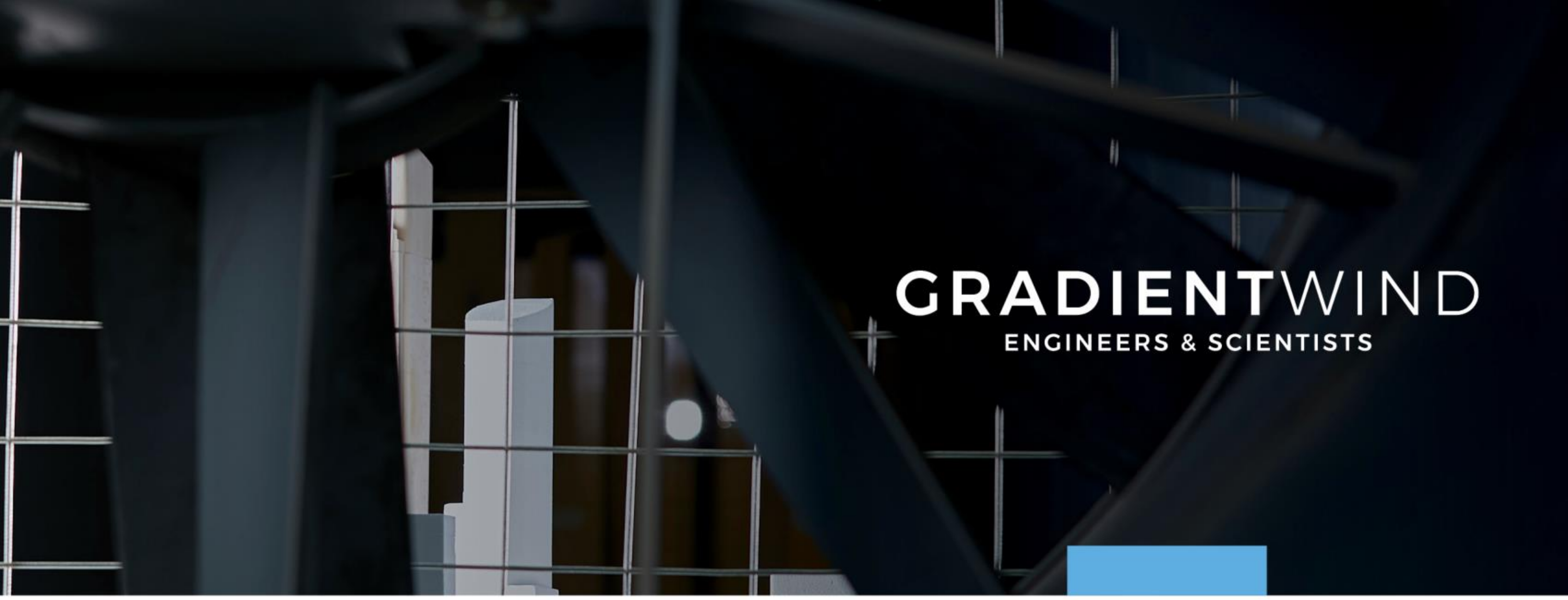
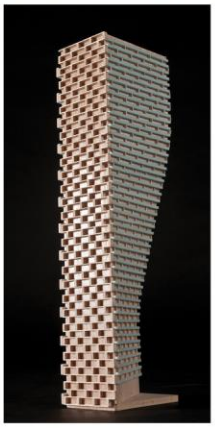
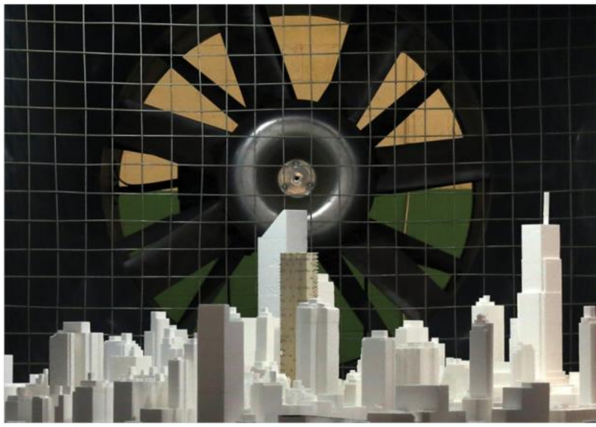


TRANSPORTATION NOISE AND GROUND VIBRATION ASSESSMENT

1200 Maritime Way
Ottawa, Ontario

Report: 20-207-T.Noise & Vibrations





January 4, 2021

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EXECUTIVE SUMMARY

This report describes a transportation noise and ground vibration assessment undertaken in support of a joint Zoning By-law Amendment (ZBA) and Site Plan Control (SPA) application submission for a proposed multi-building development located at 1200 Maritime Way in Ottawa, Ontario. The development comprises two residential buildings; a 30-storey building including a 7-storey podium situated on the west side of the site (West Tower) and a 28-storey building including a 7-storey podium at the east side of the site (East Tower). The major sources of roadway traffic noise are Highway 417 and Kanata Avenue. The future Kanata Light Rail Transit (LRT) system located to the south of the subject site, aligned along the north side of the highway, was also considered as a source of noise and ground vibrations. 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) future LRT traffic volumes based on Gradient Wind's experience, and (v) architectural drawings prepared by NEUF Architect(e)s in December 2020.

The results of the current analysis indicate that noise levels will range between 64 and 75 dBA during the daytime period (07:00-23:00) and between 56 and 67 dBA during the nighttime period (23:00-07:00). The highest noise level (75 dBA) occurs at the south façades of the buildings, which are nearest and most exposed to Highway 417. Building components with a higher Sound Transmission Class (STC) rating will be required where exterior noise levels exceed 65 dBA, as indicated in Figure 3.

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 also be required in all Lease, Purchase and Sale Agreements.

Vibration levels due to LRT activity in the area are expected to fall below the criterion of 0.10 mm/s at the nearest façade to the LRT line. Thus, mitigation for vibrations is not required.

With regard to stationary noise impacts of the development's mechanical equipment onto surrounding noise sensitive properties, a stationary noise study is recommended for the site during the detailed design once mechanical plans become available. This study would assess impacts of stationary noise from rooftop mechanical units and any other stationary sources serving the proposed building on surrounding noise-sensitive areas. This study will include recommendations for any noise control measures that may be necessary to ensure noise levels fall below ENCG limits. Noise impacts can generally be minimized by judicious selection and placement of the equipment. The best noise strategy would be to locate noisier pieces of equipment on the center of the roof or in a mechanical penthouse. Where necessary noise screens and silencers can be incorporated into the design.

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1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Claridge Homes to undertake a transportation noise and ground vibration assessment in support of a joint Zoning By-law Amendment (ZBA) and Site Plan Control (SPA) application submission for a proposed multi-building development at 1200 Maritime Way in Ottawa, Ontario. This report summarizes the methodology, results, and recommendations related to the assessment of exterior and interior noise levels generated by local roadway traffic, as well as ground vibrations generated by the future, adjacent Kanata Light Rail Transit (LRT) system.

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 prepared by NEUF Architect(e)s in December 2020, with future roadway traffic volumes corresponding to the City of Ottawa's Official Plan (OP) roadway classifications and LRT traffic information based on previous project experience.

2. TERMS OF REFERENCE

The focus of this transportation noise and ground vibration assessment is a proposed multi-building development located at 1200 Maritime Way in Ottawa, Ontario. The subject site is located on a parcel of land bounded by Maritime Way to the north and northwest, an existing pond to the east, Highway 417 to the southeast and Kanata Avenue to the southwest. Throughout this report, the Highway 417 elevation is referred to as the south elevation.

Architectural Rendering, South Perspective (Courtesy of Neuf Architect(e)s)

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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 development comprises two residential buildings; a 30-storey building including a 7-storey podium situated on the west side of the site (West Tower) and a 28-storey building including a 7-storey podium at the east side of the site (East Tower). A driveway at the north side of the site provides access to surface parking, a circular drop-off area and a ramp to three levels of below-grade parking.

The ground floor of the West Tower comprises residential units at the south side with indoor amenity space and building support facilities in the remaining areas. Levels 2 and above are reserved for residential occupancy. At Level 8, the floorplate sets back at the north side and continues to rise with a uniform planform.

The ground floor of the East Tower comprises residential units, indoor amenity space, and building support facilities. Levels 2 and above are reserved for residential occupancy, except for an indoor amenity area provided at the southeast corner of Level 2. The floorplate sets back at the southeast corner of Level 3 and the north side of Level 8. Levels 8 and above rise with a uniform planform. As the balconies serving the residential units extend less than 4 metres (m) from the façade, they do not require consideration as outdoor living areas (OLA) in this study.

The site is surrounded by low-rise and mid-rise buildings to the north and northeast beyond Maritime Way, a mid-rise building to the immediate northwest followed by a forested area beyond Maritime Way, and low- and mid-rise buildings to the west and south beyond Kanata Avenue and Highway 417, respectively. The major sources of roadway traffic noise are Highway 417 and Kanata Avenue. The future Kanata LRT system located to the south of the subject site, aligned along the north side of the highway, was considered as a source of noise and ground vibrations. Figure 1 illustrates a complete site plan with surrounding context.

3. OBJECTIVES

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

4. METHODOLOGY

4.1 Background

Noise can be defined as any obtrusive sound. It is created at a source, transmitted through a medium, such as air, and intercepted by a receiver. Noise may be characterized in terms of the power of the source or the sound pressure at a specific distance. While the power of a source is characteristic of that particular source, the sound pressure depends on the location of the receiver and the path that the noise takes to reach the receiver. Measurement of noise is based on the decibel unit, dBA, which is a logarithmic ratio referenced to a standard noise level (2×10^{-5} Pascals). The 'A' suffix refers to a weighting scale, which better represents how the noise is perceived by the human ear. With this scale, a doubling of power results in a 3 dBA increase in measured noise levels and is just perceptible to most people. An increase of 10 dBA is often perceived to be twice as loud.

4.2 Transportation Noise

4.2.1 Criteria for Roadway and LRT Traffic Noise

For roadway and LRT 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 LRT systems, 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 50, 45 and 40 dBA for reception areas, living rooms and sleeping quarters, respectively, for roadways and LRT systems as listed in Table 1.

TABLE 1: INDOOR SOUND LEVEL CRITERIA (ROAD AND LRT) [3]

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

Predicted noise levels at the plane of window (POW) dictate the action required to achieve the recommended sound levels. An open window is considered to provide a 10 dBA reduction in noise, while a standard closed window is capable of providing a minimum 20 dBA noise reduction[4]. A closed window due to a ventilation requirement will bring noise levels down to achieve an acceptable indoor environment[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].

The sound level criterion for outdoor living areas is 55 dBA, which applies during the daytime (07:00 to 23:00). When noise levels exceed 55 dBA, mitigation must be provided to reduce noise levels where technically and administratively feasible to acceptable levels at or below the criterion.

4.2.2 Roadway and LRT 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, roadway traffic volumes are based on the

[3] Adapted from ENCG 2016 – Tables 2.2b and 2.2c
[4] Burberry, P.B. (2014). Mitchell's Environment and Services. Routledge, Page 125
[5] MOECP, Environmental Noise Guidelines, NPC 300 – Part C, Section 7.8
[6] MOECP, Environmental Noise Guidelines, NPC 300 – Part C, Section 7.1.3

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. The LRT traffic volumes are based on Gradient Wind's experience with similar projects. Table 2 (below) summarizes the AADT values used for each roadway included in this assessment.

TABLE 2: ROADWAY AND LRT TRAFFIC DATA

Segment	Classification	Speed Limit (km/h)	Traffic Volumes
Queensway (Highway 417)	8-Lane Freeway	100	**146,664**
Kanata Avenue	4-Lane Urban Arterial Undivided (4-UAU)	50	**30,000**
Kanata LRT	LRT	80	**313/27***

*Daytime/nighttime traffic counts

4.2.3 Theoretical Transportation 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.

Transportation noise calculations were performed by treating each roadway and LRT 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 absorptive due to the presence of soft (lawn) ground.
- Topography was assumed to be a flat/gentle slope surrounding the study building. The Kanata Avenue overpass was taken to be 7 m above grade with a 3.5% slope, sloping down from the

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

overpass to Maritime Way. The slope of Highway 417 was considered to be insignificant as the gradient was determined to be less than 2%.

- For select sources where appropriate, the receptors considered the proposed buildings and surrounding, existing buildings as barriers, partially or fully obstructing exposure to the source as illustrated by exposure angles in Figures 4-8.
- Noise receptors were strategically placed at 10 locations around the study area (see Figure 2).
- Receptor distances and exposure angles are illustrated in Figures 4-8.

4.3 Indoor Noise Calculations

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

As per Section 4.2, when daytime noise levels (from road and rail 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.

[8] Building Practice Note: Controlling Sound Transmission into Buildings by J.D. Quirt, National Research Council of Canada, September 1985

Based on published research[9], exterior walls possess specific sound attenuation characteristics that are used as a basis for calculating the required STC ratings of windows in the same partition. Due to the limited information available at the time of the study, which was prepared for a joint ZBA and SPA application, 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).

4.4 Ground Vibration & Ground-borne Noise

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

Human response to ground vibrations is dependent on the magnitude of the vibrations, which is measured by the root mean square (RMS) of the movement of a particle on a surface. Typical units of ground vibration measures are millimeters per second (mm/s), or inch per second (in/s). Since vibrations can vary over a wide range, it is also convenient to represent them in decibel units, or dBV. In North America, it is common practice to use the reference value of one micro-inch per second (µin/s) to represent vibration levels for this purpose. The threshold level of human perception to vibrations is about 0.10 mm/s RMS or

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

about 72 dBV. Although somewhat variable, the threshold of annoyance for continuous vibrations is 0.5 mm/s RMS (or 85 dBV), five times higher than the perception threshold, whereas the threshold for significant structural damage is 10 mm/s RMS (or 112 dBV), at least one hundred times higher than the perception threshold level.

