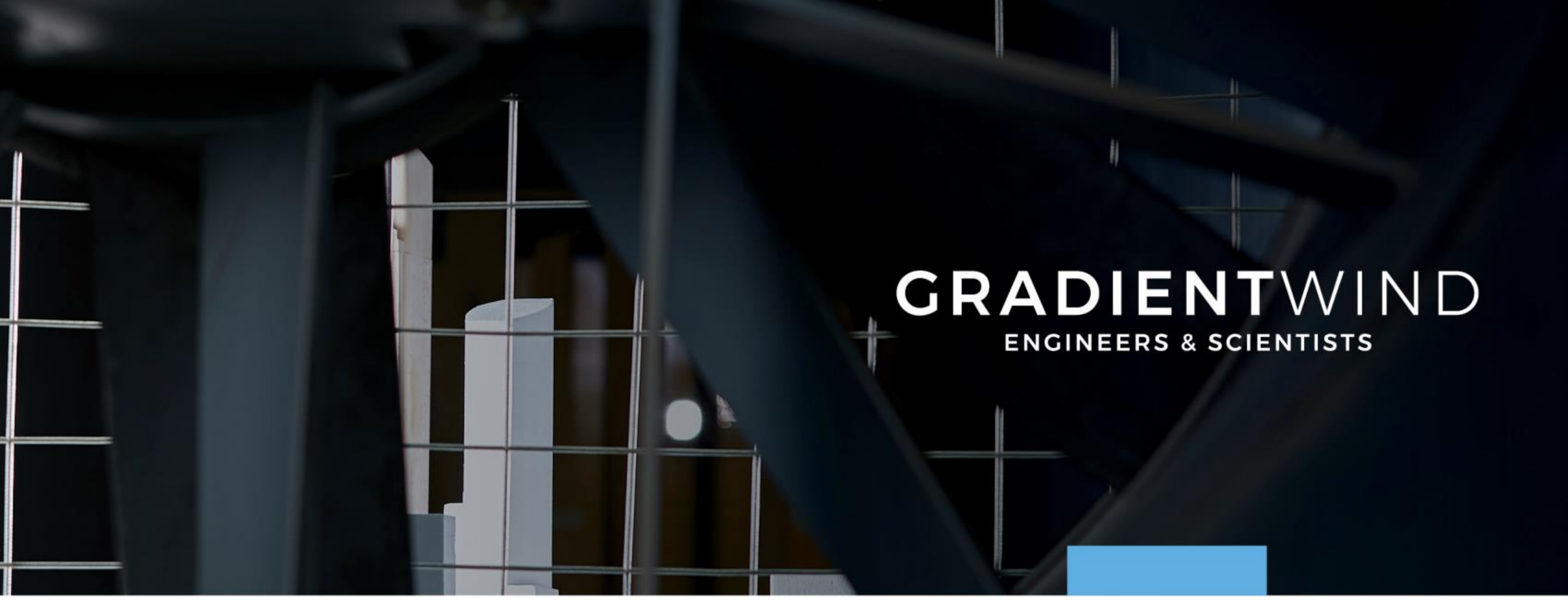
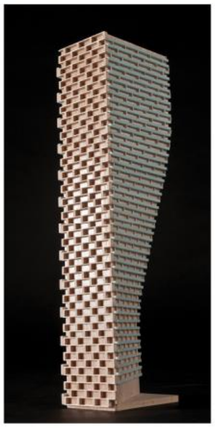
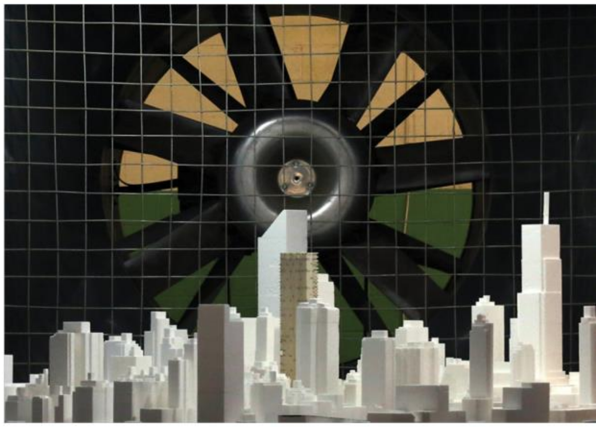


TRANSPORTATION NOISE & VIBRATION ASSESSMENT

1806 Scott Street
Ottawa, Ontario

REPORT: 22-188 – Transportation Noise & Vibration





November 9, 2022

PREPARED FOR
2851944 Ontario Inc.
14 Breadner Blvd
Trenton, ON K8V 1E2

PREPARED BY
Essraa Alqassab, BASc, Junior Environmental Scientist
Joshua Foster, P.Eng., Lead Engineer

EXECUTIVE SUMMARY

This report describes a transportation noise and ground vibration assessment for the proposed residential development located at 1806 Scott Street in Ottawa, Ontario. This study examines the impact of light rail transit corridor (Confederation Line LRT) and roadway traffic on the development to ensure that future occupants are afforded comfortable use of indoor and outdoor living spaces, as directed by the City of Ottawa's Environmental Noise Control Guidelines (ENCG). As the development is in close proximity of the Confederation Line LRT (within the 75 metres limit as indicated for railways in Guidelines for New Development in Proximity to Railway Operations); ground vibrations were considered in the study as well. Figure 1 illustrates a complete site plan with the surrounding context.

The assessment is based on (i) theoretical noise prediction methods that conform to the Ministry of the Environment, Conservation and Parks (MECP) (ii) noise level criteria as specified by the City of Ottawa's Environmental Noise Control Guidelines (ENCG); (iii) future vehicular traffic volumes based on the City of Ottawa's Official Plan roadway classifications; (iv) future rail traffic volumes based on the ultimate buildout LRT volumes were based on our past experience with the Confederation Line LRT; and (v) drawings prepared by Open Plan Architects Inc., dated January 2022.

Results of the current analysis indicate that noise levels at POW receptors will range between 65 and 69 dBA during the daytime period (07:00-23:00) and between 57 and 61 dBA during the nighttime period (23:00-07:00). The highest noise level (69 dBA) occurs at the north façades of the study site, which is nearest and most exposed to Scott Street and the future expansion of the Confederation Line LRT. The noise levels at the southwest amenity area does not exceed the 55 dBA ENCG criteria. Therefore, no noise mitigation measure is required for this area.

The results of the calculations also indicate that the development should be designed with central air conditioning or a similar system, which will allow occupants to keep windows closed and maintain a comfortable living environment. In addition, a Type D Warning Clause should be used in all Lease, Purchase and Sale Agreements, as summarized in Section 6.

Estimated vibration levels at the property line of the proposed development to the Confederation Line LRT are expected to be at 0.04 mm/s RMS (65 dBV), based on the FTA protocol and an offset distance of

43 m. Details of the calculation are provided in Appendix B. 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.

With regards to stationary noise impacts, the site is surrounded by low- to mid-rise buildings with only small equipment on the rooftop of some neighbouring buildings. Therefore, on-site stationary noise impacts from these properties are considered insignificant. Westboro Station is located approximately 750 metres to the northwest of the development; the noise generated by trains slowing down and accelerating at the station will be masked by the LRT corridor and roadway traffic noise. Similarly, Tunney's pasture Station is located 800 meters to the northeast of the development, and so stationary noise impacts are also considered insignificant. Therefore, any noise impact on the development site from the stations is not anticipated.

