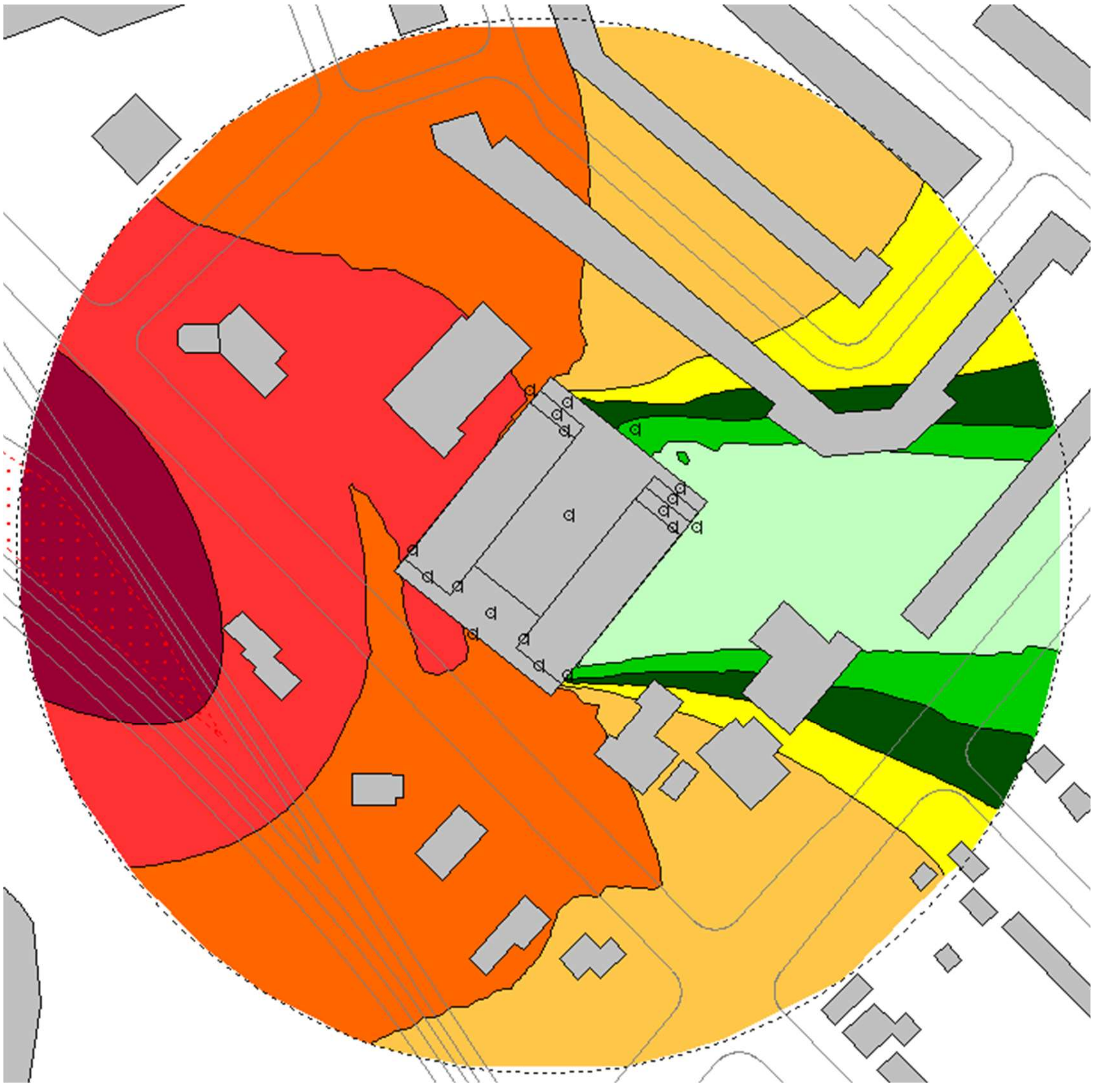
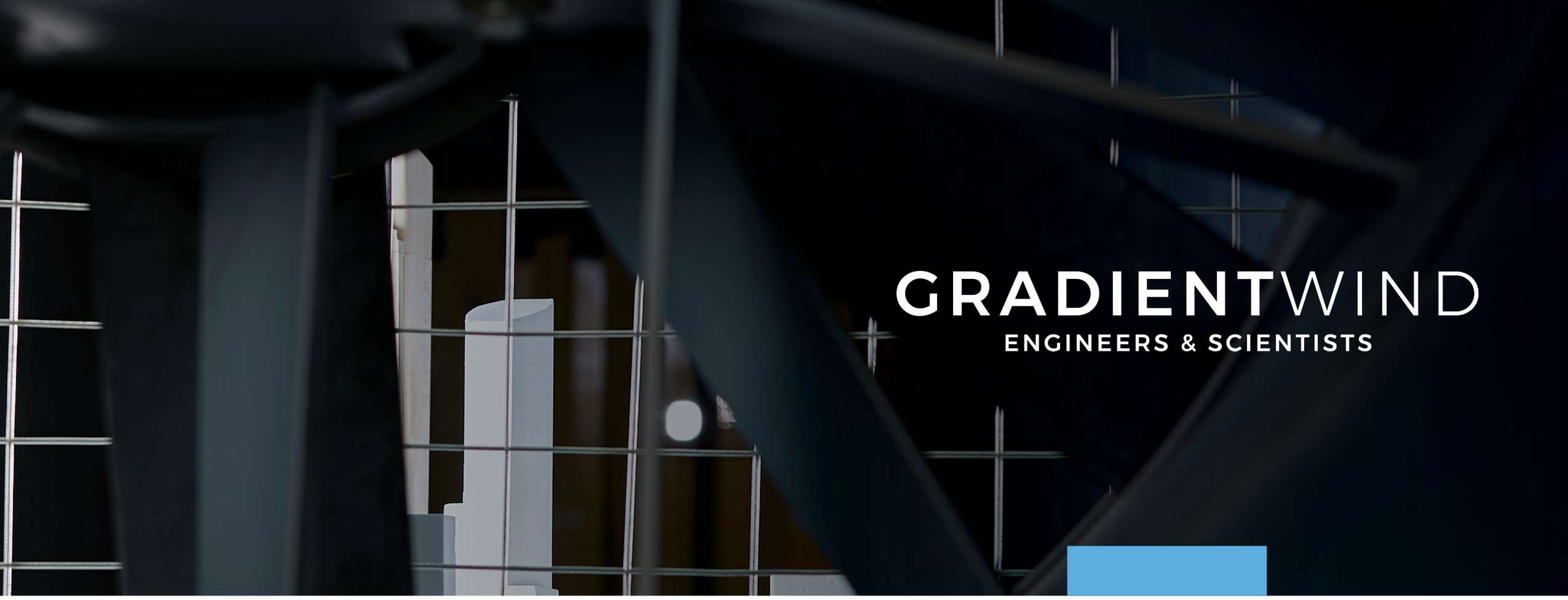