4.4.1 Ground Vibration Criteria

In the United States, the Federal Transportation Authority (FTA) has set vibration criteria for sensitive land uses next to transit corridors. Similar standards have been developed by a partnership between the MECP and the Toronto Transit Commission[10]. These standards indicate that the appropriate criteria for residential buildings is 0.10 mm/s RMS for vibrations. As the main vibration source is due to the future Kanata LRT line, which will have frequent events, the 0.10 mm/s RMS (72 dBV) vibration criteria and 35 dBA ground borne noise criteria were adopted for this study.

4.4.2 Theoretical Ground Vibration Prediction Procedure

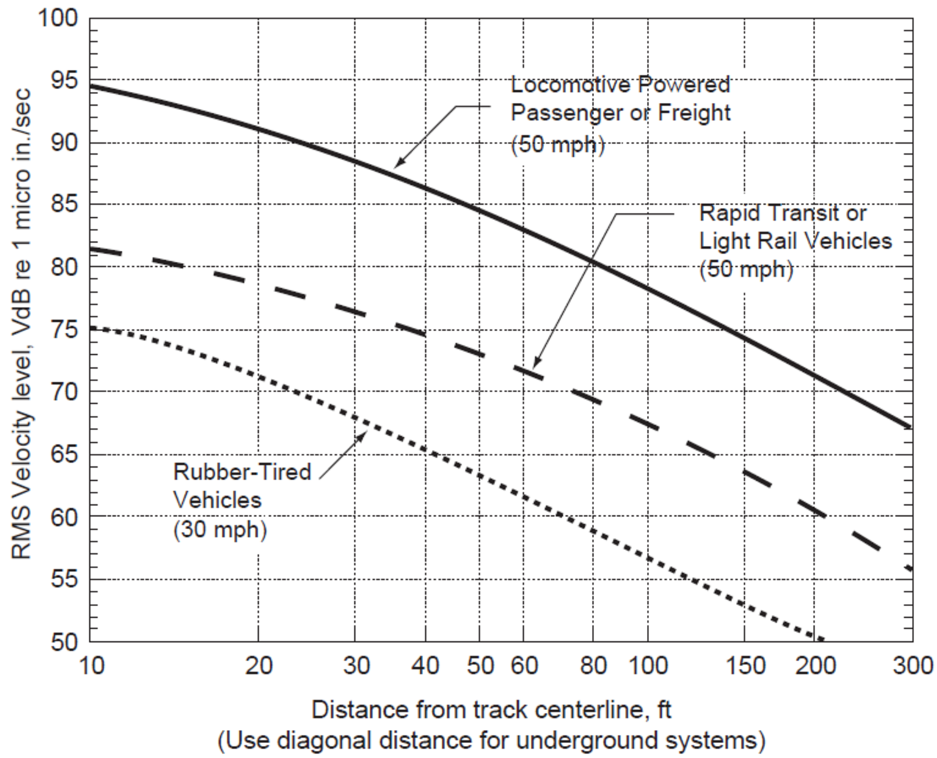
Potential vibration impacts of the future Kanata LRT line were predicted using the FTA's Transit Noise and Vibration Impact Assessment[11] protocol. The FTA general vibration assessment is based on an upper bound generic set of curves that show vibration level attenuation with distance. These curves, illustrated in the figure below, are based on ground vibration measurements at various transit systems throughout North America. Vibration levels at points of reception are adjusted by various factors to incorporate known characteristics of the system being analyzed, such as operating speed of vehicle, conditions of the track, construction of the track and geology, as well as the structural type of the impacted building structures. Based on the setback distance of the closest building (East Tower), initial vibration levels were deduced from a curve for light rail trains at 50 miles per hour (mph). Details of the vibration calculations are presented in Appendix B. Adjustment factors were considered based on the following information:

- The maximum operating speed of the LRT is 80 km/h (50 mph).

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

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

- The distance between the East Building and the centreline of the track is approximately 28 metres.
- The vehicles are assumed to have soft primary suspensions.
- Tracks are welded and in good condition.
- Soil conditions do not efficiently propagate vibrations.
- The building's foundation is large masonry on piles.
- There is no special trackwork in the area of the subject site.



FTA GENERALIZED CURVES OF VIBRATION LEVELS VERSUS DISTANCE (ADOPTED FROM FIGURE 10-1, FTA TRANSIT NOISE AND VIBRATION IMPACT ASSESSMENT)

5. RESULTS AND DISCUSSION

5.1 Transportation Noise Levels

The results of the roadway and LRT traffic noise calculations are summarized in Table 3 below. A complete set of input and output data from all STAMSON 5.04 calculations are available in Appendix A.

TABLE 3: EXTERIOR NOISE LEVELS DUE TO ROADWAY AND LRT TRAFFIC

Receptor Number	Receptor Height Above Grade (m)	Receptor Location	STAMSON 5.04 Noise Level (dBA)	
			Day	Night
East Tower				
1	4.5	POW – Level 2, East Façade	73	66
2	19.5	POW – Level 7, East Façade	71	63
3	82.5	POW – Level 28, East Façade	73	66
4	82.5	POW – Level 28, South Façade	75	68
5	82.5	POW – Level 28, West Façade	71	64
West Tower				
6	19.5	POW – Level 7, North Façade	64	56
7	88.5	POW – Level 30, North Façade	67	59
8	88.5	POW – Level 30, East Façade	70	62
9	88.5	POW – Level 30, South Façade	75	67
10	88.5	POW – Level 30, West Façade	74	66

The results of the current analysis indicate that noise levels will range between 64 and 75 dBA during the daytime period (07:00-23:00) and between 56 and 67 dBA during the nighttime period (23:00-07:00). The highest noise level (75 dBA) occurs at the south façades of the buildings, which are nearest and most exposed to Highway 417.

The LRT system to the south was considered in the noise calculations for Receptors 1 and 4. The noted receptors are nearest and most exposed to the LRT line. The results, as seen in Table 4 below, indicate that roadway traffic is the dominant source of transportation noise impact the development and the LRT noise is negligible. As such, the LRT line has been considered as insignificant for all other receptors.

TABLE 4: EXTERIOR NOISE LEVELS: COMPARISON BETWEEN ROADWAY AND LRT TRAFFIC NOISE

Receptor Number	Receptor Height Above Grade (m)	Receptor Location	STAMSON 5.04 Roadway Noise Level (dBA)		STAMSON 5.04 LRT Noise Level (dBA)	
			Day	Night	Day	Night
East Tower						
1	4.5	POW – Level 2, East Façade	67	59	53	46
4	82.5	POW – Level 28, South Façade	75	67	59	51

5.2 Noise Control Measures

The noise levels predicted due to roadway traffic exceed the criteria listed in Section 4.2 for building components. As discussed in Section 4.3, the anticipated STC requirements for windows have been estimated based on the overall noise reduction required for each intended use of space (STC = outdoor noise level – targeted indoor noise levels). As per city of Ottawa requirements, detailed STC calculations will be required to be completed prior to building permit application for each unit type. The STC requirements for the windows are summarized below for various units within the development (see Figure 3):

West Tower

- **Bedroom Windows**

(i) Bedroom windows facing northwest will require a minimum STC of 30.

(ii) Bedroom windows facing northeast will require a minimum STC of 34.

(iii) Bedroom windows facing southeast and southwest will require a minimum STC of 38.

(iv) All other bedroom windows are to satisfy Ontario Building Code (OBC 2012) requirements.

- **Living Room Windows**

(i) Living room windows facing northwest will require a minimum STC of 25.

(ii) Living room windows facing northeast will require a minimum STC of 29.

(iii) Living room windows facing southeast and southwest will require a minimum STC of 33.

(iv) All other living room windows are to satisfy Ontario Building Code (OBC 2012) requirements.

- **Reception/Lobby/Amenity Windows**

(i) Reception/lobby/amenity windows facing northwest will require a minimum STC of 25.

(ii) Reception/lobby/amenity windows facing northeast will require a minimum STC of 29.

(iii) Reception/lobby/amenity windows facing southeast and southwest will require a minimum STC of 33.

(iv) All other reception/lobby/amenity windows are to satisfy Ontario Building Code (OBC 2012) requirements.

- **Exterior Walls**

(i) Exterior wall components on the north, east, south and west façades will require a minimum STC of 45, which will be achieved with brick cladding or an acoustical equivalent according to NRC test data[12].

<u>**East Tower**</u>

- **Bedroom Windows**

(i) Bedroom windows facing west as well as those facing east at the northern portion of the podium will require a minimum STC of 34.

(ii) Bedroom windows facing east and south, including those facing east at the southeast corner of Levels 1-2, will require a minimum STC of 38.

(iii) All other bedroom windows are to satisfy Ontario Building Code (OBC 2012) requirements.

- **Living Room Windows**

(i) Living room windows facing west as well as those facing east at the northern portion of the podium will require a minimum STC of 29.

(ii) Living room windows facing east and south, including those facing east at the southeast corner of Levels 1-2, will require a minimum STC of 33.

(iii) All other living room windows are to satisfy Ontario Building Code (OBC 2012) requirements.

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[12] J.S. Bradley and J.A. Birta. Laboratory Measurements of the Sound Insulation of Building Façade Elements, National Research Council October 2000.

- **Reception/Lobby/Amenity Windows**

(i) Reception/lobby/amenity windows facing west as well as those facing east at the northern portion of the podium will require a minimum STC of 24.

(ii) Reception/lobby/amenity windows facing east and south, including those facing east at the southeast corner of Levels 1-2, will require a minimum STC of 28.

(iii) All other reception/lobby/amenity windows are to satisfy Ontario Building Code (OBC 2012) requirements.

- **Exterior Walls**

(ii) Exterior wall components on the east, south and west façades will require a minimum STC of 45, which will be achieved with brick cladding or an acoustical equivalent according to NRC test data[13].

The STC requirements apply to windows, doors, spandrel panels and curtainwall elements. Exterior wall components on these façades are recommended to have a minimum STC of 45, where a window/wall system is used. A review of window supplier literature indicates that the specified STC ratings can be achieved by a variety of window systems having a combination of glass thickness and inter-pane spacing. We have specified an example window configuration, however several manufacturers and various combinations of window components, such as those proposed, will offer the necessary sound attenuation rating. 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 each building 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.

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[13] J.S. Bradley and J.A. Birta. Laboratory Measurements of the Sound Insulation of Building Façade Elements, National Research Council October 2000.

5.3 Ground Vibrations & Ground-borne Noise Levels

Based on an offset distance of 28 metres between the Kanata LRT Line railway centerline and the nearest building foundation of the East Tower, the estimated vibration level at the nearest point of reception is expected to be 0.04 mm/s RMS (64 dBV) based on the FTA protocol. Details of the calculation are provided in Appendix B. Since predicted vibration levels are below the criterion of 0.10 mm/s RMS, no mitigation will be required.

According to the United States Federal Transit Authority's vibration assessment protocol, ground borne noise can be estimated by subtracting 35 dB from the velocity vibration level in dBV. Since vibration levels were predicted to be less than 0.10 mm/s RMS, ground borne noise levels are also expected to be below the ground borne noise criteria of 35 dB.

6. CONCLUSIONS AND RECOMMENDATIONS

The results of the current analysis indicate that noise levels will range between 64 and 75 dBA during the daytime period (07:00-23:00) and between 56 and 67 dBA during the nighttime period (23:00-07:00). The highest noise level (75 dBA) occurs at the south façades of the buildings, which are nearest and most exposed to Highway 417. Building components with a higher Sound Transmission Class (STC) rating will be required where exterior noise levels exceed 65 dBA, as indicated in Figure 3.

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. The following Warning Clause[14] will also be required be placed on all Lease, Purchase and Sale Agreements for the West Tower, as summarized below:

> *"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 roadway and LRT traffic may, on occasion, interfere with some activities of the dwelling occupants, as the sound levels exceed the sound level limits of the City and the Ministry of the Environment. To help address the need for sound attenuation, this development includes:*

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

- *STC rated multi-pane glazing elements and spandrel panels*
  - *Northwest façade bedroom/living room/reception: STC 30/25/20*
  - *Northeast façade bedroom/living room/reception: STC 34/29/24*
  - *Southwest and southeast façade bedroom/living room/reception: STC 38/33/28*
- *STC rated exterior walls*
  - *North, east, south and west façade: STC 45*

This dwelling unit has also been designed with air conditioning. Air conditioning will allow windows and exterior doors to remain closed, thereby ensuring that the indoor sound levels are within the sound level limits of the City and the Ministry of the Environment.

To ensure that provincial sound level limits are not exceeded, it is important to maintain these sound attenuation features."

The following Warning Clause[15] will also be required be placed on all Lease, Purchase and Sale Agreements for the East Tower, as summarized below:

"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 roadway and LRT traffic may, on occasion, interfere with some activities of the dwelling occupants, as the sound levels exceed the sound level limits of the City and the Ministry of the Environment. To help address the need for sound attenuation, this development includes:

- *STC rated multi-pane glazing elements and spandrel panels*
  - *West façade and east façade at northern portion of podium bedroom/living room/reception: STC 34/29/24*
  - *East and south façade, including east façade at southeast corner of Levels 1-2, bedroom/living room/reception: STC 38/33/28*
- *STC rated exterior walls*
  - *East, south and west façade: STC 45*

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

This dwelling unit has also been designed with air conditioning. Air conditioning will allow windows and exterior doors to remain closed, thereby ensuring that the indoor sound levels are within the sound level limits of the City and the Ministry of the Environment.

To ensure that provincial sound level limits are not exceeded, it is important to maintain these sound attenuation features."

