

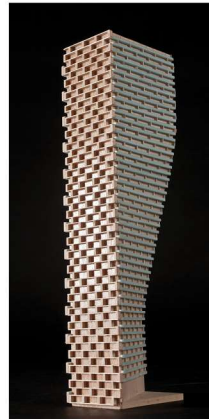
GRADIENTWIND

ENGINEERS & SCIENTISTS

ENVIRONMENTAL NOISE AND VIBRATION FEASIBILITY ASSESSMENT

17 Jacobs Terrace
Barrie, Ontario

REPORT: GW21-099-Noise & Vibration



August 25, 2021

PREPARED FOR

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EXECUTIVE SUMMARY

This report describes an environmental noise and vibration assessment in support of a Zoning By-Law Amendment (ZBA) application for the proposed mixed-use development located at 17 Jacobs Terrace in Barrie, Ontario. The development comprises two mixed-use buildings referred to as Building 1 (26-Storeys) and Building 2 (24-Storeys), linked by a 4-storey podium. Spaces considered as Outdoor Living Areas (OLA) comprise a 7th floor terrace, the podium rooftop (5th floor), and a ground-level amenity on the north side of the development. Balconies extending less than 4 metres from the building façade do not require consideration as OLAs in this study. The major sources of transportation noise are Tiffin Street, Anne Street South, Innisfil Street, and the Barrie Collingwood Railway (BCRY) corridor to the north, which is a source of both noise and vibration. 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) requirements; (ii) future vehicular traffic volumes based on projected roadway traffic counts and train information obtained from GHD Group and the City of Barrie, respectively; and (iii) architectural drawings received from Architecture Unfolded in June 2021, and updated drawings received in August 2021.

The results of the current analysis indicate that transportation noise levels will range between 50 and 55 dBA at the Plane of Window during the daytime period (07:00-23:00) and between 42 and 47 dBA during the nighttime period (23:00-07:00). The highest noise levels (i.e. 55 dBA) occur along the north and west facades of Building 2, which are nearest and most exposed to the transportation noise sources.

The noise levels predicted due to roadway and railway traffic are below the criteria listed in Section 4.2 for upgraded building components. Therefore, standard building components in conformance with the Ontario Building Code (OBC) will provide sufficient noise attenuation. Noise levels at the Outdoor Living Areas are expected to fall below the NPC-300 limits of 55 dBA, thus mitigation will not be required. There are also no ventilation or warning clause requirements.

Stationary noise impacts on the development were also predicted. Stationary noise sources in proximity to the proposed development were identified by review of satellite imagery, which revealed rooftop HVAC



units and nearby automotive repair garages. Results indicate that stationary noise impacts from the surroundings on the development are within the objective limits, and mitigation will not be required.

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 at the nearest edge of the property line to the BCRY corridor are expected to be 0.054 mm/s RMS (66.5 dBV), based on the FTA protocol and a conservative offset distance of 24 m 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 at the property line, vibration mitigation will not be required. As vibration levels are acceptable, correspondingly regenerated noise levels are also expected to be acceptable.

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1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Tonlu Holdings Ltd. to undertake an environmental noise and vibration assessment in support of a Zoning By-Law Amendment (ZBA) application for the proposed mixed-use development located at 17 Jacobs Terrace in Barrie, Ontario. This report summarizes the methodology, results, and recommendations related to an environmental 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 received from Architecture Unfolded in June 2021 and updated drawings received in August 2021, with future traffic volumes corresponding to roadway traffic counts and train information obtained from GHD Group and the City of Barrie, respectively.

2. TERMS OF REFERENCE

The focus of this environmental noise and vibration assessment is the proposed two-tower mixed-use development located at 17 Jacobs Terrace in Barrie, Ontario. The study site is situated on a trapezoidal parcel of land bounded by Jacobs Terrace to the north.

The development comprises two mixed-use buildings referred to as Building 1 (26-Storeys) and Building 2 (24-Storeys), linked by a 4-storey podium. Buildings 1 and 2 both comprise co-work space and community space at grade, and residential space on remaining floors above. Level 5 comprises a landscaped amenity terrace located between the two buildings. Building 1 floor plates set back at level 6 to 10 consecutively and level 13 on the south façade, and at level 7 to 10 and 13 on the north façade to provide multiple terraces. Building 2 floor plates set back at level 6 to 10 consecutively and level 13 on the south façade, and at level 7 and 8 on the north façade. Terraces 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. OLAs considered in this study include the ground-level landscaped amenity at the north side of the development, the 5th-level landscaped amenity terrace, and the 7th floor terrace accompanying Building 1.



The site is surrounded by low-rise commercial buildings to the east and west, the Barrie Collingwood Railway (BCRY) to the north, and low-rise residential neighbourhoods to the south. Primary sources of transportation noise are Anne Street South, Tiffin Street, Innisfil Street, and the BCRY. The BCRY is also a source of ground vibrations. Figure 1 illustrates a site plan with surrounding context.

3. OBJECTIVES

The main goals of this work are to (i) calculate the future noise levels on the study buildings produced by local transportation and stationary sources, and (ii) determine whether exterior 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 50, 45 and 40 dBA for retail space, 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 47, 42 and 37 dBA. Indoor noise levels due to railway traffic are 5 dB lower.

TABLE 1: INDOOR SOUND LEVEL CRITERIA (ROAD) 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

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 reduction². 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 attenuation³.

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.

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

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



4.2.2 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 GHD Group and train information obtained from the City of Barrie. 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.

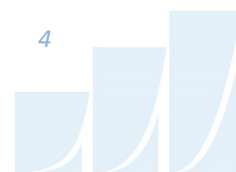
TABLE 2: ROADWAY AND RAILWAY TRAFFIC DATA

Segment	Roadway/Transit Class	Speed Limit (km/h)	Existing AADT Count	Year of Count	Projected 2031 ADT Count
Anne Street South	2-UCU	50	8,240	2021	10,045
Tiffin Street	2-UAU	50	11,050	2017	14,580
Innisfil Street	2-UCU	50	5,150	2021	6,278
BCRY	Railway	16	1/0*	-	-

* 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. 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. 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 were found to be within an imperceptible level of 0-3 dBA of those predicted in Predictor. A total of 12 receptor locations were identified around the site, as illustrated in Figure 2.



