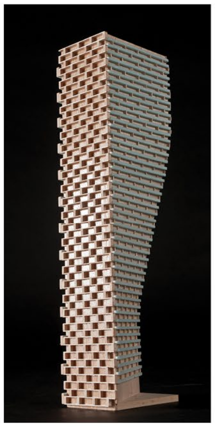
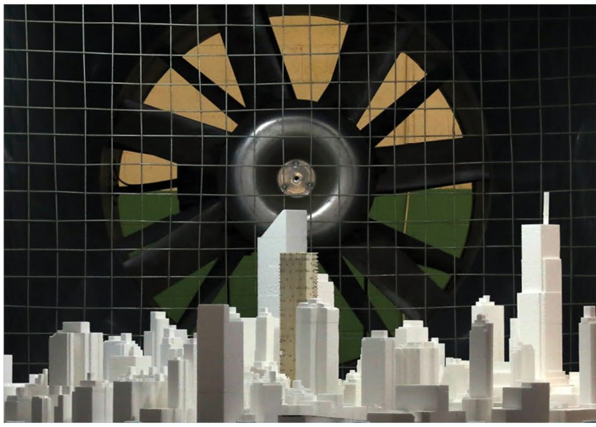
TRANSPORTATION NOISE AND VIBRATION ASSESSMENT

2009-2013 Prince of Wales Drive
Ottawa, Ontario

GRADIENT WIND REPORT: 22-190 – Transportation Noise and Vibration





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EXECUTIVE SUMMARY

This report describes a transportation noise and vibration assessment undertaken for the property located at 2009-2013 Prince of Wales Drive in Ottawa, Ontario. The proposed development comprises seven lots and a private road located between Prince of Wales Drive and the Rideau River.

The major sources of transportation noise include Prince of Wales Drive, the Via Rail corridor (Beachburg Subdivision), and the Ottawa Macdonald-Cartier International Airport. The development resides within the Airport Vicinity Development Zone between the Airport Operating Influencing Zone (i.e., Noise Exposure Forecast (NEF) or Noise Prediction Forecast (NEP) 30 contour) and the NEF 25 contour. As the site is in proximity to the Via Rail corridor, a ground vibration impact assessment from the railway on the proposed development was conducted following the procedures outlined in the Federal Transit Authorities (FTA) protocol. Figure 1 illustrates a complete site plan with surrounding context.

The assessment is based on (i) theoretical noise prediction methods that conform to the Ministry of the Environment, Conservation and Parks (MECP) and City of Ottawa requirements; (ii) noise level criteria as specified by the City of Ottawa's Environmental Noise Control Guidelines (ENCG); (iii) future vehicular traffic volumes based on the City of Ottawa's Official Plan roadway classifications, (iv) railway traffic volumes based on VIA Rail Canada Inc. operating schedule; (v) architectural drawings provided by Jane Thompson Architect in September 2022; and (vi), ground-borne vibration criteria as specified by the Federal Transit Authority (FTA) Protocol.

The results of the roadway and railway traffic noise analysis indicate that noise levels will range between 63 and 66 dBA during the daytime period (07:00-23:00) and between 55 and 60 dBA during the nighttime period (23:00-07:00). The highest noise level (66 dBA) occurs at Lot 7, which is nearest and most exposed to Prince of Wales Drive and the VIA Rail corridor. As such, upgraded building components with a higher Sound Transmission Class (STC) rating will be required to mitigate surface transportation noise. With regard to aircraft noise, the development falls within the NEF 25 composite contour line indicating that noise levels from aircraft flyovers will approach 57 dBA. As a result, upgraded building components with a higher Sound Transmission Class (STC) rating will also be required to mitigate aircraft noise.

Section 5.1 outlines the STC requirements for the exterior wall, glazing, and roof assembly to ensure indoor noise levels meet the criteria specified by ENCG and NPC-300. Results of the calculations also indicate that the development will require central air conditioning, which will allow occupants to keep windows closed and maintain a comfortable living environment. Warning Clauses will be required to address noise from roadway, railway, and aircraft traffic noise as summarized in Section 6.

Noise levels at the rear yards are expected to exceed 55 dBA during the daytime period without a noise barrier. Further analysis investigated the noise mitigating impact of installing a potential noise wall 2.2m to 3.5m above local grade at the edge of the 30 m railway setback (see Table 5 and Figure 4). Results of the investigation proved that noise levels can only be reduced to 56 dBA with the inclusion of a 3.5 m tall barrier. However, the inclusion of the noise barrier at the edge of the 30 m railway setback would cause an undesired severance of the deep rear yard. Positioning the noise barrier closer to the railway is not possible as this will require a higher noise barrier to block direct line of sight of the elevated railway. As such, implementation of a noise barrier is not considered technically and administratively feasible for the lots with a rear yard backing onto the VIA Rail corridor. A Warning Clause will be required in all Lease, Purchase and Sale Agreements, as summarized in Section 6.

It should be noted that noise levels at the rear yard of the existing 1-storey dwelling at Lot 1 are expected to be 57 dBA. Given the fact that noise levels are below 60 dBA for the existing building, the inclusion of a noise barrier is not considered technically and administratively feasible. As such, a Warning Clause will be required on all new Lease, Purchase and Sale Agreements as summarized Section 6.

Estimated vibration levels are expected to be 0.091 mm/s RMS (71 dBV), based on the FTA protocol and an offset distance of 43 m from the nearest property line to the railway track centerline. Details of the calculation are provided in Appendix C. Since predicted vibration levels do not exceed the criterion of 0.14 mm/s RMS at the foundation, concerns due to vibration impacts on the site are not expected. 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 Jane Thompson Architect to undertake a transportation noise and vibration assessment for the property located at 2009-2013 Prince of Wales Drive in Ottawa, Ontario. This report summarizes the methodology, results, and recommendations related to the assessment of exterior and interior noise and vibration levels generated by local roadway, railway, and aircraft 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 Jane Thompson Architect in September 2022, with future traffic volumes corresponding to the City of Ottawa's Official Plan (OP) roadway classifications, and railway traffic volumes based on VIA Rail Canada Inc. operating schedule. Assessment of aircraft noise has been assessed based on its proximity to the airport and the nearest Noise Exposure Forecast contour line, as per Annex 10 in the City of Ottawa's OP. As the site is in proximity to the Via Rail corridor, a ground vibration impact assessment from the railway on the proposed development was conducted following the procedures outlined in the Federal Transit Authorities (FTA) protocol.

2. TERMS OF REFERENCE

The proposed development comprises seven lots and a public road located between Prince of Wales Drive and the Rideau River. The site is surrounded by Prince of Wales Drive to the west, residential land to the north, the Rideau River to the east, and the VIA Rail corridor to the south. Low-rise residential buildings are positioned in all compass directions. The south and east perimeters of the parcel of land contains a landscaped area, and between the new road and the landscaped space are buildable areas with a driveway for each lot. The six lots nearest to Prince of Wales Drive will be new, and the last lot will consist of an existing 1-storey brick sided dwelling located at 2009 Prince of Wales Drive.

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[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

The major sources of transportation noise include Prince of Wales Drive, the Via Rail corridor (Beachburg Subdivision), and the Ottawa Macdonald-Cartier International Airport. The development resides within the Airport Vicinity Development Zone between the Airport Operating Influencing Zone (i.e., Noise Exposure Forecast (NEF) or Noise Prediction Forecast (NEP) 30 contour) and the NEF 25 contour. As the site is within 75m of the VIA Rail corridor, a ground vibration impact assessment from the railway on the proposed development was conducted following the procedures outlined in the Federal Transit Authorities (FTA) protocol.

Outdoor living areas associated with each lot, excluding Lot 3, will be located at the rear fully or partially exposed to the roadway and railway sources. Figure 1 illustrates a complete site plan with surrounding context.

Furthermore, the stationary noise impacts of the proposed development onto the surroundings were determined to be insignificant as no major mechanical equipment is planned. The only anticipated mechanical systems are residential air conditioners which, according to MECP noise guidelines, are not considered stationary noise sources. However, the location and installation of these systems are expected to comply with the noise regulations stipulated in *NPC-216: Residential and Air Conditioning Devices*[3], or local noise by-laws. As a result, noise from these units onto the surrounding area is anticipated to be minimal.

3. OBJECTIVES

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

[3] Ontario Ministry of the Environment and Energy – Residential Air Conditioning Devices, Publication NPC-216, Toronto Municipal Code, Toronto, 1993

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 by 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.

The ENCG specifies that surface transportation noise (road and rail) and airport noise should be evaluated separately. The overall building attenuation parameters are then combined. Section 4.2 and 4.3 addresses the methodology for the evaluation of roadway/railway and aircraft noise, respectively.

4.2 Roadway & Railway Traffic Noise

4.2.1 Criteria for Roadway and Railway Traffic Noise

For surface roadway and railway traffic noise, 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 and railways, 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 40 and 35 dBA for 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 37, and 32 dBA.

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

Type of Space	Time Period	Road L_{eq} (dBA)	Rail L_{eq} (dBA)
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 reduction[5]. 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[6].

Due to the characteristics of rail noise which occur over short periods (i.e. whistles, brake squealing), and a significant low frequency component produced by the movement of the locomotive along the track, road and rail traffic noise require separate analyses, particularly when assessing indoor sound levels. In order to account for the special characteristics of railway sound, the indoor sound level criteria are more stringent by 5 dB as compared to the roadway traffic criteria. This difference typically results in requirements for upgraded glazing elements to provide better noise attenuation from the building envelope. Interior noise level criteria include the influence from rail crossings and warning whistle bursts.

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

For designated Outdoor Living Areas (OLAs), the sound level limit is 55 dBA during the daytime period. An excess above the limit, between 55 dBA and 60 dBA, is acceptable only in cases where the required noise control measures are not feasible for technical, economic or administrative reasons. The development proposes several rear yards which have been identified as noise sensitive OLAs and were included in the assessment.

4.2.2 Theoretical Roadway and Railway 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 and railway traffic noise calculations were performed by treating each 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. For select receptors, the ground surface was taken to be absorptive due to the presence of soft (lawn) ground.
- Topography was assumed to be a flat/gentle slope for receptors influenced by Prince of Wales Drive.
- The VIA Rail corridor was modelled with a maximum elevation difference of 7 meters from grade level.
- Receptor height was taken to be 4.5 metres for 2-storey buildings at the centre of the Plane of Window (POW) and 1.5 meters for the Outdoor Living Area (OLA).
- Noise receptors were strategically placed at 6 locations around the study area (see Figure 2).
- Receptor distances and exposure angles are illustrated in Figure 3.
- The VIA Rail corridor was modeled as a diesel train with 1 locomotive and an average of 4 cars per train travelling at a maximum speed of 150 km/hr.

4.2.3 Roadway and Railway 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[7] 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. For railway volumes, the data was projected to 2032 at an annual rate of 2.5% per year. Table 2 summarizes the AADT values used for each roadway and VIA Rail line included in this assessment.

TABLE 2: TRANSPORTATION TRAFFIC DATA

Segment	Roadway Traffic Data	Speed Limit (km/h)	Traffic Volumes
Prince of Wales Drive	4-Lane Urban Arterial-Divided Road	50	**35,000**
VIA Rail	Passenger Rail	150	**18/4***

* Projected 2032 AADT daytime/nighttime rail traffic volumes based on the VIA Rail operating schedule.

4.2.4 Indoor Noise Calculations (Roadway and Railway)

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 (2020) 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.

