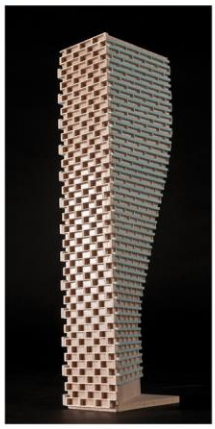
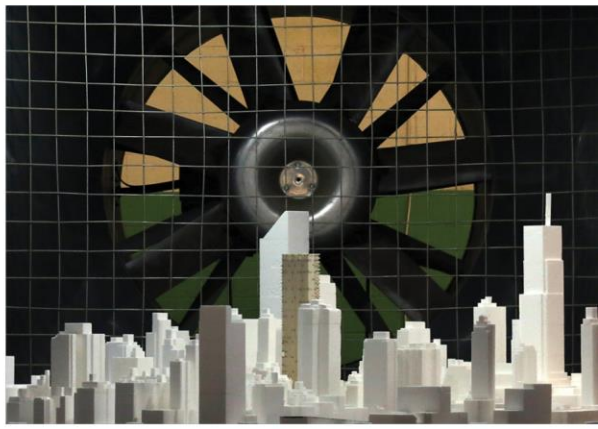
GRADIENTWIND
ENGINEERS & SCIENTISTS

ROADWAY TRAFFIC NOISE ASSESSMENT

3713 Borrisokane Road (Drummond Subdivision)
Ottawa, Ontario

Report: 19-236 – Roadway Traffic Noise





January 24, 2022

PREPARED FOR

Caivan Communities
2934 Baseline Road, Suite 302
Ottawa, Ontario
K2H 1B2

PREPARED BY

Giuseppe Garro, MASc., Junior Environmental Scientist
Joshua Foster, P.Eng., Lead Engineer

EXECUTIVE SUMMARY

This report describes a traffic noise assessment undertaken in support of a registration of subdivision application for a proposed subdivision development, referred to as Drummond Subdivision, located at 3713 Borrisokane Road in Ottawa, Ontario. Buildings within the development include a mixture of single dwellings, townhouse buildings, back-to-back townhouse blocks, as well as rear yards for most for the proposed buildings, and two communal parks. The major sources of roadway traffic noise include the realigned Greenbank Road, proposed minor collectors referred to as Elevation Road and Dundonald Drive, Highway 416, and the Bus Rapid Transit (BRT) lane in the center of the realigned Greenbank Road. Figure 1 illustrates the site location 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), Ministry of Transportation of Ontario (MTO), 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; and (iv) subdivision plan drawings provided by Caivan Communities in January 2022.

The results of the current analysis indicated that noise levels at Plane of Window (POW) receptors will range between 42 and 70 dBA during the daytime period (07:00-23:00) and between 42 and 63 dBA during the nighttime period (23:00-07:00). The highest noise level (70 dBA) occurs at the east façades of Blocks 163, 174, 185, and 186, which are nearest and most exposed to the realigned Greenbank Road.

Building components with a higher Sound Transmission Class (STC) rating will be required where exterior noise levels exceed 65 dBA as illustrated in Figure 3. The results of the analysis also indicate some dwellings will require central air conditioning, which will allow occupants to keep windows closed and maintain a comfortable living environment, and some dwellings will require forced air heating with provisions for central air conditioning, as summarized in Table 5 and outlined in Figure 4. Warning Clauses will also be required on all Lease, Purchase and Sale Agreements, as summarized in Section 6.

Noise levels at backyards for properties adjacent or exposed to the roadway sources are expected to exceed 55 dBA during the daytime period. According to the ENCG, if these areas are to be used as Outdoor Living Areas (OLA), noise mitigation should be provided to reduce noise levels at or below 55 dBA if it is technically and administratively feasible. In all cases, noise levels should not exceed 60 dBA.

Investigation into the application of 2.2-metre-high and 2.5-metre-high (above local grade) noise barriers at select properties proved that noise levels can be reduced at or below 60 dBA. Therefore, dwellings that require either a 2.2-metre-high or 2.5-metre-high noise barrier are summarized in Table 7. Furthermore, a Type A or Type B Warning Clause will be required on all Lease, Purchase and Sale Agreements for Blocks 163 (Unit 4,5), 174 (Unit 1), 185 (Unit 5), and 186-189, where noise levels fall between 55 dBA and 60 dBA, as summarized in Section 6.

It should be noted that additional residential developments are currently proposed to the immediate north and south of the subject site which will provide additional blockage from roadway traffic noise once construction begins, further reducing noise levels at the rear yards. Mitigation impacts from the north residential development was considered in the modelling as it is set to be completed prior to the subject site.

The noise barrier should be built with solid elements having a minimum surface density of 20 kg/m² and contain no gaps. The following information will be required by the City for review prior to installation of the barrier:

1. Shop drawings, signed and sealed by a qualified Professional Engineer licenced by the Professional Engineers of Ontario, showing the details of the acoustic barrier systems components, including material specifications.
2. Structural drawing(s), signed by a qualified Professional Engineer licenced by the Professional Engineers of Ontario, showing foundation details and specifying design criteria, climatic design loads, as well as applicable geotechnical data used in the design.
3. Layout plan, and wall elevations, showing proposed colours and patterns.

Regarding stationary noise impacts, Gradient Wind has prepared a stationary noise assessment and memoranda for the proposed industrial development located at 3713 Borrisokane Road in Ottawa, Ontario (*ref. Gradient Wind report #19-228 – Stationary Noise R1, dated December 16, 2019 and Gradient Wind memoranda #19-228 – Addendum Letter R1, dated May 14, 2020*). The industrial site is located immediately west of Drummond Subdivision. The results of the study indicate that noise levels at Drummond Subdivision due to the industrial facility are expected to fall below the ENCG and NPC-300 noise criteria.

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1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Caivan Communities to undertake a roadway traffic noise assessment for a proposed subdivision development, referred to as Drummond Subdivision, located at 3713 Borrisokane Road in Ottawa, Ontario. This report summarizes the methodology, results, and recommendations related to the assessment of exterior and interior noise levels generated by local roadway traffic.

Our work is based on theoretical noise calculation methods conforming to the City of Ottawa[1], Ministry of the Environment, Conservation and Parks (MECP)[2], and Ministry of Transportation of Ontario (MTO)[3] guidelines. Noise calculations were based on subdivision plan drawings provided by Caivan Communities in January 2022, with future traffic volumes corresponding to the City of Ottawa's Official Plan (OP) roadway classifications.

2. TERMS OF REFERENCE

The focus of this roadway traffic noise assessment is a proposed residential subdivision development located at 3713 Borrisokane Road in Ottawa, Ontario. The proposed subdivision, referred to as Drummond Subdivision, is on a nearly rectangular lot and comprises a mixture of detached homes, standard townhomes, and back-to-back townhomes. Two communal park areas are proposed for the site; one situated to the northwest and the other the east. The development will include creation of new walkways and residential streets feeding into the subdivision from the realigned Greenbank Road. The development site is bound by future residential developments to the north and south, a commercial facility and storm water management pond to the west, and realigned Greenbank Road to the east. The future residential development to the north is set to be completed prior to the subject site. The study site is located east of the urban boundary line which travels north and south, signifying urban development west of the boundary is restricted.

[1] City of Ottawa Environmental Noise Control Guidelines, January 2016
[2] Ontario Ministry of the Environment, Conservation and Parks – Environmental Noise Guidelines, Publication NPC-300, Queens Printer for Ontario, Toronto, 2013
[3] Ministry of Transportation, Environmental Guide for Noise, 2021

The major sources of roadway traffic noise include the realigned Greenbank Road, proposed minor collectors referred to as Elevation Road and Dundonald Drive, Highway 416, and the Bus Rapid Transit (BRT) lane in the center of the realigned Greenbank Road. Figure 1 illustrates the site location 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 traffic, and (ii) ensure that interior and exterior noise levels do not exceed the allowable limits specified by the City of Ottawa's Environmental Noise Control Guidelines as outlined in Section 4.2 of this report.

4. METHODOLOGY

4.1 Background

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

4.2 Roadway Traffic Noise

4.2.1 Criteria for Roadway Traffic Noise

For surface roadway 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, the L_{eq} is commonly calculated on the basis of a 16-hour (L_{eq16}) daytime (07:00-23:00) / 8-hour (L_{eq8}) nighttime (23:00-07:00) split to assess its impact on residential buildings. The City of Ottawa's

Environmental Noise Control Guidelines (ENCG) specifies that the recommended indoor noise limit range (that is relevant to this study) is 45 and 40 dBA for living rooms and sleeping quarters respectively for roadway as listed in Table 1.

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

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[5]. A closed window due to a ventilation requirement will bring noise levels down to achieve an acceptable indoor environment[6]. Therefore, where noise levels exceed 55 dBA daytime and 50 dBA nighttime, the ventilation for the building should consider the need for having windows and doors closed, which triggers the need for forced air heating with provision for central air conditioning. Where noise levels exceed 65 dBA daytime and 60 dBA nighttime, air conditioning will be required and building components will require higher levels of sound attenuation[7].

The sound level criterion for outdoor living areas (OLA) is 55 dBA, which applies during the daytime (07:00 to 23:00). When noise levels exceed 55 dBA, mitigation should be provided to reduce noise levels where

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

technically and administratively feasible to acceptable levels at or below the criterion. Furthermore, noise levels at the OLA must not exceed 60 dBA if mitigation can be technically and administratively achieved.

