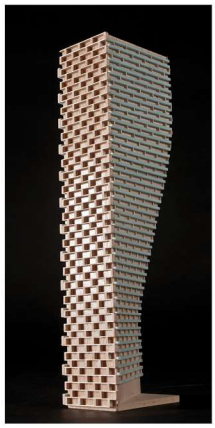
GRADIENTWIND
ENGINEERS & SCIENTISTS

ENVIRONMENTAL NOISE ASSESSMENT

403 Richmond Road
Ottawa, Ontario

REPORT: 20-174-Traffic Noise



April 7, 2022

PREPARED FOR

Westboro Inc.
115 Champagne Avenue South
Ottawa, ON
K1S 5V5

PREPARED BY

Tanyon Matheson-Fitchett, B.Eng., Junior Environmental Scientist
Joshua Foster, P.Eng., Lead Engineer

EXECUTIVE SUMMARY

This report describes an environmental noise assessment for a proposed mixed-use development located at 403 Richmond Road in Ottawa, Ontario. The proposed development comprises a 9-storey mixed-use building with an amenity room penthouse. Above two floors of underground parking, the ground floor comprises residential, lobby, and commercial space. Outdoor Living Areas (OLA) evaluated in this study comprise common and private amenity terraces on Levels 5, 9 and 10. The major sources of roadway traffic noise are Richmond Road to the south and Byron Avenue beyond. 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; and (iv) site plan drawings prepared by RLA Architecture dated January 2022.

The results of the current analysis indicate that roadway traffic noise levels will range between 39 and 68 dBA during the daytime period (07:00-23:00) and between 55 and 61 dBA during the nighttime period (23:00-07:00). The highest noise level (68 dBA) occurs at the south façade, which is nearest and most exposed to Richmond Road. 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, or a similar ventilation system, which will allow occupants to keep windows closed and maintain a comfortable living environment. A 'Type D' Warning Clause will also be required in all Lease, Purchase and Sale Agreements, as summarized in Section 6.

Traffic noise levels at the Level 9 private terraces (Receptor 5) are expected to approach 60 dBA during the daytime period. Further analysis investigated the noise mitigating impact of including a solid 1.1-meter-tall perimeter guard surrounding the OLA. Results of the investigation proved that noise levels can be reduced to 56 dBA. Reducing the noise levels below 55 dBA would require excessive barrier heights that would impede terrace views. The location of the recommended noise barrier is illustrated in Figure

4. As noise levels remain between 55 and 60 dBA at the Level 9 private terraces, a 'Type B' Warning Clause will be required on all Lease, Purchase and Sale Agreements for the dwelling units attached to featuring these terraces, as summarized in Section 6.

The perimeter guard must be constructed from materials having a minimum surface density of 20 kg/m^2 (STC rating of 30) and contain no gaps. Design will conform to the requirements outlined in Part 5 of the ENCG. 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.

Roadway traffic noise levels at all other terraces were found to fall below the ENCG criteria.

Stationary noise assessment results indicate that stationary noise levels at all nearby points of reception are expected to fall below ENCG criteria, provided our assumptions for noise control outlined in Sections 4.3.2 and 4.3.3 are followed during detailed design process. It is recommended that the maximum permissible noise levels be used within the design, where noted, to ensure noise levels meet the criteria outlined in ENCG. This can be achieved by incorporating quieter units, installing silencers or noise barriers where required. Exterior rooftop equipment should be located toward the centre of the rooftop area, avoiding direct line of sight with noise-sensitive areas if possible.

TABLE OF CONTENTS

1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Westboro Inc. to undertake an environmental assessment in support of a Site Plan Control application (SPA) for a proposed mixed-use development at 403 Richmond Road in Ottawa, Ontario. This report summarizes the methodology, results, and recommendations related to the assessment of exterior noise levels generated by local roadway traffic. Also included in this report is an assessment of stationary noise impacts from the proposed development on its surroundings.

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 RLA Architecture dated January 2022, preliminary mechanical engineering drawings and data provided by Goodkey Weedmark and Associates Ltd. in February 2022, future traffic volumes corresponding to the City of Ottawa's Official Plan (OP) roadway classifications, surrounding street layouts obtained from the City of Ottawa, and recent site imagery.