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

As per Section 4.2, when daytime noise levels from road sources at the plane of the window exceed 65 dBA, calculations must be performed to evaluate the sound transmission quality of the building components to ensure acceptable indoor noise levels. The calculation procedure[8] considers:

- Window type and total area as a percentage of total room floor area
- Exterior wall type and total area as a percentage of the total room floor area
- Acoustic absorption characteristics of the room
- Outdoor noise source type and approach geometry
- Indoor sound level criteria, which varies according to the intended use of a space

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, 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

Rail systems and heavy vehicles on roadways can produce perceptible levels of ground vibrations, especially when they are in close proximity to residential neighbourhoods or vibration-sensitive buildings. Similar to sound waves in air, vibrations in solids are generated at a source, propagated through a medium, and intercepted by a receiver. In the case of ground vibrations, the medium can be uniform, or more often, a complex layering of soils and rock strata. Also, similar to sound waves in air, ground vibrations produce perceptible motions and regenerated noise known as 'ground-borne noise' when the vibrations encounter a hollow structure such as a building. Ground-borne noise and vibrations are generated when there is excitation of the ground, such as from a train. Repetitive motion of the wheels on the track or rubber tires passing over an uneven surface causes vibrations to propagate through the soil. When they encounter a building, vibrations pass along the structure of the building beginning at the foundation and

[8] Building Practice Note: Controlling Sound Transmission into Buildings by J.D. Quirt, National Research Council of Canada, September 1985
[9] CMHC, Road & Rail Noise: Effects on Housing

propagating to all floors. Air inside the building excited by the vibrating walls and floors represents regenerated airborne noise. Characteristics of the soil and the building are imparted to the noise, thereby creating a unique noise signature.

Human response to ground vibrations is dependent on the magnitude of the vibrations, which is measured by the root mean square (RMS) of the movement of a particle on a surface. Typical units of ground vibration measures are millimeters per second (mm/s), or inch per second (in/s). Since vibrations can vary over a wide range, it is also convenient to represent them in decibel units, or dBV. In North America, it is common practice to use the reference value of one micro-inch per second (μin/s) to represent vibration levels for this purpose. The threshold level of human perception to vibrations is about 0.10 mm/s RMS or about 72 dBV. Although somewhat variable, the threshold of annoyance for continuous vibrations is 0.5 mm/s RMS (or 85 dBV), five times higher than the perception threshold, whereas the threshold for significant structural damage is 10 mm/s RMS (or 112 dBV), at least one hundred times higher than the perception threshold level.

4.3.1 Ground Vibration Criteria

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. As the main vibration source is due to a mainline railway, the 0.14 mm/s RMS (75 dBV) vibration criteria and 35 dBA ground borne noise criteria were adopted for this study.

4.3.2 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,

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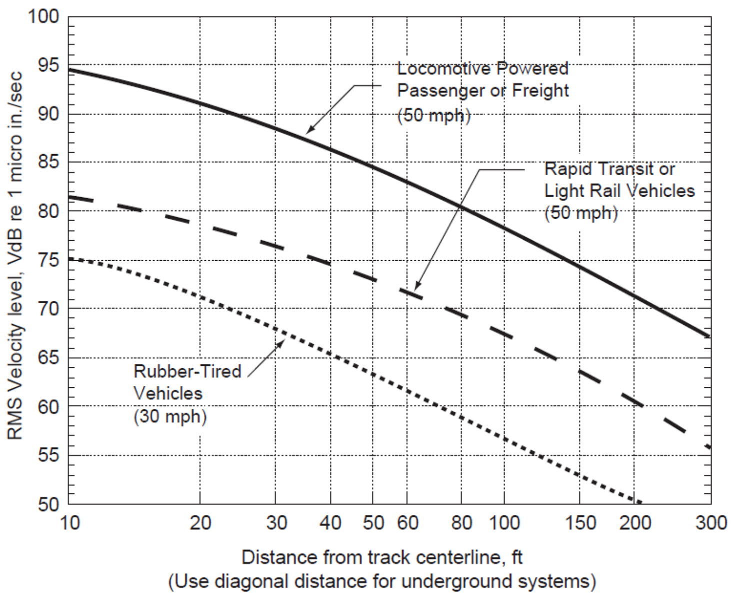
[10] Dialog and J.E. Coulter Associates Limited, prepared for The Federation of Canadian Municipalities and The Railway Association of Canada, May 2013

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

illustrated in the figure below, are based on ground vibration measurements at various transit systems throughout North America. Vibration levels at points of reception are adjusted by various factors to incorporate known characteristics of the system being analyzed, such as operating speed of vehicle, conditions of the track, construction of the track and geology, as well as the structural type of the impacted building structures. The vibration impact on the building was determined using a set of curves for Locomotive Powered Passenger train at a speed of 50 mph. Adjustment factors were considered based on the following information:

- The maximum operating speed of the VIA Rail assumed to be 90 mph (150 km/h) at peak
- The offset distance between the development and the closest track is 43 m
- The vehicles are assumed to have soft primary suspensions
- Tracks are not welded, though in otherwise good condition
- Structure is considered elevated
- Soil conditions do not efficiently propagate vibrations
- The building’s foundation coupling is 1-2 storey wood frame



FTA GENERALIZED CURVES OF VIBRATION LEVELS VERSUS DISTANCE

(ADOPTED FROM FIGURE 10-1, FTA TRANSIT NOISE AND VIBRATION IMPACT ASSESSMENT)

4.4 Aircraft Traffic Noise

4.4.1 Criteria for Aircraft Noise

As per the City of Ottawa, the ENCG[12] establishes the sound level criteria for aircraft noise with reference to the Ottawa Macdonald Cartier International Airport located near the intersection of Hunt Club Road and Limebank Road. There are four vicinity zones surrounding the Ottawa Macdonald Cartier International Airport that indicate the intensity of the noise levels within the area illustrated in the Annex 10 - Land Use Constraints Due to Aircraft Noise[13]. For convenience, Annex 10 has been reproduced in Figure 5 of this report. Noise generated from aircraft traffic is represented as Effective Perceived Noise Levels (EPNL), a unit of noise measurement that accounts for variations in the human perception of pure tones and noise duration. Plotted EPNL around airports are represented by Noise Exposure Forecast (NEF) and Noise Exposure Projection (NEP) contours which represent the current and future operations of the airport.

The NEF / NEP (NEP) contour lines define the region around the airport exposed to various levels of aircraft noise impacting noise sensitive areas, ranging from low to high outdoor noise levels. The Ottawa Airport Vicinity Development Zone is the furthest zone around the airport and holds that the development within the highlighted area will experience a minimum NEF/NEP of 25. The Airport Operating Influencing Zone (AOIZ) is the region representing 30 NEF/NEP contour where the noise levels have increased and will cause noise disruption to noise sensitive developments. No new noise sensitive development is allowed with in the AOIZ except for infill development. For infill developments residing within the Airport Operating Influencing Zone (AOIZ), the ENCG inquires that a noise assessment is to be performed to ensure that noise mitigation measures are incorporated into the building design[14]. The composite line noise contour NEF/NEP 35 illustrates the area closest to the airport and is where the highest noise levels occur. Within this region, new developments are not permitted to be constructed in the outlined vicinity.

According to accepted research[15], Health and Welfare Canada states that people continuously exposed to NEF/NEP values less than 35 will not suffer adverse physical or psychological effects. Sociological surveys[16]

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[12] City of Ottawa Environmental Noise Control Guidelines, January 2016
[13] City of Ottawa Official Plan – Annex 10 (Land Use Constraints Due to Aircraft Noise)
[14] City of Ottawa Official Plan
[15] CMHC, Road & Rail Noise: Effects on Housing
[16] Noise in Urban and Suburban Areas. Bolt, Beanik and Newman, Inc., Washington, January 1967

have indicated that negative community reactions to noise levels may start at about 25 NEF/NEP. Table 3 identifies the sound level criteria for relevant indoor spaces exposed to aircraft noise. Where developments are within the AOIZ, building components must be designed to achieve the indoor criteria outlined in Table 3.

TABLE 3: INDOOR AIRCRAFT SOUND LEVEL CRITERIA[17]

Type of Space	NEF/NEP	L_{eq} (dBA)
General offices, reception areas, retail stores, etc.	15	47
Individual or semi-private offices, conference rooms, etc.	10	42
Living/dining/den areas of residences, hospitals, schools, nursing/retirement homes, day-care centres, theatres, places of worship, libraries, Sleeping quarters of hotels/motels	5	37
Sleeping quarters of **residences**, hospitals, nursing/retirement homes, etc.	0	32

4.5 Indoor Noise Calculations (Aircraft Noise)

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 (2020) 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.

As per Section 4.2, when daytime noise levels from road and rail sources at the plane of the window exceed 65 dBA and 60 dBA respectively, calculations must be performed to evaluate the sound

[17] City of Ottawa Environmental Noise Control Guidelines, January 2016

transmission quality of the building components to ensure acceptable indoor noise levels. Noise calculations also need to be made when the aircraft noise exposure is above NEF / NEP 25 ($L_{eq-24hr}$ 57). The calculation procedure[18] considers:

- Window type and total area as a percentage of total room floor area
- Exterior wall type and total area as a percentage of the total room floor area
- Acoustic absorption characteristics of the room
- Outdoor noise source type and approach geometry
- Indoor sound level criteria, which varies according to the intended use of a space

Based on published research[19], 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. The STC requirements for walls, windows, roof and exterior doors was evaluated using the software program INSUL by Marshall Day Acoustics. The indoor noise levels generated by aircraft noise were also assessed using INSUL. As per the ENCG, the STC requirements were determined for all building components impacted by aircraft noise, including the following:

- Exterior wall components for living/dining/bedrooms
- Window and Patio door components for living/dining/bedrooms
- Exterior door components for living/dining/kitchens

The closest NEF/ NEP contour to the site establishes the required equivalent sound pressure levels for living areas, bedrooms, and the overall sound pressure in the geographical area being studied. Refer to Section 5.2 for the theoretical and required sound level values. For this noise assessment, the theoretical sound pressure levels produced by aircraft were found to be 57 dBA ($L_{eq-24hr}$). Once the 24-hour equivalent sound pressure is determined, the reference source spectrum provided in CMHC can be used to establish the full spectrum of aircraft sound pressure levels. The spectrum representing the 1/3 octave band sound pressure levels used to calculate the transmission of noise on each frequency band. Indoor and outdoor

[18] Building Practice Note: Controlling Sound Transmission into Buildings by J.D. Quirt, National Research Council of Canada, September 1985
[19] CMHC, Road & Rail Noise: Effects on Housing

noise calculations were conducted using INSUL to develop the required noise performance of building components.

As detailed drawings of the building interiors were not yet available, the indoor and outdoor calculations were based on the following assumptions:

- Typical bedroom dimension are approximately 3 meters in length and 4 meters
- Ceiling height is at 2.7 meters
- Window area is 2 m^2
- Low reverberation inside the room given the bedroom furnishings

As per NPC 300[20], the indoor aircraft noise was evaluated by converting the NEF/NEP to 24-hour equivalent sound pressure level. Since the development falls within the NEF 25 composite contour line, 25 was used as the NEF variable in the following equation NEF = $L_{eq\ (24)}$ - 32 dBA, used for the conversion. After the results were determined, INSUL was used to evaluate the building components attenuation to sound levels. Refer to Appendix B for the INSUL details and modelling of the assemblies.

[20] Environmental Noise Guideline - Stationary and Transportation Sources - Approval and Planning (NPC-300), August 2013

5. RESULTS AND DISCUSSION

5.1 Transportation Traffic Noise Levels

5.1.1 Roadway and Railway Noise Levels

The results of the roadway and railway traffic noise calculations are summarized in Table 4 below. A complete set of input and output data from all STAMSON 5.04 calculations are available in Appendix A.