Due to the size of the development, stationary noise impact on the surroundings is expected to be minimal. The building will likely have small internal Energy Recovery Ventilators or Heat pump systems, with small residential sized Air conditioning condoners on the roof. The mechanical system would be required to comply with MECP's Publication NPC-216 Residential Air Conditioning Devices.

TABLE OF CONTENTS

1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by 2851944 Ontario Inc. to undertake a transportation noise assessment for a proposed development located at 1086 Scott Street in Ottawa, Ontario. This report summarizes the methodology, results, and recommendations related to the assessment of exterior and interior noise levels generated by local roadway traffic.

Our work is based on theoretical noise calculation methods conforming to the City of Ottawa[1] and Ministry of the Environment, Conservation and Parks (MECP)[2] guidelines. Noise calculations were based on architectural drawings provided by Open Plan Architects Inc., dated January 2022, with future traffic volumes corresponding to the City of Ottawa's Official Plan (OP) roadway classifications.

2. TERMS OF REFERENCE

The focus of this transportation noise assessment is a proposed development located at 1806 Scott Street in Ottawa, Ontario. The proposed development comprises a 4-storey residential apartment building, situated on an irregular parcel of land bounded by Scott Street to the North, Oakdale Avenue to the West and Rockhurst Road to the East. The major sources of noise impacting the development are Scott Street (Arterial Roadway) and the Confederation Line LRT.

The proposed development features a 4-storey apartment building with dwelling units on all floors. The ground floor consists of a residential main entrance and bike room east of the site, coming off Rockhurst Road. At grade, a balcony facing north towards Scott Street and two balconies south of the building are featured. Six bike parking spaces are found outside the southeast corner of the building and an outdoor amenity occupies the southwest corner of the site. The basement level contains residential units and a large mechanical room.

The major sources of transportation noise impacting the site are the Confederation Line LRT and Scott Street located to the north of the site. There are no other major roads or railways within 100 metres of the site. As the development is located in close proximity of the Confederation Line LRT; within the 75 metres limit as

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

indicated for railways in Guidelines for New Development in Proximity to Railway Operations [3]; ground vibrations were considered in the study as well. The noise generated by trains slowing down and accelerating at Westboro and Tunney's Pasture Stations will be masked by the LRT corridor and roadway traffic noise. Therefore, any noise impact on the development site from the stations is not anticipated. Figure 1 illustrates a complete site plan with the surrounding context.

3. OBJECTIVES

The principal objectives of this study are to (i) calculate the future noise levels on the study building produced by local roadway traffic, and (ii) ensure that interior and exterior noise levels do not exceed the allowable limits specified by the City of Ottawa's Environmental Noise Control Guidelines as outlined in Section 4.2 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.

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

4.2 Roadway Traffic Noise

4.2.1 Criteria for Roadway Traffic Noise

For surface roadway traffic noise and LRT, the equivalent sound energy level, L_{eq}, provides a measure of the time varying noise levels, which is well correlated with the annoyance of sound. It is defined as the continuous sound level, which has the same energy as a time varying noise level over a period of time. For roadways, the L_{eq} is commonly calculated on the basis of a 16-hour (L_{eq16}) daytime (07:00-23:00) / 8-hour (L_{eq8}) nighttime (23:00-07:00) split to assess its impact on residential buildings. The City of Ottawa's Environmental Noise Control Guidelines (ENCG) specifies that the recommended indoor noise limit range (that is relevant to this study) is 45 and 40 dBA for living rooms and sleeping quarters, respectively, as listed in Table 1.

TABLE 1: INDOOR SOUND LEVEL CRITERIA (ROAD AND LRT) [4]

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

Predicted noise levels at the plane of window (POW) dictate the action required to achieve the recommended sound levels. An open window is considered to provide a 10 dBA reduction in noise, while a standard closed window is capable of providing a minimum 20 dBA noise reduction[5]. A closed window due to a ventilation requirement will bring noise levels down to achieve an acceptable indoor

[4] Adapted from ENCG 2016 – Tables 2.2b and 2.2c
[5] Burberry, P.B. (2014). Mitchell's Environment and Services. Routledge, Page 125

environment[6]. 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 triggers the need for forced air heating with provision for central air conditioning. Where noise levels exceed 65 dBA daytime and 60 dBA nighttime, air conditioning will be required and building components will require higher levels of sound attenuation[7].

The sound level criterion for outdoor living areas (OLA) is 55 dBA, which applies during the daytime (07:00 to 23:00). When noise levels exceed 55 dBA, mitigation should be provided to reduce noise levels where technically and administratively feasible to acceptable levels at or below the criterion. Furthermore, noise levels at the OLA must not exceed 60 dBA if mitigation can be technically and administratively achieved. All balconies featured in this site are below 4m deep. Therefore, they have not been identified as an Outdoor Living Area. The only Outdoor Living Area identified on-site is the southwest amenity area.

4.2.2 Theoretical Roadway Noise Predictions

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

Roadway traffic noise calculations were performed by treating each roadway segment as separate line sources of noise. In addition to the traffic volumes summarized in Table 2, theoretical noise predictions were based on the following parameters:

- Truck traffic on all roadways was taken to comprise 5% heavy trucks and 7% medium trucks, as per ENCG requirements for noise level predictions.
- The day/night split for all streets was taken to be 92%/8%, respectively.
- Ground surfaces were taken to be reflective due to the presence of hard (paved) ground.
- Topography was assumed to be a flat/gentle slope surrounding the study building.
- Receptors considered the existing surrounding buildings as a barrier partially or fully obstructing exposure to the source.
- Noise receptors were strategically placed at 4 locations around the study area (see Figure 2).

[6] MOECP, Environmental Noise Guidelines, NPC 300 – Part C, Section 7.8
[7] MOECP, Environmental Noise Guidelines, NPC 300 – Part C, Section 7.1.3

- Receptor distances and exposure angles are illustrated in Figure 3.

4.2.3 Roadway Traffic Volumes

The ENCG dictates that noise calculations should consider future sound levels based on a roadway's classification at the mature state of development. Therefore, traffic volumes are based on the roadway classifications outlined in the City of Ottawa's Official Plan (OP) and Transportation Master Plan[8] which provide additional details on future roadway expansions. Average Annual Daily Traffic (AADT) volumes are then based on data in Table B1 of the ENCG for each roadway classification. Table 2 (below) summarizes the AADT values used for each roadway included in this assessment.

TABLE 1: TRANSPORTATION TRAFFIC DATA

Segment	Roadway / LRT Traffic Data	Speed Limit (km/h)	Traffic Volumes
Scott Street	2-Lane Urban Arterial (2-UAU)	50	**15,000**
Confederation Line LRT	LRT	70	**540/60***

* Daytime/nighttime volumes

4.2.4 Indoor Noise Calculations

The difference between outdoor and indoor noise levels is the noise attenuation provided by the building envelope. According to common industry practice, complete walls and individual wall elements are rated according to the Sound Transmission Class (STC). The STC ratings of common residential walls built in conformance with the Ontario Building Code (2012) typically exceed STC 35, depending on exterior cladding, thickness and interior finish details. For example, brick veneer walls can achieve STC 50 or more. Standard commercially sided exterior metal stud walls have around STC 45. Standard good quality double-glazed non-operable windows can have STC ratings ranging from 25 to 40, depending on the window manufacturer, pane thickness and inter-pane spacing. As previously mentioned, the windows are the known weak point in a partition.