Vibration levels due to LRT activity in the area are expected to fall below the criterion of 0.10 mm/s at the nearest façade to the LRT line. Thus, mitigation for vibrations is not required.

With regard to stationary noise impacts of the development's mechanical equipment onto surrounding noise sensitive properties, a stationary noise study is recommended for the site during the detailed design once mechanical plans become available. This study would assess impacts of stationary noise from rooftop mechanical units and any other stationary sources serving the proposed building on surrounding noise-sensitive areas. This study will include recommendations for any noise control measures that may be necessary to ensure noise levels fall below ENCG limits. Noise impacts can generally be minimized by judicious selection and placement of the equipment. The best noise strategy would be to locate noisier pieces of equipment on the center of the roof or in a mechanical penthouse. Where necessary noise screens and silencers can be incorporated into the design.

This concludes our transportation noise and ground vibration assessment and report. If you have any questions or wish to discuss our findings, please advise us. In the interim, we thank you for the opportunity to be of service.

Sincerely,

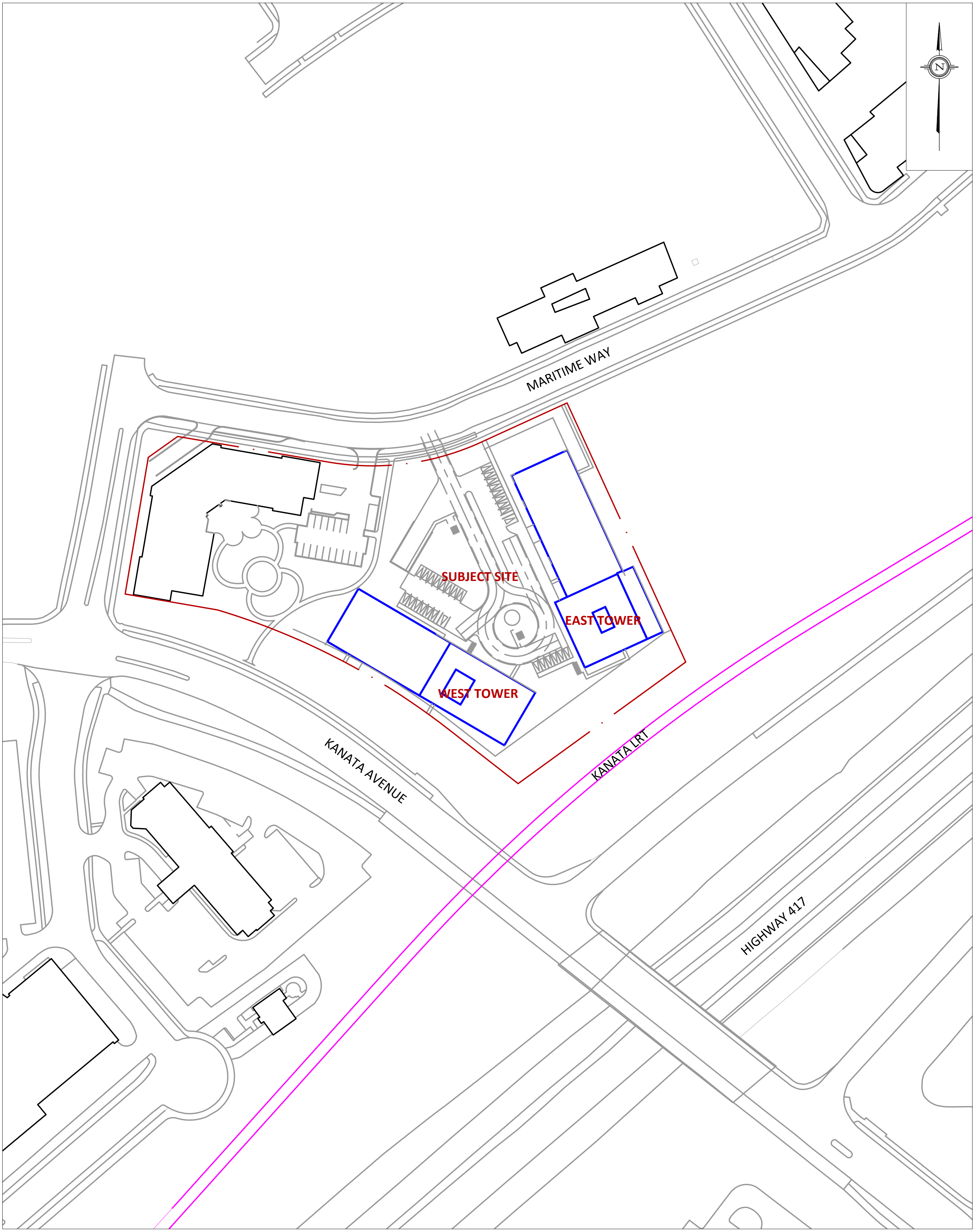
Gradient Wind Engineering Inc.

LICENSED PROFESSIONAL ENGINEER
J. R. FOSTER
100155655
Jan 4, 2020
PROVINCE OF ONTARIO

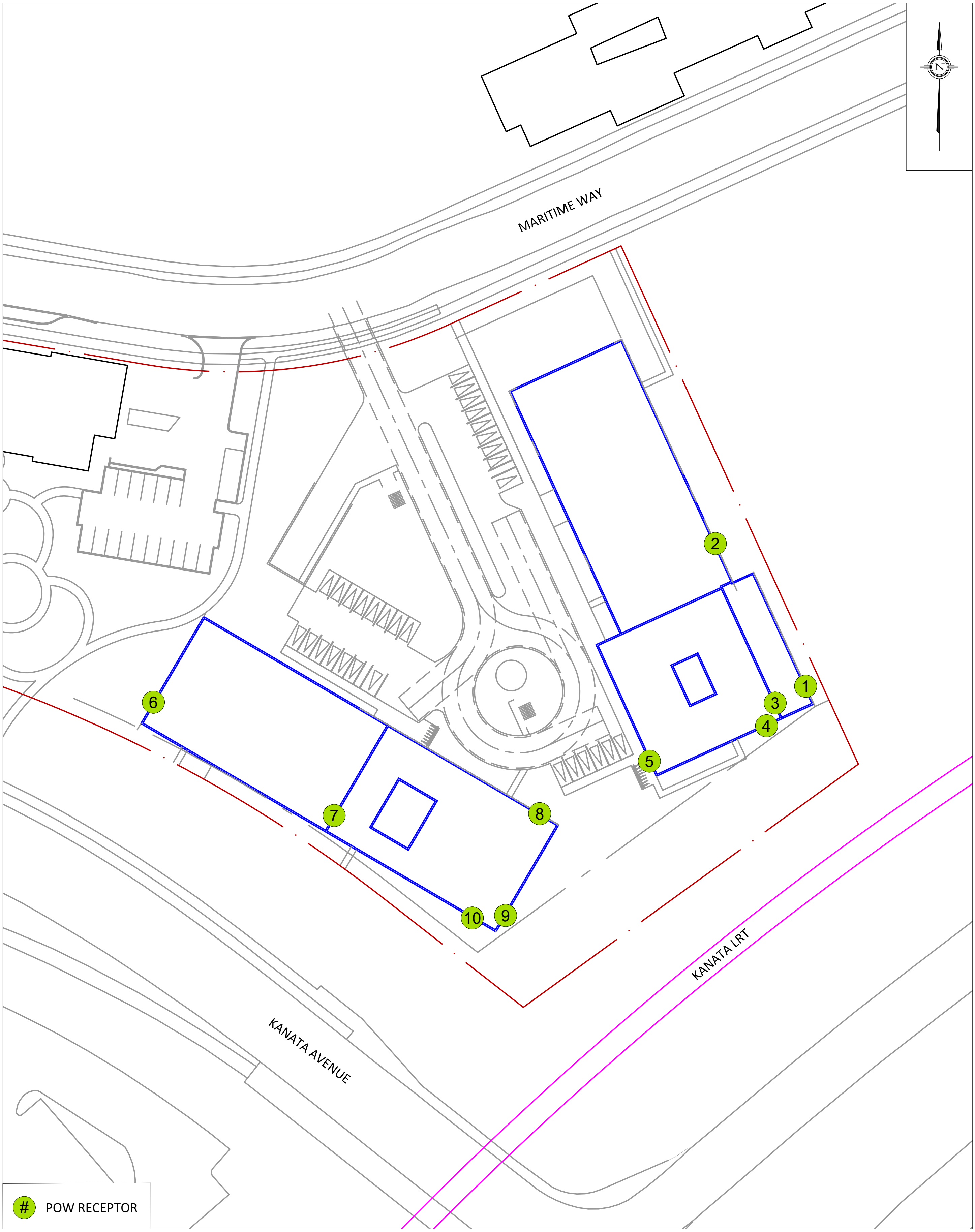
Michael Lafortune, C.E.T.
Environmental Scientist

Joshua Foster, P.Eng.
Principal

Gradient Wind File 20-207-T.Noise & Vibrations



GRADIENTWIND ENGINEERS & SCIENTISTS 127 WALGREEN ROAD , OTTAWA, ON 613 836 0934 • GRADIENTWIND.COM	PROJECT: 1200 MARITIME WAY, OTTAWA TRANSPORTATION NOISE AND GROUND VIBRATION ASSESSMENT		DESCRIPTION: FIGURE 1: SITE PLAN AND SURROUNDING CONTEXT
	SCALE: 1:2000 (APPROX.)	DRAWING NO.: GW20-207-1	
	DATE: OCTOBER 15, 2020	DRAWN BY: S.P.	



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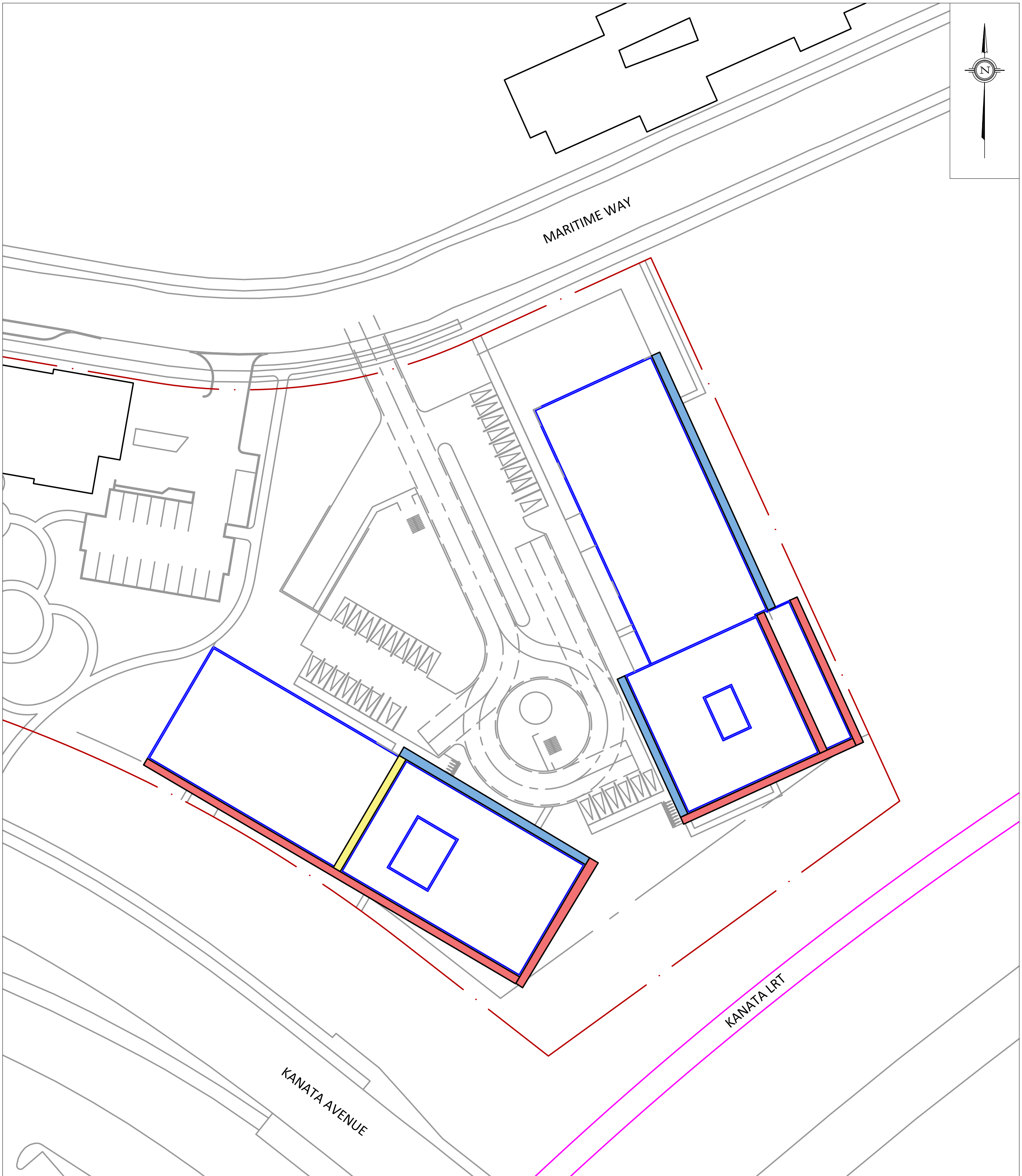
PROJECT	1200 MARITIME WAY, OTTAWA TRANSPORTATION NOISE AND GROUND VIBRATION ASSESSMENT		
SCALE	1:1000 (APPROX.)	DRAWING NO.	GW20-207-2
DATE	OCTOBER 15, 2020	DRAWN BY	S.P.