TABLE 4: EXTERIOR NOISE LEVELS DUE TO ROAD AND RAIL TRAFFIC (STAMSON 5.04)

Receptor Number	Receptor Height Above Grade (m)	Receptor Location	Roadway Noise Level (dBA)		Railway Noise Level (dBA)		Combined Noise Level (dBA)	
			Day	Night	Day	Night	Day	Night
1	4.5	POW — Lot 7 North Façade	63	55	-	-	63	55
2	4.5	POW — Lot 7 West Façade	65	58	58	54	66	59
3	4.5	POW — Lot 7 South Façade	62	54	61	58	65	60
4	4.5	POW — Lot 3 South Façade	51	44	63	59	63	59
5	1.5	OLA — Lot 7 Rear Yard	62	N/a*	61	N/a*	65	N/a*
6	1.5	OLA — Lot 1 Rear Yard†	-	-	57	N/a*	57	N/a*

*Nighttime noise levels are not considered for OLAs as per ENCG
†Existing Lot

The results of the current analysis indicate that noise levels will range between 57 and 66 dBA during the daytime period (07:00-23:00) and between 55 and 60 dBA during the nighttime period (23:00-07:00). The highest noise level (66 dBA) occurs at Lot 7, which is nearest and most exposed to Prince of Wales Drive and the VIA Rail corridor. The noise levels exceed the ENCG criteria requiring the need for upgraded building components. Furthermore, the results indicate that the buildings associated with each lot would require central air conditioning which will allow occupants to keep windows closed and maintain a comfortable living environment. As the OLAs are also expected to exceed the ENCG noise criteria, noise mitigation in the form of a barrier will also be required for select lots. Specific noise mitigation requirements are summarized in subsequent sections.

5.1.2 Aircraft Traffic Noise Levels

The theoretical sound levels from the NEF/ NEP 25 were found to be equivalent to 57 dBA outside the buildings. The noise inside the dwellings would need to be reduced to 32 dBA for bedrooms and 37 dBA for indoor living rooms.

5.1.3 Noise Control Measures

The noise levels predicted due to roadway and railway traffic exceed the criteria listed in Section 4.2 for building components. In addition, the development is located between the NEF 25 contour and the AOIZ which also requires the need for upgraded building components.

Taking into consideration the surface transportation sources and aircraft sources, the building components described below should be considered in the building design to provide the necessary noise attenuation. The mitigation measures presented below are designed to mitigate the highest expected noise levels at all facades (i.e., 66 dBA). It should be noted that these measures are required for new buildings for Lots 2-7 as Lot 1 will comprise an existing 1-storey brick cladding building.

Window and exterior walls were evaluated to determine the attenuation required for indoor sound levels assuming windows are closed. Exterior building components have been evaluated using NRC testing data and INSUL to determine the necessary STC for proper indoor sound attenuation. The assemblies that were chosen to provide adequate sound insulation are based on prescribed measures outlined in the ENCG[21] and Gradient Wind's past experience. Refer to Appendix B for further STC details and modeling of the assemblies.

EXTERIOR WALL STC REVIEW

The exterior walls of the development have been evaluated using NRC test data to determine the required STC requirements established by ENCG. Greater mitigation in sound levels is achieved by higher STC ratings and are determined by the material selection of the exterior walls. Exterior wall components on

[21] City of Ottawa Environmental Noise Control Guidelines, January 2016. Part 6, page 1

all façades will require a minimum STC of 45, which will be achieved with brick cladding as per NPC-300 guidelines[22].

The architectural detail for the exterior wall sample is listed below. Alternative assemblies are permissible provided they meet the same STC rating.

Exterior Wall (Enhanced) – EW1

- 110 mm of brick
- 50 mm air space
- 13 mm of oriented strand board
- 140 mm wood studs at 400 mm o.c.
- 140 mm of acoustic batt insulation
- 15.9 mm of gypsum board Type X

Predicted STC Rating: 56 (similar to NRC TLA-99-098a)

ROOF STC REVIEW

The roof STC requirements were determined using the INSUL software by Marshall Day Acoustics. The attic of the dwellings is required to be ventilated as per ENCG. The roof the dwelling was assumed to be inclined at an angle of 30 degrees. The recommended architectural details for the roof are listed below. Alternative assemblies are permissible provided they meet the same STC rating.

Roof – R1

- 3 mm of asphalt shingles
- 15 mm of oriented strand board
- 262 mm wood trusses 600 mm O.C with ventilated attic
- 75 mm of acoustic batt insulation
- 12.7 mm of gypsum board Type C

INSUL Predicted STC Rating: 56

[22] MOECP, Environmental Noise Guidelines, NPC 300 – Part C, Section 7.2.3

WINDOW AND DOOR GLAZING STC REVIEW

The window STC requirements for the bedroom and living/dining area were also evaluated. Windows generally have lower sound attenuation in comparison to exterior walls or other building components. As a result, the STC level is lower than exterior walls, floors, roofs and exterior doors. As per the ENCG[23], if the window area exceeds 20 percent or 50 percent of the floor area for bedrooms and dining areas, respectively, then it is necessary to acquire certification from the acoustical consultant. The recommended architectural details for the windows are listed below. Alternative assemblies are permissible provided they meet the same STC rating.

Window (Bedroom and Living Room) – W1

- 3 mm inner pane
- 16 mm air space
- 6 mm outer pane

INSUL Predicted STC Rating: 34

It is the responsibility of the manufacturer to ensure that the specified window achieves the required STC. This can only be assured by using window configurations that have been certified by laboratory testing. The requirements for STC ratings assume that the remaining components of the building are constructed and installed according to the minimum standards of the Ontario Building Code. The specified STC requirements also apply to swinging and/or sliding patio doors.

Results of the calculations also indicate that the dwellings will require central air conditioning, which will allow occupants to keep windows closed and maintain a comfortable living environment. In addition to ventilation requirements, Warning Clauses will also be required in all Lease, Purchase and Sale Agreements, as summarized in Section 6.

5.1.4 Noise Barrier Calculation

Noise levels at the rear yards are expected to exceed 55 dBA during the daytime period without a noise barrier. If these areas are to be used as outdoor living areas, noise control measures are required to reduce noise levels as close as possible to 55 dBA where technically and administratively feasible. Further analysis

---

[23] City of Ottawa Environmental Noise Control Guidelines, January 2016

investigated the noise mitigating impact of installing a potential noise wall 2.2m to 3.5m above local grade at the edge of the 30 m railway setback (see Table 5 and Figure 4).

Results of the investigation proved that noise levels can only be reduced to 56 dBA with the inclusion of a 3.5 m tall barrier. However, the inclusion of the noise barrier at the edge of the 30 m railway setback would cause an undesired severance of the deep rear yard. Positioning the noise barrier closer to the railway is not possible as this will require a higher noise barrier to block direct line of sight of the elevated railway. As such, implementation of a noise barrier is not considered technically and administratively feasible for the lots with a rear yard backing onto the VIA Rail corridor. A Warning Clause will be required in all Lease, Purchase and Sale Agreements, as summarized in Section 6.

It should be noted that noise levels at the rear yard of the existing 1-storey dwelling at Lot 1 are expected to be 57 dBA. Given the fact that noise levels are below 60 dBA for the existing building, the inclusion of a noise barrier is not considered technically and administratively feasible. As such, a Warning Clause will be required on all new Lease, Purchase and Sale Agreements, as summarized in Section 6.

TABLE 5: RESULTS OF NOISE BARRIER INVESTIGATION

Receptor Number	Receptor Height Above Grade (m)	Receptor Location	Daytime L_{eq} Noise Levels (dBA)				
			No Barrier	With 2.2 m Barrier	With 2.5 m Barrier	With 3 m Barrier	With 3.5 m Barrier
5	1.5	OLA — Lot 7 Rear Yard	65	59	59	57	56

5.2 Ground Vibrations and Ground-borne Noise Levels

Estimated vibration levels are expected to be 0.091 mm/s RMS (71 dBV), based on the FTA protocol and an offset distance of 43 m from the nearest property line to the railway track centerline. Details of the calculation are provided in Appendix C. Since predicted vibration levels do not exceed the criterion of 0.14 mm/s RMS at the foundation, concerns due to vibration impacts on the site are not expected. As vibration levels are acceptable, correspondingly, regenerated noise levels are also expected to be acceptable.

6. CONCLUSIONS AND RECOMMENDATIONS

The results of the roadway and railway traffic noise analysis indicate that noise levels will range between 63 and 66 dBA during the daytime period (07:00-23:00) and between 55 and 60 dBA during the nighttime period (23:00-07:00). The highest noise level (66 dBA) occurs at Lot 7, which is nearest and most exposed to Prince of Wales Drive and the VIA Rail corridor. As such, upgraded building components with a higher Sound Transmission Class (STC) rating will be required to mitigate surface transportation noise. With regard to aircraft noise, the development falls within the NEF 25 composite contour line indicating that noise levels from aircraft flyovers will approach 57 dBA. As a result, upgraded building components with a higher Sound Transmission Class (STC) rating will also be required to mitigate aircraft noise.

Section 5.1 outlines the STC requirements for the exterior wall, glazing, and roof assembly to ensure indoor noise levels meet the criteria specified by ENCG and NPC-300. Results of the calculations also indicate that the development will require central air conditioning, which will allow occupants to keep windows closed and maintain a comfortable living environment.

With respect to roadway and railway sources, Warning Clauses will be required on all Lease, Purchase and Sale Agreements, as summarized below. Furthermore, a VIA Rail Warning Clause will be required in all Lease, Purchase and Sale Agreements, as well as agreements registered on title, because the development is with 300 m of the VIA Rail corridor.

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, Conservation and Parks."*

VIA Rail Warning Clause:

> *"Warning: VIA Railway Company or its assigns or successors in interest has or have a rights-of-way within 300 metres from the land the subject hereof. There may be alterations to or expansions of the railway facilities on such rights-of-way in the future including the possibility that the railway or its assigns or successors as aforesaid may expand its operations, which*

expansion may affect the living environment of the residents in the vicinity, notwithstanding the inclusion of any noise and vibration attenuating measures in the design of the development and individual dwelling(s). VIA will not be responsible for any complaints or claims arising from use of such facilities and/or operations on, over or under the aforesaid rights-of-way."

With respect to aircraft noise, the following Warning Clause will also be required on all Lease, Purchase and Sale Agreements, as summarized below:

"Purchasers/building occupants are forewarned that this property/dwelling unit is located in a noise sensitive area due to its proximity to Ottawa Macdonald-Cartier International Airport.

In order to reduce the impact of aircraft noise in the indoor spaces, the unit has been designed and built to meet provincial standards for noise control by the use of components and building systems that provide sound attenuation. In addition to the building components (i.e. walls, windows, doors, ceiling-roof), since the benefit of sound attenuation is lost when windows or doors are left open, this unit has been fitted with a central air conditioning system.

Despite the inclusion of noise control features within the dwelling unit, noise due to aircraft operations may continue to interfere with some indoor activities and with outdoor activities, particularly during the summer months. The purchaser/building occupant is further advised that the Airport is open and operates 24 hours a day, and that changes to operations or expansion of the airport facilities, including the construction of new runways, may affect the living environment of the residents of this property/area.

The Ottawa Macdonald-Cartier International Airport Authority, its acoustical consultants and the City of Ottawa are not responsible if, regardless of the implementation of noise control features, the purchaser/occupant of this dwelling finds that the indoor and/or outdoor noise levels due to aircraft operations are of or are offensive."