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

Based on published research[9], exterior walls possess specific sound attenuation characteristics that are used as a basis for calculating the required STC ratings of windows in the same partition. Due to the limited information available at the time of the study, which was prepared for site plan approval, detailed floor layouts and building elevations have not been finalized; therefore, detailed STC calculations could not be performed at this time. As a guideline, the anticipated STC requirements for windows have been estimated based on the overall noise reduction required for each intended use of space (STC = outdoor noise level – targeted indoor noise levels).

4.3 Ground Vibration and Ground-Borne Noise

4.3.1 Background on Vibration

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 vibration 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 millimetres per second (mm/s) or inches per second (in/s). Since vibrations can vary

[9] CMHC, Road & Rail Noise: Effects on Housing

over a wide range, it is also convenient to represent them in decibel units, or dBV. In North America, it is common practice to use the reference value of one micro-inch per second (μin/s) to represent vibration levels for this purpose. The threshold level of human perception to vibrations is about 0.10 mm/s RMS or about 72 dBV. Although somewhat variable, the threshold of annoyance for continuous vibrations is 0.5 mm/s RMS (or 85 dBV), five times higher than the perception threshold, whereas the threshold for significant structural damage is 10 mm/s RMS (or 112 dBV), at least one hundred times higher than the perception threshold level.

4.3.2 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.

4.3.3 Theoretical Ground Vibration Prediction Procedure

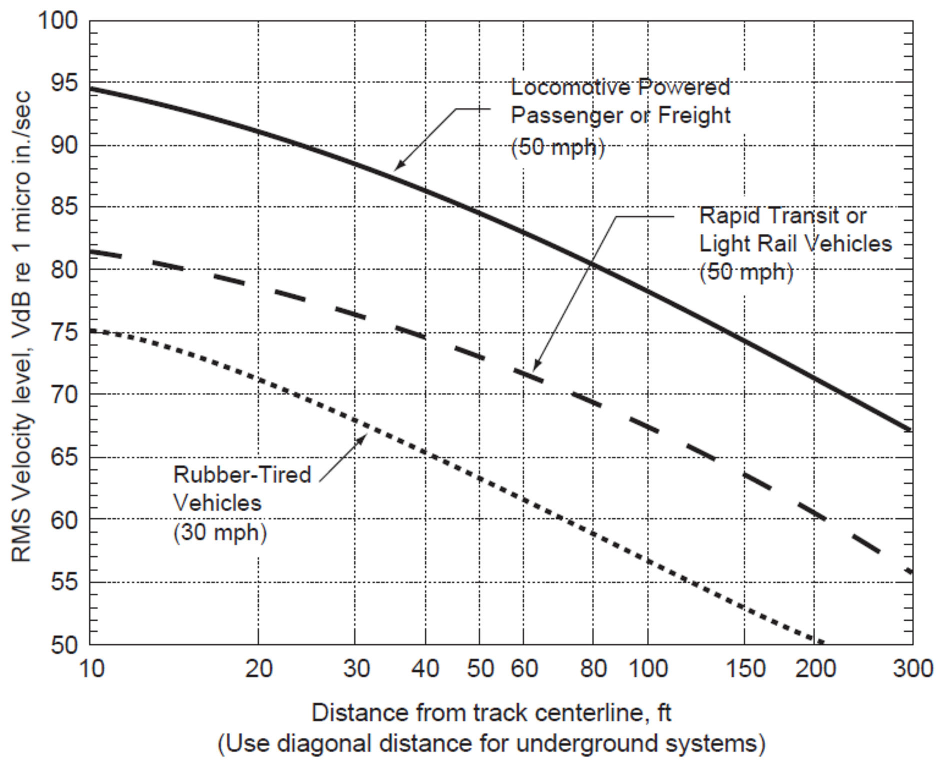
Potential vibration impacts of the trains were predicted using the Federal Transit Authority's (FTA) Transit Noise and Vibration Impact Assessment[11] protocol. The FTA general vibration assessment is based on an upper bound generic set of curves that show vibration level attenuation with distance. These 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.

Confederation Line LRT passes approximately 43 metres to the north of the development. Therefore, the vibration impact of the transit line on the building was determined using a set of curves for Rapid Transit

[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

or Light Rail Vehicles at a speed of 43 mph (equals to 70 km/hr, maximum speed for the train) using FTA's Transit Noise and Vibration Impact Assessment protocol. Adjustment factors were considered based on the following information:

- The maximum operating speed of the subway train is 70 km/h (43 mph)
- The distance between the development's property line and the closest subway track is 43 m
- There are no crossover tracks near the development
- The vehicles are assumed to have soft primary suspensions
- Tracks are not welded, though in otherwise good condition
- Soil conditions; propagation through rock
- The building's foundation is in rock



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 Roadway Traffic Noise Levels

The results of the transportation noise calculations are summarized in Table 3 below. A complete set of input and output data from all STAMSON 5.04 calculations are available in Appendix A. The results of the current analysis indicate that noise levels will range between 65 and 69 dBA during the daytime period (07:00-23:00) and 57 and 61 dBA during the nighttime period (23:00-07:00). The highest noise level occurs at the North façade, which is nearest and most exposed to Scott Street and the Transitway. Results can be seen in Table 3 (below).

TABLE 3: EXTERIOR NOISE LEVELS DUE TO ROAD TRAFFIC

Receptor Number	Receptor Height Above Grade (m)	Receptor Location	STAMSON 5.04 Noise Level (dBA)	
			Day	Night
1	13	POW –North Façade	69	61
2	13	POW– East Façade	65	57
3	13	POW– West Façade	65	57
4	1.5	OLA – Southwest Amenity Area	46	N/A*

*OLA noise levels during the nighttime are not considered as per the ENCG

5.1.1 Noise Control Measures

The noise level on the north façade predicted due to transportation traffic exceed the criteria listed in Section 4.2 for building components for the development. As discussed in Section 4.2, the anticipated STC requirements for windows have been estimated based on the overall noise reduction required for each intended use of space (STC = outdoor noise level – targeted indoor noise levels). As per NPC-300 requirements, detailed STC calculations will be required to be completed prior to building permit application for each unit type. The STC requirements for the windows are summarized below for various units within the development (see Figure 4).

TABLE 5: NOISE CONTROL REQUIREMENTS

Façade	Window STC (Bedroom/Living Room)	Exterior Wall STC
North	32/27	45

The site favourably shields the southwest amenity area from transportation noise sources. As such, OLA noise levels are below the NPC-300 criterion of 55 dBA and no noise mitigation will be required.

The results of the calculations also indicate that the development should be designed with central air conditioning or a similar system, which will allow occupants to keep windows closed and maintain a comfortable living environment. A Type D Warning Clause should be used in all Lease, Purchase and Sale Agreements of the building's units, as summarized in section 6.

5.2 Ground Vibration and Ground-Borne Noise Levels

Estimated vibration levels at the property line of the proposed development to the Confederation Line LRT are expected to be at 0.04 mm/s RMS (65 dBV), based on the FTA protocol and an offset distance of 43 m. Details of the calculation are provided in Appendix B. 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.

6. CONCLUSIONS AND RECOMMENDATIONS

Results of the current analysis indicate that noise levels at POW receptors will range between 65 and 69 dBA during the daytime period (07:00-23:00) and between 57 and 61 dBA during the nighttime period (23:00-07:00). The highest noise levels (69 dBA) occur at the north façades of the study site, which is nearest and most exposed to Scott Street and the Confederation Line LRT (future expansion).

The noise level at the southwest amenity area does not exceed the 55 dBA ENCG criteria. Therefore, no noise mitigation measure is required for this area.