2. TERMS OF REFERENCE

The subject site is located 403 Richmond Road, on a parcel of land on the northeast corner of the intersection of Richmond Road and Roosevelt Avenue. The proposed development comprises a 9-storey mixed-use building with an amenity room penthouse. Above two floors of underground parking, the ground floor comprises residential, lobby, and commercial space. The amenity space includes an outdoor amenity terrace located along the east elevation. The residential space includes a lobby accessed via Roosevelt Avenue along the north elevation. The commercial space includes an outdoor patio at the southwest corner of the development. The building rises with a near-rectangular planform, with floorplate setbacks on the north, west and south elevations at Level 5 comprising private terraces. Floorplate setback also occur the north and south elevations on Level 9 to form private terraces. Levels 2 through 9 comprise residential space, while Level 10 comprises amenity space (including an outdoor amenity terrace), a party

[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

room, a gym, and a mechanical room. Balconies extending less than 4 meters from the building façade are not considered as Outdoor Living Areas in this assessment, per ENCG guidelines.

The site is surrounded by low and medium-rise commercial and residential buildings to the south and east, along Richmond Road, with low-rise residential dwellings to the north and west. The major sources of roadway traffic noise are Richmond Road to the south and Byron Avenue beyond. 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 traffic; (ii) calculate the future on-site and off-site noise levels produced by stationary sources; (iii) ensure that 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 50, 45 and 40 dBA for retail, living rooms and sleeping quarters respectively for roadway traffic noise as listed in Table 1. Based on Gradient Wind's experience, these indoor noise levels should be targeted at 47, 42 and 37 dBA, to account for building deficiencies and to account for peak noise.

TABLE 1: INDOOR SOUND LEVEL CRITERIA (ROAD) [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

[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] MECP, Environmental Noise Guidelines, NPC 300 – Part C, Section 7.8

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 but do not exceed 60 dBA, mitigation is recommended to reduce noise levels towards 55 dBA where technically and administratively feasible. Where noise levels exceed 60 dBA, mitigation must be provided.

4.2.2 Theoretical Roadway Noise Predictions

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

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

- Truck traffic on all roadways was taken to comprise 5% heavy trucks and 7% medium trucks, as per ENCG requirements for noise level predictions.
- The day/night split for all streets was taken to be 92%/8%, respectively.
- Ground surfaces were taken to be reflective due to the presence of hard (paved) ground.
- Topography was assumed to be a flat/gentle slope surrounding the study building.
- Noise receptors were strategically placed at 6 locations around the study area (see Figure 2).
- Receptor distances and exposure angles are illustrated in Appendix A Figures A1 - A4.

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[7] which provide additional details on future roadway expansions. Average Annual Daily Traffic (AADT) volumes

[6] MECP, Environmental Noise Guidelines, NPC 300 – Part C, Section 7.1.3
[7] City of Ottawa Transportation Master Plan, November 2013

are then based on data in Table B1 of the ENCG for each roadway classification. Table 2 (below) summarizes the AADT values used for each roadway included in this assessment.

TABLE 2: ROADWAY TRAFFIC DATA

Segment	Roadway Traffic Data	Speed Limit (km/h)	Traffic Volumes
Richmond Road	2-UAU	50	**15,000**
Byron Avenue	2-UCU	50	**8,000**

4.2.4 Indoor Noise Calculations

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

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

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

[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 site plan approval, detailed floor layouts and building elevations have not been finalized; therefore, detailed STC calculations could not be performed at this time. As a guideline, the anticipated STC requirements for windows have been estimated based on the overall noise reduction required for each intended use of space (STC = outdoor noise level – targeted indoor noise levels).

4.3 Stationary Noise

4.3.1 Stationary Noise Criteria

Noise criteria taken from the ENCG and NPC-300 apply to outdoor points of reception (POR). A POR is defined under NPC-300 as "any location on a noise-sensitive land use where noise from a stationary source is received"[10]. A POR can be located on an existing or zoned for future use premises of permanent or seasonal residences, hotels/motels, nursing/retirement homes, rental residences, hospitals, campgrounds, and noise-sensitive buildings such as schools and places of worship. The recommended maximum noise levels for a Class 1 area in an urban environment adjacent to an arterial roadway at a POR are outlined in Table 3 below. The study site is considered to be Class 1 as it is located within the "Urban Area" boundary as defined in Schedule A and B of the City of Ottawa Official Plan[11]. These conditions indicate that the sound field is dominated by manmade sources.

Additionally, when analysing standby power equipment such as emergency generators, NPC-300 specifies a noise level limit of 55 dBA for daytime testing. Generators are also investigated separately, without the combined effect of other equipment.