Noise levels at the rear yards are expected to exceed 55 dBA during the daytime period without a noise barrier. Further analysis investigated the noise mitigating impact of installing a potential noise wall 2.2m to 3.5m above local grade at the edge of the 30 m railway setback (see Table 5 and Figure 4). Results of the investigation proved that noise levels can only be reduced to 56 dBA with the inclusion of a 3.5 m tall barrier. However, the inclusion of the noise barrier at the edge of the 30 m railway setback would cause an undesired severance of the deep rear yard. Positioning the noise barrier closer to the railway is not possible as this will require a higher noise barrier to block direct line of sight of the elevated railway. As such, implementation of a noise barrier is not considered technically and administratively feasible for the lots with a rear yard backing onto the VIA Rail corridor. A Warning Clause will be required in all Lease, Purchase and Sale Agreements, as summarized below:

Type B

> *"Purchasers/tenants are advised that despite the inclusion of noise control features in the development and within the building units, sound levels due to increasing road traffic and rail traffic may on occasions interfere with some activities of the dwelling occupants as the sound levels exceed the sound level limits of the Municipality and the Ministry of the Environment."*

It should be noted that the noise level at the rear yard of the existing 1-storey dwelling at Lot 1 is expected to be 57 dBA. Given the fact that noise levels are below 60 dBA for the existing building, the inclusion of a noise barrier is not considered technically and administratively feasible. As such, a Warning Clause will be required on all new Lease, Purchase and Sale Agreements as summarized below:

Type A

> *"Purchasers/tenants are advised that sound levels due to increasing road traffic and rail traffic may occasionally interfere with some activities of the dwelling occupants as the sound levels exceed the sound level limits of the Municipality and the Ministry of the Environment."*

Estimated vibration levels are expected to be 0.091 mm/s RMS (71 dBV), based on the FTA protocol and an offset distance of 43 m from the nearest property line to the railway track centerline. Details of the calculation are provided in Appendix C. Since predicted vibration levels do not exceed the criterion of 0.14 mm/s RMS at the foundation, concerns due to vibration impacts on the site are not expected. As vibration levels are acceptable, correspondingly, regenerated noise levels are also expected to be acceptable.

This concludes our vibration and roadway, railway, and aircraft traffic noise assessment. 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.

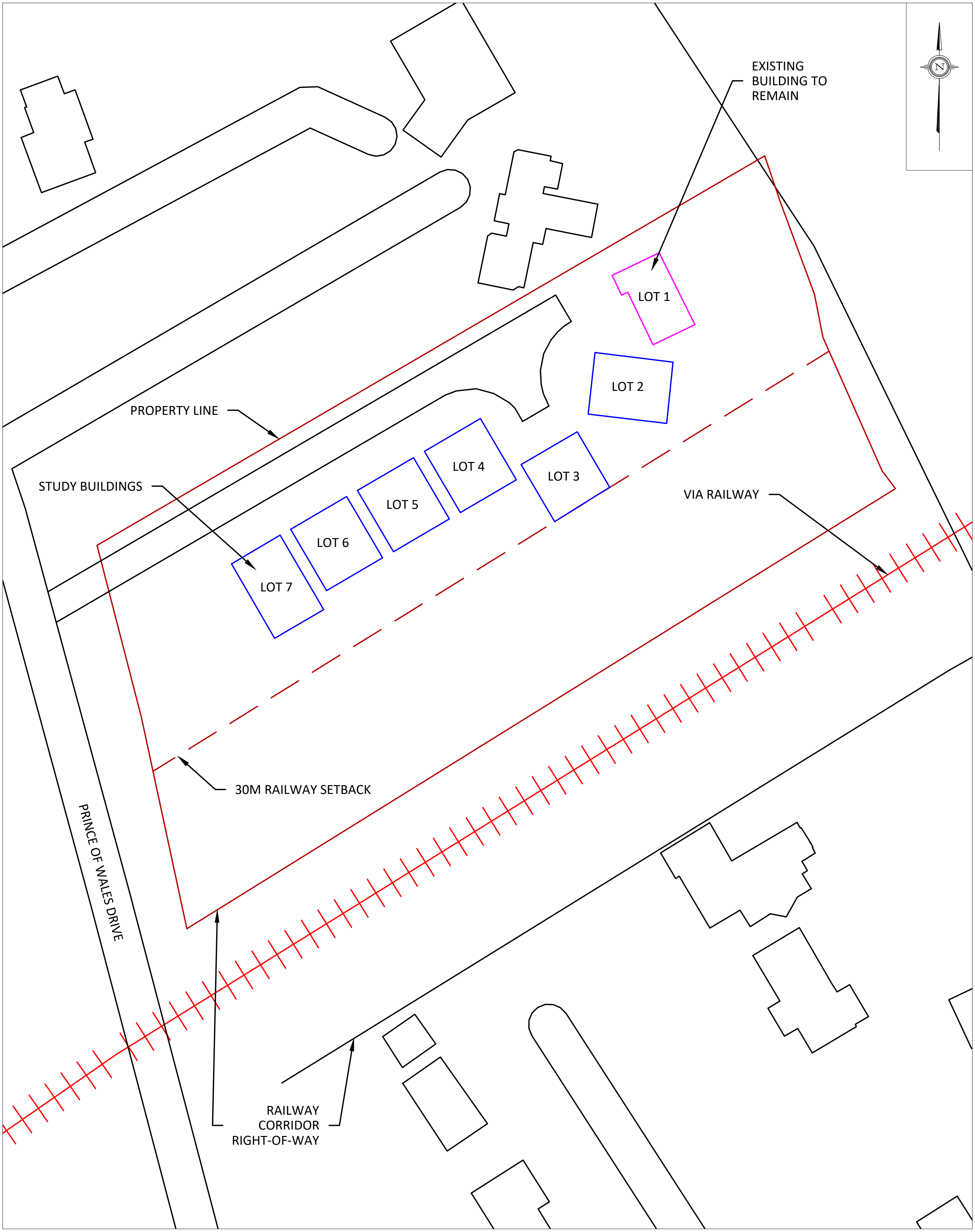
Sincerely,

Gradient Wind Engineering Inc.

Giuseppe Garro, MASc.
Environmental Scientist

Joshua Foster, P.Eng.
Lead Engineer

GW22-190 -Transportation Noise & Vibration



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PROJECT	2009-2013 PRINCE OF WALES DRIVE, OTTAWA TRANSPORTATION NOISE AND VIBRATION ASSESSMENT		
SCALE	1:1000 (APPROX.)	DRAWING NO.	GW22-190 -1
DATE	OCTOBER 28, 2022	DRAWN BY	G.G.

DESCRIPTION

FIGURE 1:
SITE PLAN AND SURROUNDING CONTEXT

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PROJECT	2009-2013 PRINCE OF WALES DRIVE, OTTAWA TRANSPORTATION NOISE AND VIBRATION ASSESSMENT		DESCRIPTION FIGURE 2: RECEPTOR LOCATIONS
SCALE	1:1000 (APPROX.)	DRAWING NO. GW22-190 -2	
DATE	OCTOBER 28, 2022	DRAWN BY G.G.	

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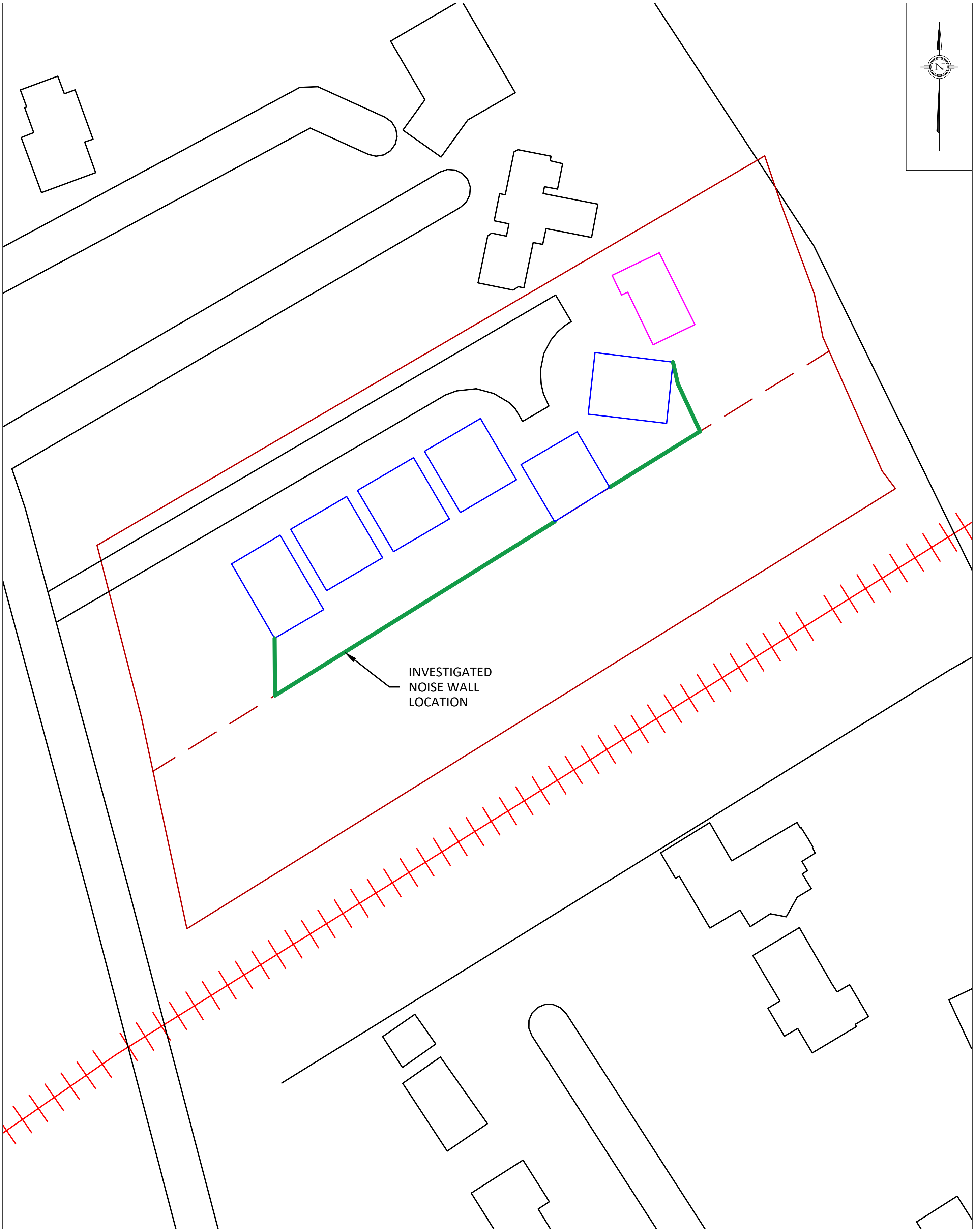
PROJECT 2009-2013 PRINCE OF WALES DRIVE, OTTAWA TRANSPORTATION NOISE AND VIBRATION ASSESSMENT		DESCRIPTION FIGURE 3: STAMSON INPUT PARAMETERS
SCALE 1:1000 (APPROX.)	DRAWING NO. GW22-190 -3	
DATE OCTOBER 28, 2022	DRAWN BY G.G.	