The results of the calculations also indicate that the development should be designed with central air conditioning or a similar system, which will allow occupants to keep windows closed and maintain a comfortable living environment. A Type D Warning Clause should be used in all Lease, Purchase and Sale Agreements of the building's units, as summarized below:

TYPE D

> *"This dwelling unit has been supplied with a central air conditioning system which will allow windows and exterior doors to remain closed, thereby ensuring that the indoor sound levels are within the sound level limits of the Municipality and the Ministry of the Environment."*

In addition, the Rail Construction Program Office recommends that the warning clause identified below be included in all agreements of purchase and sale and lease agreements for the proposed development including those prepared prior to the registration of the Site Plan Agreement:

"The Owner hereby acknowledges and agrees:

i) *The proximity of the proposed development of the lands described in Schedule "A" hereto (the "Lands") to the City's existing and future transit operations, may result in noise, vibration, electromagnetic interferences, stray current transmissions, smoke and particulate matter (collectively referred to as "Interferences") to the development;*

ii) *It has been advised by the City to apply reasonable attenuation measures with respect to the level of the Interferences on and within the Lands and the proposed development; and*

iii) *The Owner acknowledges and agrees all agreements of purchase and sale and lease agreements, and all information on all plans and documents used for marketing purposes, for the whole or any part of the subject lands, shall contain the following clauses which shall also be incorporated in all transfer/deeds and leases from the Owner so that the clauses shall be covenants running with the lands for the benefit of the owner of the adjacent road:*

    'The Transferee/Lessee for himself, his heirs, executors, administrators, successors and assigns acknowledges being advised that a public transit light-rail rapid transit system (LRT) is proposed to be located in proximity to the subject lands, and the construction,

operation and maintenance of the LRT may result in environmental impacts including, but not limited to noise, vibration, electromagnetic interferences, stray current transmissions, smoke and particulate matter (collectively referred to as the Interferences) to the subject lands. The Transferee/Lessee acknowledges and agrees that despite the inclusion of noise control features within the subject lands, Interferences may continue to be of concern, occasionally interfering with some activities of the occupants on the subject lands.

The Transferee covenants with the Transferor and the Lessee covenants with the Lessor that the above clauses verbatim shall be included in all subsequent lease agreements, agreements of purchase and sale and deeds conveying the lands described herein, which covenants shall run with the lands and are for the benefit of the owner of the adjacent road.'"

Estimated vibration levels at the property line of the proposed development to the Confederation Line LRT are expected to be at 0.04 mm/s RMS (65 dBV), based on the FTA protocol and an offset distance of 43 m. Details of the calculation are provided in Appendix B. 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.

With regards to stationary noise impacts, the site is surrounded by low- to mid-rise buildings with only small equipment on the rooftop of some neighbouring buildings. Therefore, on-site stationary noise impacts from these properties are considered insignificant. Westboro and Tunney's Pasture Stations are located 750 meters and 800 meters away from the study site. As such, the noise generated by trains slowing down and accelerating at the station will be masked by the LRT corridor and roadway traffic noise. Therefore, any noise impact on the development site from the station is not anticipated.

Due to the size of the development, stationary noise impact on the surroundings is expected to be minimal. The building will likely have small internal Energy Recovery Ventilators or Heat pump systems, with small residential sized Air conditioning condoners on the roof. The mechanical system would be required to comply with MECP's Publication NPC-216 Residential Air Conditioning Devices.

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,

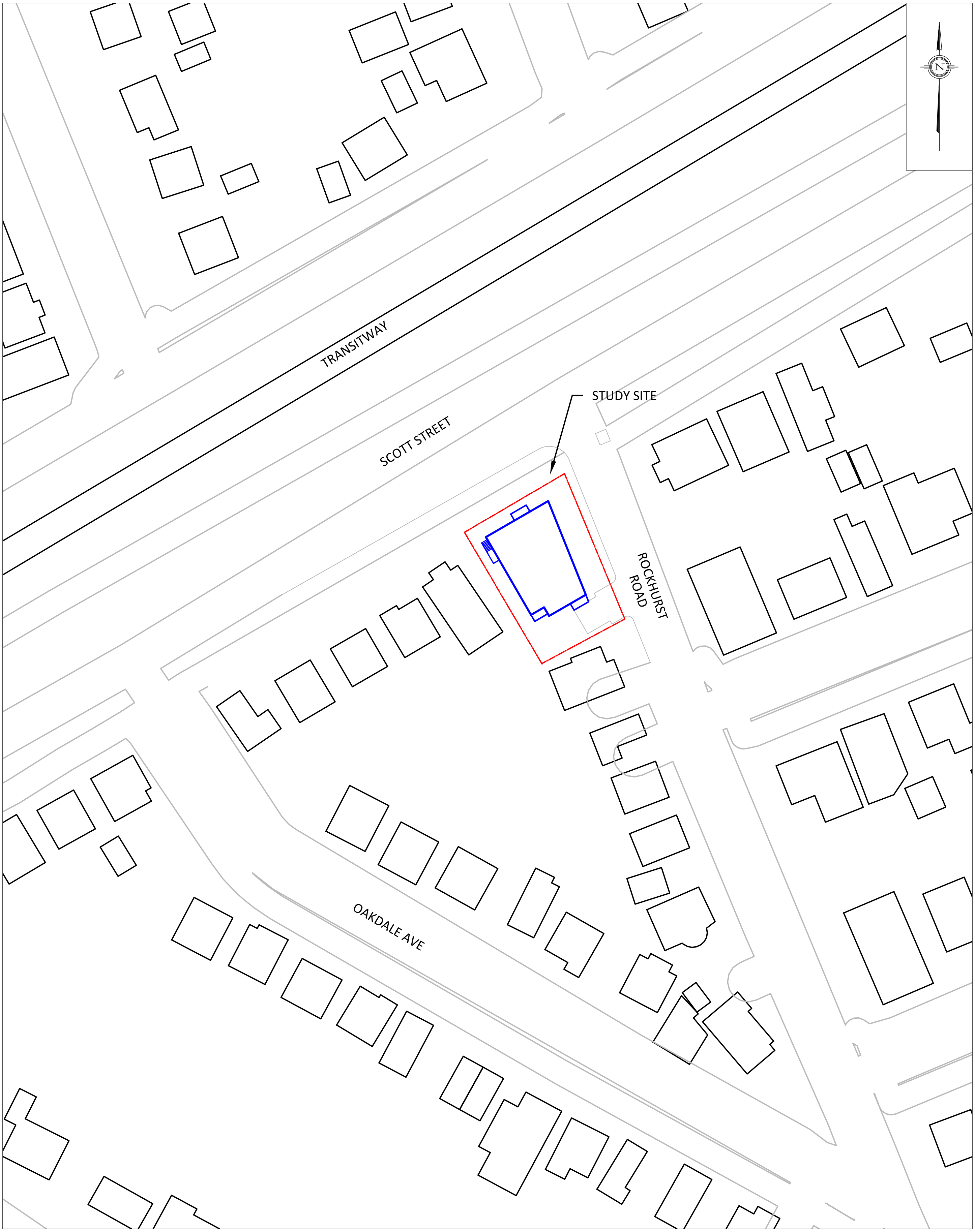
Gradient Wind Engineering Inc.

LICENSED PROFESSIONAL ENGINEER
J. R. FOSTER
100155655
Nov 9, 2022
PROVINCE OF ONTARIO

Essraa Alqassab, BASc.
Junior Environmental Scientist

Joshua Foster, P.Eng.
Lead Engineer

Gradient Wind File #22-188-Transportation Noise & Vibration



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

PROJECT	1806 SCOTT STREET, OTTAWA TRANSPORTATION NOISE ASSESSMENT		
SCALE	1:1000 (APPROX.)	DRAWING NO.	GW22-188-1
DATE	JULY 20, 2022	DRAWN BY	E.A.