DESCRIPTION

FIGURE 2:
RECEPTOR LOCATIONS



BEDROOM/LIVING ROOM/RECEPTION WINDOW: STC 30/25/20

BEDROOM/LIVING ROOM/RECEPTION WINDOW: STC 34/29/24

BEDROOM/LIVING ROOM/RECEPTION WINDOW: STC 38/33/28

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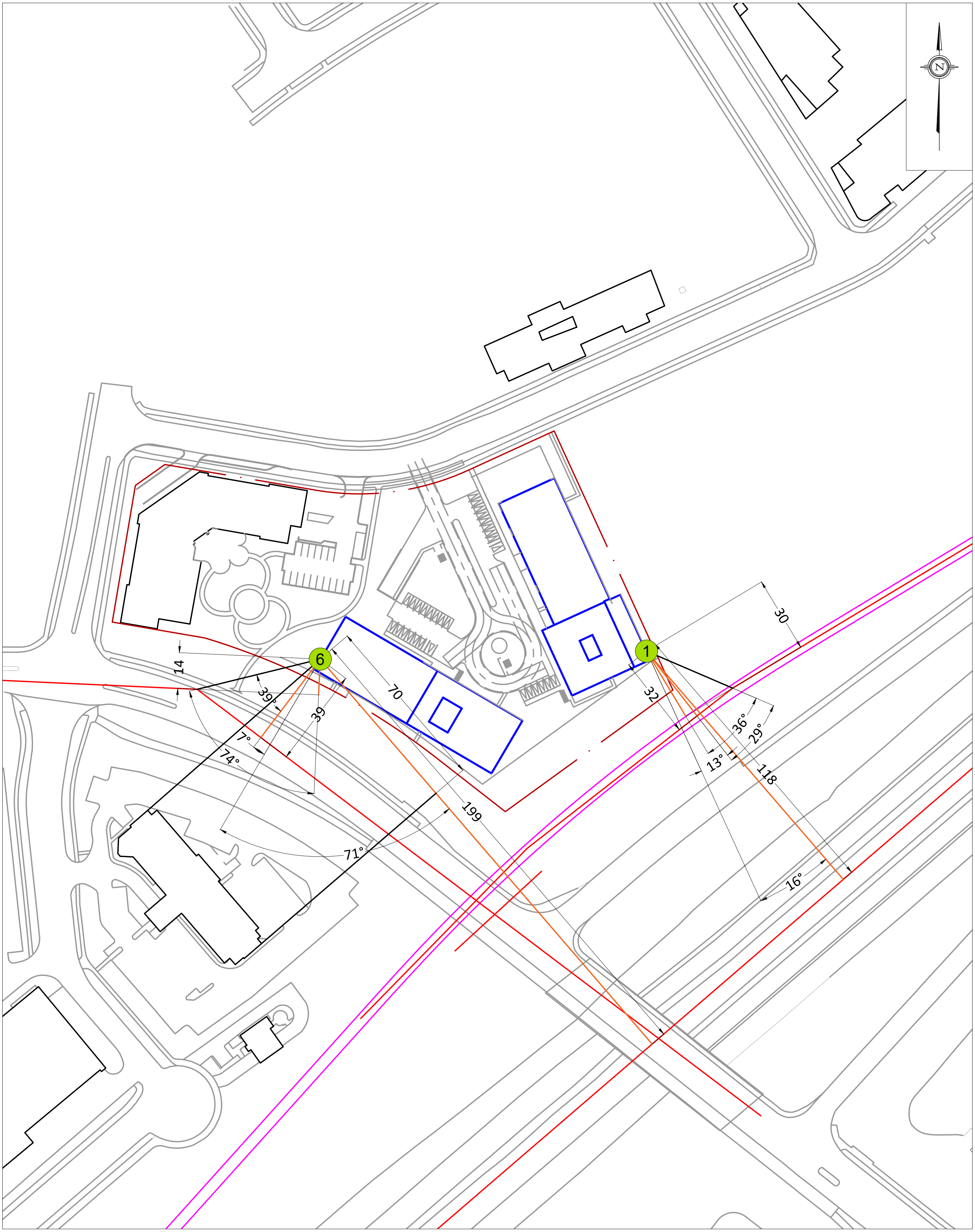
	SCALE: 1:1000 (APPROX.)	DRAWING NO.: GW20-207-3		
	DATE: OCTOBER 15, 2020	DRAWN BY: S.P.		



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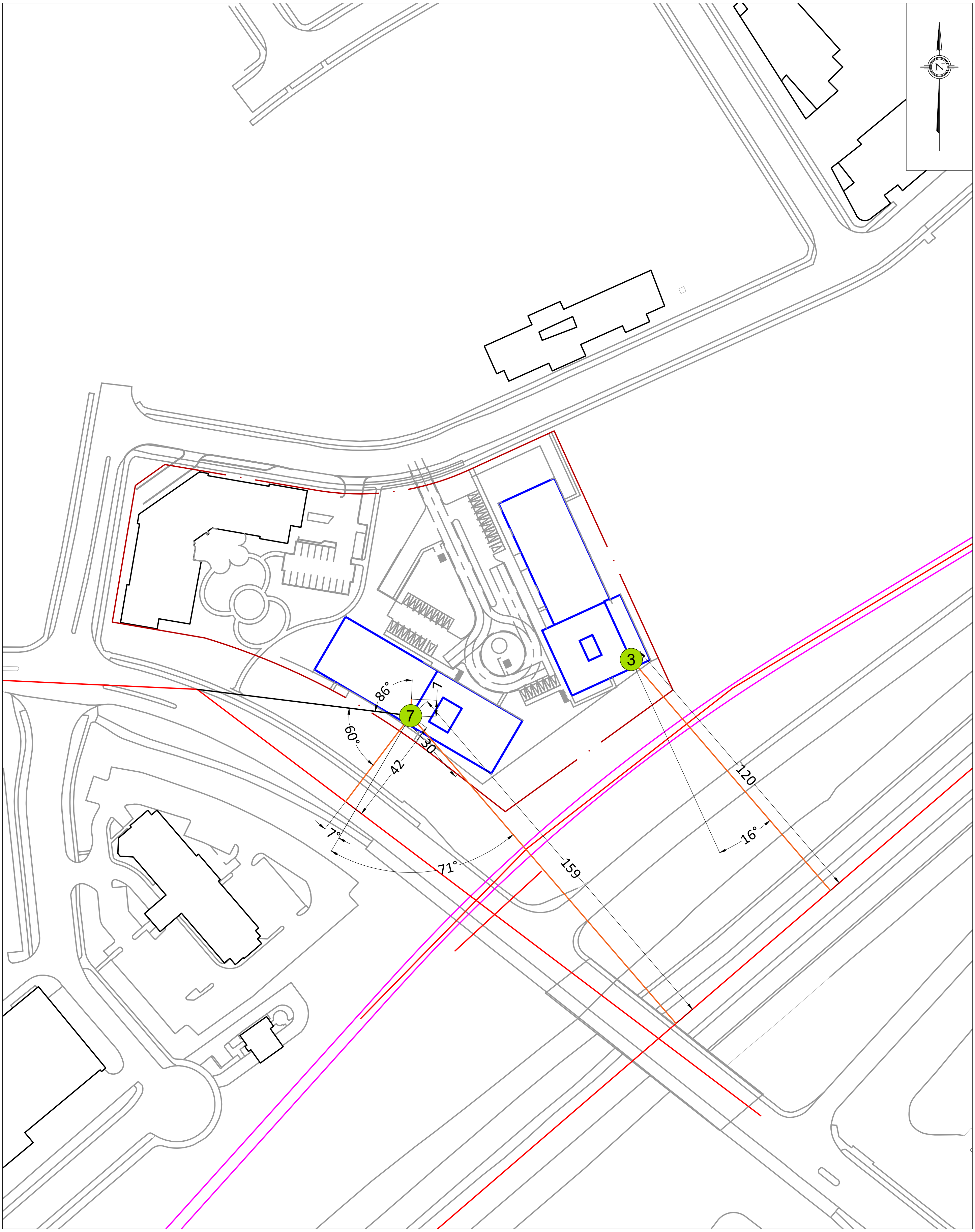
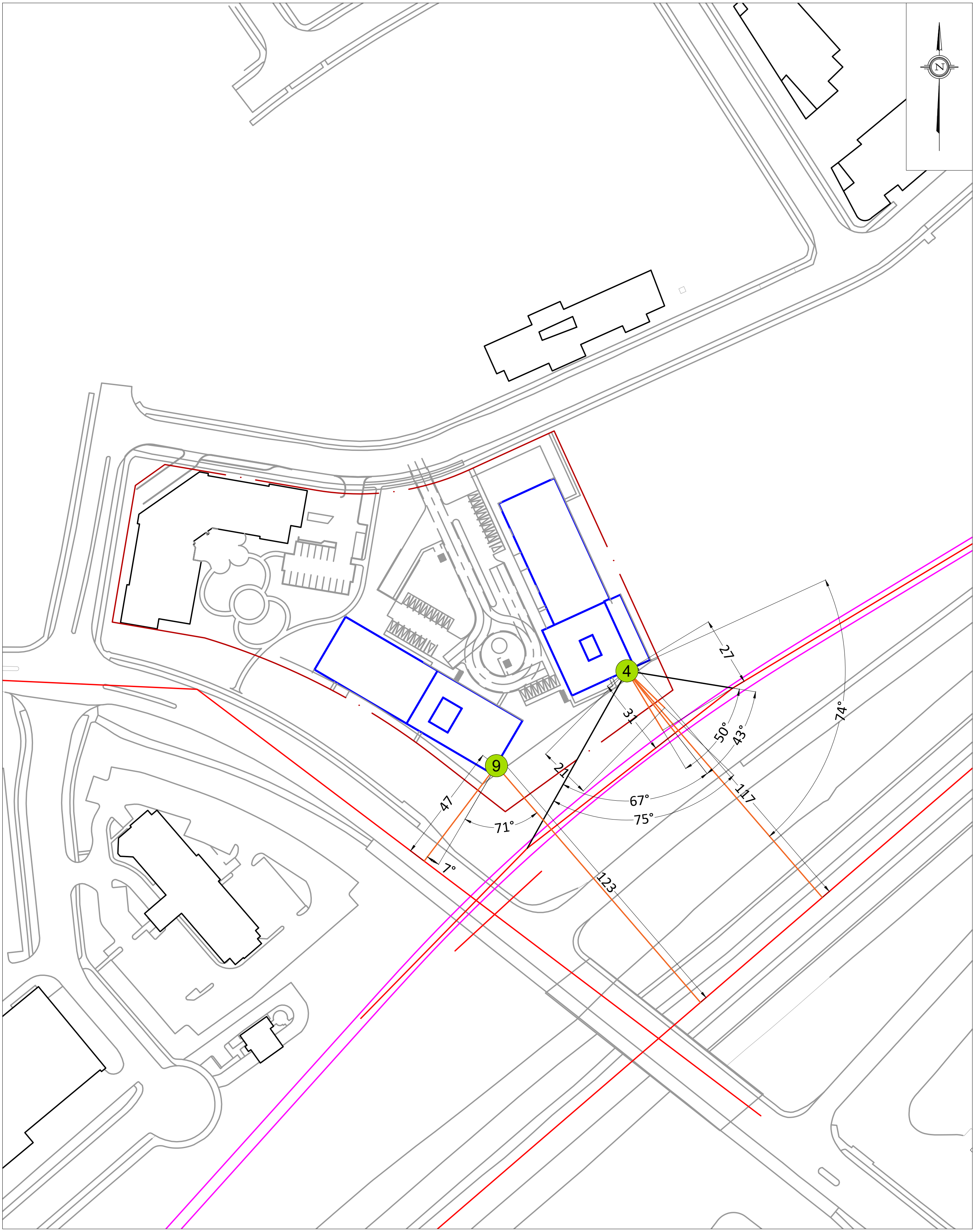
PROJECT	1200 MARITIME WAY, OTTAWA TRANSPORTATION NOISE AND GROUND VIBRATION ASSESSMENT		
SCALE	1:2000 (APPROX.)	DRAWING NO.	GW20-207-4
DATE	OCTOBER 15, 2020	DRAWN BY	S.P.

DESCRIPTION

FIGURE 4:
STAMSON INPUT PARAMETERS - RECEPTORS 1 & 6



GRADIENTWIND ENGINEERS & SCIENTISTS 127 WALGREEN ROAD , OTTAWA, ON 613 836 0934 • GRADIENTWIND.COM	PROJECT 1200 MARITIME WAY, OTTAWA TRANSPORTATION NOISE AND GROUND VIBRATION ASSESSMENT		DESCRIPTION FIGURE 5: STAMSON INPUT PARAMETERS - RECEPTORS 3 & 7
	SCALE 1:2000 (APPROX.)	DRAWING NO. GW20-207-5	
	DATE OCTOBER 15, 2020	DRAWN BY S.P.	