FIGURE 5: STATIONARY NOISE CONTOURS (25 METRES ABOVE GRADE)

- *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

FTA VIBRATION CALCULATIONS

127 WALGREEN ROAD, OTTAWA, ON, CANADA K0A 1L0 | 613 836 0934
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GW21-164 16-Aug-21

Possible Vibration Impacts on 21-51 Queen Street North
Perdicted using FTA General Assesment

Train Speed 80 km/h 50 mph

	Distance	
	(m)	(ft)
LRT	64.0	210.0

Vibration

From FTA Manual Fig 10-1

Vibration Levels at distance from tra	72	dBV re 1 micro in/sec	

Adjustment Factors FTA Table 10-1

Speed reference 50 mph	0		
Vehicle Parameters	0	Assume Soft primary suspension, Wheels run true	
Track Condition	5	Jointed	
Track Treatments	0	None	
Type of Transit Structure	0	None	
Efficient vibration Propagation	0	None	
Vibration Levels at Pptyline	77		0.180
Coupling to Building Foundation	-10	Large Masonry on Piles	
Floor to Floor Attenuation	-1.0	Ground Floor Ocupied	
Amplification of Floor and Walls	6		
Total Vibration Level	72	dBV or	0.101 mm/s
Noise Level in dBA	37	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**
Speed		Reference Speed		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 $\log(speed/speed_{ref})$.
	Vehicle Speed	50 mph	30 mph	
	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.