4.2.2 Theoretical Roadway Noise Predictions

The impact of transportation noise sources on the development was determined by computer modelling. Transportation noise source modelling is based on the software program *Predictor-Lima* which utilizes the United States Federal Highway Administration's Traffic Noise Model (TNM) to represent the roadway line sources. The TNM model is also being accepted in the updated Environmental Guide for Noise of Ontario, 2021 by the Ministry of Transportation (MTO)[8]. This computer program can represent three-dimensional surfaces and first reflections of sound waves over a suitable spectrum for human hearing. A set of comparative calculations were performed in the current Ontario traffic noise prediction model STAMSON for comparisons to Predictor simulation results. The STAMSON model is, however, older and requires each receptor to be calculated separately. STAMSON also does not accurately account for building reflections and multiple screening elements, and curved road geometry. A total of thirty-one (31) receptor locations were identified around the site, as illustrated in Figures 2A and 2B.

Roadway noise calculations were performed by treating each road segment as separate line sources of noise, and by using existing and proposed building locations as noise barriers. In addition to the traffic volumes summarized in Table 2, theoretical noise predictions were based on the following parameters:

- Truck traffic on all roadways was taken to comprise 5% heavy trucks and 7% medium trucks, as per ENCG requirements for noise level predictions.
- The day/night split for all roads was taken to be 92% / 8%, respectively.
- The ground surface was modelled as absorptive where grass and foliage (soft ground) are present, and as reflective where pavement and concrete (hard ground) are present.
- Topography was assumed to be a flat/gentle slope surrounding the study site.
- Roadways exceeding a distance of 500 m from a discrete receptor were omitted.

[8] Ministry of Transportation, Environmental Guide for Noise, 2021. Retrieved from https://prod-environmental-registry.s3.amazonaws.com/2021-08/Environmental%20Guide%20for%20Noise%20 2021%20%28Aug%202021%29.pdf

- Nineteen (19) receptor locations were chosen at the façades of the dwellings as Plane of Window (POW) receptors heights of 4.5 metres above grade.
- Twelve (12) receptor locations were chosen as OLA receptors at 1.5 metres above grade.
- Five (5) POW receptors were calculated in STAMSON in order to display the correlation between the Predictor and STAMSON calculation results.
- Detached and standard townhouse buildings were modelled with height of 9 m above local grade. Similarly, back-to-back townhouse buildings were modelled with a height of 12 m above local grade.
- The site elevation was based on a grading plan provided by Caivan Communities in December 2021.
- The future residential development to the north is set to be completed prior to the subject site. Block 41 (associated with the north development) is expected to include a 2.5m noise barrier along the east property line to mitigate noise generated from the realigned Greenbank Road (see Figure 2B).

4.2.3 Roadway Traffic Volumes

The ENCG dictates that noise calculations should consider future sound levels based on a roadway's classification at the mature state of development. Therefore, traffic volumes are based on the roadway classifications outlined in the City of Ottawa's Official Plan (OP) and Transportation Master Plan[9] which provide additional details on future roadway expansions. Average Annual Daily Traffic (AADT) volumes are then based on data in Table B1 of the ENCG for each roadway classification. Table 2 summarizes the AADT values used for each roadway included in this assessment.

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

TABLE 2: ROADWAY TRAFFIC DATA

Segment	Roadway Traffic Data	Speed Limit (km/h)	Traffic Volumes	Assumed Volumes
Greenbank Road (Realigned)	4-Lane Urban Arterial Divided (4-UAD)	70	**35,000**	-
Veterans Memorial Highway (Highway 416)	4 Lane Freeway	100	**18,333/Lane**	-
Bus Rapid Transit	BRT	80	-	***191/67**
Elevation Road, Dundonald Drive	2-Lane Urban Collector Undivided (2-UCU)	40	**8,000**	-

*Daytime and nighttime volumes based on correspondence with the City of Ottawa

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 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 are achieved. The calculation procedure[10] considers:

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

Based on published research[11], exterior walls possess specific sound attenuation characteristics that are used as a basis for calculating the required STC ratings of windows in the same partition. Due to the limited information available at the time of the study, detailed floor layouts 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).

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

5. RESULTS

5.1 Roadway Traffic Noise Levels

The results of the roadway traffic noise calculations are summarized in Table 3 below.

TABLE 3: EXTERIOR NOISE LEVELS DUE TO ROADWAY TRAFFIC

Receptor ID	Receptor Location	Receptor Height (m)	PREDICTOR-LIMA Noise Level (dBA)	
			Day	Night
R1	POW - Block 69 - Unit 2 - West Facade	4.5	56	49
R2	POW - Block 74 - Unit 1 - West Facade	4.5	57	49
R3	POW - Block 76 - Unit 2 - West Facade	4.5	56	48
R4	POW - Block 118 - Unit 3 - South Facade	4.5	62	54
R5	POW - Block 171 - Unit 8 - East Facade	4.5	68	60
R6	POW - Block 185 - Unit 5 - East Facade	4.5	70	63
R7	POW - Block 76 - Unit 1 - South Facade	4.5	56	48
R8	POW - Block 62 - Unit 1 - North Facade	4.5	59	51
R9	POW - Block 62 - Unit 4 - North Facade	4.5	52	45
R10	POW - Lot 61 - East Facade	4.5	62	54
R11	POW - Block 97 - Unit 5 - South Facade	4.5	52	45
R12	POW - Block 97 - Unit 1 - East Facade	4.5	62	54
R13	POW - Block 120 - Unit 1 - East Facade	4.5	50	43
R14	POW - Block 142 - Unit 1 - South Facade	4.5	61	54
R15	POW - Block 184 - Unit 3 - South Facade	4.5	63	55
R16	POW - Block 183 - Unit 1 - South Facade	4.5	63	55
R17	POW - Block 163 - Unit 5 - North Facade	4.5	68	60
R18	POW - Block 162 - Unit 5 - North Facade	4.5	55	48

TABLE 3 CONT.: EXTERIOR NOISE LEVELS DUE TO ROADWAY TRAFFIC

Receptor ID	Receptor Location	Receptor Height (m)	PREDICTOR-LIMA Noise Level (dBA)	
			Day	Night
R19	POW - Block 161 - Unit 4 - North Facade	4.5	50	42
R20	OLA - Block 69 - Unit 2 – Rear Yard	1.5	55	N/A*
R21	OLA - Block 74 - Unit 1 – Rear Yard	1.5	42	N/A*
R22	OLA - Block 76 - Unit 2 – Rear Yard	1.5	55	N/A*
R23	OLA - Block 81 - Unit 5 – Rear Yard	1.5	60	N/A*
R24	OLA - Block 96 - Unit 1 – Rear Yard	1.5	61	N/A*
R25	OLA - Block 62 - Unit 1 – Rear Yard	1.5	58	N/A*
R26	OLA - Block 119 - Unit 1 – Rear Yard	1.5	60	N/A*
R27	OLA - Block 186 - Unit 1 – Rear Yard	1.5	69	N/A*
R28	OLA - Block 186 - Unit 3 – Rear Yard	1.5	64	N/A*
R29	OLA - Block 185 - Unit 5 – Rear Yard	1.5	69	N/A*
R30	OLA - Block 163 - Unit 5 – Rear Yard	1.5	69	N/A*
R31	OLA - Block 162 - Unit 5 – Rear Yard	1.5	54	N/A*

*Nighttime noise levels are not considered for OLAs, as per ENCG

The results of the current analysis indicated that noise levels at Plane of Window (POW) receptors will range between 42 and 70 dBA during the daytime period (07:00-23:00) and between 42 and 63 dBA during the nighttime period (23:00-07:00). The highest noise level (70 dBA) occurs at the east façades of Blocks 163, 174, 185, and 186, which are nearest and most exposed to the realigned Greenbank Road. Figures 5 and 6 illustrate daytime and nighttime noise contours throughout the site at a height of 1.5 m above grade.

Table 4 shows a comparison in results between Predictor-Lima and STAMSON. Noise levels calculated in STAMSON were found to have a good correlation with Predictor-Lima and variability between the two programs was within an acceptable level of ±0-3 dBA. Sample calculations are presented Appendix A. Upgraded building components will be required for the dwellings where noise levels exceed 65 dBA at the

Plane of Window (POW), as per ENCG criteria. Building components compliant with the Ontario Building Code (OBC 2020) will be sufficient for all other dwellings. Mitigation will be required where noise levels exceed 55 dBA at Outdoor Living Areas (OLA). A noise barrier investigation was conducted using Predictor-Lima (see Section 5.3).

TABLE 4: RESULTS OF STAMSON/PREDICTOR-LIMA CORRELATION

Receptor ID	Receptor Location	Receptor Height (m)	STAMSON 5.04 Noise Level (dBA)		PREDICTOR-LIMA Noise Level (dBA)	
			Day	Night	Day	Night
R1	POW - Block 69 - Unit 2 - West Facade	4.5	57	50	56	49
R3	POW - Block 76 - Unit 2 - West Facade	4.5	57	49	56	48
R4	POW - Block 118 - Unit 3 - South Facade	4.5	64	56	62	54
R5	POW - Block 171 - Unit 8 - East Facade	4.5	71	63	68	60
R6	POW - Block 185 - Unit 5 - East Facade	4.5	73	66	70	63

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 and walls have been estimated based on the overall noise reduction required for each intended use of space (STC = Outdoor Noise Level – Targeted Indoor Noise Levels). The STC requirements for the windows are summarized below for various units within the development (see Figure 3):

- **Bedroom Windows**

(i) Bedroom windows facing north, east, and south on Blocks 163, 174, 185, and 186 will require a minimum STC of 33.

(ii) Bedroom windows facing east on Blocks 169-173 will require a minimum STC of 33.

(iii) Bedroom windows facing north on Block 169 will require a minimum STC of 33.

(iv) Bedroom windows facing south on Block 173 will require a minimum STC of 33.

(v) All other bedroom windows are to satisfy Ontario Building Code (OBC 2020) requirements

- **Living Room Windows**

(i) Living room windows facing north, east, and south on 163, 174, 185, and 186 will require a minimum STC of 28.

(ii) Living room windows facing east on Blocks 169-173 will require a minimum STC of 28.

(iii) Living room windows facing north on Block 169 will require a minimum STC of 28.