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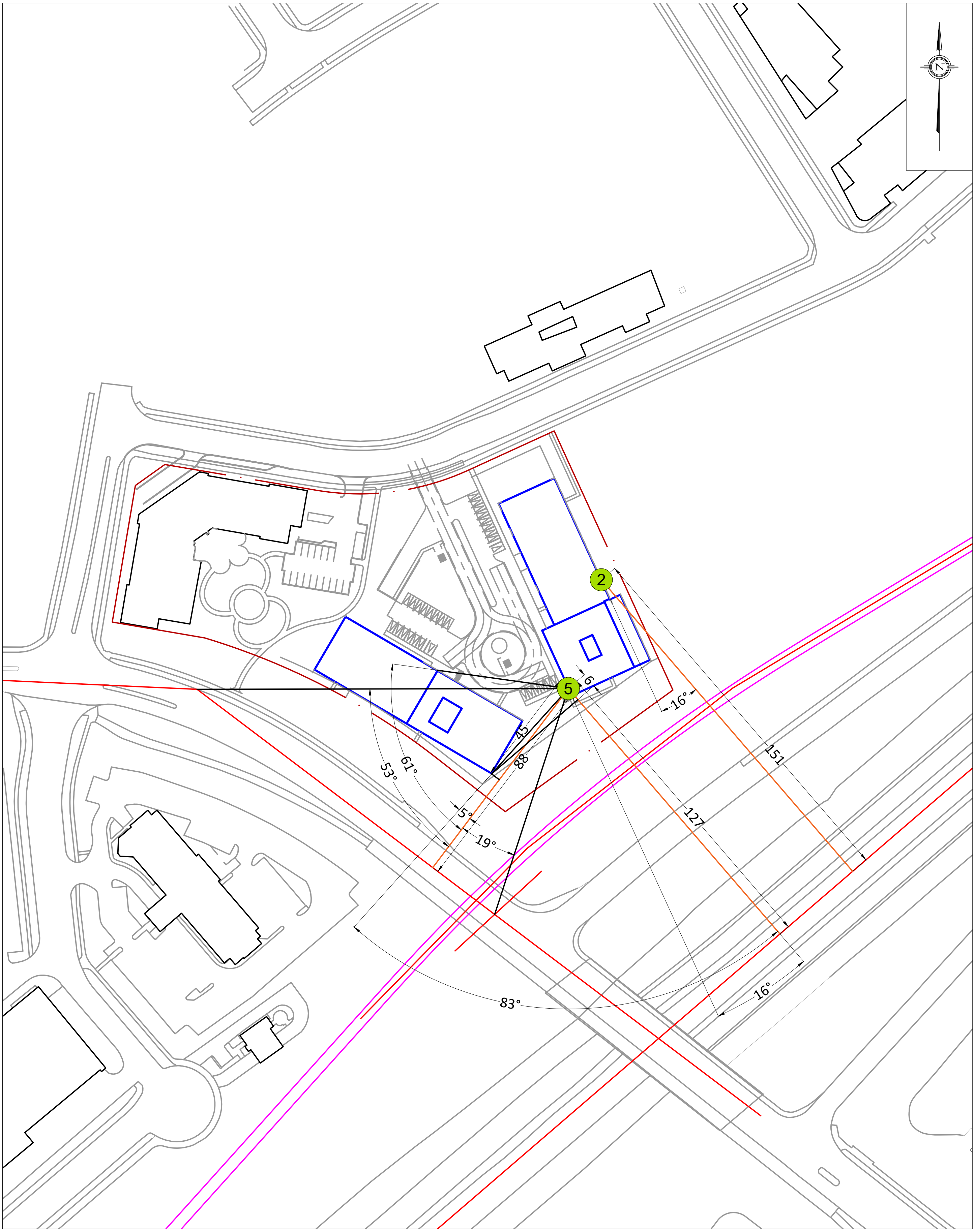
PROJECT	1200 MARITIME WAY, OTTAWA TRANSPORTATION NOISE AND GROUND VIBRATION ASSESSMENT		DESCRIPTION FIGURE 6: STAMSON INPUT PARAMETERS - RECEPTORS 4 & 9
SCALE	1:2000 (APPROX.)	DRAWING NO. GW20-207-6	
DATE	OCTOBER 15, 2020	DRAWN BY S.P.	



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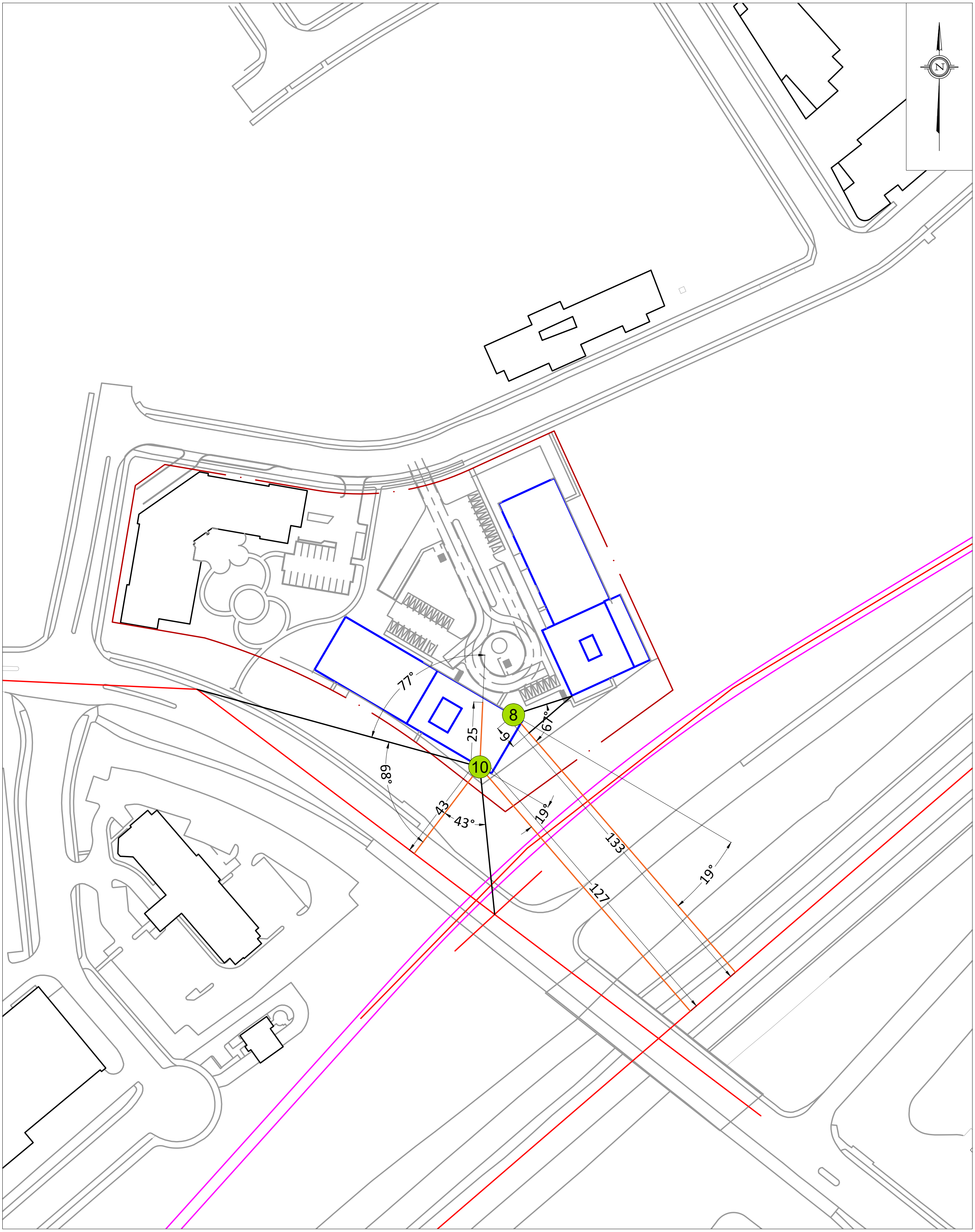
PROJECT	1200 MARITIME WAY, OTTAWA TRANSPORTATION NOISE AND GROUND VIBRATION ASSESSMENT
SCALE	1:2000 (APPROX.)
DRAWING NO.	GW20-207-7
DATE	OCTOBER 15, 2020
DRAWN BY	S.P.
DESCRIPTION	FIGURE 7: STAMSON INPUT PARAMETERS - RECEPTORS 2 & 5



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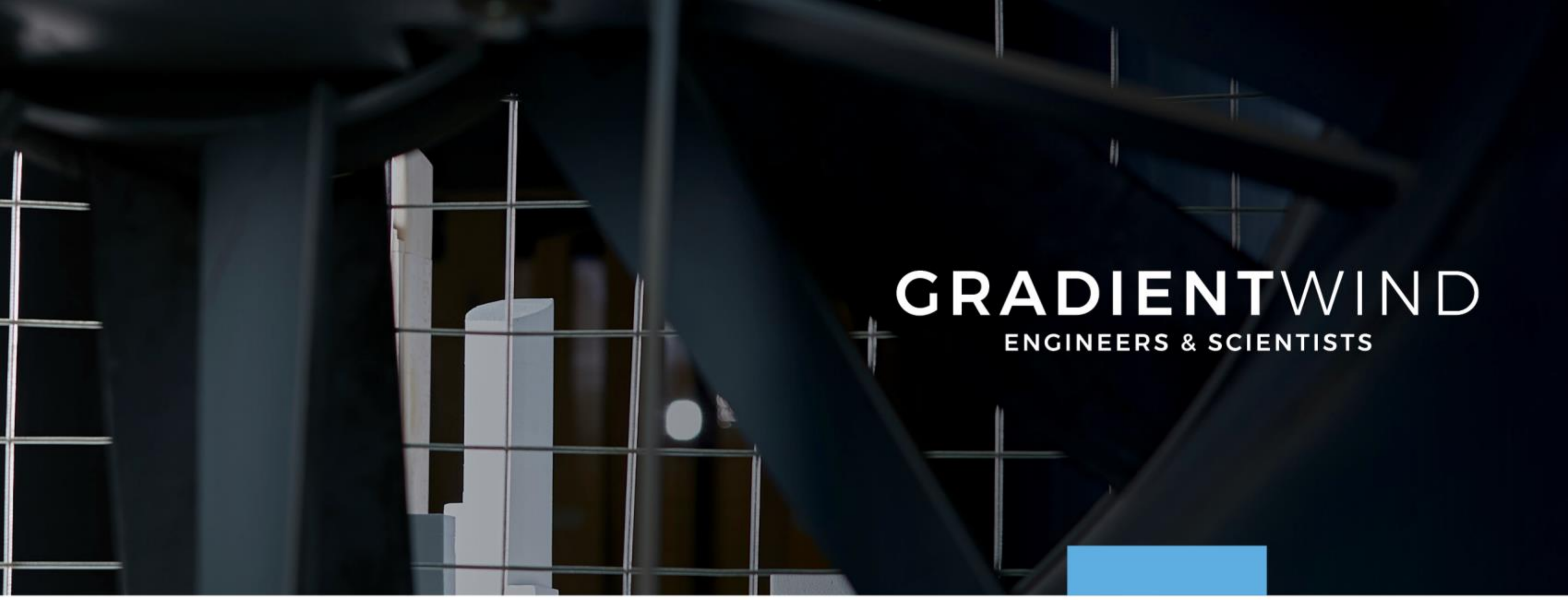
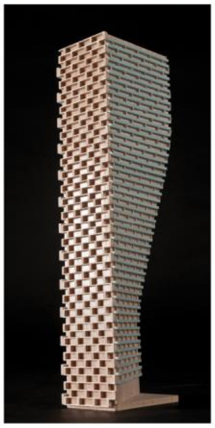
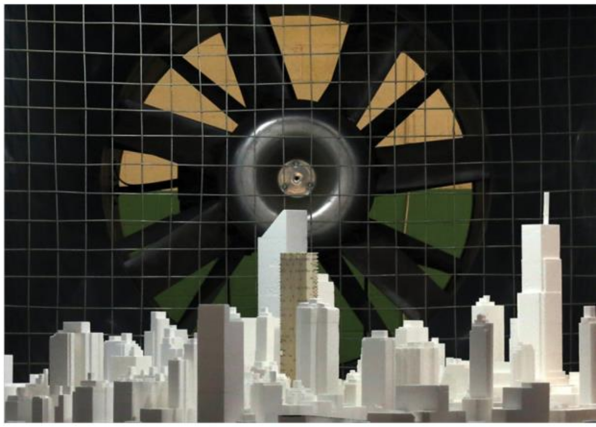
PROJECT	1200 MARITIME WAY, OTTAWA TRANSPORTATION NOISE AND GROUND VIBRATION ASSESSMENT		
SCALE	1:2000 (APPROX.)	DRAWING NO.	GW20-207-8
DATE	OCTOBER 15, 2020	DRAWN BY	S.P.