Roadway and railway noise calculations were performed by treating each transportation segment as separate line sources of noise, and by using existing building locations as noise barriers. 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 1% heavy trucks and 2% medium trucks, based on averages derived from traffic count data.
- The daytime/nighttime traffic volume split was taken as 90% daytime and 10% nighttime.
- Reflective intermediate ground surfaces were assumed.
- Receptor heights were placed at 76.5 metres for façades of Building 1; 70.5 m for façades of Building 2; 13.5 m for façades of the podium; 22.5 m for the level-7 OLA; 16.5 m for the level-5 OLA; and 1.5 m for ground-level OLA.
- Surrounding buildings were considered as noise barriers.
- The study site was treated as having gently sloping topography.
- Noise receptors were strategically placed at 12 locations around the study area (Figure 2).
- For the BCRY, one locomotive was modelled per train, with six cars per train.
- Railway tracks were assumed to be welded.

The noise generated from both on-road and railway traffic were combined for the 12 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 C1 of the “Land Use Planning Requirements” guideline.

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”⁴. Common stationary sources of noise include HVAC equipment, emergency generators, cooling towers and exhaust fans, which are often found on industrial and commercial facilities. As stationary noise can cause

⁴ NPC – 300, page 16



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.

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”⁵. 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 recommended maximum noise levels for a Class 1 area in an urban environment adjacent to arterial roadways at a POR are outlined in Table 3 below. The study site is considered to be in a Class 1 area because it is located on a parcel of land bounded by arterial roadways. This condition indicates that the sound field is dominated by manmade sources.

TABLE 3: EXCLUSIONARY LIMITS FOR CLASS 1 AREA

Time of Day	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

The sound level limit for stationary noise is the higher of the exclusion limit value given in Table 3, or the background sound level caused by transportation noise sources. A review of satellite imagery identified the following stationary noise sources impacting the development:

- HVAC equipment on rooftops of surrounding buildings
- Garage doors of and idling vehicles associated with nearby automotive repair garages

4.3.2 Determination of Noise Source Power Levels

Mechanical information for the surrounding stationary noise sources impacting the development has been based on Gradient Wind’s experience. Table 4 summarizes the sound power of each source used in the analysis. Figure 3 illustrates the location of each stationary noise source used in the analysis. The following assumptions have been made in the analysis:

⁵ NPC – 300, page 14



- (i) The locations, quantity and tonnage of rooftop units has been assumed based on Gradient Wind's experience with similar developments.
- (ii) The rooftop mechanical units are assumed to operate continuously over a 1-hour period during the daytime period (07:00 - 23:00) and at 50% operation during the nighttime period (23:00 - 07:00).
- (iii) The automotive repair garage doors operate for 30 minutes per hour during the daytime period and do not operate during the nighttime period.
- (iv) Three idling cars are assumed for the automotive shop

TABLE 4: EQUIPMENT SOUND POWER LEVELS (dBA)

Source ID	Description	Height Above Grade/Roof (m)	Frequency (Hz)								
			63	125	250	500	1000	2000	4000	8000	Total
S1 - S5	Rooftop Air-Handling Unit	1.0	61	69	75	79	80	77	73	66	85
S6 - S11	Exhaust Fan	0.75	72	74	79	78	78	73	65	56	84
S12 - S14	Automotive Shop Idling Cars	1.5	-	-	-	-	82	-	-	-	82
S15	Automotive Shop Garage Doors	3.0	-	-	-	-	86	-	-	-	86

4.3.3 Stationary Noise Source Predictions

The impact of stationary noise sources on nearby residential areas 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 12 receptor locations were chosen around the site, corresponding to the locations chosen in section 4.2.3. This enables measurement and comparison of stationary noise and transportation noise



impacts. Figure 2 illustrates the location of all PORs used in this study. In the predictor model, all sources of stationary noise were modelled as point sources. Table 5 below contains Predictor-Lima calculation settings. These are typical settings that have been based on ISO 9613 standards and guidance from the MECP.

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 5: 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 inches 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 ($\mu\text{in/s}$) 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*⁶, 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.

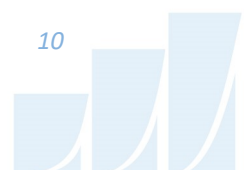
4.4.3 Theoretical Ground Vibration Prediction Procedure

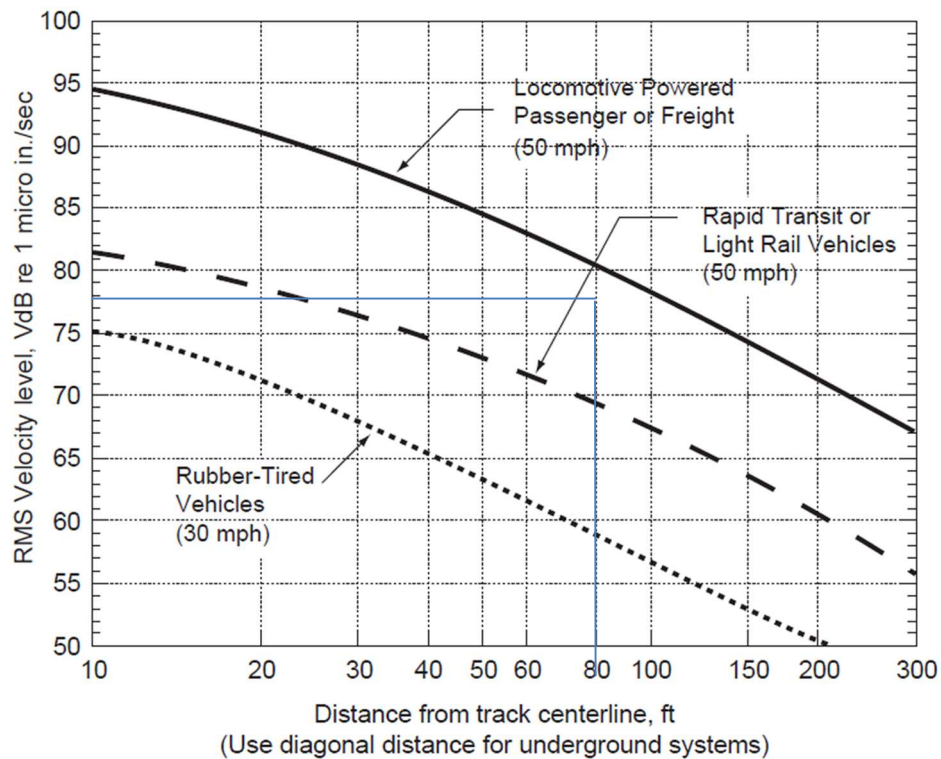
Potential vibration impacts of the trains were predicted using the Federal Transit Authority's (FTA) Transit Noise and Vibration Impact Assessment⁷ protocol. The FTA general vibration assessment is based on an upper bound generic set of curves that show vibration level attenuation with distance. These 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 or Freight at a speed of 50 mph. Adjustment factors were considered based on the following information:

- The maximum operating speed of the trains near the study site is 16 km/h (10 mph)
- The distance between the property line of the development and the closest track is 24 m
- The vehicles are assumed to have soft primary suspensions
- Tracks are welded, and in good condition
- Soil conditions do not efficiently propagate vibrations
- The building's foundation is large masonry on piles

⁶ Dialog and J.E. Coulter Associates Limited, prepared for The Federation of Canadian Municipalities and The Railway Association of Canada, May 2013

⁷ 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.

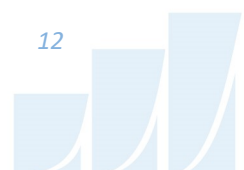
TABLE 6: EXTERIOR NOISE LEVELS DUE TO TRANSPORTATION SOURCES

Receptor Number	Plane of Window Receptor Location	Roadway Noise Level (dBA)		Railway Noise Level (dBA)		Total Noise Level (dBA)	
		Day	Night	Day	Night	Day	Night
1	POW - Building 1 - North Façade	53	47	41	N/A*	54	47
2	POW - Building 1 - East Façade	53	46	37	N/A*	54	46
3	POW - Building 1 - South Façade	52	45	21	N/A*	53	45
4	POW - Building 1 - West Façade	51	44	37	N/A*	52	44
5	POW - Building 2 - North Façade	54	47	42	N/A*	55	47
6	POW - Building 2 - East Façade	51	44	38	N/A*	52	44
7	POW - Building 2 - South Façade	52	46	26	N/A*	53	46
8	POW - Building 2 - West Façade	54	47	39	N/A*	55	47
9	POW - Podium - South Façade	49	42	23	N/A*	50	42
10	OLA - 7 th floor terrace	54	N/A**	41	N/A*	55	N/A**
11	OLA - 5 th floor rooftop	43	N/A**	35	N/A*	44	N/A**
12	OLA - Ground-level	54	N/A**	48	N/A*	55	N/A**

*Zero train passes are expected during the nighttime period

** 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 50 and 55 dBA at the Plane of Window during the daytime period (07:00-23:00) and between 42 and 47 dBA during the nighttime period (23:00-07:00). The highest noise levels (i.e. 55 dBA) occur along the north and west facades of Building 2, which are nearest and most exposed to the transportation noise sources. Noise levels at Outdoor Living Areas are expected to approach 54 dBA, 43 dBA, and 54 dBA for the 7th floor terrace, 5th floor rooftop, and ground-level amenity respectively. Roadway traffic noise contours at 30 metres above grade for daytime and nighttime periods can be seen in Figures 4 and 5 respectively.



5.2 Stationary Noise Levels

The sound levels listed in Table 7 are based on the assumptions outlined in Section 2.1.

TABLE 7: NOISE LEVELS FROM STATIONARY SOURCES

Receptor Number	Receptor Location	Noise Level (dBA)		Sound Level Limits		Meets NPC-300 Class 1 Criteria	
		Day	Night	Day	Night	Day	Night
1	POW - Building 1 - North Façade	43	42	50	45	YES	YES
2	POW - Building 1 - East Façade	47	44	50	45	YES	YES
3	POW - Building 1 - South Façade	40	25	50	45	YES	YES
4	POW - Building 1 - West Façade	35	33	50	45	YES	YES
5	POW - Building 2 - North Façade	41	39	50	45	YES	YES
6	POW - Building 2 - East Façade	31	31	50	45	YES	YES
7	POW - Building 2 - South Façade	39	36	50	45	YES	YES
8	POW - Building 2 - West Façade	44	41	50	45	YES	YES
9	POW - Podium - South Façade	28	25	50	45	YES	YES
10	OPOR - 7 th floor terrace	41	39	50	N/A*	YES	N/A*
11	OPOR - 5 th floor rooftop	32	28	50	N/A*	YES	N/A*
12	OPOR - Ground-level	39	36	50	N/A*	YES	N/A*

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

Noise levels from stationary sources are expected to meet NPC-300 criteria at all points of reception. Stationary noise contours at 30 metres above grade can be seen in Figures 6 and 7 for daytime and nighttime periods respectively.



5.3 Ground Vibrations & Ground-Borne Noise Levels

Estimated vibration levels at the nearest edge of the property line to the BCRY corridor are expected to be 0.054 mm/s RMS (66.5 dBV), based on the FTA protocol and a conservative offset distance of 24 m 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 at the property line, vibration mitigation will not be required. Further justification considers the expected offset distance to the building foundation (34 metres) and the coupling to the building foundation (large masonry on piles) which will result in attenuated vibration levels within the building compared to those predicted at the property line. As vibration levels are acceptable, correspondingly, regenerated noise levels are also expected to be acceptable.