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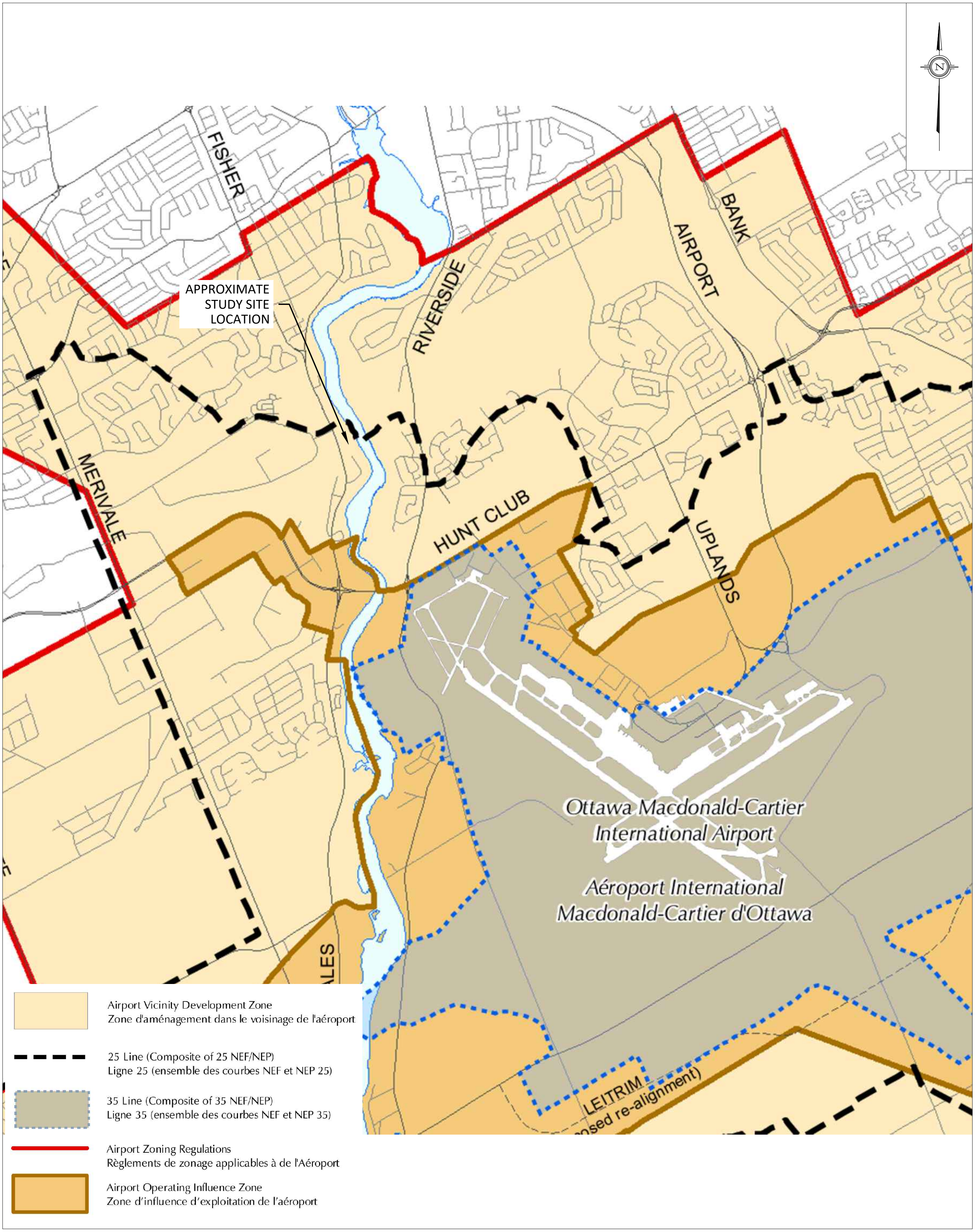
SCALE 1:1000 (APPROX.)	DRAWING NO. GW22-190 -4		FIGURE 4: NOISE BARRIER LOCATION
DATE OCTOBER 28, 2022	DRAWN BY G.G.		



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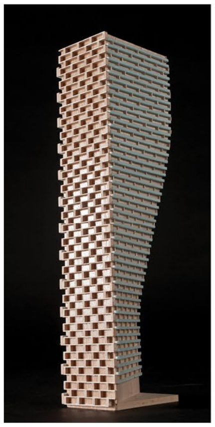
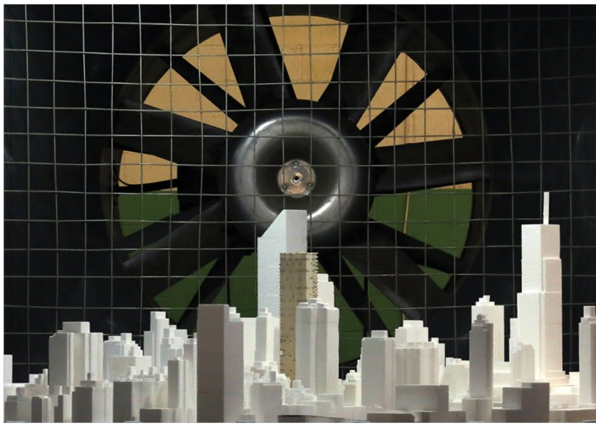
PROJECT	2009-2013 PRINCE OF WALES DRIVE, OTTAWA TRANSPORTATION NOISE AND VIBRATION ASSESSMENT		
SCALE	1:1000 (APPROX.)	DRAWING NO.	GW22-190 -5
DATE	OCTOBER 28, 2022	DRAWN BY	G.G.

DESCRIPTION

FIGURE 5:
ANNEX 10 - LAND USE CONSTRAINTS DUE TO AIRCRAFT NOISE WITH REFERENCE TO STUDY SITE





APPENDIX A

STAMSON 5.04 – INPUT AND OUTPUT DATA

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```
STAMSON 5.0        NORMAL REPORT        Date: 28-10-2022 14:32:06
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: POW (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  :    60 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  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: POW (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   :  42.00 / 42.00  m
Receiver height            :   4.50 / 4.50   m
Topography                 :      1       (Flat/gentle slope; no barrier)
Reference angle            :   0.00

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

Source height = 1.50 m

ROAD (0.00 + 62.51 + 0.00) = 62.51 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
     0     90   0.00  70.00   0.00  -4.47  -3.01   0.00   0.00   0.00
62.51
--------------------------------------------------------------------------
--
```

```
Segment Leq : 62.51 dBA

Total Leq All Segments: 62.51 dBA

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

Source height = 1.50 m

ROAD (0.00 + 54.92 + 0.00) = 54.92 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
     0     90   0.00  62.40   0.00  -4.47  -3.01   0.00   0.00   0.00
54.92
--------------------------------------------------------------------------
--

Segment Leq : 54.92 dBA

Total Leq All Segments: 54.92 dBA


TOTAL Leq FROM ALL SOURCES (DAY): 62.51
                         (NIGHT): 54.92
```

```
STAMSON 5.0        NORMAL REPORT        Date: 28-10-2022 14:32:13
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Rail data, segment # 1: VIA (day/night)
---------------------------------------
Train            ! Trains      ! Speed !# loc !# Cars! Eng  !Cont
Type             !             !(km/h) !/Train!/Train! type !weld
-----------------+-------------+-------+------+------+------+----
  1. PASSENGER   !  18.0/4.0   ! 150.0 !  1.0 !  4.0 !Diesel!  No

Data for Segment # 1: VIA (day/night)
-------------------------------------
Angle1   Angle2           :   0.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  59.00 / 59.00  m
Receiver height           :   4.50 / 4.50   m
Topography                :      3       (Elevated; no barrier)
No Whistle
Elevation                 :   7.00 m
Reference angle           :   0.00

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

LOCOMOTIVE (0.00 + 57.10 + 0.00) = 57.10 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
     0     90   0.28  68.49  -7.64  -3.75   0.00   0.00   0.00  57.10
----------------------------------------------------------------------

WHEEL (0.00 + 49.33 + 0.00) = 49.33 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
     0     90   0.39  61.57  -8.27  -3.97   0.00   0.00   0.00  49.33
----------------------------------------------------------------------

Segment Leq : 57.77 dBA

Total Leq All Segments: 57.77 dBA
```

```
Results segment # 1: VIA (night)
--------------------------------

LOCOMOTIVE (0.00 + 53.58 + 0.00) = 53.58 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
     0     90   0.28  64.97  -7.64  -3.75   0.00   0.00   0.00  53.58
----------------------------------------------------------------------

WHEEL (0.00 + 45.81 + 0.00) = 45.81 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
     0     90   0.39  58.05  -8.27  -3.97   0.00   0.00   0.00  45.81
----------------------------------------------------------------------

Segment Leq : 54.25 dBA

Total Leq All Segments: 54.25 dBA

Road data, segment # 1: POW (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  :    60 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  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: POW (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  :  44.00 / 44.00  m
Receiver height           :   4.50 / 4.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

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

Source height = 1.50 m

ROAD (0.00 + 65.32 + 0.00) = 65.32 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.00  70.00   0.00  -4.67   0.00   0.00   0.00   0.00
65.32
--------------------------------------------------------------------------
--

Segment Leq : 65.32 dBA

Total Leq All Segments: 65.32 dBA

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

Source height = 1.50 m

ROAD (0.00 + 57.73 + 0.00) = 57.73 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.00  62.40   0.00  -4.67   0.00   0.00   0.00   0.00
57.73
--------------------------------------------------------------------------
--

Segment Leq : 57.73 dBA

Total Leq All Segments: 57.73 dBA


TOTAL Leq FROM ALL SOURCES (DAY): 66.02
                         (NIGHT): 59.34
```

```
STAMSON 5.0        NORMAL REPORT        Date: 28-10-2022 14:32:25
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Rail data, segment # 1: VIA (day/night)
---------------------------------------
Train             ! Trains        ! Speed !# loc !# Cars! Eng  !Cont
Type              !               !(km/h) !/Train!/Train! type !weld
------------------+--------------+--------+------+------+------+----
  1. PASSENGER    !  18.0/4.0    ! 150.0 !  1.0 !  4.0 !Diesel!  No

Data for Segment # 1: VIA (day/night)
-------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  53.00 / 53.00   m
Receiver height           :   4.50 / 4.50   m
Topography                :      3       (Elevated; no barrier)
No Whistle
Elevation                 :   7.00 m
Reference angle           :   0.00

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

LOCOMOTIVE (0.00 + 60.71 + 0.00) = 60.71 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.28  68.49  -7.04  -0.74   0.00   0.00   0.00  60.71
----------------------------------------------------------------------

WHEEL (0.00 + 52.99 + 0.00) = 52.99 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.39  61.57  -7.62  -0.96   0.00   0.00   0.00  52.99
----------------------------------------------------------------------

Segment Leq : 61.39 dBA

Total Leq All Segments: 61.39 dBA
```

```
Results segment # 1: VIA (night)
--------------------------------

LOCOMOTIVE (0.00 + 57.19 + 0.00) = 57.19 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.28  64.97  -7.04  -0.74   0.00   0.00   0.00  57.19
----------------------------------------------------------------------

WHEEL (0.00 + 49.47 + 0.00) = 49.47 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.39  58.05  -7.62  -0.96   0.00   0.00   0.00  49.47
----------------------------------------------------------------------

Segment Leq : 57.87 dBA

Total Leq All Segments: 57.87 dBA

Road data, segment # 1: POW (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  :    60 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  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: POW (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   :  47.00 / 47.00  m
Receiver height            :   4.50 / 4.50   m
Topography                 :      1       (Flat/gentle slope; no barrier)
Reference angle            :   0.00
```

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

Source height = 1.50 m

ROAD (0.00 + 62.03 + 0.00) = 62.03 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90      0   0.00  70.00   0.00  -4.96  -3.01   0.00   0.00   0.00
62.03
--------------------------------------------------------------------------
--

Segment Leq : 62.03 dBA

Total Leq All Segments: 62.03 dBA

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

Source height = 1.50 m

ROAD (0.00 + 54.43 + 0.00) = 54.43 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90      0   0.00  62.40   0.00  -4.96  -3.01   0.00   0.00   0.00
54.43
--------------------------------------------------------------------------
--

Segment Leq : 54.43 dBA

Total Leq All Segments: 54.43 dBA


TOTAL Leq FROM ALL SOURCES (DAY): 64.73
                         (NIGHT): 59.49
```

```
STAMSON 5.0        NORMAL REPORT        Date: 28-10-2022 14:32:32
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Rail data, segment # 1: VIA (day/night)
---------------------------------------
Train             ! Trains        ! Speed !# loc !# Cars! Eng  !Cont
Type              !               !(km/h) !/Train!/Train! type !weld
-----------------+--------------+--------+------+------+------+----
  1. PASSENGER   !  18.0/4.0    ! 150.0 !  1.0 !  4.0 !Diesel!  No

Data for Segment # 1: VIA (day/night)
-------------------------------------
Angle1   Angle2            : -90.00 deg   90.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      1       (Absorptive ground surface)
Receiver source distance   :  43.00 / 43.00  m
Receiver height            :   4.50 / 4.50   m
Topography                 :      3       (Elevated; no barrier)
No Whistle
Elevation                  :   7.00 m
Reference angle            :   0.00

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

LOCOMOTIVE (0.00 + 61.88 + 0.00) = 61.88 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.28  68.49  -5.88  -0.74   0.00   0.00   0.00  61.88
----------------------------------------------------------------------

WHEEL (0.00 + 54.25 + 0.00) = 54.25 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.39  61.57  -6.36  -0.96   0.00   0.00   0.00  54.25
----------------------------------------------------------------------

Segment Leq : 62.57 dBA

Total Leq All Segments: 62.57 dBA
```

```
Results segment # 1: VIA (night)
--------------------------------

LOCOMOTIVE (0.00 + 58.36 + 0.00) = 58.36 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.28  64.97  -5.88  -0.74   0.00   0.00   0.00  58.36
----------------------------------------------------------------------

WHEEL (0.00 + 50.73 + 0.00) = 50.73 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.39  58.05  -6.36  -0.96   0.00   0.00   0.00  50.73
----------------------------------------------------------------------

Segment Leq : 59.05 dBA

Total Leq All Segments: 59.05 dBA

Road data, segment # 1: POW (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  :    60 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  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: POW (day/night)
-------------------------------------
Angle1   Angle2           : -90.00 deg   -13.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  : 111.00 / 111.00 m
Receiver height           :   4.50 / 4.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

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