(iv) Living room windows facing south on Block 173 will require a minimum STC of 28.

(v) All other living room windows are to satisfy Ontario Building Code (OBC 2020) requirements

- **Exterior Walls**

(i) Exterior wall components on the north, east, and south façades of Blocks 163, 169-174, 185, and 186 will require a minimum STC of 35, which will be achieved with standard 152 mm x 38 mm wood stud construction or an acoustical equivalent according to NRC test data[12]

Exterior wall components on these façades are recommended to have a minimum STC of 35, which is achievable with standard wood frame exterior wall construction. A review of window supplier literature indicates that the specified STC ratings can be achieved by a variety of window systems that have a combination of glass thickness and inter-pane spacing. 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 some dwellings will require central air conditioning, which will allow occupants to keep windows closed and maintain a comfortable living environment, and some dwellings will require forced air heating with provisions for central air conditioning as a minimum requirement (see Figure 4). In addition to ventilation requirements, Warning Clauses will also be required in all Lease, Purchase and Sale Agreements, as summarized in Table 5 below. The wording for Warning Clauses is presented in Section 6.

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

TABLE 5: WARNING CLAUSE REQUIREMENTS

Warning Clause	Applicable Blocks/Dwellings
Type C	Block 62 (Unit 1-3), 69-76, 81, 82, 96 (Unit 1-3), 97 (Unit 1-3, 6-8), 108, 109 (Unit 1-3, 6-8), 114-119, 132 (Unit 1-3), 142-144, 153, 154, 162, 164 (Unit 1, 2), 168 (Unit 1), 169 (Unit 2-4), 170 (Unit 1-4), 171 (Unit 1-4), 172 (Unit 1-5), 173 (Unit 1-4), 175, 180-184, 187-197; Lots 1-3, 60, and 61
Type D	Blocks 163, 169 (Units 1, 5-8), 170 (Units 5-8), 171 (Units 5-8), 172 (Units 6-10), 173 (Units 5-10), 174, 185, and 186

5.3 Noise Barrier Calculation

Noise levels at backyards for properties adjacent or exposed to the roadway sources are expected to exceed 55 dBA during the daytime period. According to the ENCG, if these areas are to be used as Outdoor Living Areas (OLA), noise mitigation should be provided to reduce noise levels at or below 55 dBA if it is technically and administratively feasible. In all cases, noise levels should not exceed 60 dBA.

Investigation into the application of 2.2-metre-high and 2.5-metre-high (above local grade) noise barriers for Receptors 23-30 proved that noise levels can be reduced at or below 60 dBA, as summarized in Table 6. Similar dwellings siding onto or exposed to the roadway sources will also require a noise barrier at the rear yards. Therefore, dwellings that require either a 2.2-metre-high or 2.5-metre-high noise barrier are summarized in Table 7. Figure 4 depicts the proposed noise barrier locations. The noise barrier should be built with solid elements having a minimum surface density of 20 kg/m² and contain no gaps. Furthermore, a Type A or Type B Warning Clause will be required on all Lease, Purchase and Sale Agreements for Blocks 163 (Unit 4,5), 174 (Unit 1), 185 (Unit 5), and 186-189, where noise levels fall between 55 dBA and 60 dBA, as summarized in Section 6.

TABLE 6: RESULTS OF NOISE BARRIER INVESTIGATION

Receptor ID	Receptor Location	Above Grade Receptor Height (m)	Daytime L_{eq} Noise Levels (dBA)		
			Without Barrier	With 2.2m Barrier	With 2.5m Barrier
R23	OLA - Block 81 - Unit 5 – Rear Yard	1.5	60	53	-
R24	OLA - Block 96 - Unit 1 – Rear Yard	1.5	61	51	-
R25	OLA - Block 62 - Unit 1 – Rear Yard	1.5	58	54	-
R26	OLA - Block 119 - Unit 1 – Rear Yard	1.5	60	50	-
R27	OLA - Block 186 - Unit 1 – Rear Yard	1.5	69	59	57
R28	OLA - Block 186 - Unit 3 – Rear Yard	1.5	64	55	54
R29	OLA - Block 185 - Unit 5 – Rear Yard	1.5	69	58	56*
R30	OLA - Block 163 - Unit 5 – Rear Yard	1.5	69	60	58

*A taller barrier is suggested to provide additional mitigation for the adjacent rear yards to the west of Blocks 175 and 186.

TABLE 7: BLOCK/LOT BARRIER REQUIREMENTS

Barrier Height	Lot	Block
2.2m Above Local Grade	1, 61	62 (Unit 1), 81 (Unit 5), 82 (Unit 3), 96 (Unit 1), 118 (Unit 3), 119 (Unit 1), 132 (Unit 1), 153 (Unit 3), 154 (Unit 1), 197 (Unit 3)
2.5m Above Local Grade	-	163 (Unit 4,5), 174 (Unit 1), 185 (Unit 5), 186

It should be noted that additional residential developments are currently proposed to the immediate north and south of the subject site which will provide additional blockage from roadway traffic noise once construction begins, further reducing noise levels at the rear yards. As mentioned, mitigation impacts from the north residential development were considered in the modelling as it is set to be completed prior to the subject site.

6. CONCLUSIONS AND RECOMMENDATIONS

The results of the current analysis indicated that noise levels at Plane of Window (POW) receptors will range between 42 and 70 dBA during the daytime period (07:00-23:00) and between 42 and 63 dBA during the nighttime period (23:00-07:00). The highest noise level (70 dBA) occurs at the east façades of Blocks 163, 174, 185, and 186, which are nearest and most exposed to the realigned Greenbank Road. Figures 5 and 6 illustrate daytime and nighttime noise contours throughout the site at a height of 1.5 m above grade.

Building components with a higher Sound Transmission Class (STC) rating will be required where exterior noise levels exceed 65 dBA. The results of the analysis also indicate some dwellings will require central air conditioning, which will allow occupants to keep windows closed and maintain a comfortable living environment, and some dwellings will require forced air heating with provisions for central air conditioning as summarized in Table 5 and outlined in Figure 4. Warning Clauses will also be required be placed on all Lease, Purchase and Sale Agreements, as summarized below:

Type C

> *"This dwelling unit has been designed with the provision for adding central air conditioning at the occupant's discretion. Installation of central air conditioning by the occupant in low and medium density developments will allow windows and exterior doors to remain closed, thereby ensuring that the indoor sound levels are within the sound level limits of the Municipality and the Ministry of the Environment, Conservation and Parks."*

Type D

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

Noise levels at backyards for properties adjacent or exposed to the roadway sources are expected to exceed 55 dBA during the daytime period. According to the ENCG, if these areas are to be used as Outdoor Living Areas (OLA), noise mitigation should be provided to reduce noise levels at or below 55 dBA if it is technically and administratively feasible. In all cases, noise levels should not exceed 60 dBA.

Investigation into the application of 2.2-metre-high and 2.5-metre-high (above local grade) noise barriers at select properties proved that noise levels can be reduced at or below 60 dBA. Therefore, dwellings that require either a 2.2-metre-high or 2.5-metre-high noise barrier are summarized in Table 7. Furthermore, a Type B Warning Clause will be required on all Lease, Purchase and Sale Agreements for Blocks 163 (Unit 4,5), 174 (Unit 1), 185 (Unit 5), and 186, where noise levels fall between 55 dBA and 60 dBA with a proposed barrier, as summarized below:

Type B

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

Moreover, a Type A Warning Clause will be required on all Lease, Purchase and Sale Agreements for Blocks 187-189, where noise levels fall between 55 dBA and 60 dBA without a barrier, as summarized below:

Type A

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

The noise barrier should be built with solid elements having a minimum surface density of 20 kg/m² and contain no gaps. The following information will be required by the city for review prior to installation of the barrier:

1. Shop drawings, signed and sealed by a qualified Professional Engineer licenced by the Professional Engineers of Ontario, showing the details of the acoustic barrier systems components, including material specifications.
2. Structural drawing(s), signed by a qualified Professional Engineer licenced by the Professional Engineers of Ontario, showing foundation details and specifying design criteria, climatic design loads, as well as applicable geotechnical data used in the design.
3. Layout plan, and wall elevations, showing proposed colours and patterns.

It should be noted that additional residential developments are currently proposed to the immediate north and south of the subject site which will provide additional blockage from roadway traffic noise once construction begins, further reducing noise levels at the rear yards. Mitigation impacts from the north residential development was considered in the modelling as it is set to be completed prior to the subject site.

Regarding stationary noise impacts, Gradient Wind has prepared a stationary noise assessment and memoranda for the proposed industrial development located at 3713 Borrisokane Road in Ottawa, Ontario (*ref. Gradient Wind report #19-228 – Stationary Noise R1, dated December 16, 2019 and Gradient Wind memoranda #19-228 – Addendum Letter R1, dated May 14, 2020*). The industrial site is located immediately west of Drummond Subdivision. The results of the study indicate that noise levels at Drummond Subdivision due to the industrial facility are expected to fall below the ENCG and NPC-300 noise criteria.

This concludes our roadway traffic noise 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.