[9] CMHC, Road & Rail Noise: Effects on Housing
[10] NPC – 300, page 14
[11] City of Ottawa Official Plan Vol 1: Section 6

TABLE 3: EXCLUSIONARY LIMITS FOR CLASS 1 AREA

Time of Day	Outdoor Points of Reception (dBA)	Plane of Window (dBA)
07:00 – 19:00	50	50
19:00 – 23:00	50	50
23:00 – 07:00	N/A	45

4.3.2 Assumptions

As a conservative approach, the building equipment is assumed to operate at all hours of the day, however, certain sources are likely to have reduced operation during the nighttime period between 23:00 and 07:00. Exterior sources of stationary noise include a cooling tower, an emergency generator, and various exhaust fans. All other mechanical equipment serving the building will be contained in the mechanical penthouse. Figure 2B illustrates the location of all noise sources included in this study.

The following assumptions have been made in the analysis:

(i) The locations, quantity and tonnage of rooftop units have been based on architectural and preliminary mechanical drawings provided.

(ii) Sound data for all noise sources for the development have been based on preliminary mechanical drawings and schedules provided.

(iii) Sound data for the emergency generator was based on the requirements of O. Reg. 524/94[12], as well as mechanical drawings and schedules provided.

(iv) The cooling tower was assumed to operate continuously over a 1-hour period during the daytime and at 50% operation during the nighttime period.

(v) Due to the absence of detailed mechanical plans for the building, parking garage exhaust fan locations were unknown. Thus, the location of an exhaust fan shaft was chosen to minimize noise impacts on the surroundings. Once the mechanical plans become available, they should be forwarded to Gradient Wind for review.

(vi) Exhaust fans were assumed to operate for 10 minutes and 5 minutes over a 1-hour period during the daytime and nighttime periods, respectively. This is due to the fact that the fans

[12] Environmental Protection Act, Ontario Regulation 524/98: Section 4.7

only operate periodically when internal CO levels in the parking levels exceed a specific threshold. As a conservative approach, it was also assumed that all fans would operate at a given time.

(vii) The ground region was conservatively modelled as reflective due to the presence of hard ground (pavement).

4.3.3 Determination of Noise Source Power Levels

Preliminary mechanical information for the development was provided by Goodkey Weedmark and Associates Ltd. in February 2022. Table 4 summarizes the sound power of each source used in the analysis. The table summarizes the unmitigated noise levels from the data provided or maximum permissible levels determined through modelling. Once mechanical equipment plans and selections for the building have been finalized they should be forwarded to Gradient Wind for review.

TABLE 4: EQUIPMENT SOUND POWER LEVELS (dBA)

Source	Description	Height Above Grade/Roof (m)	Correction Applied	Frequency (Hz)								
				63	125	250	500	1000	2000	4000	8000	Total
S1	Cooling Tower	3.5	Maximum permissible	-	-	-	-	100	-	-	-	**100**
S2	Exhaust Fans	0.1	Unmitigated	58	75	88	87	85	81	75	72	**90**
GEN	Emergency Generator	1.7	Unmitigated	-	-	-	-	101	-	-	-	**101**

4.3.4 Stationary Source Noise Predictions

The impact of stationary noise sources on nearby noise-sensitive areas was determined by computer modelling using the software program Predictor-Lima. This program was developed from the International Standards Organization (ISO) standard 9613 Parts 1 and 2 and represents three-dimensional surfaces and first reflections of sound waves over a suitable spectrum for human hearing. The methodology has been used on numerous assignments and has been accepted by the Ministry of the Environment, Conservation and Parks (MECP) as part of Environmental Compliance Approval applications.

Fifteen (15) receptor locations were chosen to measure the noise impact at points of reception (POR) during the daytime/evening period (07:00 – 23:00), and nighttime period (23:00 – 07:00). POR locations include outdoor points of reception (OPOR) and the plane of window (POW) of adjacent residential properties. Sensor locations are described in Table 5 and illustrated in Figures 2B.