```
Source height = 1.50 m

ROAD (0.00 + 51.10 + 0.00) = 51.10 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90    -13   0.57  70.00   0.00 -13.65  -5.25   0.00   0.00   0.00
51.10
--------------------------------------------------------------------------
--

Segment Leq : 51.10 dBA

Total Leq All Segments: 51.10 dBA

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

Source height = 1.50 m

ROAD (0.00 + 43.50 + 0.00) = 43.50 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90    -13   0.57  62.40   0.00 -13.65  -5.25   0.00   0.00   0.00
43.50
--------------------------------------------------------------------------
--

Segment Leq : 43.50 dBA

Total Leq All Segments: 43.50 dBA


TOTAL Leq FROM ALL SOURCES (DAY): 62.87
                         (NIGHT): 59.17
```

```
STAMSON 5.0        NORMAL REPORT        Date: 28-10-2022 14:32:44
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r5.te                Time Period: Day/Night 16/8 hours
Description:


Rail data, segment # 1: VIA (day/night)
---------------------------------------
Train            ! Trains       ! Speed !# loc !# Cars! Eng  !Cont
Type             !              !(km/h) !/Train!/Train! type !weld
-----------------+--------------+-------+------+------+------+----
  1. PASSENGER   !  18.0/4.0    ! 150.0 !  1.0 !  4.0 !Diesel!  No

Data for Segment # 1: VIA (day/night)
-------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  50.00 / 50.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      3       (Elevated; no barrier)
No Whistle
Elevation                 :   7.00 m
Reference angle           :   0.00

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

LOCOMOTIVE (0.00 + 60.37 + 0.00) = 60.37 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.38  68.49  -7.19  -0.93   0.00   0.00   0.00  60.37
----------------------------------------------------------------------

WHEEL (0.00 + 52.69 + 0.00) = 52.69 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.48  61.57  -7.74  -1.14   0.00   0.00   0.00  52.69
----------------------------------------------------------------------

Segment Leq : 61.05 dBA

Total Leq All Segments: 61.05 dBA

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

LOCOMOTIVE (0.00 + 56.85 + 0.00) = 56.85 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
```

```
----------------------------------------------------------------------
   -90      90    0.38   64.97   -7.19   -0.93    0.00    0.00    0.00   56.85
----------------------------------------------------------------------

WHEEL (0.00 + 49.17 + 0.00) = 49.17 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90      90    0.48   58.05   -7.74   -1.14    0.00    0.00    0.00   49.17
----------------------------------------------------------------------

Segment Leq : 57.53 dBA

Total Leq All Segments: 57.53 dBA

Road data, segment # 1: POW (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  :    60 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  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: POW (day/night)
-------------------------------------
Angle1   Angle2           : -90.00 deg   14.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  51.00 / 51.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

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

Source height = 1.50 m

ROAD (0.00 + 62.30 + 0.00) = 62.30 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
```

```
--------------------------------------------------------------------------
--
   -90     14   0.00  70.00   0.00  -5.31  -2.38   0.00   0.00   0.00
62.30
--------------------------------------------------------------------------
--

Segment Leq : 62.30 dBA

Total Leq All Segments: 62.30 dBA

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

Source height = 1.50 m

ROAD (0.00 + 54.70 + 0.00) = 54.70 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     14   0.00  62.40   0.00  -5.31  -2.38   0.00   0.00   0.00
54.70
--------------------------------------------------------------------------
--

Segment Leq : 54.70 dBA

Total Leq All Segments: 54.70 dBA


TOTAL Leq FROM ALL SOURCES (DAY): 64.73
                         (NIGHT): 59.35
```

```
STAMSON 5.0        NORMAL REPORT        Date: 02-11-2022 17:10:18
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r5b.te               Time Period: Day/Night 16/8 hours
Description:


Rail data, segment # 1: VIA (day/night)
---------------------------------------
Train            ! Trains       ! Speed !# loc !# Cars! Eng  !Cont
Type             !              !(km/h) !/Train!/Train! type !weld
-----------------+--------------+-------+------+------+------+----
  1. PASSENGER   !  18.0/4.0    ! 150.0 !  1.0 !  4.0 !Diesel!  No

Data for Segment # 1: VIA (day/night)
-------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  50.00 / 50.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      4       (Elevated; with barrier)
No Whistle
Barrier angle1            : -90.00 deg   Angle2 : 90.00 deg
Barrier height            :   2.20 m
Elevation                 :   7.00 m
Barrier receiver distance :   6.00 / 6.00   m
Source elevation          :   1.50 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00


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

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver     ! Barrier      ! Elevation of
Height  (m) ! Height   (m) ! Height   (m) ! Barrier Top  (m)
------------+--------------+--------------+--------------
       4.00 !         1.50 !         1.98 !          1.98
       0.50 !         1.50 !         1.56 !          1.56

LOCOMOTIVE (0.00 + 56.20 + 0.00) = 56.20 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.24  68.49  -6.50  -0.64   0.00   0.00  -5.15  56.20
----------------------------------------------------------------------
```

```
WHEEL (0.00 + 47.52 + 0.00) = 47.52 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.35  61.57  -7.05  -0.87   0.00   0.00  -6.13  47.52
----------------------------------------------------------------------

Segment Leq : 56.75 dBA

Total Leq All Segments: 56.75 dBA


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

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+---------------
       4.00 !        1.50 !        1.98 !         1.98
       0.50 !        1.50 !        1.56 !         1.56

LOCOMOTIVE (0.00 + 52.68 + 0.00) = 52.68 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.24  64.97  -6.50  -0.64   0.00   0.00  -5.15  52.68
----------------------------------------------------------------------

WHEEL (0.00 + 44.00 + 0.00) = 44.00 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.35  58.05  -7.05  -0.87   0.00   0.00  -6.13  44.00
----------------------------------------------------------------------

Segment Leq : 53.23 dBA

Total Leq All Segments: 53.23 dBA

Road data, segment # 1: POW (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  :    60 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  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: POW (day/night)
-------------------------------------
Angle1   Angle2           : -90.00 deg   14.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  51.00 / 51.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : 14.00 deg
Barrier height            :   2.20 m
Barrier receiver distance :   6.00 / 6.00   m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00

Results segment # 1: POW (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 + 55.90 + 0.00) = 55.90 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     14   0.00  70.00   0.00  -5.31  -2.38   0.00   0.00  -6.40
55.90
--------------------------------------------------------------------------
--

Segment Leq : 55.90 dBA

Total Leq All Segments: 55.90 dBA

Results segment # 1: POW (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 + 48.30 + 0.00) = 48.30 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     14   0.00  62.40   0.00  -5.31  -2.38   0.00   0.00  -6.40
48.30
--------------------------------------------------------------------------
--

Segment Leq : 48.30 dBA

Total Leq All Segments: 48.30 dBA


TOTAL Leq FROM ALL SOURCES (DAY): 59.36
                         (NIGHT): 54.44
```

```
STAMSON 5.0        NORMAL REPORT        Date: 02-11-2022 17:10:34
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r5b2.te              Time Period: Day/Night 16/8 hours
Description:


Rail data, segment # 1: VIA (day/night)
---------------------------------------
Train            ! Trains       ! Speed !# loc !# Cars! Eng  !Cont
Type             !              !(km/h) !/Train!/Train! type !weld
-----------------+--------------+-------+------+------+------+----
  1. PASSENGER   !  18.0/4.0    ! 150.0 !  1.0 !  4.0 !Diesel!  No

Data for Segment # 1: VIA (day/night)
-------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  50.00 / 50.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      4       (Elevated; with barrier)
No Whistle
Barrier angle1            : -90.00 deg   Angle2 : 90.00 deg
Barrier height            :   2.50 m
Elevation                 :   7.00 m
Barrier receiver distance :   6.00 / 6.00   m
Source elevation          :   1.50 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00

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

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver     ! Barrier      ! Elevation of
Height  (m) ! Height   (m) ! Height   (m) ! Barrier Top  (m)
------------+--------------+--------------+---------------
       4.00 !         1.50 !         1.98 !         1.98
       0.50 !         1.50 !         1.56 !         1.56

LOCOMOTIVE (0.00 + 55.72 + 0.00) = 55.72 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.22  68.49  -6.41  -0.60   0.00   0.00  -5.77  55.72
----------------------------------------------------------------------

WHEEL (0.00 + 46.67 + 0.00) = 46.67 dBA
```

```
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.33  61.57  -6.95  -0.83   0.00   0.00  -7.11  46.67
----------------------------------------------------------------------

Segment Leq : 56.23 dBA

Total Leq All Segments: 56.23 dBA

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

Barrier height for grazing incidence
------------------------------------
Source       ! Receiver     ! Barrier      ! Elevation of
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top   (m)
-------------+--------------+--------------+---------------
       4.00 !         1.50 !         1.98 !          1.98
       0.50 !         1.50 !         1.56 !          1.56

LOCOMOTIVE (0.00 + 52.20 + 0.00) = 52.20 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.22  64.97  -6.41  -0.60   0.00   0.00  -5.77  52.20
----------------------------------------------------------------------

WHEEL (0.00 + 43.15 + 0.00) = 43.15 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.33  58.05  -6.95  -0.83   0.00   0.00  -7.11  43.15
----------------------------------------------------------------------

Segment Leq : 52.71 dBA

Total Leq All Segments: 52.71 dBA

Road data, segment # 1: POW (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  :    60 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  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: POW (day/night)
-------------------------------------
Angle1   Angle2            : -90.00 deg   14.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      2       (Reflective ground surface)
Receiver source distance   :  51.00 / 51.00  m
Receiver height            :   1.50 / 1.50   m
Topography                 :      2       (Flat/gentle slope; with barrier)
Barrier angle1             : -90.00 deg   Angle2 : 14.00 deg
Barrier height             :   2.50 m
Barrier receiver distance  :   6.00 / 6.00   m
Source elevation           :   0.00 m
Receiver elevation         :   0.00 m
Barrier elevation          :   0.00 m
Reference angle            :   0.00

Results segment # 1: POW (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 + 54.83 + 0.00) = 54.83 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     14   0.00  70.00   0.00  -5.31  -2.38   0.00   0.00  -7.47
54.83
--------------------------------------------------------------------------
--

Segment Leq : 54.83 dBA

Total Leq All Segments: 54.83 dBA

Results segment # 1: POW (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 + 47.23 + 0.00) = 47.23 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     14   0.00  62.40   0.00  -5.31  -2.38   0.00   0.00  -7.47
47.23
--------------------------------------------------------------------------
--

Segment Leq : 47.23 dBA

Total Leq All Segments: 47.23 dBA



TOTAL Leq FROM ALL SOURCES (DAY): 58.60
                         (NIGHT): 53.79
```

```
STAMSON 5.0         NORMAL REPORT         Date: 02-11-2022 17:10:51
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r5b3.te              Time Period: Day/Night 16/8 hours
Description:


Rail data, segment # 1: VIA (day/night)
---------------------------------------
Train             ! Trains       ! Speed !# loc !# Cars! Eng  !Cont
Type              !              !(km/h) !/Train!/Train! type !weld
------------------+--------------+-------+------+------+------+----
  1. PASSENGER    !  18.0/4.0    ! 150.0 !  1.0 !  4.0 !Diesel!  No

Data for Segment # 1: VIA (day/night)
-------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  50.00 / 50.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      4       (Elevated; with barrier)
No Whistle
Barrier angle1            : -90.00 deg   Angle2 : 90.00 deg
Barrier height            :   3.00 m
Elevation                 :   7.00 m
Barrier receiver distance :   6.00 / 6.00   m
Source elevation          :   1.50 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00

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

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver     ! Barrier      ! Elevation of
Height  (m) ! Height   (m) ! Height   (m) ! Barrier Top  (m)
------------+--------------+--------------+---------------
       4.00 !         1.50 !         1.98 !          1.98
       0.50 !         1.50 !         1.56 !          1.56

LOCOMOTIVE (0.00 + 54.37 + 0.00) = 54.37 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.19  68.49  -6.25  -0.52   0.00   0.00  -7.35  54.37
----------------------------------------------------------------------

WHEEL (0.00 + 45.20 + 0.00) = 45.20 dBA
```

```
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.30  61.57  -6.80  -0.77   0.00   0.00  -8.81  45.20
----------------------------------------------------------------------

Segment Leq : 54.87 dBA

Total Leq All Segments: 54.87 dBA

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

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+---------------
       4.00 !        1.50 !        1.98 !         1.98
       0.50 !        1.50 !        1.56 !         1.56

LOCOMOTIVE (0.00 + 50.84 + 0.00) = 50.84 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.19  64.97  -6.25  -0.52   0.00   0.00  -7.35  50.84
----------------------------------------------------------------------

WHEEL (0.00 + 41.67 + 0.00) = 41.67 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.30  58.05  -6.80  -0.77   0.00   0.00  -8.81  41.67
----------------------------------------------------------------------

Segment Leq : 51.34 dBA

Total Leq All Segments: 51.34 dBA

Road data, segment # 1: POW (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  :    60 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  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: POW (day/night)
-------------------------------------
Angle1   Angle2            : -90.00 deg   14.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      2       (Reflective ground surface)
Receiver source distance   :  51.00 / 51.00   m
Receiver height            :   1.50 / 1.50   m
Topography                 :      2       (Flat/gentle slope; with barrier)
Barrier angle1             : -90.00 deg   Angle2 : 14.00 deg
Barrier height             :   3.00 m
Barrier receiver distance  :   6.00 / 6.00   m
Source elevation           :   0.00 m
Receiver elevation         :   0.00 m
Barrier elevation          :   0.00 m
Reference angle            :   0.00

Results segment # 1: POW (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 + 53.06 + 0.00) = 53.06 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
---------------------------------------------------------------------------
--
   -90     14   0.00  70.00   0.00  -5.31  -2.38   0.00   0.00  -9.24
53.06
---------------------------------------------------------------------------
--

Segment Leq : 53.06 dBA

Total Leq All Segments: 53.06 dBA

Results segment # 1: POW (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 + 45.47 + 0.00) = 45.47 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     14   0.00  62.40   0.00  -5.31  -2.38   0.00   0.00  -9.24
45.47
--------------------------------------------------------------------------
--

Segment Leq : 45.47 dBA

Total Leq All Segments: 45.47 dBA


TOTAL Leq FROM ALL SOURCES (DAY): 57.07
                         (NIGHT): 52.34
```

```
STAMSON 5.0        NORMAL REPORT        Date: 02-11-2022 17:11:09
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r5b4.te              Time Period: Day/Night 16/8 hours
Description:


Rail data, segment # 1: VIA (day/night)
---------------------------------------
Train            ! Trains       ! Speed !# loc !# Cars! Eng  !Cont
Type             !              !(km/h) !/Train!/Train! type !weld
-----------------+--------------+-------+------+------+------+----
  1. PASSENGER   !  18.0/4.0    ! 150.0 !  1.0 !  4.0 !Diesel!  No

Data for Segment # 1: VIA (day/night)
-------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  50.00 / 50.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      4       (Elevated; with barrier)
No Whistle
Barrier angle1            : -90.00 deg   Angle2 : 90.00 deg
Barrier height            :   3.50 m
Elevation                 :   7.00 m
Barrier receiver distance :   6.00 / 6.00   m
Source elevation          :   1.50 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00

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

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+---------------
       4.00 !        1.50 !        1.98 !         1.98
       0.50 !        1.50 !        1.56 !         1.56

LOCOMOTIVE (0.00 + 52.94 + 0.00) = 52.94 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.17  68.49  -6.09  -0.45   0.00   0.00  -9.01  52.94
----------------------------------------------------------------------

WHEEL (0.00 + 43.90 + 0.00) = 43.90 dBA
```

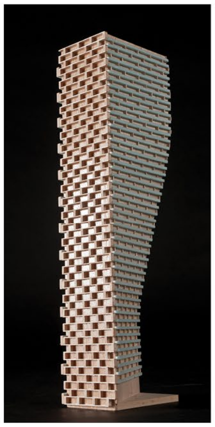
```
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-----------------------------------------------------------------------
   -90     90   0.27  61.57  -6.64  -0.70   0.00   0.00 -10.33  43.90
-----------------------------------------------------------------------

Segment Leq : 53.45 dBA

Total Leq All Segments: 53.45 dBA

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

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver     ! Barrier      ! Elevation of
Height  (m) ! Height   (m) ! Height   (m) ! Barrier Top   (m)
------------+--------------+--------------+---------------
       4.00 !         1.50 !         1.98 !          1.98
       0.50 !         1.50 !         1.56 !          1.56

LOCOMOTIVE (0.00 + 49.42 + 0.00) = 49.42 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-----------------------------------------------------------------------
   -90     90   0.17  64.97  -6.09  -0.45   0.00   0.00  -9.01  49.42
-----------------------------------------------------------------------

WHEEL (0.00 + 40.38 + 0.00) = 40.38 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-----------------------------------------------------------------------
   -90     90   0.27  58.05  -6.64  -0.70   0.00   0.00 -10.33  40.38
-----------------------------------------------------------------------

Segment Leq : 49.93 dBA

Total Leq All Segments: 49.93 dBA

Road data, segment # 1: POW (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  :    60 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  15000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
```

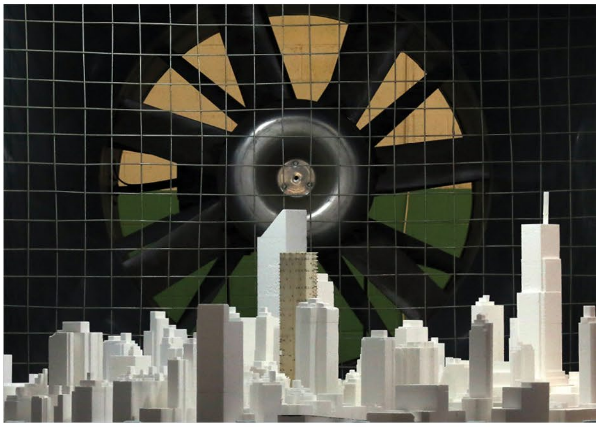
```
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 1: POW (day/night)
-------------------------------------
Angle1   Angle2           : -90.00 deg   14.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  51.00 / 51.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : 14.00 deg
Barrier height            :   3.50 m
Barrier receiver distance :   6.00 / 6.00   m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00

Results segment # 1: POW (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 + 51.51 + 0.00) = 51.51 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
---------------------------------------------------------------------------
--
   -90     14   0.00  70.00   0.00  -5.31  -2.38   0.00   0.00 -10.79
51.51
---------------------------------------------------------------------------
--

Segment Leq : 51.51 dBA

Total Leq All Segments: 51.51 dBA

Results segment # 1: POW (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 + 43.91 + 0.00) = 43.91 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     14   0.00  62.40   0.00  -5.31  -2.38   0.00   0.00 -10.79
43.91
--------------------------------------------------------------------------
--

Segment Leq : 43.91 dBA

Total Leq All Segments: 43.91 dBA


TOTAL Leq FROM ALL SOURCES (DAY): 55.60
                         (NIGHT): 50.90
```

```
STAMSON 5.0        NORMAL REPORT        Date: 31-10-2022 16:45:28
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r4test.te            Time Period: Day/Night 16/8 hours
Description:


Rail data, segment # 1: VIA (day/night)
---------------------------------------
Train            ! Trains       ! Speed !# loc !# Cars! Eng  !Cont
Type             !              !(km/h) !/Train!/Train! type !weld
-----------------+--------------+-------+------+------+------+----
  1. PASSENGER   !  18.0/4.0    ! 150.0 !  1.0 !  4.0 !Diesel!  No

Data for Segment # 1: VIA (day/night)
-------------------------------------
Angle1   Angle2          : -90.00 deg   25.00 deg
Wood depth               :      0       (No woods.)
No of house rows         :      0 / 0
Surface                  :      1       (Absorptive ground surface)
Receiver source distance :  69.00 / 69.00  m
Receiver height          :   1.50 / 1.50   m
Topography               :      3       (Elevated; no barrier)
No Whistle
Elevation                :   7.00 m
Reference angle          :   0.00

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

LOCOMOTIVE (0.00 + 56.71 + 0.00) = 56.71 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     25   0.38  68.49  -9.11  -2.67   0.00   0.00   0.00  56.71
----------------------------------------------------------------------

WHEEL (0.00 + 48.93 + 0.00) = 48.93 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     25   0.48  61.57  -9.81  -2.83   0.00   0.00   0.00  48.93
----------------------------------------------------------------------

Segment Leq : 57.38 dBA

Total Leq All Segments: 57.38 dBA

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

LOCOMOTIVE (0.00 + 53.19 + 0.00) = 53.19 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
```

```
-----------------------------------------------------------------------
   -90     25    0.38  64.97  -9.11  -2.67   0.00   0.00   0.00  53.19
-----------------------------------------------------------------------

WHEEL (0.00 + 45.41 + 0.00) = 45.41 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-----------------------------------------------------------------------
   -90     25    0.48  58.05  -9.81  -2.83   0.00   0.00   0.00  45.41
-----------------------------------------------------------------------