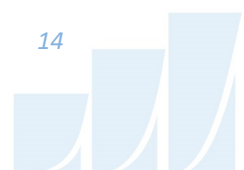
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The results of the current analysis indicate that transportation noise levels will range between 50 and 55 dBA at the Plane of Window during the daytime period (07:00-23:00) and between 42 and 47 dBA during the nighttime period (23:00-07:00). The highest noise levels (i.e. 55 dBA) occur along the north and west facades of Building 2, which are nearest and most exposed to the transportation noise sources.

The noise levels predicted due to roadway and railway traffic are below the criteria listed in Section 4.2 for upgraded building components. Therefore, standard building components in conformance with the Ontario Building Code (OBC) will provide sufficient noise attenuation. Noise levels at the Outdoor Living Areas are expected to fall below the NPC-300 limits of 55 dBA, thus mitigation will not be required. Furthermore, ventilation requirements and warning clauses are also not required.

Stationary noise impacts on the development were also predicted. Stationary noise sources in proximity to the proposed development were identified by review of satellite imagery, which revealed rooftop HVAC units and nearby automotive repair garages. Results indicate that stationary noise impacts from the surroundings on the development are within the NPC-300 objective limits, and mitigation will not be required.

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 at the nearest edge of the property line to the BCRY corridor are expected to be 0.054 mm/s RMS (66.5 dBV), based on the FTA protocol and a conservative offset distance of 24 m 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 at the property line, vibration mitigation will not be required. As vibration levels are acceptable, correspondingly regenerated noise levels are also expected to be acceptable.

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.



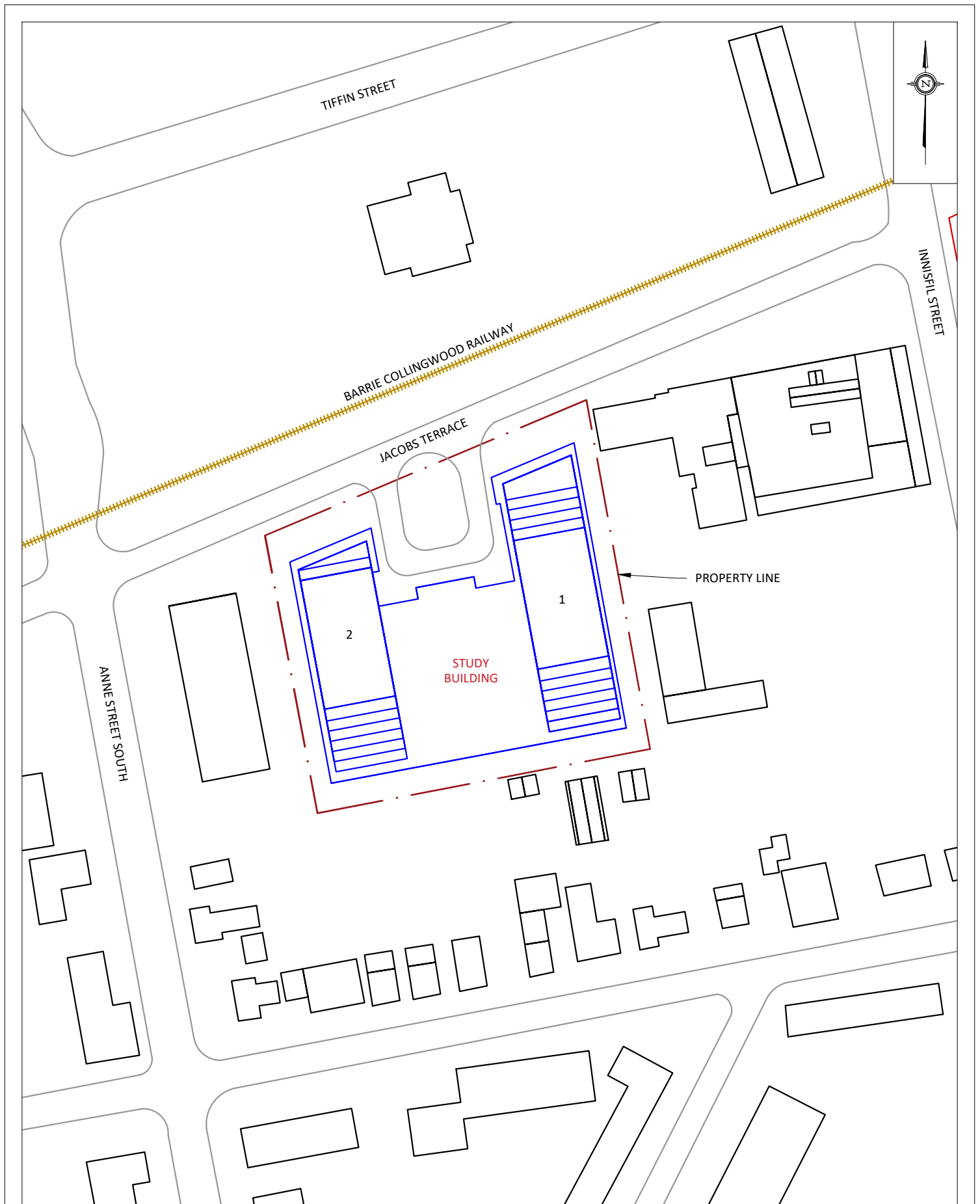
Tanyon Matheson-Fitchett, B.Eng.
Junior Environmental Scientist