DESCRIPTION

FIGURE 8:
STAMSON INPUT PARAMETERS - RECEPTORS 8 & 10







APPENDIX A

STAMSON 5.04 – INPUT AND OUTPUT DATA

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

```
STAMSON 5.0        COMPREHENSIVE REPORT        Date: 14-10-2020 16:56:42
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: HWY 417 (day/night)
-------------------------------------------
Car traffic volume  : 118739/10325 veh/TimePeriod  *
Medium truck volume :  9445/821   veh/TimePeriod  *
Heavy truck volume  :  6747/587   veh/TimePeriod  *
Posted speed limit  :   100 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): 146664
    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: HWY 417 (day/night)
-----------------------------------------
Angle1   Angle2            : -90.00 deg   16.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      2       (Reflective ground surface)
Receiver source distance   : 118.00 / 118.00 m
Receiver height            :   4.50 / 4.50   m
Topography                 :      1       (Flat/gentle slope; no barrier)
Reference angle            :   0.00
```

```
Segment # 1: HWY 417 (day)
--------------------------

Source height = 1.50 m

ROAD (0.00 + 73.15 + 0.00) = 73.15 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     16   0.00  84.41   0.00  -8.96  -2.30   0.00   0.00   0.00
73.15
--------------------------------------------------------------------------
--

Segment Leq : 73.15 dBA

Total Leq All Segments: 73.15 dBA


Segment # 1: HWY 417 (night)
----------------------------

Source height = 1.50 m

ROAD (0.00 + 65.55 + 0.00) = 65.55 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     16   0.00  76.81   0.00  -8.96  -2.30   0.00   0.00   0.00
65.55
--------------------------------------------------------------------------
--

Segment Leq : 65.55 dBA

Total Leq All Segments: 65.55 dBA
```

```
RT/Custom data, segment # 1: LRT 1 (day/night)
----------------------------------------------
1 - 4-car SRT:
Traffic volume    :   313/27    veh/TimePeriod
Speed             :    80  km/h

Data for Segment # 1: LRT 1 (day/night)
---------------------------------------
Angle1   Angle2             : -90.00 deg   -36.00 deg
Wood depth                  :      0       (No woods.)
No of house rows            :      0 / 0
Surface                     :      2       (Reflective ground surface)
Receiver source distance    :  30.00 / 30.00  m
Receiver height             :   4.50 / 4.50   m
Topography                  :      1       (Flat/gentle slope; no barrier)
Reference angle             :   0.00


RT/Custom data, segment # 2: LRT 2 (day/night)
----------------------------------------------
1 - 4-car SRT:
Traffic volume    :   313/27    veh/TimePeriod
Speed             :    80  km/h

Data for Segment # 2: LRT 2 (day/night)
---------------------------------------
Angle1   Angle2             : -29.00 deg   13.00 deg
Wood depth                  :      0       (No woods.)
No of house rows            :      0 / 0
Surface                     :      2       (Reflective ground surface)
Receiver source distance    :  32.00 / 32.00  m
Receiver height             :   4.50 / 4.50   m
Topography                  :      1       (Flat/gentle slope; no barrier)
Reference angle             :   0.00
```

```
Segment # 1: LRT 1 (day)
------------------------

Source height = 0.50 m

RT/Custom (0.00 + 53.99 + 0.00) = 53.99 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90    -36   0.00  62.23  -3.01  -5.23   0.00   0.00   0.00  53.99
----------------------------------------------------------------------

Segment Leq : 53.99 dBA


Segment # 2: LRT 2 (day)
------------------------

Source height = 0.50 m

RT/Custom (0.00 + 52.62 + 0.00) = 52.62 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -29     13   0.00  62.23  -3.29  -6.32   0.00   0.00   0.00  52.62
----------------------------------------------------------------------

Segment Leq : 52.62 dBA

Total Leq All Segments: 56.37 dBA
```

```
Segment # 1: LRT 1 (night)
--------------------------

Source height = 0.50 m

RT/Custom (0.00 + 46.36 + 0.00) = 46.36 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
------------------------------------------------------------------------
   -90    -36   0.00  54.60  -3.01  -5.23   0.00   0.00   0.00  46.36
------------------------------------------------------------------------

Segment Leq : 46.36 dBA


Segment # 2: LRT 2 (night)
--------------------------

Source height = 0.50 m

RT/Custom (0.00 + 44.99 + 0.00) = 44.99 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
------------------------------------------------------------------------
   -29     13   0.00  54.60  -3.29  -6.32   0.00   0.00   0.00  44.99
------------------------------------------------------------------------

Segment Leq : 44.99 dBA

Total Leq All Segments: 48.74 dBA



TOTAL Leq FROM ALL SOURCES (DAY): 73.24
                         (NIGHT): 65.64
```

```
STAMSON 5.0        COMPREHENSIVE REPORT        Date: 14-10-2020 16:58:34
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: HWY 417 (day/night)
-------------------------------------------
Car traffic volume  : 118739/10325 veh/TimePeriod  *
Medium truck volume :  9445/821   veh/TimePeriod  *
Heavy truck volume  :  6747/587   veh/TimePeriod  *
Posted speed limit  :   100 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): 146664
    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: HWY 417 (day/night)
-----------------------------------------
Angle1   Angle2           : -90.00 deg   16.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  : 151.00 / 151.00 m
Receiver height           :  19.50 / 19.50  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Segment # 1: HWY 417 (day)
--------------------------

Source height = 1.50 m

ROAD (0.00 + 70.59 + 0.00) = 70.59 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     16   0.12  84.41   0.00 -11.23  -2.58   0.00   0.00   0.00
70.59
--------------------------------------------------------------------------
--

Segment Leq : 70.59 dBA

Total Leq All Segments: 70.59 dBA


Segment # 1: HWY 417 (night)
----------------------------

Source height = 1.50 m

ROAD (0.00 + 62.99 + 0.00) = 62.99 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     16   0.12  76.81   0.00 -11.23  -2.58   0.00   0.00   0.00
62.99
--------------------------------------------------------------------------
--

Segment Leq : 62.99 dBA

Total Leq All Segments: 62.99 dBA




TOTAL Leq FROM ALL SOURCES (DAY): 70.59
                         (NIGHT): 62.99
```

```
STAMSON 5.0        COMPREHENSIVE REPORT        Date: 14-10-2020 16:55:04
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: HWY 417 (day/night)
-------------------------------------------
Car traffic volume  : 118739/10325 veh/TimePeriod  *
Medium truck volume :  9445/821   veh/TimePeriod  *
Heavy truck volume  :  6747/587   veh/TimePeriod  *
Posted speed limit  :   100 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): 146664
    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: HWY 417 (day/night)
-----------------------------------------
Angle1   Angle2            : -90.00 deg   16.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      1       (Absorptive ground surface)
Receiver source distance   : 120.00 / 120.00 m
Receiver height            :  82.50 / 82.50  m
Topography                 :      1       (Flat/gentle slope; no barrier)
Reference angle            :   0.00
```

```
Segment # 1: HWY 417 (day)
--------------------------

Source height = 1.50 m

ROAD (0.00 + 73.08 + 0.00) = 73.08 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     16   0.00  84.41   0.00  -9.03  -2.30   0.00   0.00   0.00
73.08
--------------------------------------------------------------------------
--

Segment Leq : 73.08 dBA

Total Leq All Segments: 73.08 dBA


Segment # 1: HWY 417 (night)
----------------------------

Source height = 1.50 m

ROAD (0.00 + 65.48 + 0.00) = 65.48 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     16   0.00  76.81   0.00  -9.03  -2.30   0.00   0.00   0.00
65.48
--------------------------------------------------------------------------
--

Segment Leq : 65.48 dBA

Total Leq All Segments: 65.48 dBA



TOTAL Leq FROM ALL SOURCES (DAY): 73.08
                         (NIGHT): 65.48
```

```
STAMSON 5.0        COMPREHENSIVE REPORT        Date: 14-10-2020 16:54:51
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r4lrt.te              Time Period: Day/Night 16/8 hours
Description:


Road data, segment # 1: HWY 417 (day/night)
-------------------------------------------
Car traffic volume  : 118739/10325 veh/TimePeriod  *
Medium truck volume :  9445/821   veh/TimePeriod  *
Heavy truck volume  :  6747/587   veh/TimePeriod  *
Posted speed limit  :   100 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): 146664
    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: HWY 417 (day/night)
-----------------------------------------
Angle1   Angle2           : -74.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  : 117.00 / 117.00 m
Receiver height           :  82.50 / 82.50  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Segment # 1: HWY 417 (day)
--------------------------

Source height = 1.50 m

ROAD (0.00 + 75.08 + 0.00) = 75.08 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -74     90   0.00  84.41   0.00  -8.92  -0.40   0.00   0.00   0.00
75.08
--------------------------------------------------------------------------
--

Segment Leq : 75.08 dBA

Total Leq All Segments: 75.08 dBA


Segment # 1: HWY 417 (night)
----------------------------

Source height = 1.50 m

ROAD (0.00 + 67.49 + 0.00) = 67.49 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -74     90   0.00  76.81   0.00  -8.92  -0.40   0.00   0.00   0.00
67.49
--------------------------------------------------------------------------
--

Segment Leq : 67.49 dBA

Total Leq All Segments: 67.49 dBA
```

```
RT/Custom data, segment # 1: LRT 1 (day/night)
----------------------------------------------
1 - 4-car SRT:
Traffic volume    :   313/27    veh/TimePeriod
Speed             :    80 km/h

Data for Segment # 1: LRT 1 (day/night)
---------------------------------------
Angle1   Angle2            : -90.00 deg   -50.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      1       (Absorptive ground surface)
Receiver source distance   :  27.00 / 27.00  m
Receiver height            :  82.50 / 4.50   m
Topography                 :      1       (Flat/gentle slope; no barrier)
Reference angle            :   0.00


RT/Custom data, segment # 2: LRT 2 (day/night)
----------------------------------------------
1 - 4-car SRT:
Traffic volume    :   313/27    veh/TimePeriod
Speed             :    80 km/h

Data for Segment # 2: LRT 2 (day/night)
---------------------------------------
Angle1   Angle2            : -43.00 deg   67.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      1       (Absorptive ground surface)
Receiver source distance   :  31.00 / 31.00  m
Receiver height            :  82.50 / 82.50  m
Topography                 :      1       (Flat/gentle slope; no barrier)
Reference angle            :   0.00
```

```
RT/Custom data, segment # 3: LRT 3 (day/night)
----------------------------------------------
1 - 4-car SRT:
Traffic volume    :   313/27    veh/TimePeriod
Speed             :    80 km/h

Data for Segment # 3: LRT 3 (day/night)
---------------------------------------
Angle1   Angle2           :  75.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  21.00 / 21.00  m
Receiver height           :  82.50 / 82.50  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00


Segment # 1: LRT 1 (day)
------------------------

Source height = 0.50 m

RT/Custom (0.00 + 53.14 + 0.00) = 53.14 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90    -50   0.00  62.23  -2.55  -6.53   0.00   0.00   0.00  53.14
----------------------------------------------------------------------

Segment Leq : 53.14 dBA


Segment # 2: LRT 2 (day)
------------------------

Source height = 0.50 m

RT/Custom (0.00 + 56.94 + 0.00) = 56.94 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -43     67   0.00  62.23  -3.15  -2.14   0.00   0.00   0.00  56.94
----------------------------------------------------------------------

Segment Leq : 56.94 dBA
```

```
Segment # 3: LRT 3 (day)
------------------------

Source height = 0.50 m

RT/Custom (0.00 + 49.98 + 0.00) = 49.98 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
    75     90   0.00  62.23  -1.46 -10.79   0.00   0.00   0.00  49.98
----------------------------------------------------------------------

Segment Leq : 49.98 dBA

Total Leq All Segments: 59.03 dBA


Segment # 1: LRT 1 (night)
--------------------------

Source height = 0.50 m

RT/Custom (0.00 + 40.91 + 0.00) = 40.91 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90    -50   0.60  54.60  -4.08  -9.60   0.00   0.00   0.00  40.91
----------------------------------------------------------------------

Segment Leq : 40.91 dBA


Segment # 2: LRT 2 (night)
--------------------------

Source height = 0.50 m

RT/Custom (0.00 + 49.31 + 0.00) = 49.31 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -43     67   0.00  54.60  -3.15  -2.14   0.00   0.00   0.00  49.31
----------------------------------------------------------------------

Segment Leq : 49.31 dBA
```

```
Segment # 3: LRT 3 (night)
--------------------------

Source height = 0.50 m

RT/Custom (0.00 + 42.34 + 0.00) = 42.34 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
    75     90   0.00  54.60  -1.46 -10.79   0.00   0.00   0.00  42.34
----------------------------------------------------------------------

Segment Leq : 42.34 dBA

Total Leq All Segments: 50.60 dBA



TOTAL Leq FROM ALL SOURCES (DAY): 75.19
                         (NIGHT): 67.58
```

```
STAMSON 5.0        COMPREHENSIVE REPORT        Date: 14-10-2020 16:54:13
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: HWY 417 (day/night)
-------------------------------------------
Car traffic volume  : 118739/10325 veh/TimePeriod  *
Medium truck volume :  9445/821    veh/TimePeriod  *
Heavy truck volume  :  6747/587    veh/TimePeriod  *
Posted speed limit  :   100 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): 146664
    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: HWY 417 (day/night)
-----------------------------------------
Angle1   Angle2            :  16.00 deg   90.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      1       (Absorptive ground surface)
Receiver source distance   : 127.00 / 127.00 m
Receiver height            :  82.50 / 82.50  m
Topography                 :      2       (Flat/gentle slope; with barrier)
Barrier angle1             :  83.00 deg   Angle2 : 90.00 deg
Barrier height             :  90.00 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
```

```
Road data, segment # 2: KANATA AVE1 (day/night)
-----------------------------------------------
Car traffic volume  : 24288/2112  veh/TimePeriod  *
Medium truck volume :  1932/168   veh/TimePeriod  *
Heavy truck volume  :  1380/120   veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  30000
    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 # 2: KANATA AVE1 (day/night)
---------------------------------------------
Angle1   Angle2           : -90.00 deg   -19.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  88.00 / 88.00  m
Receiver height           :  82.50 / 82.50  m
Topography                :      3       (Elevated; no barrier)
Elevation                 :   7.00 m
Reference angle           :   0.00
```

```
Road data, segment # 3: KANATA AVE2 (day/night)
-----------------------------------------------
Car traffic volume  : 24288/2112  veh/TimePeriod  *
Medium truck volume :  1932/168   veh/TimePeriod  *
Heavy truck volume  :  1380/120   veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     4 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  30000
    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 # 3: KANATA AVE2 (day/night)
---------------------------------------------
Angle1   Angle2            : -19.00 deg   53.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      1       (Absorptive ground surface)
Receiver source distance   :  88.00 / 88.00  m
Receiver height            :  82.50 / 82.50  m
Topography                 :      2       (Flat/gentle slope; with barrier)
Barrier angle1             :   5.00 deg   Angle2 : 53.00 deg
Barrier height             :  90.00 m
Barrier receiver distance  :  45.00 / 45.00  m
Source elevation           :   0.00 m
Receiver elevation         :   0.00 m
Barrier elevation          :   0.00 m
Reference angle            :   0.00
```

```
Segment # 1: HWY 417 (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 !       82.50 !       78.67 !         78.67

ROAD (70.84 + 48.37 + 0.00) = 70.86 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
    16     83   0.00  84.41   0.00  -9.28  -4.29   0.00   0.00   0.00
70.84
--------------------------------------------------------------------------
--
    83     90   0.00  84.41   0.00  -9.28 -14.10   0.00   0.00 -12.66
48.37
--------------------------------------------------------------------------
--

Segment Leq : 70.86 dBA


Segment # 2: KANATA AVE1 (day)
------------------------------

Source height = 1.50 m

ROAD (0.00 + 59.77 + 0.00) = 59.77 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90    -19   0.00  71.49   0.00  -7.68  -4.04   0.00   0.00   0.00
59.77
--------------------------------------------------------------------------
--

Segment Leq : 59.77 dBA
```

```
Segment # 3: KANATA AVE2 (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 !       82.50 !       41.08 !        41.08

ROAD (55.68 + 38.69 + 0.00) = 55.77 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -19      5   0.00  72.12   0.00  -7.68  -8.75   0.00   0.00   0.00
55.68
--------------------------------------------------------------------------
--