DESCRIPTION

FIGURE 1:
SITE PLAN AND SURROUNDING CONTEXT

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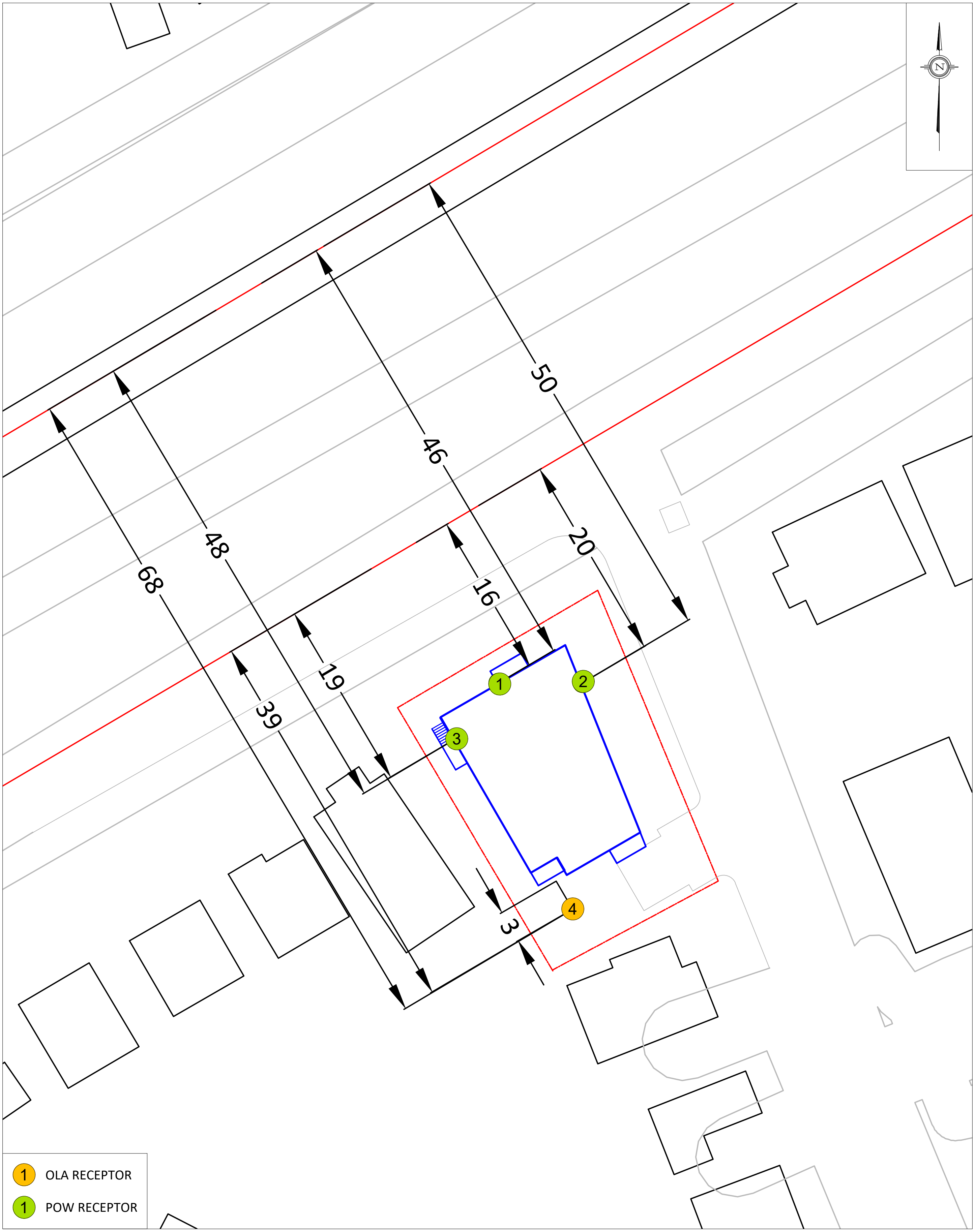
PROJECT: 1806 SCOTT STREET, OTTAWA TRANSPORTATION NOISE ASSESSMENT		DESCRIPTION: FIGURE 2: RECEPTOR LOCATIONS
SCALE: 1:40 (APPROX.)	DRAWING NO.: GW22-188-2	
DATE: JULY 20, 2022	DRAWN BY: E.A.	



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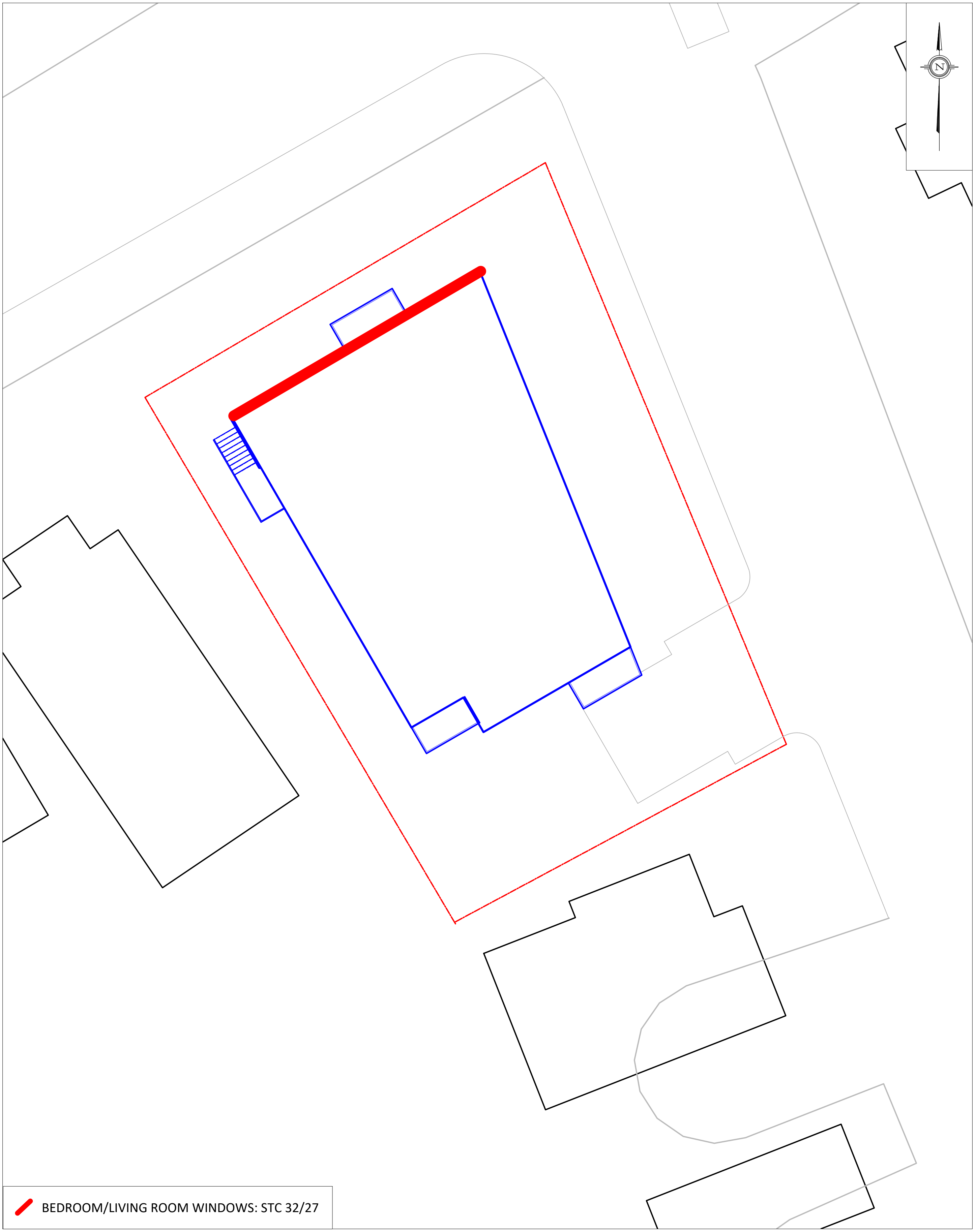
PROJECT	1806 SCOTT STREET, OTTAWA TRANSPORTATION NOISE ASSESSMENT		
SCALE	1:200 (APPROX.)	DRAWING NO.	GW22-188-3
DATE	JULY 20, 2022	DRAWN BY	E.A.