GW21-099



Joshua Foster, P.Eng.
Principal





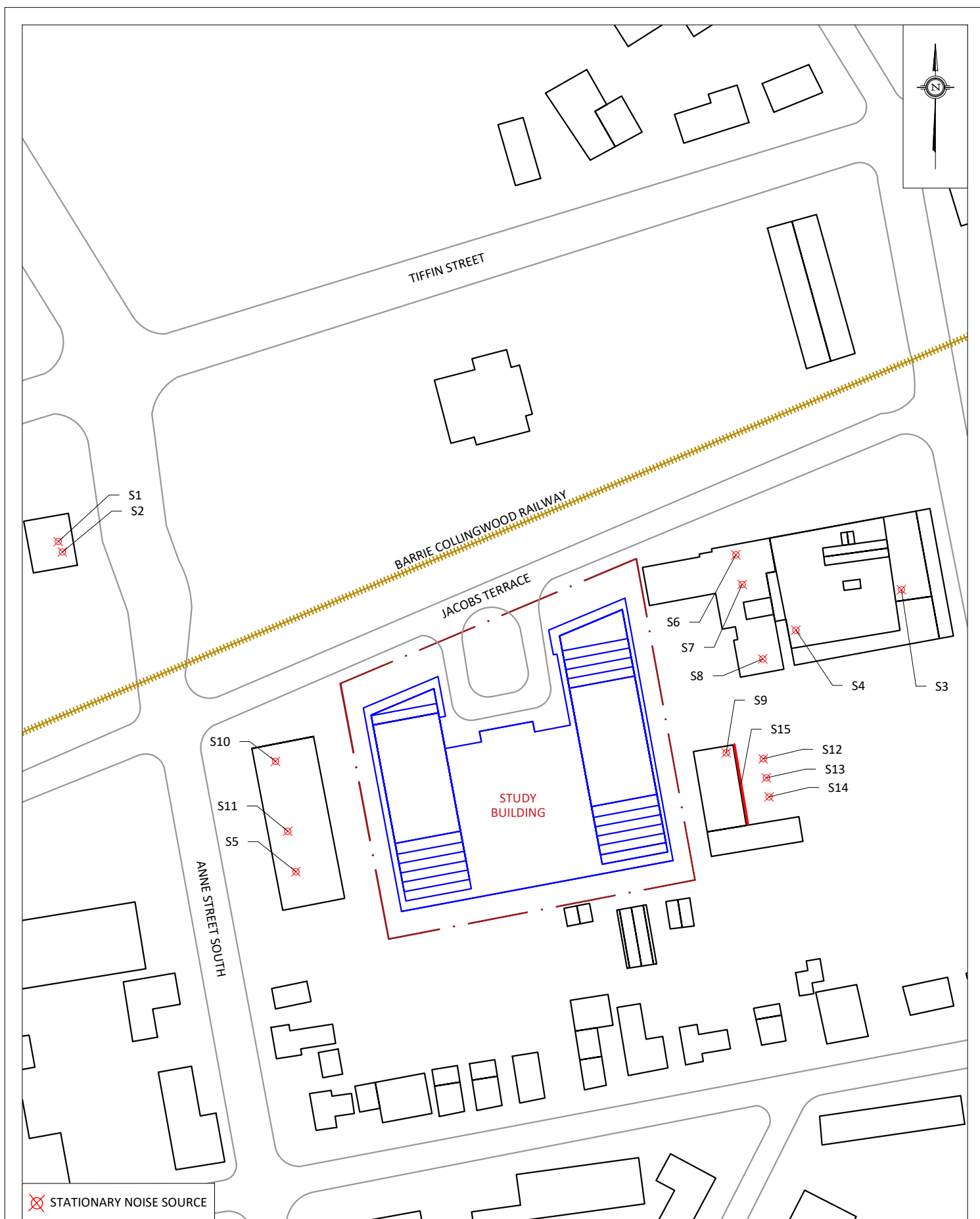
BARRIE COLLINGWOOD RAILWAY

JACOBS TERRACE



- # OLA RECEPTOR
- # POW RECEPTOR

PROJECT	17 JACOBS TERRACE - BARRIE, ON ENVIRONMENTAL NOISE FEASIBILITY ASSESSMENT	
SCALE	1:1000 (APPROX.)	DRAWING NO. GW21-099-2
DATE	JULY 20, 2021	DRAWN BY T.M.F.



GRADIENTWIND ENGINEERS & SCIENTISTS 127 WALGREEN ROAD, OTTAWA, ON 613 836 0934 • GRADIENTWIND.COM	PROJECT	17 JACOBS TERRACE - BARRIE, ON ENVIRONMENTAL NOISE FEASIBILITY ASSESSMENT		DESCRIPTION
	SCALE	1:1500 (APPROX.)	DRAWING NO.	FIGURE 3: STATIONARY NOISE SOURCE LOCATIONS
	DATE	JULY 23, 2021	DRAWN BY	
			T.M.F.	