     5     53   0.00  72.12   0.00  -7.68  -5.74   0.00   0.00 -20.00
38.69
--------------------------------------------------------------------------
--

Segment Leq : 55.77 dBA

Total Leq All Segments: 71.31 dBA
```

```
Segment # 1: HWY 417 (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 !        82.50 !        78.67 !         78.67

ROAD (63.24 + 40.78 + 0.00) = 63.27 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
----------------------------------------------------------------------------
--
    16     83   0.00  76.81   0.00  -9.28  -4.29   0.00   0.00   0.00
63.24
----------------------------------------------------------------------------
--
    83     90   0.00  76.81   0.00  -9.28 -14.10   0.00   0.00 -12.66
40.78
----------------------------------------------------------------------------
--

Segment Leq : 63.27 dBA


Segment # 2: KANATA AVE1 (night)
--------------------------------

Source height = 1.50 m

ROAD (0.00 + 52.17 + 0.00) = 52.17 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
----------------------------------------------------------------------------
--
   -90    -19   0.00  63.89   0.00  -7.68  -4.04   0.00   0.00   0.00
52.17
----------------------------------------------------------------------------
--

Segment Leq : 52.17 dBA
```

```
Segment # 3: KANATA AVE2 (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 !        82.50 !        41.08 !         41.08

ROAD (48.09 + 31.10 + 0.00) = 48.17 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -19      5   0.00  64.52   0.00  -7.68  -8.75   0.00   0.00   0.00
48.09
--------------------------------------------------------------------------
--
     5     53   0.00  64.52   0.00  -7.68  -5.74   0.00   0.00 -20.00
31.10
--------------------------------------------------------------------------
--

Segment Leq : 48.17 dBA

Total Leq All Segments: 63.72 dBA




TOTAL Leq FROM ALL SOURCES (DAY): 71.31
                         (NIGHT): 63.72
```

```
STAMSON 5.0        COMPREHENSIVE REPORT        Date: 14-10-2020 16:53:28
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r6.te                Time Period: Day/Night 16/8 hours
Description:


Road data, segment # 1: KANATA AVE1 (day/night)
-----------------------------------------------
Car traffic volume  : 24288/2112  veh/TimePeriod  *
Medium truck volume :  1932/168   veh/TimePeriod  *
Heavy truck volume  :  1380/120   veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  30000
    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: KANATA AVE1 (day/night)
---------------------------------------------
Angle1   Angle2           :  74.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  15.00 / 15.00  m
Receiver height           :  19.50 / 19.50  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Road data, segment # 2: KANATA AVE2 (day/night)
-----------------------------------------------
Car traffic volume  : 24288/2112  veh/TimePeriod  *
Medium truck volume :  1932/168   veh/TimePeriod  *
Heavy truck volume  :  1380/120   veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  30000
    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 # 2: KANATA AVE2 (day/night)
---------------------------------------------
Angle1   Angle2           :  -7.00 deg   39.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  39.00 / 39.00  m
Receiver height           :  19.50 / 19.50  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Road data, segment # 3: HWY 417 (day/night)
-------------------------------------------
Car traffic volume  : 118739/10325 veh/TimePeriod  *
Medium truck volume :  9445/821   veh/TimePeriod  *
Heavy truck volume  :  6747/587   veh/TimePeriod  *
Posted speed limit  :   100 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): 146664
    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 # 3: HWY 417 (day/night)
-----------------------------------------
Angle1   Angle2           :  71.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  : 199.00 / 199.00 m
Receiver height           :  19.50 / 19.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            :  71.00 deg   Angle2 : 90.00 deg
Barrier height            :  28.00 m
Barrier receiver distance :  70.00 / 70.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Segment # 1: KANATA AVE1 (day)
------------------------------

Source height = 1.50 m

ROAD (0.00 + 59.82 + 0.00) = 59.82 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
----------------------------------------------------------------------------
--
    74     90   0.12  71.49   0.00   0.00 -11.67   0.00   0.00   0.00
59.82
----------------------------------------------------------------------------
--

Segment Leq : 59.82 dBA


Segment # 2: KANATA AVE2 (day)
------------------------------

Source height = 1.50 m

ROAD (0.00 + 60.88 + 0.00) = 60.88 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
----------------------------------------------------------------------------
--
    -7     39   0.12  71.49   0.00  -4.65  -5.96   0.00   0.00   0.00
60.88
----------------------------------------------------------------------------
--

Segment Leq : 60.88 dBA
```

```
Segment # 3: HWY 417 (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 !       19.50 !       13.17 !        13.17

ROAD (0.00 + 51.71 + 0.00) = 51.71 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
    71     90   0.00  84.41   0.00 -11.23  -9.77   0.00   0.00 -11.71
51.71
--------------------------------------------------------------------------
--

Segment Leq : 51.71 dBA

Total Leq All Segments: 63.68 dBA


Segment # 1: KANATA AVE1 (night)
--------------------------------

Source height = 1.50 m

ROAD (0.00 + 52.22 + 0.00) = 52.22 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
    74     90   0.12  63.89   0.00   0.00 -11.67   0.00   0.00   0.00
52.22
--------------------------------------------------------------------------
--

Segment Leq : 52.22 dBA
```

```
Segment # 2: KANATA AVE2 (night)
--------------------------------

Source height = 1.50 m

ROAD (0.00 + 53.28 + 0.00) = 53.28 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
    -7     39   0.12  63.89   0.00  -4.65  -5.96   0.00   0.00   0.00
53.28
--------------------------------------------------------------------------
--

Segment Leq : 53.28 dBA


Segment # 3: HWY 417 (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 !       19.50 !       13.17 !        13.17

ROAD (0.00 + 44.11 + 0.00) = 44.11 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
    71     90   0.00  76.81   0.00 -11.23  -9.77   0.00   0.00 -11.71
44.11
--------------------------------------------------------------------------
--

Segment Leq : 44.11 dBA

Total Leq All Segments: 56.08 dBA



TOTAL Leq FROM ALL SOURCES (DAY): 63.68
                         (NIGHT): 56.08
```

```
STAMSON 5.0        COMPREHENSIVE REPORT        Date: 14-10-2020 16:53:14
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r7.te                Time Period: Day/Night 16/8 hours
Description:


Road data, segment # 1: KANATA AVE1 (day/night)
-----------------------------------------------
Car traffic volume  : 24288/2112  veh/TimePeriod  *
Medium truck volume :  1932/168   veh/TimePeriod  *
Heavy truck volume  :  1380/120   veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     4 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  30000
    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: KANATA AVE1 (day/night)
---------------------------------------------
Angle1   Angle2           :  -7.00 deg   60.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  42.00 / 42.00  m
Receiver height           :  88.50 / 88.50  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Road data, segment # 2: HWY 417 (day/night)
-------------------------------------------
Car traffic volume  : 118739/10325 veh/TimePeriod  *
Medium truck volume :  9445/821   veh/TimePeriod  *
Heavy truck volume  :  6747/587   veh/TimePeriod  *
Posted speed limit  :   100 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): 146664
    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 # 2: HWY 417 (day/night)
-----------------------------------------
Angle1   Angle2           :  71.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  : 159.00 / 159.00 m
Receiver height           :  88.50 / 88.50  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Segment # 1: KANATA AVE1 (day)
------------------------------

Source height = 1.50 m

ROAD (0.00 + 63.35 + 0.00) = 63.35 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
----------------------------------------------------------------------------
--
    -7     60   0.00  72.12   0.00  -4.47  -4.29   0.00   0.00   0.00
63.35
----------------------------------------------------------------------------
--

Segment Leq : 63.35 dBA


Segment # 2: HWY 417 (day)
--------------------------

Source height = 1.50 m

ROAD (0.00 + 64.39 + 0.00) = 64.39 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
----------------------------------------------------------------------------
--
    71     90   0.00  84.41   0.00 -10.25  -9.77   0.00   0.00   0.00
64.39
----------------------------------------------------------------------------
--

Segment Leq : 64.39 dBA

Total Leq All Segments: 66.91 dBA
```

```
Segment # 1: KANATA AVE1 (night)
--------------------------------

Source height = 1.50 m

ROAD (0.00 + 55.76 + 0.00) = 55.76 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -7     60   0.00  64.52   0.00  -4.47  -4.29   0.00   0.00   0.00
55.76
--------------------------------------------------------------------------
--

Segment Leq : 55.76 dBA


Segment # 2: HWY 417 (night)
----------------------------

Source height = 1.50 m

ROAD (0.00 + 56.79 + 0.00) = 56.79 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   71     90   0.00  76.81   0.00 -10.25  -9.77   0.00   0.00   0.00
56.79
--------------------------------------------------------------------------
--

Segment Leq : 56.79 dBA

Total Leq All Segments: 59.32 dBA



TOTAL Leq FROM ALL SOURCES (DAY): 66.91
                         (NIGHT): 59.32
```

```
STAMSON 5.0        NORMAL REPORT        Date: 14-10-2020 16:52:56
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r8.te                 Time Period: Day/Night 16/8 hours
Description:


Road data, segment # 1: HWY 417 (day/night)
-------------------------------------------
Car traffic volume  : 118739/10325 veh/TimePeriod  *
Medium truck volume :  9445/821   veh/TimePeriod  *
Heavy truck volume  :  6747/587   veh/TimePeriod  *
Posted speed limit  :   100 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): 146664
    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: HWY 417 (day/night)
-----------------------------------------
Angle1   Angle2           : -90.00 deg   -19.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  : 133.00 / 133.00 m
Receiver height           :  88.50 / 88.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : -67.00 deg
Barrier height            :  84.00 m
Barrier receiver distance :   9.00 / 9.00   m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Results segment # 1: HWY 417 (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 !       88.50 !       82.61 !        82.61

ROAD (0.00 + 60.31 + 69.19) = 69.72 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90    -67   0.00  84.41   0.00  -9.48  -8.94   0.00   0.00  -5.68
60.31
--------------------------------------------------------------------------
--
   -67    -19   0.00  84.41   0.00  -9.48  -5.74   0.00   0.00   0.00
69.19
--------------------------------------------------------------------------
--

Segment Leq : 69.72 dBA

Total Leq All Segments: 69.72 dBA
```

```
Results segment # 1: HWY 417 (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 !        88.50 !        82.61 !         82.61

ROAD (0.00 + 52.72 + 61.59) = 62.12 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
---------------------------------------------------------------------------
--
   -90    -67   0.00  76.81   0.00  -9.48  -8.94   0.00   0.00  -5.68
52.72
---------------------------------------------------------------------------
--
   -67    -19   0.00  76.81   0.00  -9.48  -5.74   0.00   0.00   0.00
61.59
---------------------------------------------------------------------------
--

Segment Leq : 62.12 dBA

Total Leq All Segments: 62.12 dBA



TOTAL Leq FROM ALL SOURCES (DAY): 69.72
                          (NIGHT): 62.12
```

```
STAMSON 5.0        NORMAL REPORT        Date: 14-10-2020 16:52:33
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r9.te                Time Period: Day/Night 16/8 hours
Description:


Road data, segment # 1: HWY 417 (day/night)
-------------------------------------------
Car traffic volume  : 118739/10325 veh/TimePeriod  *
Medium truck volume :  9445/821   veh/TimePeriod  *
Heavy truck volume  :  6747/587   veh/TimePeriod  *
Posted speed limit  :   100 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): 146664
    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: HWY 417 (day/night)
-----------------------------------------
Angle1   Angle2           : -90.00 deg   71.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  : 123.00 / 123.00 m
Receiver height           :  88.50 / 88.50  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Road data, segment # 2: KANATA AVE (day/night)
----------------------------------------------
Car traffic volume  : 24288/2112  veh/TimePeriod  *
Medium truck volume :  1932/168   veh/TimePeriod  *
Heavy truck volume  :  1380/120   veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  30000
    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 # 2: KANATA AVE (day/night)
--------------------------------------------
Angle1   Angle2           : -90.00 deg   -7.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  47.00 / 47.00  m
Receiver height           :  88.50 / 88.50  m
Topography                :      3       (Elevated; no barrier)
Elevation                 :   7.00 m
Reference angle           :   0.00
```

```
Results segment # 1: HWY 417 (day)
----------------------------------

Source height = 1.50 m

ROAD (0.00 + 74.78 + 0.00) = 74.78 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     71   0.00  84.41   0.00  -9.14  -0.48   0.00   0.00   0.00
74.78
--------------------------------------------------------------------------
--

Segment Leq : 74.78 dBA


Results segment # 2: KANATA AVE (day)
-------------------------------------

Source height = 1.50 m

ROAD (0.00 + 63.17 + 0.00) = 63.17 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     -7   0.00  71.49   0.00  -4.96  -3.36   0.00   0.00   0.00
63.17
--------------------------------------------------------------------------
--

Segment Leq : 63.17 dBA

Total Leq All Segments: 75.07 dBA
```

```
Results segment # 1: HWY 417 (night)
------------------------------------

Source height = 1.50 m

ROAD (0.00 + 67.19 + 0.00) = 67.19 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     71   0.00  76.81   0.00  -9.14  -0.48   0.00   0.00   0.00
67.19
--------------------------------------------------------------------------
--

Segment Leq : 67.19 dBA


Results segment # 2: KANATA AVE (night)
---------------------------------------

Source height = 1.50 m

ROAD (0.00 + 55.57 + 0.00) = 55.57 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     -7   0.00  63.89   0.00  -4.96  -3.36   0.00   0.00   0.00
55.57
--------------------------------------------------------------------------
--

Segment Leq : 55.57 dBA

Total Leq All Segments: 67.48 dBA




TOTAL Leq FROM ALL SOURCES (DAY): 75.07
                         (NIGHT): 67.48
```

```
STAMSON 5.0        NORMAL REPORT        Date: 14-10-2020 16:52:13
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r10.te                Time Period: Day/Night 16/8 hours
Description:


Road data, segment # 1: HWY 417 (day/night)
-------------------------------------------
Car traffic volume  : 118739/10325 veh/TimePeriod  *
Medium truck volume :  9445/821   veh/TimePeriod  *
Heavy truck volume  :  6747/587   veh/TimePeriod  *
Posted speed limit  :   100 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): 146664
    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: HWY 417 (day/night)
-----------------------------------------
Angle1   Angle2           : -19.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  : 127.00 / 127.00 m
Receiver height           :  88.50 / 88.50  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Road data, segment # 2: KANATA AVE1 (day/night)
-----------------------------------------------
Car traffic volume  : 24288/2112  veh/TimePeriod  *
Medium truck volume :  1932/168   veh/TimePeriod  *
Heavy truck volume  :  1380/120   veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  30000
    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 # 2: KANATA AVE1 (day/night)
---------------------------------------------
Angle1   Angle2           : -90.00 deg   -43.00 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           :  88.50 / 88.50  m
Topography                :      3       (Elevated; no barrier)
Elevation                 :   7.00 m
Reference angle           :   0.00
```

```
Road data, segment # 3: KANATA AVE2 (day/night)
-----------------------------------------------
Car traffic volume  : 24288/2112  veh/TimePeriod  *
Medium truck volume :  1932/168   veh/TimePeriod  *
Heavy truck volume  :  1380/120   veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     4 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  30000
    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 # 3: KANATA AVE2 (day/night)
---------------------------------------------
Angle1   Angle2            : -43.00 deg   68.00 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            :  88.50 / 88.50  m
Topography                 :      1       (Flat/gentle slope; no barrier)
Reference angle            :   0.00
```