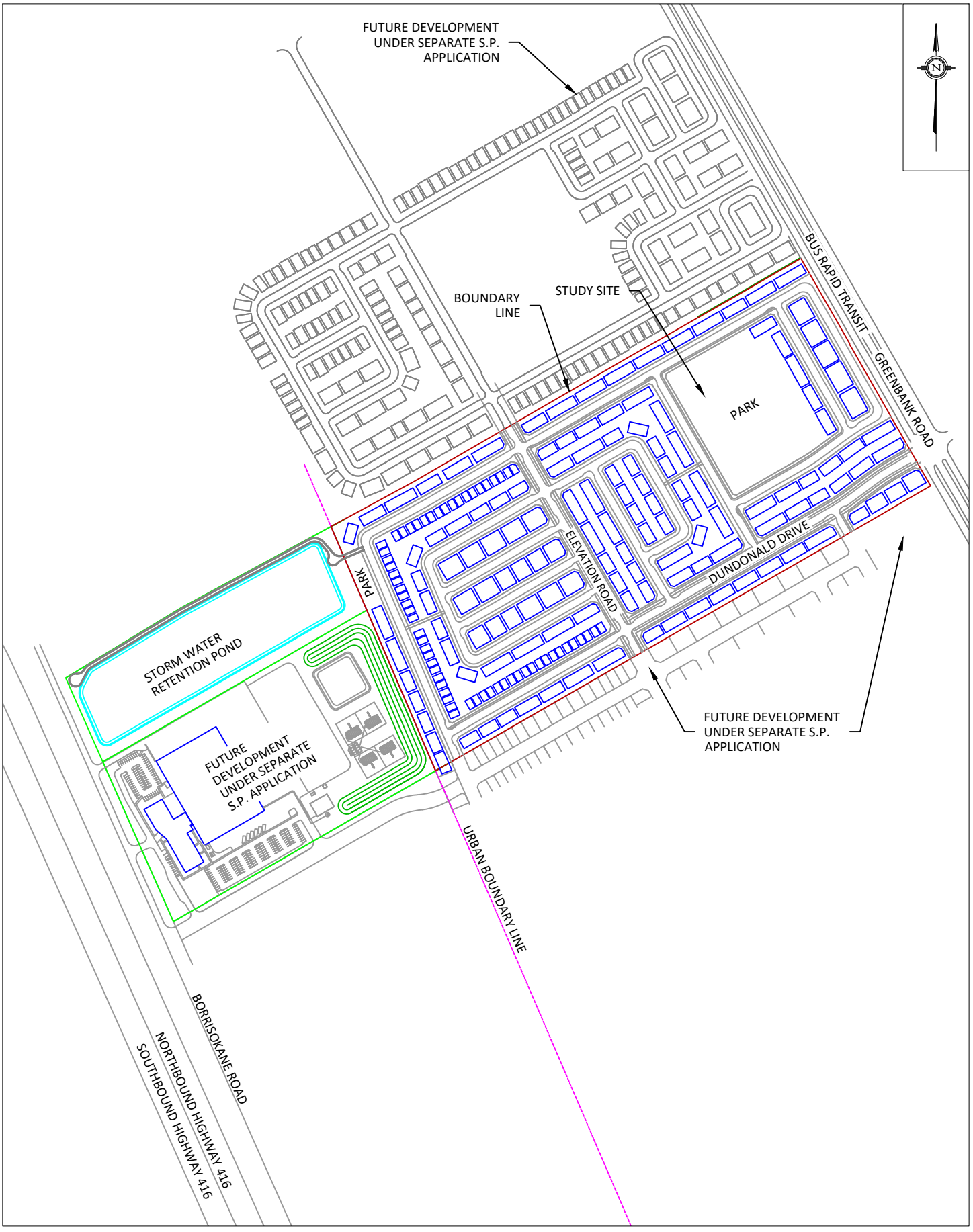
Sincerely,

Gradient Wind Engineering Inc.

Giuseppe Garro, MASc.
Junior Environmental Scientist

Joshua Foster, P.Eng.
Lead Engineer

Gradient Wind File #19-236 – Roadway Traffic Noise



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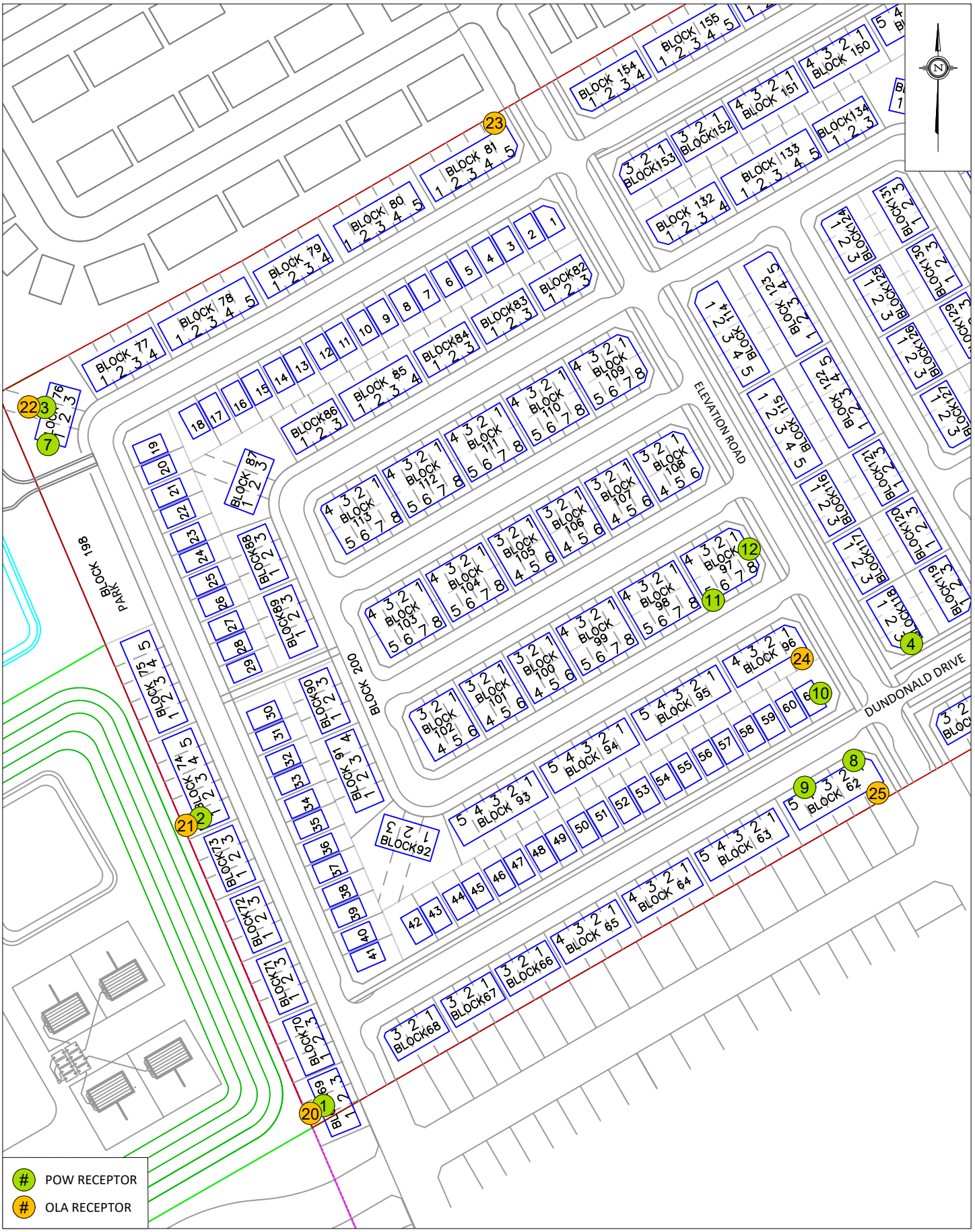
PROJECT	3717 BORRISOKANE ROAD, OTTAWA ROADWAY TRAFFIC NOISE ASSESSMENT
SCALE	1:6000 (APPROX.)
DRAWING NO.	GW19-236-1
DATE	JANUARY 21, 2022
DRAWN BY	G.G.

DESCRIPTION

FIGURE 1:
SITE PLAN AND SURROUNDING CONTEXT



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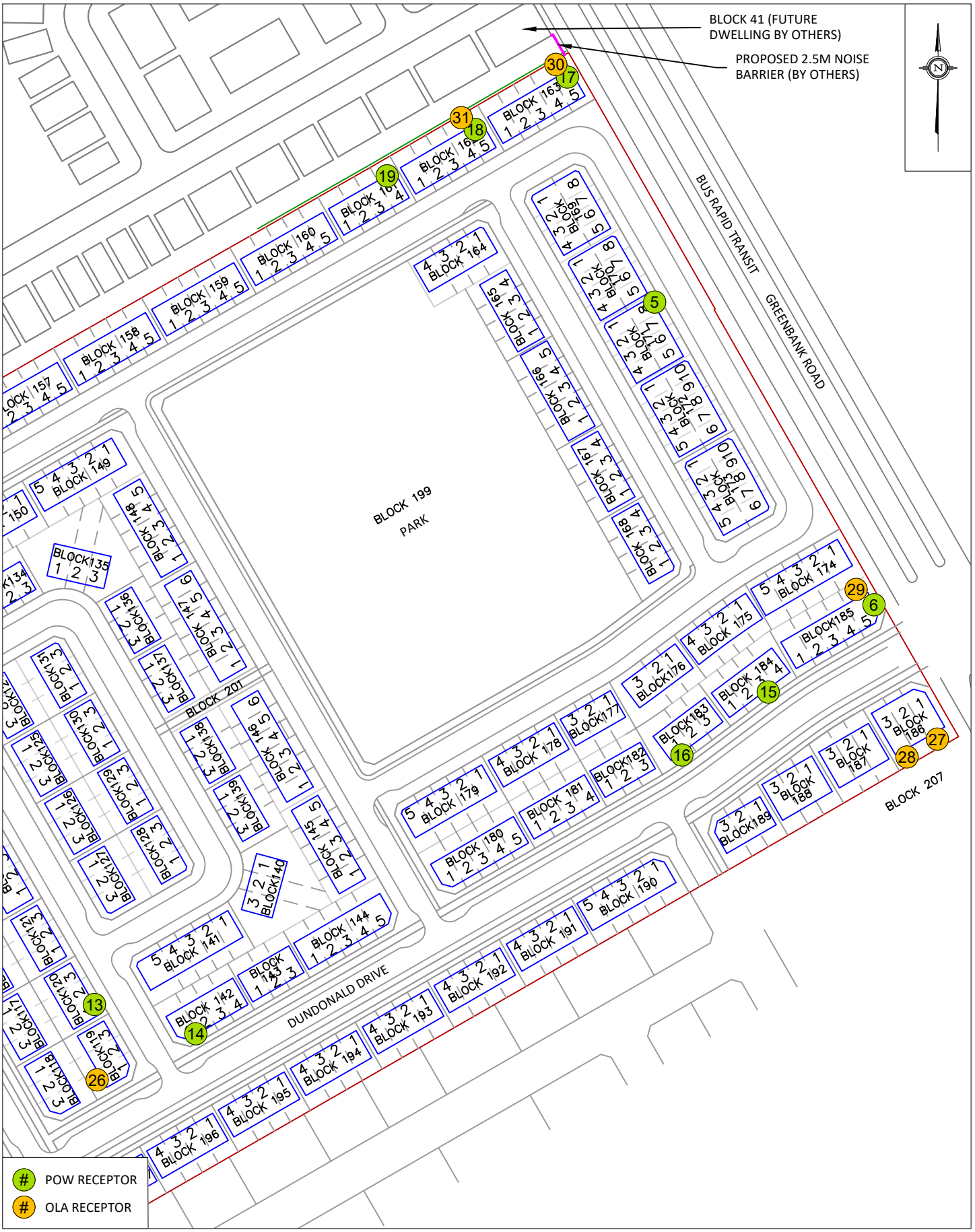
PROJECT	3717 BORRISOKANE ROAD, OTTAWA ROADWAY TRAFFIC NOISE ASSESSMENT		DESCRIPTION
SCALE	1:2000 (APPROX.)	DRAWING NO. GW19-236-2A	FIGURE 2A: RECEPTOR LOCATIONS
DATE	JANUARY 21, 2022	DRAWN BY G.G.	