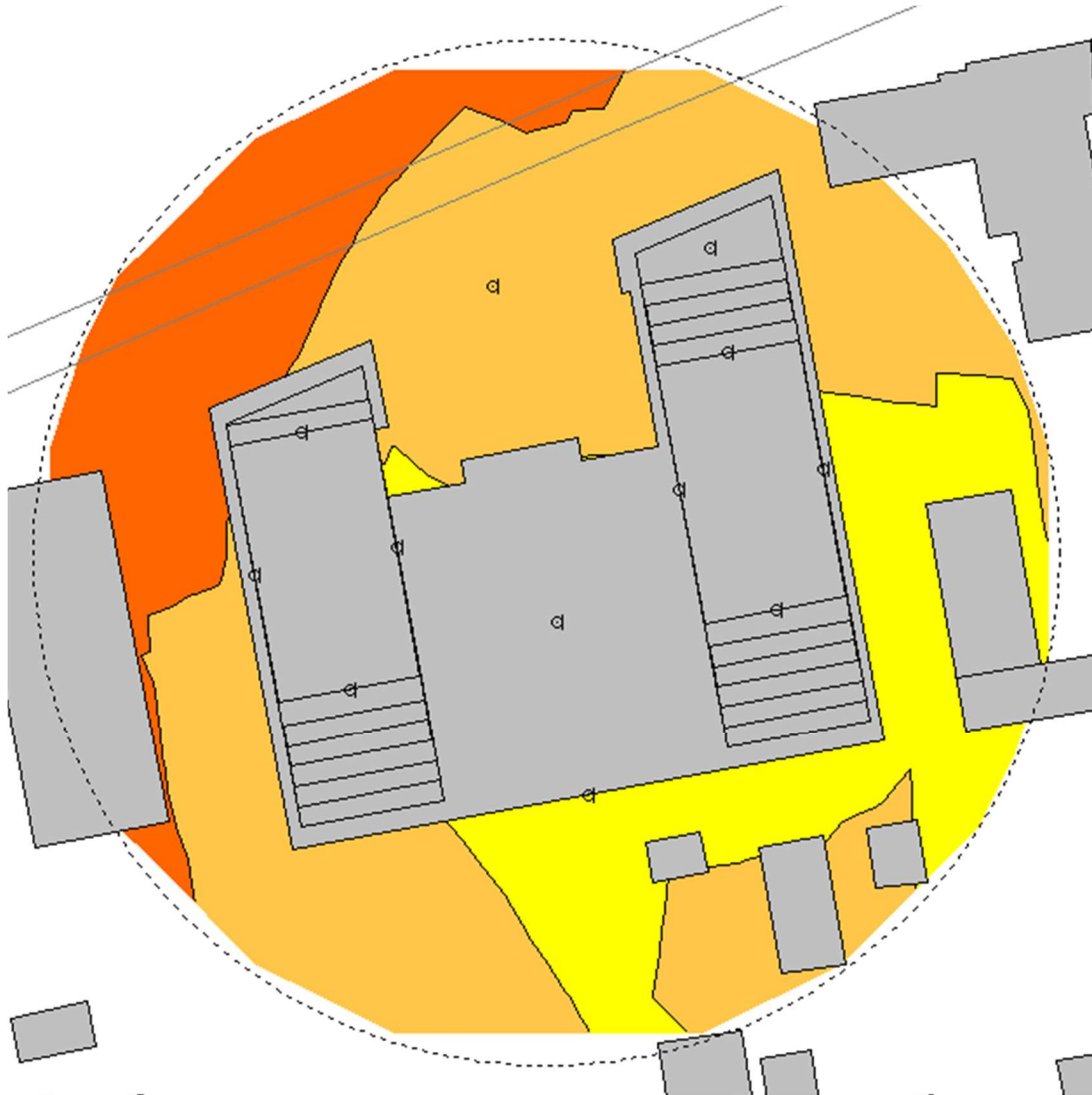
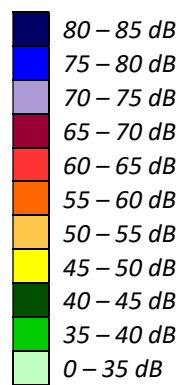


FIGURE 4: DAYTIME ROADWAY TRAFFIC NOISE CONTOURS (30 METERS ABOVE GRADE)



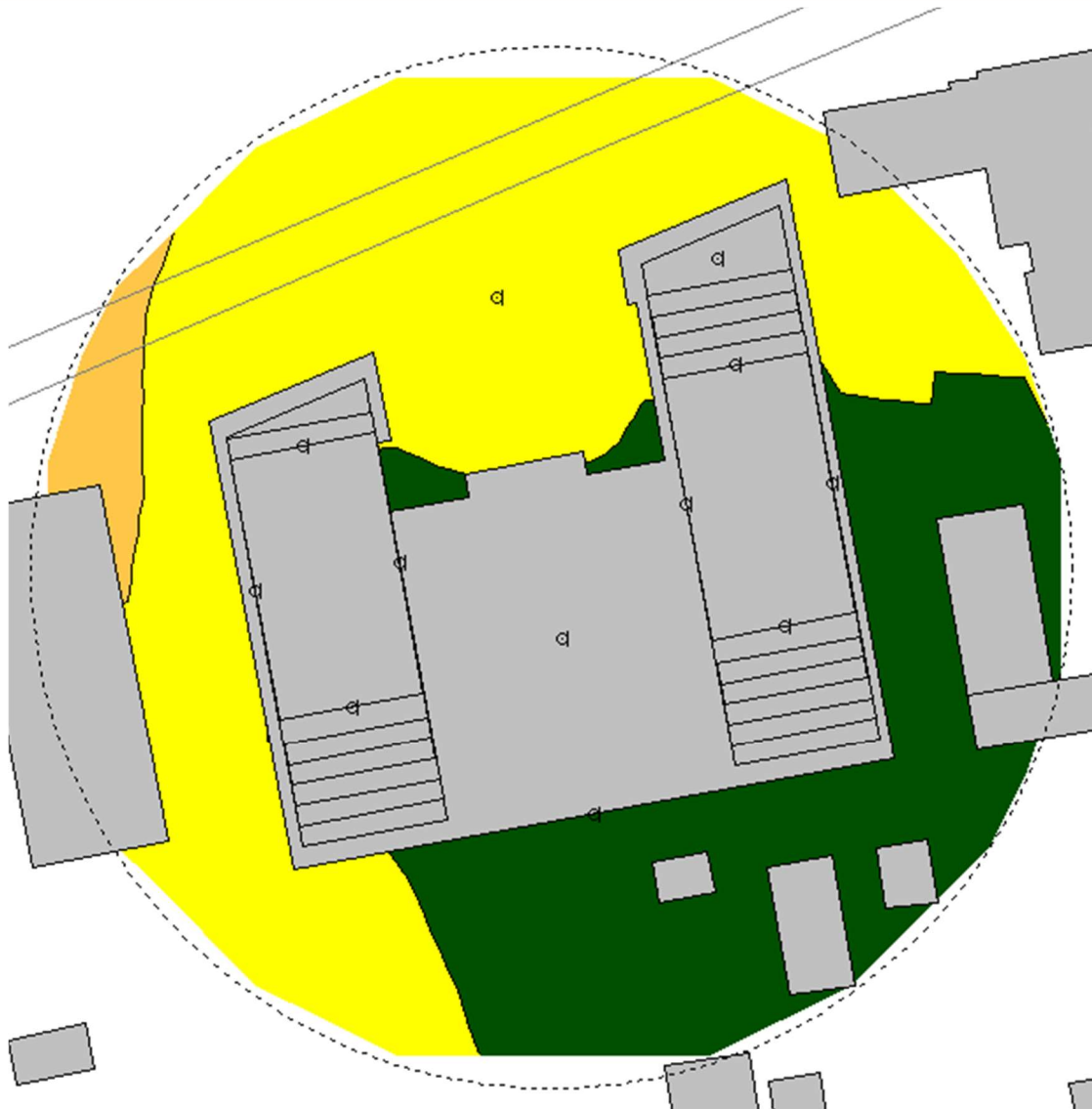
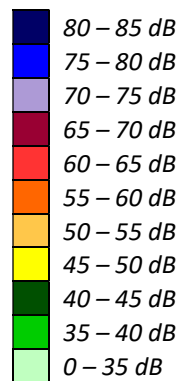