TABLE 5: POINTS OF RECEPTION - STATIONARY NOISE

Receptor Number	Receptor Location	Height Above Grade/Roof (m)
R1	POW - 396 Winston Avenue	4.5
R2	OPOR - 396 Winston Avenue	1.5
R3	POW - 392 Winston Avenue	4.5
R4	OPOR - 392 Winston Avenue	1.5
R5	POW - 390 Winston Avenue	4.5
R6	OPOR - 390 Winston Avenue	1.5
R7	POW - 389 Roosevelt Avenue	4.5
R8	OPOR - 389 Roosevelt Avenue	1.5
R9	POW - 390 Roosevelt Avenue	4.5
R10	POW - 394 Roosevelt Avenue	4.5
R11	POW - 398 Roosevelt Avenue	4.5
R12	POW - 402 Roosevelt Avenue	4.5
R13	POW - 406 Roosevelt Avenue	4.5
R14	POW - 410 Richmond Road	13.5
R15	POW - 411 Richmond Road	25.5

Table 6 below contains Predictor-Lima calculation settings. These are typical settings that have been based on ISO 9613 standards and guidance from the MECP. Ground absorption over the study area was determined based on topographical features (such as water, concrete, grassland, etc.). An absorption value of 0 is representative of hard ground, while a value of 1 represents grass and similar soft surface conditions. The mechanical units were represented as point sources and emitting facade objects in the Predictor model. Existing and proposed buildings were added to the model to account for screening and reflection effects from building façades. Predictor-Lima modelling data is available upon request.

TABLE 6: CALCULATION SETTINGS

Parameter	Setting
Meteorological correction method	Single value for C0
Value C0	2.0
Ground attenuation factor for lawn areas	1
Ground attenuation factor for roadways and paved areas	0
Temperature (K)	283.15
Pressure (kPa)	101.33
Air humidity (%)	70

5. RESULTS AND DISCUSSION

5.1 Roadway Traffic Noise Levels

The results of the roadway traffic noise calculations are summarized in Table 7 below. A complete set of input and output data from all STAMSON 5.04 calculations are available in Appendix A.

TABLE 7: EXTERIOR NOISE LEVELS DUE TO ROAD TRAFFIC

Receptor Number	Receptor Height Above Grade (m)	Receptor Location	STAMSON 5.04 Noise Level (dBA)	
			Day	Night
1	1.5	POW – 1st Floor – South Façade	68	61
2	1.5	POW – 1st Floor – East Façade	66	58
3	1.5	POW – 1st Floor – West Façade	62	55
4	15.5	OLA – 5th Floor Terrace (North Side)	39	N/A*
5	25.5	OLA – 9th Floor Terrace (South Side)	60	N/A*
6	28.5	OLA – 10th Floor Terrace (South Side)	53	N/A*

*Nighttime noise levels are not considered at OLA receptors as per ENCG

The results of the current analysis indicate that noise levels will range between 39 and 68 dBA during the daytime period (07:00-23:00) and between 55 and 61 dBA during the nighttime period (23:00-07:00). The highest noise level (68 dBA) occurs at the south façade, which is nearest and most exposed to Richmond Road.

5.2 Stationary Noise Levels

Noise levels on the surroundings produced by the mechanical equipment and the emergency generator associated with the proposed development are presented in Tables 8 and 9, respectively. The sound levels are based on the assumptions outlined in Section 4.3.1.

TABLE 8: NOISE LEVELS ONTO SURROUNDINGS FROM HVAC STATIONARY SOURCES

Receptor Number	Receptor Location	Height Above Grade/Roof (m)	Noise Level (dBA)		Sound Level Limits		Meets ENCG Class 1 Criteria	
			Day	Night	Day	Night	Day	Night
R1	POW - 396 Winston Ave.	4.5	41	38	50	45	**Yes**	**Yes**
R2	OPOR - 396 Winston Ave.	1.5	41	38	50	N/A*	**Yes**	**N/A***
R3	POW - 392 Winston Ave.	4.5	39	36	50	45	**Yes**	**Yes**
R4	OPOR - 392 Winston Ave.	1.5	40	37	50	N/A*	**Yes**	**N/A***
R5	POW - 390 Winston Ave.	4.5	39	36	50	45	**Yes**	**Yes**
R6	OPOR - 390 Winston Ave.	1.5	39	36	50	N/A*	**Yes**	**N/A***
R7	POW - 389 Roosevelt Ave.	4.5	35	32	50	45	**Yes**	**Yes**
R8	OPOR - 389 Roosevelt Ave.	1.5	33	30	50	N/A*	**Yes**	**N/A***
R9	POW - 390 Roosevelt Ave.	4.5	43	40	50	45	**Yes**	**Yes**
R10	POW - 394 Roosevelt Ave.	4.5	45	42	50	45	**Yes**	**Yes**
R11	POW - 398 Roosevelt Ave.	4.5	46	42	50	45	**Yes**	**Yes**
R12	POW - 402 Roosevelt Ave.	4.5	47	44	50	45	**Yes**	**Yes**
R13	POW - 406 Roosevelt Ave.	4.5	48	45	50	45	**Yes**	**Yes**
R14	POW - 410 Richmond Road	13.5	47	44	50	45	**Yes**	**Yes**
R15	POW - 411 Richmond Road	25.5	37	34	50	45	**Yes**	**Yes**