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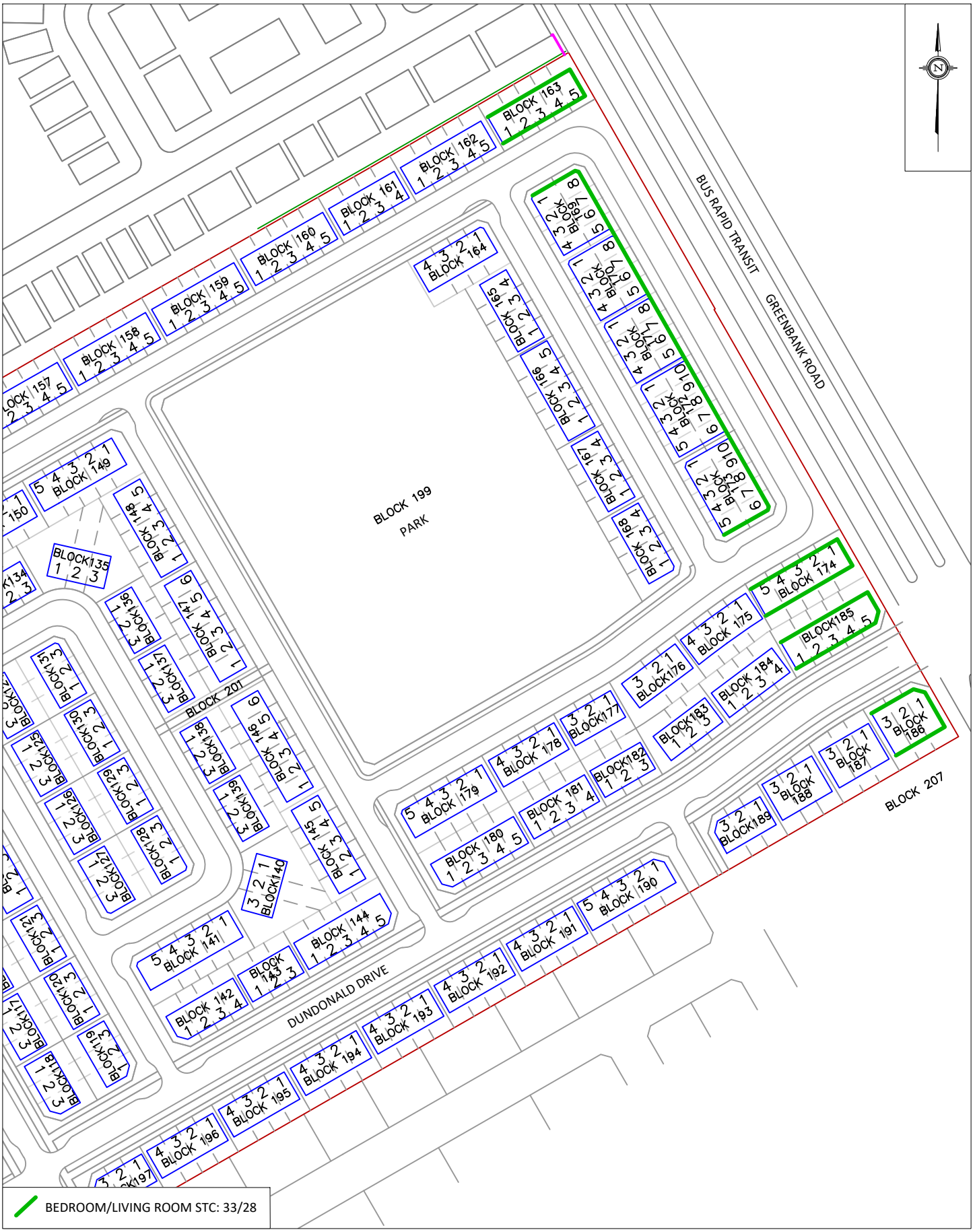
PROJECT	3717 BORRISOKANE ROAD, OTTAWA ROADWAY TRAFFIC NOISE ASSESSMENT
SCALE	1:2000 (APPROX.)
DRAWING NO.	GW19-236-2B
DATE	JANUARY 21, 2022
DRAWN BY	G.G.

DESCRIPTION

FIGURE 2B:
RECEPTOR LOCATIONS



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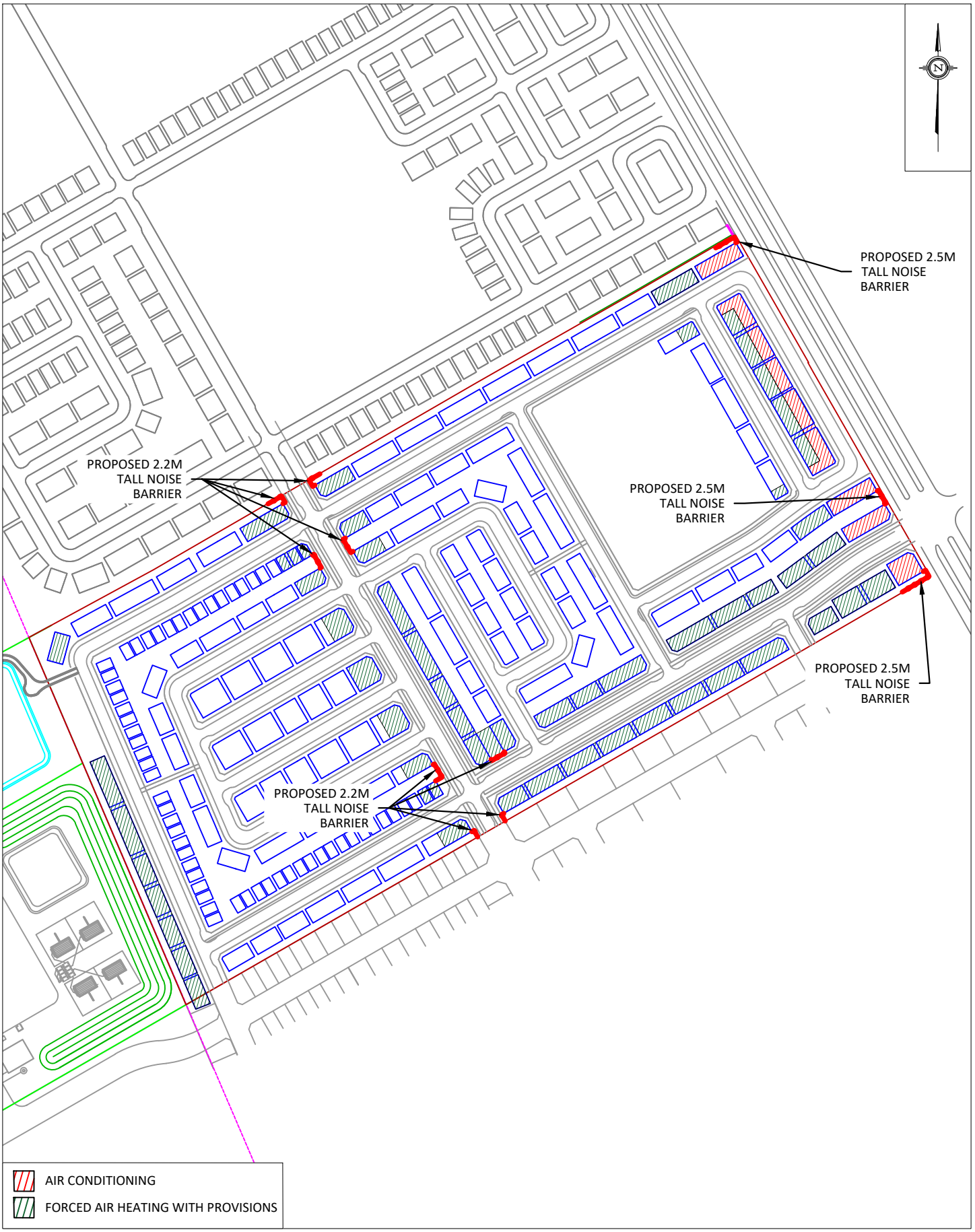
PROJECT	3717 BORRISOKANE ROAD, OTTAWA ROADWAY TRAFFIC NOISE ASSESSMENT		DESCRIPTION
SCALE	1:2000 (APPROX.)	DRAWING NO.	GW19-236-3
DATE	JANUARY 21, 2022	DRAWN BY	G.G.