FIGURE 5: NIGHTTIME ROADWAY TRAFFIC NOISE CONTOURS (30 METERS ABOVE GRADE)



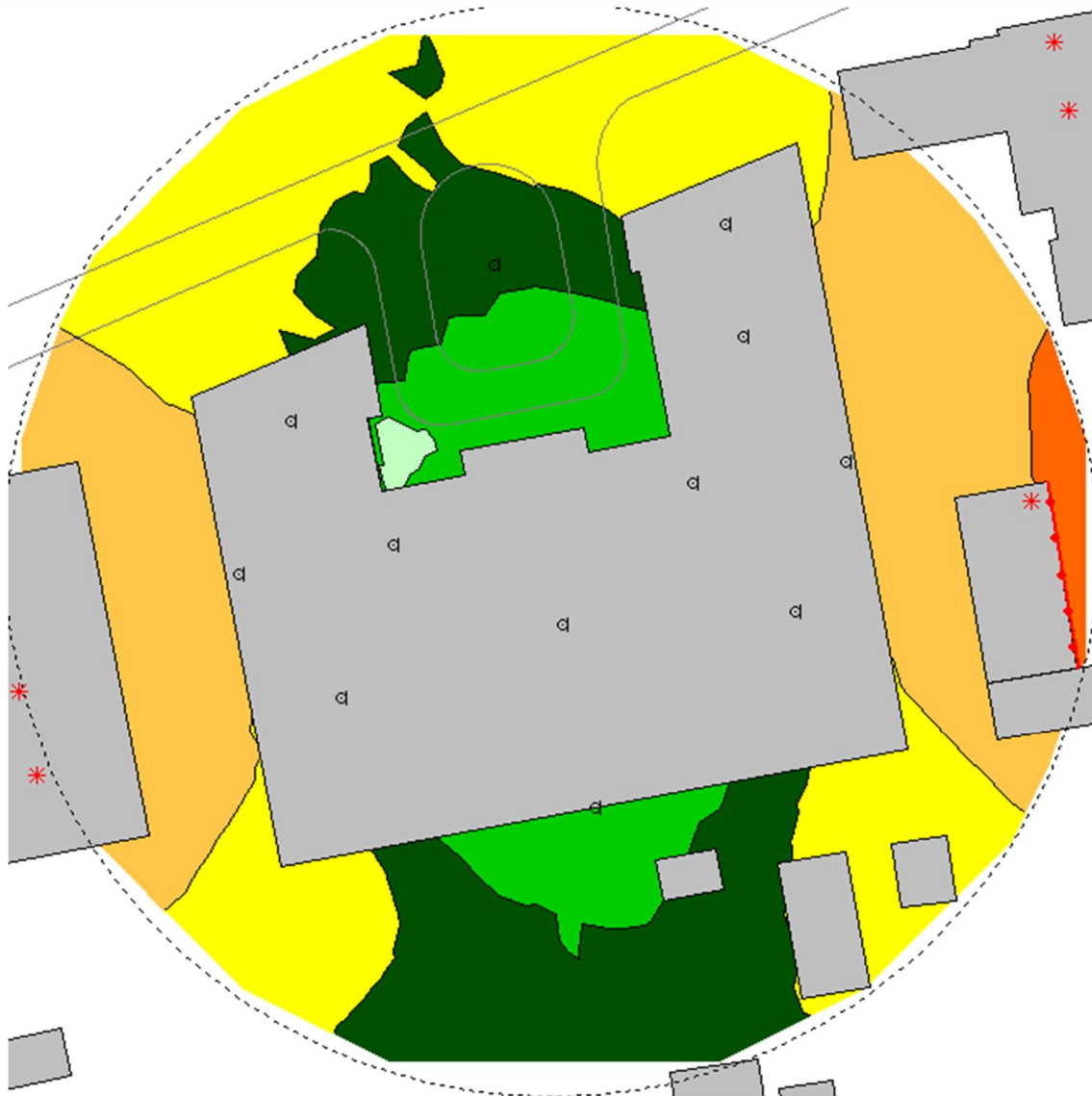
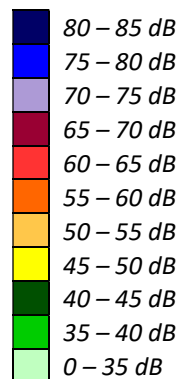


FIGURE 6: DAYTIME STATIONARY NOISE CONTOURS (30 METERS ABOVE GRADE)