DESCRIPTION

FIGURE 3:
STAMSON PARAMETERS



GRADIENTWIND ENGINEERS & SCIENTISTS 127 WALGREEN ROAD , OTTAWA, ON 613 836 0934 • GRADIENTWIND.COM	PROJECT: 1806 SCOTT STREET, OTTAWA TRANSPORTATION NOISE ASSESSMENT		DESCRIPTION: FIGURE 4: STC WINDOW RECOMMENDATION
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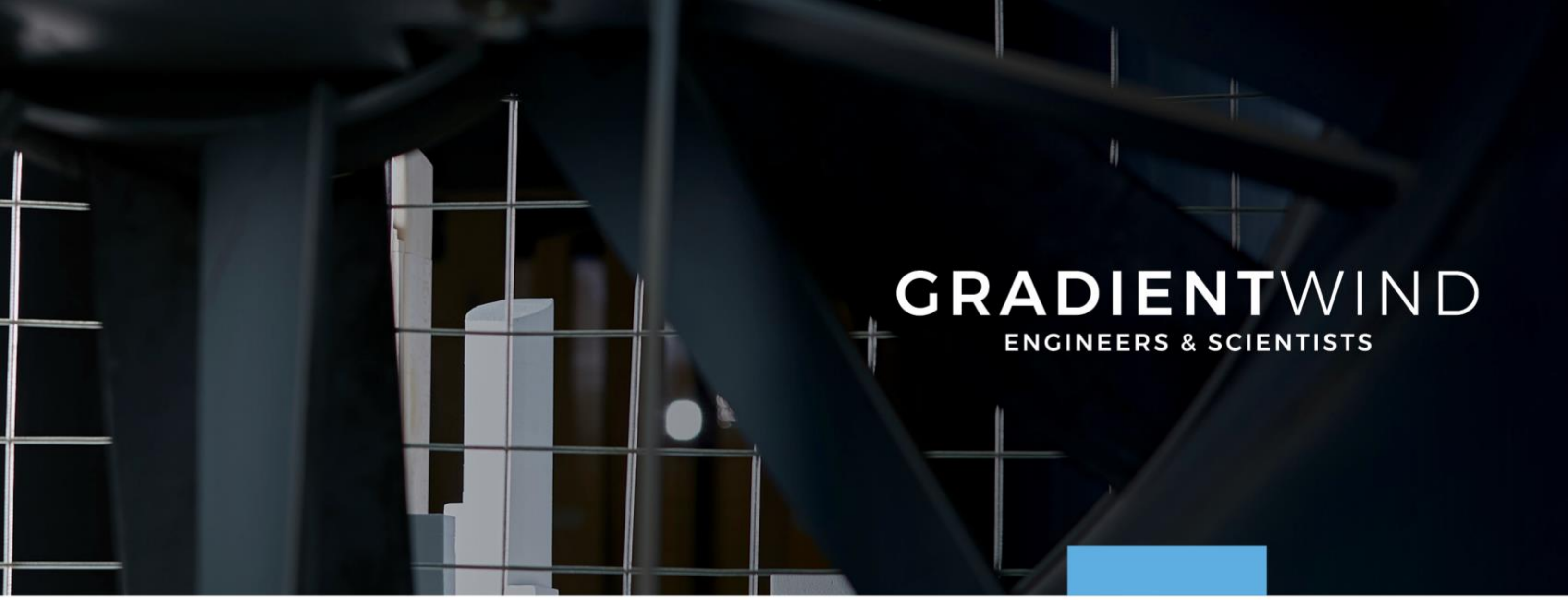
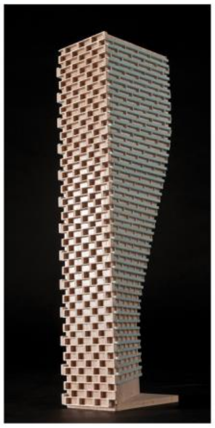
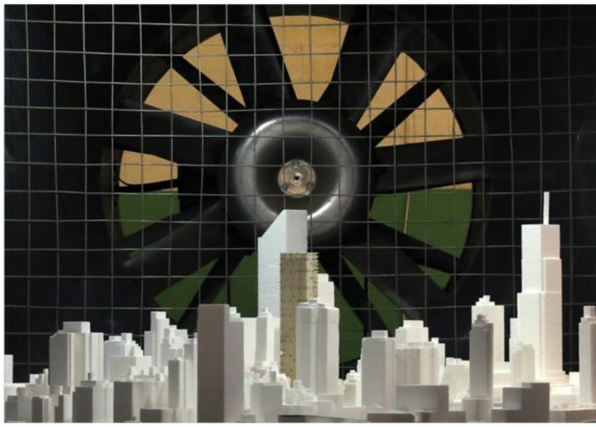
	DATE: JULY 20, 2022	DRAWN BY: E.A.	