FIGURE 3:
WINDOW STC REQUIREMENTS



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PROJECT	3717 BORRISOKANE ROAD, OTTAWA ROADWAY TRAFFIC NOISE ASSESSMENT
SCALE	1:4000 (APPROX.)
DRAWING NO.	GW19-236-4
DATE	JANUARY 21, 2022
DRAWN BY	G.G.

DESCRIPTION

FIGURE 4:
VENTILATION AND BARRIER REQUIREMENTS

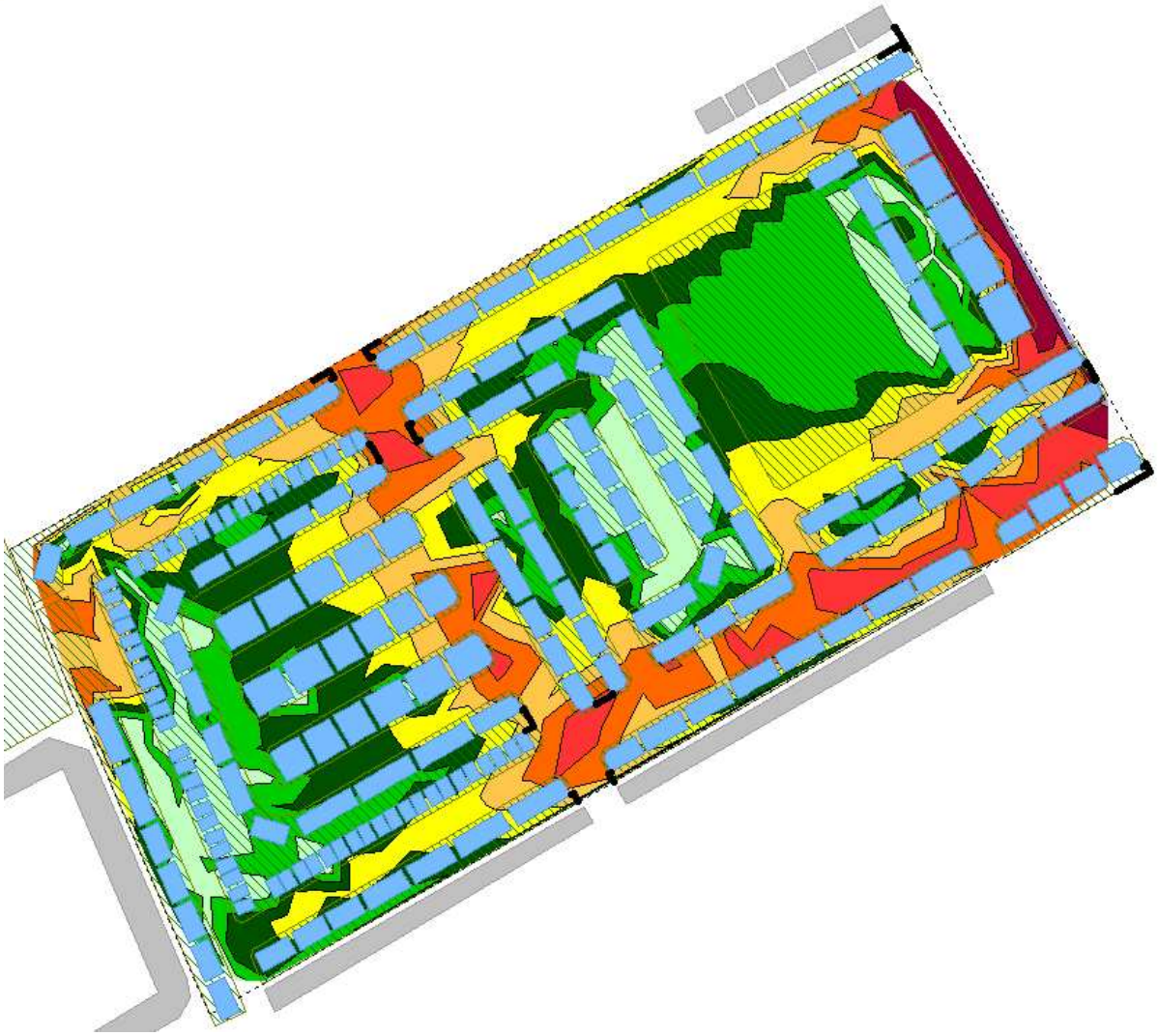

FIGURE 5: DAYTIME TRAFFIC NOISE CONTOURS (1.5 M ABOVE GRADE)

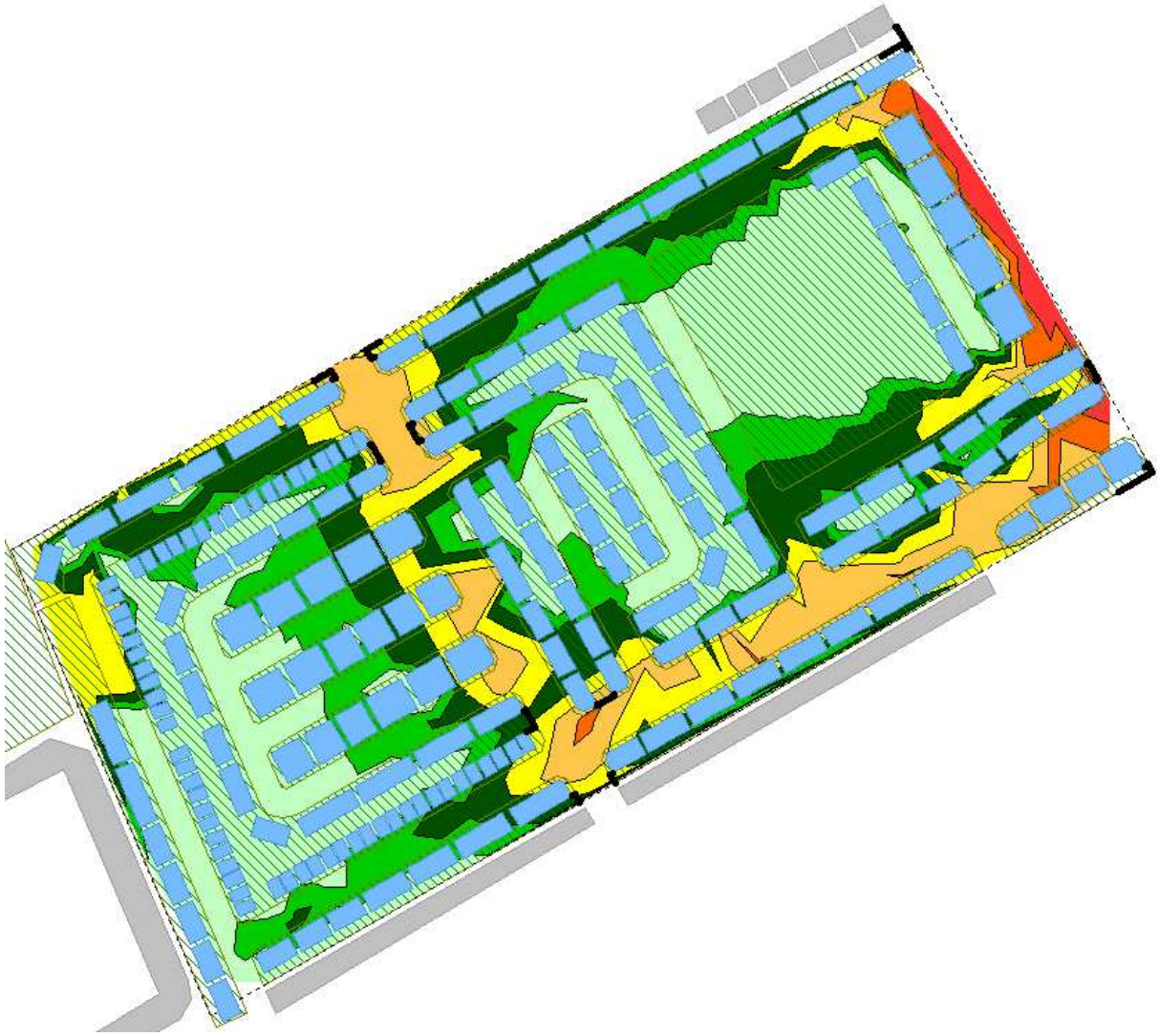

FIGURE 6: NIGHTTIME TRAFFIC NOISE CONTOURS (1.5 M ABOVE GRADE)

80 – 85 dB
75 – 80 dB
70 – 75 dB
65 – 70 dB
60 – 65 dB
55 – 60 dB
50 – 55 dB
45 – 50 dB
40 – 45 dB
35 – 40 dB
0 – 35 dB