Segment Leq : 53.86 dBA

Total Leq All Segments: 53.86 dBA


TOTAL Leq FROM ALL SOURCES (DAY): 57.38
                         (NIGHT): 53.86
```



APPENDIX B

INSUL CALCULATIONS

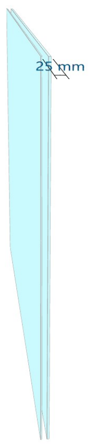
127 WALGREEN ROAD, OTTAWA, ON, CANADA K0A 1L0 | 613 836 0934
GRADIENTWIND.COM

Sound Insulation Prediction (v9.0.24)

Program copyright Marshall Day Acoustics 2017
Margin of error is generally within STC ±3 dB
- Key No. 11036

Job Name:
Job No.: Initials:ggarro
Date:01/11/22
File Name:Glazing STC 36.ixl

Notes:



STC 34
OITC 28

Mass-air-mass resonant frequency = =212 Hz

Panel Size = 2.0 m x 1.5 m

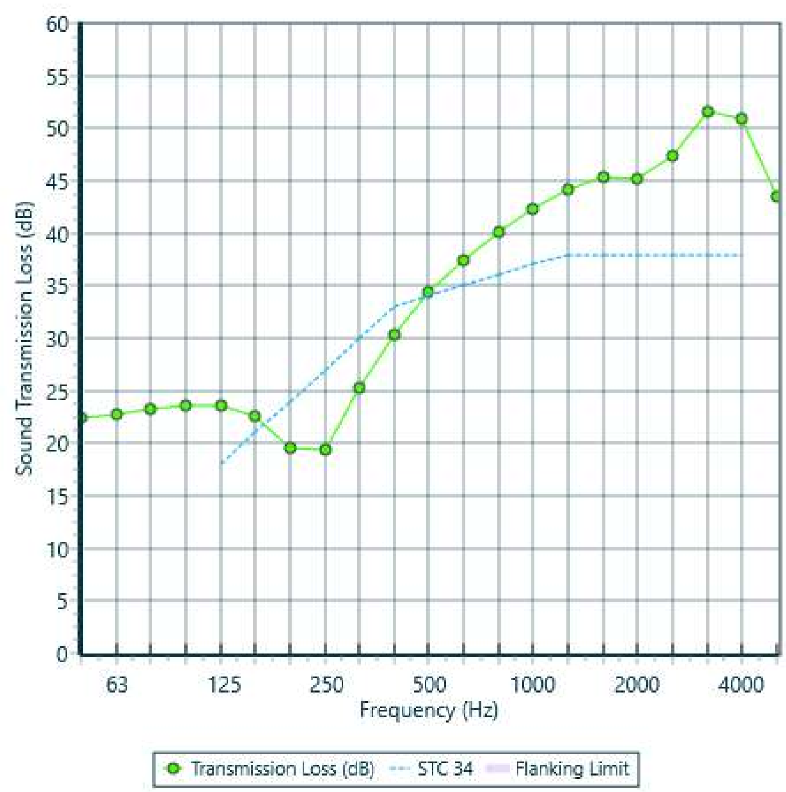
Partition surface mass = 22.5 kg/m²

System description

Pane 1 : 1 x 3 mm Glass

air: 16 mm
Pane 2 : 1 x 6 mm Glass

freq.(Hz)	TL(dB)	TL(dB)
50	22	
63	23	23
80	23	
100	24	
125	24	23
160	23	
200	20	
250	19	21
315	25	
400	30	
500	34	33
630	37	
800	40	
1000	42	42
1250	44	
1600	45	
2000	45	46
2500	47	
3150	52	
4000	51	47
5000	44	

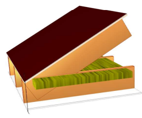


Sound Insulation Prediction (v9.0.24)

Program copyright Marshall Day Acoustics 2017
Margin of error is generally within STC ±3 dB
- Key No. 11036

Job Name:
Job No.: Initials:ggarro
Date:01/11/22
File Name:Roof - R1 - STC.ixl

Notes:



STC 56
OITC 45

Mass-air-mass resonant frequency = =34 Hz

Panel Size = 2.7 m x 4.0 m

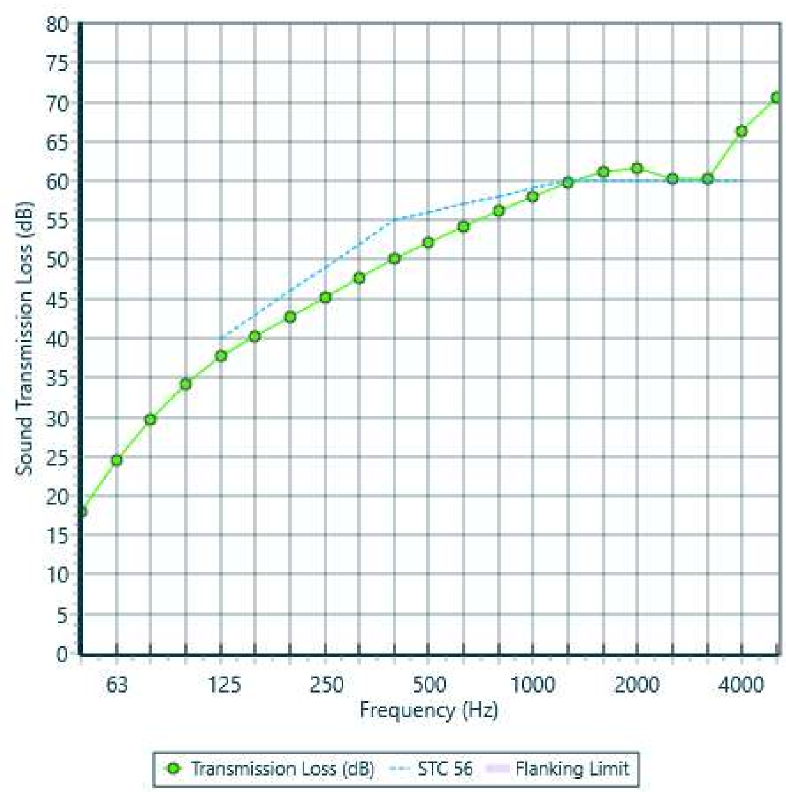
Partition surface mass = 31 kg/m²

System description

Panel 1 : 1 x 3 mm Asphalt Shingles (2.7lb/ft²) + 1 x 15 mm OSB (Oriented Strand Board)

Frame: Pitched Roof (2.6E2 mm x 45 mm), Stud spacing 600 mm ; Cavity Width 355.3 mm , 1 x Fibreglass (10kg/m3) 60mm Thickness 75 mm
Panel 2 : 1 x 12.7 mm Type C Gypsum Board

freq.(Hz)	TL(dB)	TL(dB)
50	18	
63	24	22
80	30	
100	34	
125	38	37
160	40	
200	43	
250	45	45
315	48	
400	50	
500	52	52
630	54	
800	56	
1000	58	58
1250	60	
1600	61	
2000	62	61
2500	60	
3150	60	
4000	66	64
5000	70	



APPENDIX C

FTA VIBRATION CALCULATIONS

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

GWE22-190 02-Nov-22

Possible Vibration Impacts on 2009-2013 Prince of Wales
Predicted using FTA General Assesment

Train Speed 150 km/h 90 mph

	Distance from C/L of track to Edge of Fdn	
	(m)	(ft)
VIA Rail	43.0	141.1

	Vibration		
From FTA Manual Fig 10-1			
Vibration Levels at distance from track	75	dBV re 1 micro in/sec	
Adjustment Factors FTA Table 10-1			
Speed reference 50 mph	5	Speed Limit of 150 km/h (90 mph)	
Vehicle Parameters	0	Assume Soft primary suspension, Wheels run true	
Track Condition	0	None	
Track Treatments	0	None	
Type of Transit Structure	-10	Elevated	
Efficient vibration Propagation	0	Till/Clay	
Vibration Levels at Fdn	70		0.081
Coupling to Building Foundation	-5	1-2 Storey Wood Frame	
Floor to Floor Attenuation	0.0	Ground Floor Ocupied	
Amplification of Floor and Walls	6		
Total Vibration Level	71.1054501	dBV or	0.091 mm/s
Noise Level in dBA	36.1054501	dBA	

Table 10-1. Adjustment Factors for Generalized Predictions of Ground-Borne Vibration and Noise

Factors Affecting Vibration Source				
Source Factor	**Adjustment to Propagation Curve**			**Comment**
Speed		Reference Speed		Vibration level is approximately proportional to 20*log(speed/speed$_{ref}$). Sometimes the variation with speed has been observed to be as low as 10 to 15 log(speed/speed$_{ref}$).
	Vehicle Speed	50 mph	30 mph	
	60 mph	+1.6 dB	+6.0 dB	
	50 mph	0.0 dB	+4.4 dB	
	40 mph	-1.9 dB	+2.5 dB	
	30 mph	-4.4 dB	0.0 dB	
	20 mph	-8.0 dB	-3.5 dB	
Vehicle Parameters (not additive, apply greatest value only)				
Vehicle with stiff primary suspension	+8 dB			Transit vehicles with stiff primary suspensions have been shown to create high vibration levels. Include this adjustment when the primary suspension has a vertical resonance frequency greater than 15 Hz.
Resilient Wheels	0 dB			Resilient wheels do not generally affect ground-borne vibration except at frequencies greater than about 80 Hz.
Worn Wheels or Wheels with Flats	+10 dB			Wheel flats or wheels that are unevenly worn can cause high vibration levels. This can be prevented with wheel truing and slip-slide detectors to prevent the wheels from sliding on the track.
Track Conditions (not additive, apply greatest value only)				
Worn or Corrugated Track	+10 dB			If both the wheels and the track are worn, only one adjustment should be used. Corrugated track is a common problem. Mill scale on new rail can cause higher vibration levels until the rail has been in use for some time.
Special Trackwork	+10 dB			Wheel impacts at special trackwork will significantly increase vibration levels. The increase will be less at greater distances from the track.
Jointed Track or Uneven Road Surfaces	+5 dB			Jointed track can cause higher vibration levels than welded track. Rough roads or expansion joints are sources of increased vibration for rubber-tire transit.
Track Treatments (not additive, apply greatest value only)				
Floating Slab Trackbed	-15 dB			The reduction achieved with a floating slab trackbed is strongly dependent on the frequency characteristics of the vibration.
Ballast Mats	-10 dB			Actual reduction is strongly dependent on frequency of vibration.
High-Resilience Fasteners	-5 dB			Slab track with track fasteners that are very compliant in the vertical direction can reduce vibration at frequencies greater than 40 Hz.

Table 10-1. Adjustment Factors for Generalized Predictions of Ground-Borne Vibration and Noise (Continued)

Factors Affecting Vibration Path		
Path Factor	**Adjustment to Propagation Curve**	**Comment**
Resiliently Supported Ties	-10 dB	Resiliently supported tie systems have been found to provide very effective control of low-frequency vibration.
Track Configuration (not additive, apply greatest value only)		
Type of Transit Structure	Relative to at-grade tie & ballast: Elevated structure -10 dB Open cut 0 dB	The general rule is the heavier the structure, the lower the vibration levels. Putting the track in cut may reduce the vibration levels slightly. Rock-based subways generate higher-frequency vibration.
	Relative to bored subway tunnel in soil: Station -5 dB Cut and cover -3 dB Rock-based - 15 dB	
Ground-borne Propagation Effects		
Geologic conditions that promote efficient vibration propagation	Efficient propagation in soil +10 dB	Refer to the text for guidance on identifying areas where efficient propagation is possible.
	Propagation in rock layer — **Dist.** / **Adjust.**: 50 ft +2 dB 100 ft +4 dB 150 ft +6 dB 200 ft +9 dB	The positive adjustment accounts for the lower attenuation of vibration in rock compared to soil. It is generally more difficult to excite vibrations in rock than in soil at the source.
Coupling to building foundation	Wood Frame Houses -5 dB 1-2 Story Masonry -7 dB 3-4 Story Masonry -10 dB Large Masonry on Piles -10 dB Large Masonry on Spread Footings -13 dB Foundation in Rock 0 dB	The general rule is the heavier the building construction, the greater the coupling loss.
Factors Affecting Vibration Receiver		
Receiver Factor	**Adjustment to Propagation Curve**	**Comment**
Floor-to-floor attenuation	1 to 5 floors above grade: -2 dB/floor 5 to 10 floors above grade: -1 dB/floor	This factor accounts for dispersion and attenuation of the vibration energy as it propagates through a building.
Amplification due to resonances of floors, walls, and ceilings	+6 dB	The actual amplification will vary greatly depending on the type of construction. The amplification is lower near the wall/floor and wall/ceiling intersections.
Conversion to Ground-borne Noise		
Noise Level in dBA	Peak frequency of ground vibration: Low frequency (<30 Hz): -50 dB Typical (peak 30 to 60 Hz): -35 dB High frequency (>60 Hz): -20 dB	Use these adjustments to estimate the A-weighted sound level given the average vibration velocity level of the room surfaces. See text for guidelines for selecting low, typical or high frequency characteristics. Use the high-frequency adjustment for subway tunnels in rock or if the dominant frequencies of the vibration spectrum are known to be 60 Hz or greater.