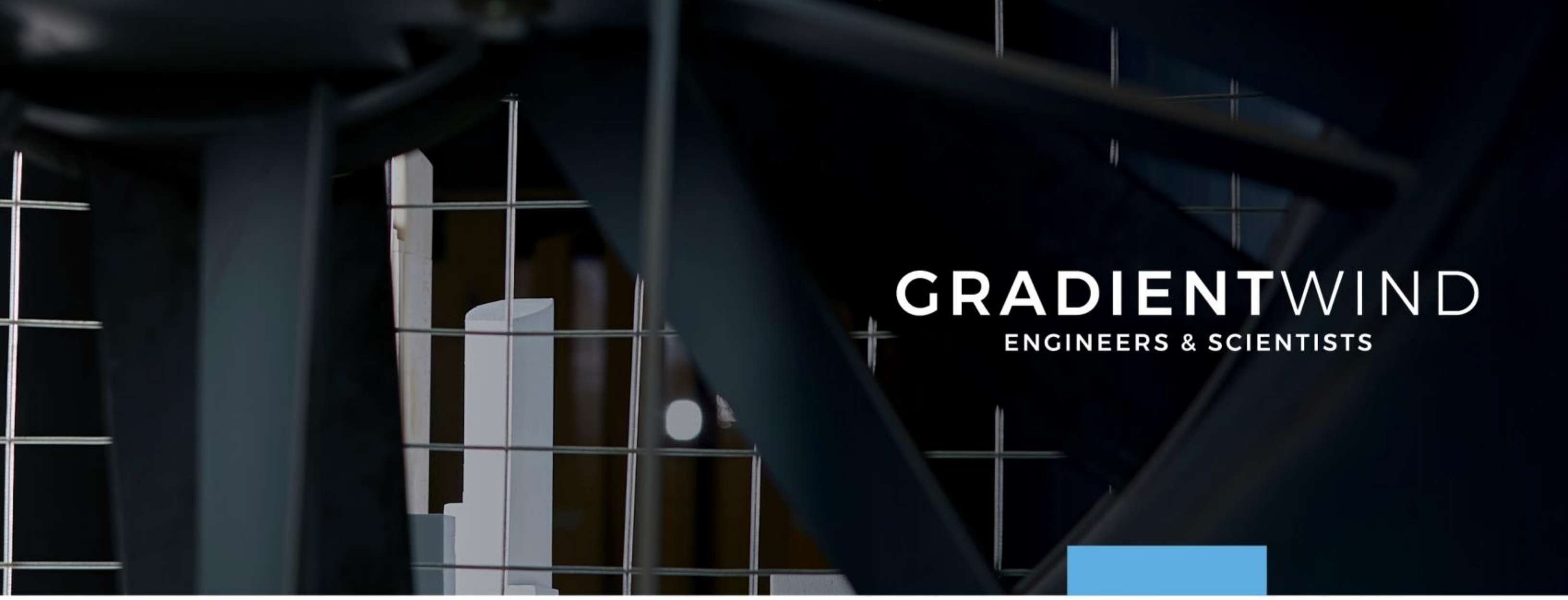
```
Road data, segment # 4: KANATA AVE3 (day/night)
-----------------------------------------------
Car traffic volume  : 24288/2112  veh/TimePeriod  *
Medium truck volume :  1932/168   veh/TimePeriod  *
Heavy truck volume  :  1380/120   veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  30000
    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 # 4: KANATA AVE3 (day/night)
---------------------------------------------
Angle1   Angle2            : -90.00 deg   -77.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      1       (Absorptive ground surface)
Receiver source distance   :  25.00 / 25.00  m
Receiver height            :  88.50 / 88.50  m
Topography                 :      1       (Flat/gentle slope; no barrier)
Reference angle            :   0.00
```

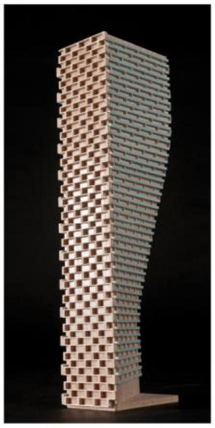
```
Results segment # 1: HWY 417 (day)
----------------------------------

Source height = 1.50 m

ROAD (0.00 + 72.95 + 0.00) = 72.95 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -19     90   0.00  84.41   0.00  -9.28  -2.18   0.00   0.00   0.00
72.95
--------------------------------------------------------------------------
--

Segment Leq : 72.95 dBA


Results segment # 2: KANATA AVE1 (day)
--------------------------------------

Source height = 1.50 m

ROAD (0.00 + 61.08 + 0.00) = 61.08 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90    -43   0.00  71.49   0.00  -4.57  -5.83   0.00   0.00   0.00
61.08
--------------------------------------------------------------------------
--

Segment Leq : 61.08 dBA
```

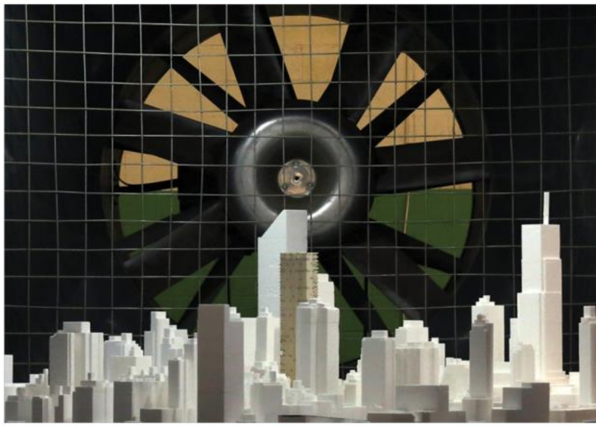
```
Results segment # 3: KANATA AVE2 (day)
--------------------------------------

Source height = 1.50 m

ROAD (0.00 + 65.44 + 0.00) = 65.44 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -43     68   0.00  72.12   0.00  -4.57  -2.10   0.00   0.00   0.00
65.44
--------------------------------------------------------------------------
--

Segment Leq : 65.44 dBA


Results segment # 4: KANATA AVE3 (day)
--------------------------------------

Source height = 1.50 m

ROAD (0.00 + 57.86 + 0.00) = 57.86 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90    -77   0.00  71.49   0.00  -2.22 -11.41   0.00   0.00   0.00
57.86
--------------------------------------------------------------------------
--

Segment Leq : 57.86 dBA

Total Leq All Segments: 74.00 dBA
```

```
Results segment # 1: HWY 417 (night)
------------------------------------

Source height = 1.50 m

ROAD (0.00 + 65.36 + 0.00) = 65.36 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -19     90   0.00  76.81   0.00  -9.28  -2.18   0.00   0.00   0.00
65.36
--------------------------------------------------------------------------
--

Segment Leq : 65.36 dBA

Results segment # 2: KANATA AVE1 (night)
----------------------------------------

Source height = 1.50 m

ROAD (0.00 + 53.49 + 0.00) = 53.49 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90    -43   0.00  63.89   0.00  -4.57  -5.83   0.00   0.00   0.00
53.49
--------------------------------------------------------------------------
--

Segment Leq : 53.49 dBA
```

```
Results segment # 3: KANATA AVE2 (night)
----------------------------------------

Source height = 1.50 m

ROAD (0.00 + 57.85 + 0.00) = 57.85 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
---------------------------------------------------------------------------
--
   -43     68   0.00  64.52   0.00  -4.57  -2.10   0.00   0.00   0.00
57.85
---------------------------------------------------------------------------
--

Segment Leq : 57.85 dBA


Results segment # 4: KANATA AVE3 (night)
----------------------------------------

Source height = 1.50 m

ROAD (0.00 + 50.26 + 0.00) = 50.26 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
---------------------------------------------------------------------------
--
   -90    -77   0.00  63.89   0.00  -2.22 -11.41   0.00   0.00   0.00
50.26
---------------------------------------------------------------------------
--

Segment Leq : 50.26 dBA

Total Leq All Segments: 66.41 dBA



TOTAL Leq FROM ALL SOURCES (DAY): 74.00
                         (NIGHT): 66.41
```







APPENDIX B

FTA VIBRATION CALCULATIONS

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

GW20-207 14-Oct-20

Possible Vibration Impacts
Predicted using FTA General Assesment

Train Speed 80 km/h 49.7 mph

	Distance from C/L	
	(m)	(ft)
LRT	28.0	91.9

Vibration

From FTA Manual Fig 10-1		
Vibration Levels at distance from track	68	dBV re 1 micro in/sec
Adjustment Factors FTA Table 10-1		
Speed reference 50 mph	0	Speed Limit of 80 km/h (49.7 mph)
Vehicle Parameters	0	Assume Soft primary suspension, Weels run true
Track Condition	0	Track not worn or corrugated
Track Treatments	0	None
Type of Transit Structure	0	N/A
Efficient vibration Propagation	0	Propagation through rock
Vibration Levels at Fdn	68	
Coupling to Building Foundation	-10	Large masonry on piles
Floor to Floor Attenuation	0.0	Ground Floor Occupied
Amplification of Floor and Walls	6	
Total Vibration Level	64	dBV or 0.040 mm/s
Noise Level in dBA	29	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	Vehicle Speed	Reference Speed 50 mph	Reference Speed 30 mph	Vibration level is approximately proportional to 20*log(speed/speed$_{ref}$). Sometimes the variation with speed has been observed to be as low as 10 to 15 log(speed/speed$_{ref}$).
	60 mph	+1.6 dB	+6.0 dB	
	50 mph	0.0 dB	+4.4 dB	
	40 mph	-1.9 dB	+2.5 dB	
	30 mph	-4.4 dB	0.0 dB	
	20 mph	-8.0 dB	-3.5 dB	
Vehicle Parameters (not additive, apply greatest value only)				
Vehicle with stiff primary suspension	+8 dB			Transit vehicles with stiff primary suspensions have been shown to create high vibration levels. Include this adjustment when the primary suspension has a vertical resonance frequency greater than 15 Hz.
Resilient Wheels	0 dB			Resilient wheels do not generally affect ground-borne vibration except at frequencies greater than about 80 Hz.
Worn Wheels or Wheels with Flats	+10 dB			Wheel flats or wheels that are unevenly worn can cause high vibration levels. This can be prevented with wheel truing and slip-slide detectors to prevent the wheels from sliding on the track.
Track Conditions (not additive, apply greatest value only)				
Worn or Corrugated Track	+10 dB			If both the wheels and the track are worn, only one adjustment should be used. Corrugated track is a common problem. Mill scale on new rail can cause higher vibration levels until the rail has been in use for some time.
Special Trackwork	+10 dB			Wheel impacts at special trackwork will significantly increase vibration levels. The increase will be less at greater distances from the track.
Jointed Track or Uneven Road Surfaces	+5 dB			Jointed track can cause higher vibration levels than welded track. Rough roads or expansion joints are sources of increased vibration for rubber-tire transit.
Track Treatments (not additive, apply greatest value only)				
Floating Slab Trackbed	-15 dB			The reduction achieved with a floating slab trackbed is strongly dependent on the frequency characteristics of the vibration.
Ballast Mats	-10 dB			Actual reduction is strongly dependent on frequency of vibration.
High-Resilience Fasteners	-5 dB			Slab track with track fasteners that are very compliant in the vertical direction can reduce vibration at frequencies greater than 40 Hz.

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