APPENDIX A

STAMSON 5.04 – INPUT AND OUTPUT DATA

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GRADIENTWIND.COM

```
 STAMSON 5.0        NORMAL REPORT        Date: 02-12-2021 22:46:49
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: HWY 416 SB (day/night)
----------------------------------------------
Car traffic volume  : 29685/2581  veh/TimePeriod  *
Medium truck volume :  2361/205   veh/TimePeriod  *
Heavy truck volume  :  1687/147   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):  36666
    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 416 SB (day/night)
--------------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  : 453.00 / 453.00 m
Receiver height           :   4.50 / 4.50   m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -13.00 deg   Angle2 : 90.00 deg
Barrier height            :   3.50 m
Barrier receiver distance :  23.00 / 23.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00


Road data, segment # 2: HWY 416 NB (day/night)
----------------------------------------------
Car traffic volume  : 29685/2581  veh/TimePeriod  *
Medium truck volume :  2361/205   veh/TimePeriod  *
Heavy truck volume  :  1687/147   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):  36666
    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 416 NB (day/night)
---------------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  : 423.00 / 423.00 m
Receiver height           :   4.50 / 4.50   m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -13.00 deg   Angle2 : 90.00 deg
Barrier height            :   3.50 m
Barrier receiver distance :  23.00 / 23.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00


Results segment # 1: HWY 416 SB (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 !        4.50 !        4.35 !         4.35

ROAD (49.90 + 51.61 + 0.00) = 53.85 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-------------------------------------------------------------------------
--
   -90    -13   0.57  78.39   0.00 -23.24  -5.25   0.00   0.00   0.00
49.90
-------------------------------------------------------------------------
--
   -13     90   0.36  78.39   0.00 -20.13  -3.20   0.00   0.00  -4.36
50.70*
```

```
   -13     90    0.57  78.39    0.00 -23.24  -3.54    0.00    0.00    0.00
51.61
-------------------------------------------------------------------------
--

 * Bright Zone !

Segment Leq : 53.85 dBA


Results segment # 2: HWY 416 NB (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 !        4.50 !        4.34 !         4.34

ROAD (50.37 + 52.07 + 0.00) = 54.31 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-------------------------------------------------------------------------
--
   -90    -13   0.57  78.39    0.00 -22.77  -5.25    0.00    0.00    0.00
50.37
-------------------------------------------------------------------------
--
   -13     90    0.36  78.39    0.00 -19.73  -3.20    0.00    0.00  -4.37
51.09*
   -13     90    0.57  78.39    0.00 -22.77  -3.54    0.00    0.00    0.00
52.07
-------------------------------------------------------------------------
--

 * Bright Zone !

Segment Leq : 54.31 dBA

Total Leq All Segments: 57.10 dBA


Results segment # 1: HWY 416 SB (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  !        4.50 !        4.35 !         4.35

ROAD (42.30 + 44.01 + 0.00) = 46.25 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-------------------------------------------------------------------------
--
   -90    -13   0.57  70.79   0.00 -23.24  -5.25   0.00   0.00   0.00
42.30
-------------------------------------------------------------------------
--
   -13     90   0.36  70.79   0.00 -20.13  -3.20   0.00   0.00  -4.36
43.10*
   -13     90   0.57  70.79   0.00 -23.24  -3.54   0.00   0.00   0.00
44.01
-------------------------------------------------------------------------
--

 * Bright Zone !

Segment Leq : 46.25 dBA


Results segment # 2: HWY 416 NB (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  !        4.50 !        4.34 !         4.34

ROAD (42.77 + 44.48 + 0.00) = 46.72 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-------------------------------------------------------------------------
--
   -90    -13   0.57  70.79   0.00 -22.77  -5.25   0.00   0.00   0.00
42.77
-------------------------------------------------------------------------
--
   -13     90   0.36  70.79   0.00 -19.73  -3.20   0.00   0.00  -4.37
43.49*
```

```
   -13      90    0.57   70.79    0.00 -22.77   -3.54    0.00    0.00    0.00
44.48
-------------------------------------------------------------------------------
--

 * Bright Zone !

Segment Leq : 46.72 dBA

Total Leq All Segments: 49.50 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 57.10
                           (NIGHT): 49.50
```

```
STAMSON 5.0        NORMAL REPORT        Date: 02-12-2021 22:46:57
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: HWY 416 SB (day/night)
----------------------------------------------
Car traffic volume  : 29685/2581  veh/TimePeriod  *
Medium truck volume :  2361/205   veh/TimePeriod  *
Heavy truck volume  :  1687/147   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):  36666
    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 416 SB (day/night)
--------------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  : 461.00 / 461.00 m
Receiver height           :   4.50 / 4.50   m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : -24.00 deg
Barrier height            :  13.00 m
Barrier receiver distance : 312.00 / 312.00 m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00


Road data, segment # 2: HWY 416 NB (day/night)
----------------------------------------------
Car traffic volume  : 29685/2581  veh/TimePeriod  *
Medium truck volume :  2361/205   veh/TimePeriod  *
Heavy truck volume  :  1687/147   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):  36666
    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 416 NB (day/night)
---------------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  : 432.00 / 432.00 m
Receiver height           :   4.50 / 4.50   m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : -24.00 deg
Barrier height            :  13.00 m
Barrier receiver distance : 312.00 / 312.00 m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00


Results segment # 1: HWY 416 SB (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 !        4.50 !        2.47 !         2.47

ROAD (0.00 + 48.25 + 52.03) = 53.55 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-------------------------------------------------------------------------------
--
   -90    -24    0.00  78.39   0.00 -14.88  -4.36   0.00   0.00 -10.90
48.25
-------------------------------------------------------------------------------
--
   -24     90    0.57  78.39   0.00 -23.36  -3.00   0.00   0.00   0.00
52.03
```

```
------------------------------------------------------------------------------
--

Segment Leq : 53.55 dBA


Results segment # 2: HWY 416 NB (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 !        4.50 !        2.33 !         2.33

ROAD (0.00 + 48.02 + 52.48) = 53.81 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
------------------------------------------------------------------------------
--
   -90    -24   0.00  78.39   0.00 -14.59  -4.36   0.00   0.00 -11.42
48.02
------------------------------------------------------------------------------
--
   -24     90   0.57  78.39   0.00 -22.91  -3.00   0.00   0.00   0.00
52.48
------------------------------------------------------------------------------
--

Segment Leq : 53.81 dBA

Total Leq All Segments: 56.69 dBA


Results segment # 1: HWY 416 SB (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 !        4.50 !        2.47 !         2.47

ROAD (0.00 + 40.66 + 44.44) = 45.96 dBA
```

```
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-------------------------------------------------------------------------
--
   -90    -24   0.00  70.79   0.00 -14.88  -4.36   0.00   0.00 -10.90
40.66
-------------------------------------------------------------------------
--
   -24     90   0.57  70.79   0.00 -23.36  -3.00   0.00   0.00   0.00
44.44
-------------------------------------------------------------------------
--

Segment Leq : 45.96 dBA


Results segment # 2: HWY 416 NB (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 !        4.50 !        2.33 !         2.33

ROAD (0.00 + 40.43 + 44.88) = 46.21 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-------------------------------------------------------------------------
--
   -90    -24   0.00  70.79   0.00 -14.59  -4.36   0.00   0.00 -11.41
40.43
-------------------------------------------------------------------------
--
   -24     90   0.57  70.79   0.00 -22.91  -3.00   0.00   0.00   0.00
44.88
-------------------------------------------------------------------------
--

Segment Leq : 46.21 dBA

Total Leq All Segments: 49.10 dBA


TOTAL Leq FROM ALL SOURCES (DAY): 56.69
                           (NIGHT): 49.10
```

```
STAMSON 5.0        NORMAL REPORT        Date: 02-12-2021 22:47:09
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: ED (day/night)
---------------------------------------
Car traffic volume  :  6477/563   veh/TimePeriod  *
Medium truck volume :   515/45    veh/TimePeriod  *
Heavy truck volume  :   368/32    veh/TimePeriod  *
Posted speed limit  :    40 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):   8000
    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: ED (day/night)
-------------------------------------
Angle1   Angle2           : -76.00 deg   0.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  22.00 / 22.00  m
Receiver height           :   4.50 / 4.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

Road data, segment # 2: DD (day/night)
---------------------------------------
Car traffic volume  :  6477/563   veh/TimePeriod  *
Medium truck volume :   515/45    veh/TimePeriod  *
Heavy truck volume  :   368/32    veh/TimePeriod  *
Posted speed limit  :    40 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):   8000
    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: DD (day/night)
------------------------------------
Angle1   Angle2           : -90.00 deg   51.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  18.00 / 18.00  m
Receiver height           :   4.50 / 4.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

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

Source height = 1.50 m

ROAD (0.00 + 58.55 + 0.00) = 58.55 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-------------------------------------------------------------------------------
--
   -76      0   0.00  63.96   0.00  -1.66  -3.74   0.00   0.00   0.00
58.55
-------------------------------------------------------------------------------
--

Segment Leq : 58.55 dBA

Results segment # 2: DD (day)
-----------------------------

Source height = 1.50 m

ROAD (0.00 + 62.10 + 0.00) = 62.10 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-------------------------------------------------------------------------------
--
   -90     51   0.00  63.96   0.00  -0.79  -1.06   0.00   0.00   0.00
62.10
-------------------------------------------------------------------------------
--

Segment Leq : 62.10 dBA

Total Leq All Segments: 63.69 dBA
```

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

Source height = 1.50 m

ROAD (0.00 + 50.95 + 0.00) = 50.95 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-------------------------------------------------------------------------
--
   -76      0   0.00  56.36   0.00  -1.66  -3.74   0.00   0.00   0.00
50.95
-------------------------------------------------------------------------
--

Segment Leq : 50.95 dBA

Results segment # 2: DD (night)
-------------------------------

Source height = 1.50 m

ROAD (0.00 + 54.51 + 0.00) = 54.51 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-------------------------------------------------------------------------
--
   -90     51   0.00  56.36   0.00  -0.79  -1.06   0.00   0.00   0.00
54.51
-------------------------------------------------------------------------
--

Segment Leq : 54.51 dBA

Total Leq All Segments: 56.10 dBA


TOTAL Leq FROM ALL SOURCES (DAY): 63.69
                           (NIGHT): 56.10
```

```
STAMSON 5.0        NORMAL REPORT        Date: 02-12-2021 22:47:17
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: GREENBANK RD (day/night)
-----------------------------------------------
Car traffic volume  : 28336/2464  veh/TimePeriod  *
Medium truck volume :  2254/196   veh/TimePeriod  *
Heavy truck volume  :  1610/140   veh/TimePeriod  *
Posted speed limit  :    70 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):  35000
    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: GREENBANK RD (day/night)
-----------------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  41.00 / 41.00  m
Receiver height           :   4.50 / 4.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