APPENDIX A

STAMSON 5.04 – INPUT AND OUTPUT DATA

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

```
STAMSON 5.0        NORMAL REPORT        Date: 19-07-2022 16:22:19
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Scott Street (day/night)
------------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 1: Scott Street (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  :  16.00 / 16.00  m
Receiver height           :  13.00 / 13.00  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00


Results segment # 1: Scott Street (day)
---------------------------------------

Source height = 1.50 m

ROAD (0.00 + 68.20 + 0.00) = 68.20 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.00  68.48   0.00  -0.28   0.00   0.00   0.00   0.00
68.20
--------------------------------------------------------------------------
--
```

```
Segment Leq : 68.20 dBA

Total Leq All Segments: 68.20 dBA


Results segment # 1: Scott Street (night)
-----------------------------------------

Source height = 1.50 m

ROAD (0.00 + 60.60 + 0.00) = 60.60 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-----------------------------------------------------------------------------
--
   -90     90   0.00  60.88   0.00  -0.28   0.00   0.00   0.00   0.00
60.60
-----------------------------------------------------------------------------
--

Segment Leq : 60.60 dBA

Total Leq All Segments: 60.60 dBA


RT/Custom data, segment # 1: Confed. Line (day/night)
-----------------------------------------------------
1 - 4-car SRT:
Traffic volume    :   540/60    veh/TimePeriod
Speed             :    70 km/h

Data for Segment # 1: Confed. Line (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  :  46.00 / 46.00  m
Receiver height           :  13.00 / 13.00  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00


Results segment # 1: Confed. Line (day)
---------------------------------------

Source height = 0.50 m

RT/Custom (0.00 + 58.57 + 0.00) = 58.57 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
```

```
---------------------------------------------------------------------
   -90     90    0.00  63.44  -4.87   0.00   0.00   0.00   0.00  58.57
---------------------------------------------------------------------

Segment Leq : 58.57 dBA

Total Leq All Segments: 58.57 dBA


Results segment # 1: Confed. Line (night)
-----------------------------------------

Source height = 0.50 m

RT/Custom (0.00 + 52.04 + 0.00) = 52.04 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
---------------------------------------------------------------------
   -90     90    0.00  56.91  -4.87   0.00   0.00   0.00   0.00  52.04
---------------------------------------------------------------------

Segment Leq : 52.04 dBA

Total Leq All Segments: 52.04 dBA



TOTAL Leq FROM ALL SOURCES (DAY): 68.65
                         (NIGHT): 61.17
```

```
STAMSON 5.0        NORMAL REPORT        Date: 19-07-2022 16:19:15
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Scott Street (day/night)
------------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 1: Scott Street (day/night)
----------------------------------------------
Angle1   Angle2           :   0.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  20.00 / 20.00  m
Receiver height           :  13.00 / 13.00  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00


Results segment # 1: Scott Street (day)
---------------------------------------

Source height = 1.50 m

ROAD (0.00 + 64.22 + 0.00) = 64.22 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
     0     90   0.00  68.48   0.00  -1.25  -3.01   0.00   0.00   0.00
64.22
--------------------------------------------------------------------------
--
```

```
Segment Leq : 64.22 dBA

Total Leq All Segments: 64.22 dBA


Results segment # 1: Scott Street (night)
-----------------------------------------

Source height = 1.50 m

ROAD (0.00 + 56.62 + 0.00) = 56.62 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
------------------------------------------------------------------------
--
     0     90   0.00  60.88   0.00  -1.25  -3.01   0.00   0.00   0.00
56.62
------------------------------------------------------------------------
--

Segment Leq : 56.62 dBA

Total Leq All Segments: 56.62 dBA


RT/Custom data, segment # 1: Confed. Line (day/night)
-----------------------------------------------------
1 - 4-car SRT:
Traffic volume    :   540/60    veh/TimePeriod
Speed             :    70 km/h

Data for Segment # 1: Confed. Line (day/night)
----------------------------------------------
Angle1   Angle2           :   0.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  50.00 / 50.00  m
Receiver height           :  13.00 / 13.00  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00


Results segment # 1: Confed. Line (day)
---------------------------------------

Source height = 0.50 m

RT/Custom (0.00 + 55.20 + 0.00) = 55.20 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
```

```
------------------------------------------------------------------------
     0      90    0.00  63.44  -5.23  -3.01   0.00   0.00   0.00  55.20
------------------------------------------------------------------------

Segment Leq : 55.20 dBA

Total Leq All Segments: 55.20 dBA


Results segment # 1: Confed. Line (night)
-----------------------------------------

Source height = 0.50 m

RT/Custom (0.00 + 48.67 + 0.00) = 48.67 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
------------------------------------------------------------------------
     0      90    0.00  56.91  -5.23  -3.01   0.00   0.00   0.00  48.67
------------------------------------------------------------------------

Segment Leq : 48.67 dBA

Total Leq All Segments: 48.67 dBA




TOTAL Leq FROM ALL SOURCES (DAY): 64.73
                          (NIGHT): 57.27
```

```
STAMSON 5.0        NORMAL REPORT        Date: 19-07-2022 16:20:35
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Scott Street (day/night)
------------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 1: Scott Street (day/night)
----------------------------------------------
Angle1   Angle2           : -90.00 deg   0.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  19.00 / 19.00  m
Receiver height           :  13.00 / 13.00  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00


Results segment # 1: Scott Street (day)
---------------------------------------

Source height = 1.50 m

ROAD (0.00 + 64.44 + 0.00) = 64.44 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90      0   0.00  68.48   0.00  -1.03  -3.01   0.00   0.00   0.00
64.44
--------------------------------------------------------------------------
--
```

```
Segment Leq : 64.44 dBA

Total Leq All Segments: 64.44 dBA


Results segment # 1: Scott Street (night)
-----------------------------------------

Source height = 1.50 m

ROAD (0.00 + 56.85 + 0.00) = 56.85 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90      0   0.00  60.88   0.00  -1.03  -3.01   0.00   0.00   0.00
56.85
--------------------------------------------------------------------------
--

Segment Leq : 56.85 dBA

Total Leq All Segments: 56.85 dBA


RT/Custom data, segment # 1: Confed. Line (day/night)
-----------------------------------------------------
1 - 4-car SRT:
Traffic volume    :   540/60    veh/TimePeriod
Speed             :    70 km/h

Data for Segment # 1: Confed. Line (day/night)
----------------------------------------------
Angle1   Angle2            : -90.00 deg   0.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      2       (Reflective ground surface)
Receiver source distance   :  48.00 / 48.00  m
Receiver height            :  13.00 / 13.00  m
Topography                 :      1       (Flat/gentle slope; no barrier)
Reference angle            :   0.00


Results segment # 1: Confed. Line (day)
---------------------------------------

Source height = 0.50 m

RT/Custom (0.00 + 55.38 + 0.00) = 55.38 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
```

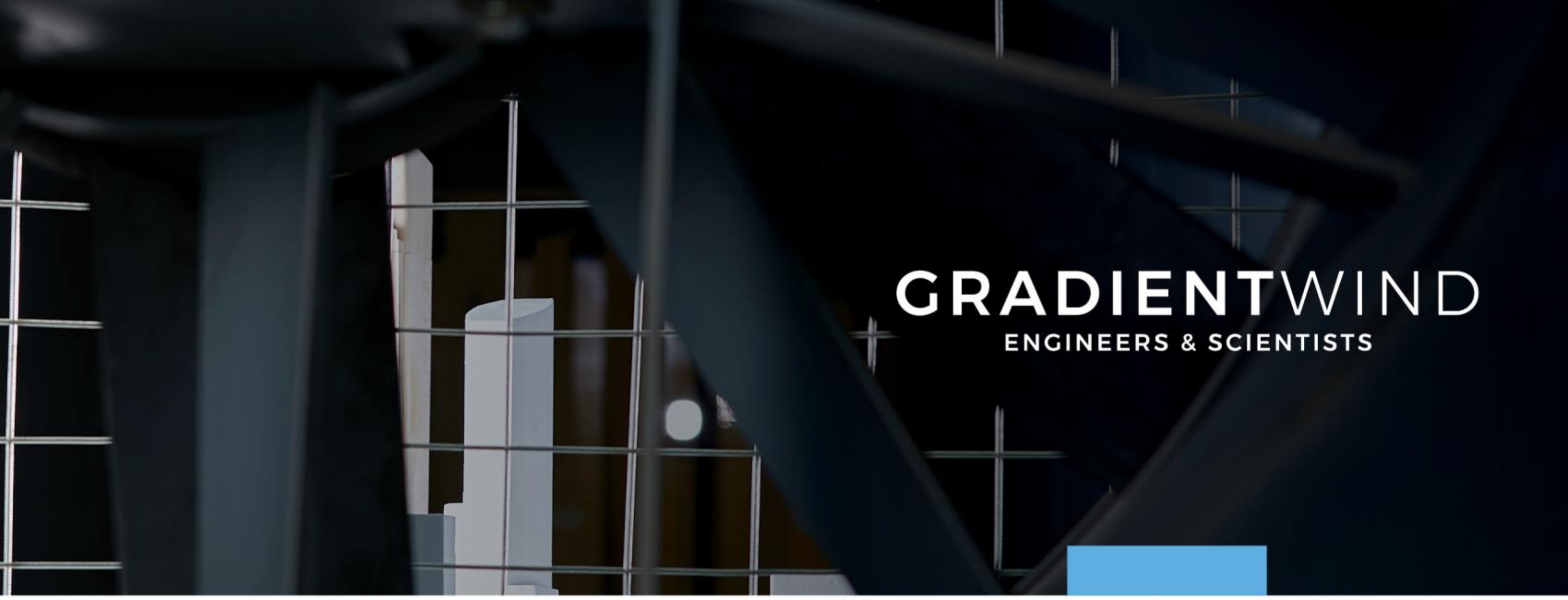
```
------------------------------------------------------------------------
   -90      0   0.00  63.44  -5.05  -3.01   0.00   0.00   0.00  55.38
------------------------------------------------------------------------

Segment Leq : 55.38 dBA

Total Leq All Segments: 55.38 dBA


Results segment # 1: Confed. Line (night)
-----------------------------------------

Source height = 0.50 m

RT/Custom (0.00 + 48.84 + 0.00) = 48.84 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
------------------------------------------------------------------------
   -90      0   0.00  56.91  -5.05  -3.01   0.00   0.00   0.00  48.84
------------------------------------------------------------------------

Segment Leq : 48.84 dBA

Total Leq All Segments: 48.84 dBA



TOTAL Leq FROM ALL SOURCES (DAY): 64.95
                          (NIGHT): 57.49
```