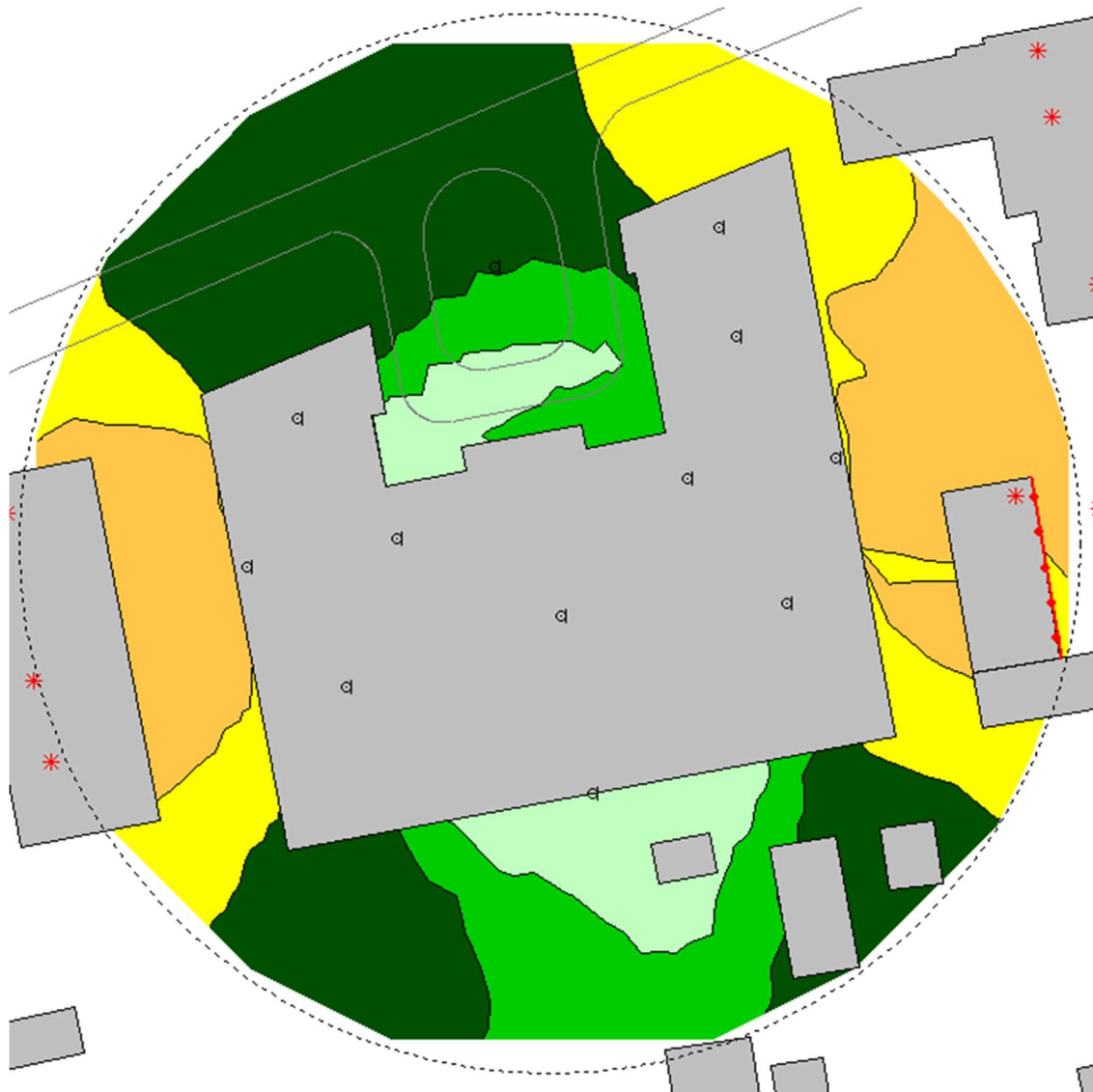
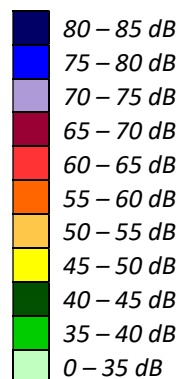
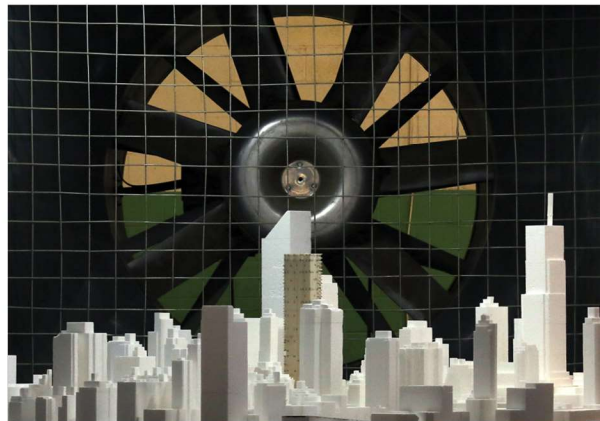
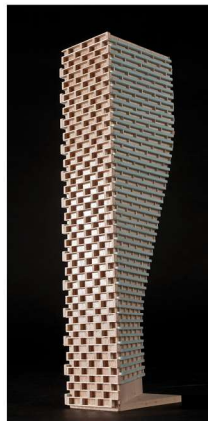


FIGURE 7: NIGHTTIME STATIONARY NOISE CONTOURS (30 METERS ABOVE GRADE)



GRADIENTWIND

ENGINEERS & SCIENTISTS



APPENDIX A

FTA VIBRATION CALCULATIONS

GW21-099

27-Jul-21

Possible Vibration Impacts on 17 Jacobs Terrace
Predicted using FTA General Assessment

Train Speed

16 km/h

10 mph

	Distance	
	(m)	(ft)
BCRY	24.0	78.7

Vibration

From FTA Manual Fig 10-1

Vibration Levels at distance from tra 80.5 dBV re 1 micro in/sec

Adjustment Factors FTA Table 10-1

Speed reference 50 mph	-14	16 km/h (10 mph)
Vehicle Parameters	0	Assume Soft primary suspension,
Track Condition	0	None Wheels run true
Track Treatments	0	None
Type of Transit Structure	0	None
Efficient vibration Propagation	0	None
Vibration Levels at Ppty Line	67	0.054



**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	Vehicle Speed	Reference Speed		Vibration level is approximately proportional to $20 \cdot \log(\text{speed}/\text{speed}_{\text{ref}})$. Sometimes the variation with speed has been observed to be as low as 10 to 15 $\log(\text{speed}/\text{speed}_{\text{ref}})$.	
		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**

Factors Affecting Vibration Source				
Source Factor	Adjustment to Propagation Curve			Comment
Speed		Reference Speed		Vibration level is approximately proportional to $20 \cdot \log(\text{speed}/\text{speed}_{\text{ref}})$. Sometimes the variation with speed has been observed to be as low as 10 to 15 $\log(\text{speed}/\text{speed}_{\text{ref}})$.
	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.
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