Results segment # 1: GREENBANK RD (day)
---------------------------------------

Source height = 1.50 m

ROAD (0.00 + 70.63 + 0.00) = 70.63 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-------------------------------------------------------------------------------
--
   -90     90    0.00  75.00   0.00  -4.37   0.00   0.00   0.00   0.00
70.63
-------------------------------------------------------------------------------
--
```

```
Segment Leq : 70.63 dBA

Total Leq All Segments: 70.63 dBA

Results segment # 1: GREENBANK RD (night)
----------------------------------------

Source height = 1.50 m

ROAD (0.00 + 63.03 + 0.00) = 63.03 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-------------------------------------------------------------------------
--
   -90     90   0.00  67.40   0.00  -4.37   0.00   0.00   0.00   0.00
63.03
-------------------------------------------------------------------------
--

Segment Leq : 63.03 dBA

Total Leq All Segments: 63.03 dBA

RT/Custom data, segment # 1: BRT (day/night)
-----------------------------------------
1 - Bus:
Traffic volume    :   191/67    veh/TimePeriod
Speed             :    80 km/h

Data for Segment # 1: BRT (day/night)
-------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  41.00 / 41.00  m
Receiver height           :   4.50 / 4.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

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

Source height = 0.50 m

RT/Custom (0.00 + 55.05 + 0.00) = 55.05 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------
   -90     90   0.00  59.41  -4.37   0.00   0.00   0.00   0.00  55.05
-------------------------------------------------------------------------
```

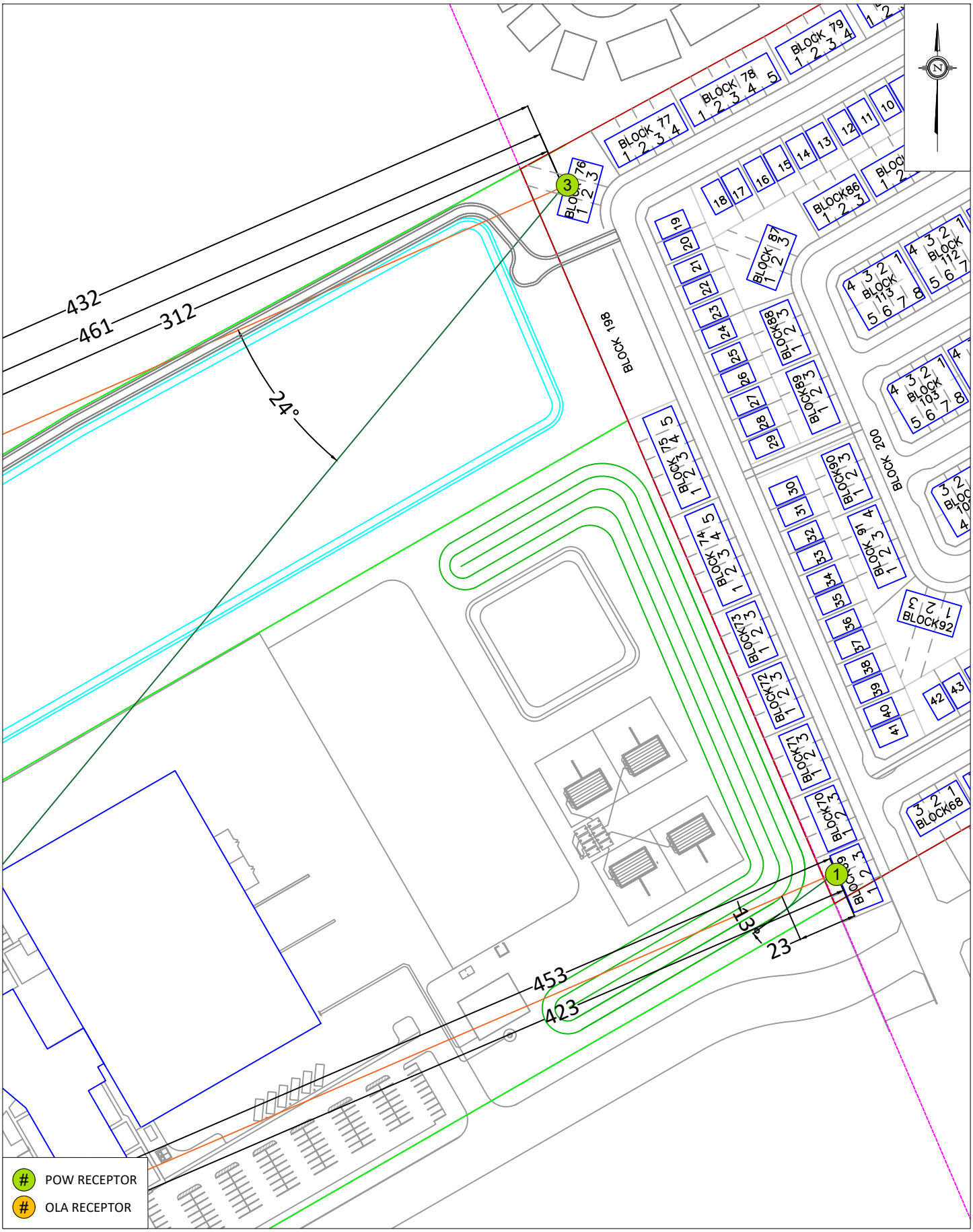
```
Segment Leq : 55.05 dBA

Total Leq All Segments: 55.05 dBA

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

Source height = 0.50 m

RT/Custom (0.00 + 53.51 + 0.00) = 53.51 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------
   -90     90   0.00  57.87  -4.37   0.00   0.00   0.00   0.00  53.51
-------------------------------------------------------------------------

Segment Leq : 53.51 dBA

Total Leq All Segments: 53.51 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 70.75
                           (NIGHT): 63.49
```

```
STAMSON 5.0        NORMAL REPORT        Date: 02-12-2021 22:47:23
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: GREENBANK RD (day/night)
-----------------------------------------------
Car traffic volume  : 28336/2464  veh/TimePeriod  *
Medium truck volume :  2254/196   veh/TimePeriod  *
Heavy truck volume  :  1610/140   veh/TimePeriod  *
Posted speed limit  :    70 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):  35000
    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: GREENBANK RD (day/night)
-----------------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  24.00 / 24.00  m
Receiver height           :   4.50 / 4.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

Road data, segment # 2: DUN. DR. (day/night)
-------------------------------------------
Car traffic volume  :  6477/563   veh/TimePeriod  *
Medium truck volume :   515/45    veh/TimePeriod  *
Heavy truck volume  :   368/32    veh/TimePeriod  *
Posted speed limit  :    40 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):   8000
    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: DUN. DR. (day/night)
-------------------------------------------
Angle1   Angle2           : -46.00 deg   0.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  22.00 / 22.00  m
Receiver height           :   4.50 / 4.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

Results segment # 1: GREENBANK RD (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
-------------------------------------------------------------------------------
--
   -90     90   0.00  75.00   0.00  -2.04   0.00   0.00   0.00   0.00
72.95
-------------------------------------------------------------------------------
--

Segment Leq : 72.95 dBA

Results segment # 2: DUN. DR. (day)
-----------------------------------

Source height = 1.50 m

ROAD (0.00 + 56.37 + 0.00) = 56.37 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-------------------------------------------------------------------------------
--
   -46      0   0.00  63.96   0.00  -1.66  -5.93   0.00   0.00   0.00
56.37
-------------------------------------------------------------------------------
--

Segment Leq : 56.37 dBA

Total Leq All Segments: 73.04 dBA
```

```
Results segment # 1: GREENBANK RD (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
-------------------------------------------------------------------------------
--
   -90     90   0.00  67.40   0.00  -2.04   0.00   0.00   0.00   0.00
65.36
-------------------------------------------------------------------------------
--

Segment Leq : 65.36 dBA

Results segment # 2: DUN. DR. (night)
-------------------------------------

Source height = 1.50 m

ROAD (0.00 + 48.77 + 0.00) = 48.77 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-------------------------------------------------------------------------------
--
   -46      0   0.00  56.36   0.00  -1.66  -5.93   0.00   0.00   0.00
48.77
-------------------------------------------------------------------------------
--

Segment Leq : 48.77 dBA

Total Leq All Segments: 65.45 dBA

RT/Custom data, segment # 1: BRT (day/night)
--------------------------------------------
1 - Bus:
Traffic volume    :   191/67    veh/TimePeriod
Speed             :    80 km/h

Data for Segment # 1: BRT (day/night)
-------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  24.00 / 24.00  m
Receiver height           :   4.50 / 4.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
```

```
Reference angle           :   0.00

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

Source height = 0.50 m

RT/Custom (0.00 + 57.37 + 0.00) = 57.37 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------
   -90     90   0.00  59.41  -2.04   0.00   0.00   0.00   0.00  57.37
-------------------------------------------------------------------------

Segment Leq : 57.37 dBA

Total Leq All Segments: 57.37 dBA

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

Source height = 0.50 m

RT/Custom (0.00 + 55.83 + 0.00) = 55.83 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------
   -90     90   0.00  57.87  -2.04   0.00   0.00   0.00   0.00  55.83
-------------------------------------------------------------------------

Segment Leq : 55.83 dBA

Total Leq All Segments: 55.83 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 73.16
                           (NIGHT): 65.90
```



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PROJECT	3717 BORRISOKANE ROAD, OTTAWA ROADWAY TRAFFIC NOISE ASSESSMENT		DESCRIPTION
SCALE	1:2000 (APPROX.)	DRAWING NO.	GW19-236-A1
DATE	JANUARY 21, 2022	DRAWN BY	G.G.

FIGURE A1:
STAMSON INPUT PARAMETERS

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SCALE	1:2000 (APPROX.)	DRAWING NO.	GW19-236-A2
DATE	JANUARY 21, 2022	DRAWN BY	G.G.

FIGURE A2:
STAMSON INPUT PARAMETERS