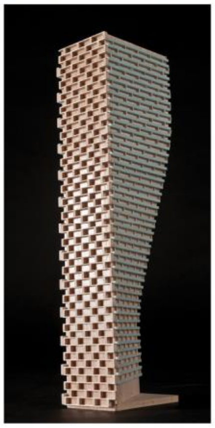
```
STAMSON 5.0         NORMAL REPORT         Date: 20-07-2022 13:05:11
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r4.te                 Time Period: Day/Night 16/8 hours
Description:


Road data, segment # 1: Scott Street (day/night)
------------------------------------------------
Car traffic volume   : 12144/1056  veh/TimePeriod  *
Medium truck volume  :   966/84    veh/TimePeriod  *
Heavy truck volume   :   690/60    veh/TimePeriod  *
Posted speed limit   :    50 km/h
Road gradient        :     0 %
Road pavement        :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 1: Scott Street (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  :  39.00 / 39.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : 90.00 deg
Barrier height            :  14.50 m
Barrier receiver distance :   3.00 / 3.00   m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00

Results segment # 1: Scott Street (day)
---------------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
```

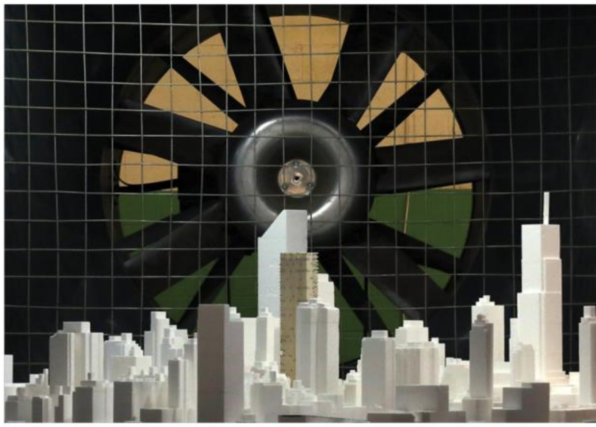
```
------------+-------------+-------------+--------------
       1.50 !        1.50 !        1.50 !         1.50

ROAD (0.00 + 45.30 + 0.00) = 45.30 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.00  68.48   0.00  -4.15   0.00   0.00   0.00 -19.03
45.30
--------------------------------------------------------------------------
--

Segment Leq : 45.30 dBA

Total Leq All Segments: 45.30 dBA

Results segment # 1: Scott Street (night)
-----------------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !        1.50 !        1.50 !         1.50

ROAD (0.00 + 37.70 + 0.00) = 37.70 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.00  60.88   0.00  -4.15   0.00   0.00   0.00 -19.03
37.70
--------------------------------------------------------------------------
--

Segment Leq : 37.70 dBA

Total Leq All Segments: 37.70 dBA

RT/Custom data, segment # 1: Confed. Line (day/night)
----------------------------------------------------
1 - 4-car SRT:
Traffic volume    :   540/60    veh/TimePeriod
Speed             :    70  km/h

Data for Segment # 1: Confed. Line (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   :  68.00 / 68.00  m
Receiver height            :   1.50 / 1.50   m
Topography                 :      2       (Flat/gentle slope; with barrier)
Barrier angle1             : -90.00 deg   Angle2 : 90.00 deg
Barrier height             :  14.50 m
Barrier receiver distance  :   3.00 / 3.00   m
Source elevation           :  -5.00 m
Receiver elevation         :   0.00 m
Barrier elevation          :   0.00 m
Reference angle            :   0.00

Results segment # 1: Confed. Line (day)
---------------------------------------

Source height = 0.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver     ! Barrier      ! Elevation of
Height  (m) ! Height   (m) ! Height   (m) ! Barrier Top  (m)
------------+--------------+--------------+---------------
       0.50 !         1.50 !         1.24 !         1.24

RT/Custom (0.00 + 37.83 + 0.00) = 37.83 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.00  63.44  -6.56   0.00   0.00   0.00 -19.04  37.83
----------------------------------------------------------------------

Segment Leq : 37.83 dBA

Total Leq All Segments: 37.83 dBA

Results segment # 1: Confed. Line (night)
-----------------------------------------

Source height = 0.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver     ! Barrier      ! Elevation of
Height  (m) ! Height   (m) ! Height   (m) ! Barrier Top  (m)
------------+--------------+--------------+---------------
       0.50 !         1.50 !         1.24 !         1.24

RT/Custom (0.00 + 31.30 + 0.00) = 31.30 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
```

```
-----------------------------------------------------------------------
   -90      90   0.00  56.91  -6.56   0.00   0.00   0.00 -19.04  31.30
-----------------------------------------------------------------------

Segment Leq : 31.30 dBA

Total Leq All Segments: 31.30 dBA



TOTAL Leq FROM ALL SOURCES (DAY): 46.02
                          (NIGHT): 38.60
```







APPENDIX B

FTA VIBRATION CALCULATIONS

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

GW22-188 22-Jul-22

Possible Vibration Impacts on 1806 Scott Street
Perdicted using FTA General Assesment

Train Speed 70 km/h 43 mph

	Distance from	
	(m)	(ft)
LRT	43.0	141.1

Vibration

From FTA Manual Fig 10-1

Vibration Levels at distance from trac	65	dBV re 1 micro in/sec	

Adjustment Factors FTA Table 10-1

Speed reference 50 mph	-1	Operating Speed 43 mph	
Vehicle Parameters	0	Assume Soft primary suspension, Wheels run true	
Track Condition	0	Good condition	
Track Treatments	0	none	
Type of Transit Structure	-15	Rock Based	
Efficient vibration Propagation	10	Propagation through rock	
Vibration Levels at Fdn	59		0.022
Coupling to Building Foundation	0	Fondation in rock	
Floor to Floor Attenuation	0	Ground Floor ocupied	
Amplification of Floor and Walls	6		
Total Vibration Level	64.79	dBV or	0.044 mm/s
Noise Level in dBA	29.79	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.