*Noise levels at OPORs during the nighttime period are not considered as per ENCG

TABLE 9: NOISE LEVELS ONTO SURROUNDINGS FROM EMERGENCY GENERATOR

Receptor Number	Receptor Location	Height Above Grade/Roof (m)	Noise Level (dBA)		Sound Level Limits		Meets ENCG Class 1 Criteria	
			Day	Night	Day	Night	Day	Night
R1	POW - 396 Winston Ave.	4.5	40	N/A*	55	N/A*	**Yes**	N/A*
R2	OPOR - 396 Winston Ave.	1.5	40	N/A*	55	N/A*	**Yes**	N/A*
R3	POW - 392 Winston Ave.	4.5	38	N/A*	55	N/A*	**Yes**	N/A*
R4	OPOR - 392 Winston Ave.	1.5	38	N/A*	55	N/A*	**Yes**	N/A*
R5	POW - 390 Winston Ave.	4.5	37	N/A*	55	N/A*	**Yes**	N/A*
R6	OPOR - 390 Winston Ave.	1.5	37	N/A*	55	N/A*	**Yes**	N/A*
R7	POW - 389 Roosevelt Ave.	4.5	32	N/A*	55	N/A*	**Yes**	N/A*
R8	OPOR - 389 Roosevelt Ave.	1.5	32	N/A*	55	N/A*	**Yes**	N/A*
R9	POW - 390 Roosevelt Ave.	4.5	38	N/A*	55	N/A*	**Yes**	N/A*
R10	POW - 394 Roosevelt Ave.	4.5	39	N/A*	55	N/A*	**Yes**	N/A*
R11	POW - 398 Roosevelt Ave.	4.5	39	N/A*	55	N/A*	**Yes**	N/A*
R12	POW - 402 Roosevelt Ave.	4.5	39	N/A*	55	N/A*	**Yes**	N/A*
R13	POW - 406 Roosevelt Ave.	4.5	41	N/A*	55	N/A*	**Yes**	N/A*
R14	POW - 410 Richmond Road	13.5	51	N/A*	55	N/A*	**Yes**	N/A*
R15	POW - 411 Richmond Road	25.5	44	N/A*	55	N/A*	**Yes**	N/A*

*Noise levels during the nighttime period are not considered as per ENCG

As Tables 8 and 9 summarize, noise levels fall below ENCG criteria at all receptors. Noise contours at 4.5 meters above grade for HVAC and emergency equipment sources can be seen in Figures 5-7 for daytime and nighttime conditions. The results indicate that different equipment will have a greater contribution to the noise impact at nearby facades depending on their position and orientation. It is recommended that the maximum permissible noise levels be used within the design, where noted, to ensure noise levels meet the criteria outlined in NPC-300 and ENCG. This can be achieved by incorporating quieter units, installing silencers or noise barriers where required. As a general recommendation, rooftop equipment should be located toward the centre of the rooftop area, avoiding direct line of sight with noise-sensitive areas, if possible.

5.3 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):

- **Bedroom Windows**

(i) Bedroom windows facing south will require a minimum STC of 31

(ii) Bedroom windows facing east will require a minimum STC of 29

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

- **Living Room Windows**

(i) Living room windows facing south will require a minimum STC of 26

(ii) Living room windows facing east will require a minimum STC of 24

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

- **Retail Windows**

(iv) Retail windows facing south will require a minimum STC of 21

(v) Retail windows facing east will require a minimum STC of 19

(vi) All other living room windows are to satisfy Ontario Building Code (OBC 2020) 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[13]

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

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

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

5.4 Noise Barrier Calculation

Noise levels at the Level 9 Outdoor Living Area (Receptor 5) are expected to approach 60 dBA during the daytime period. Noise control measures are recommended to reduce the L_{eq} towards 55 dBA as is technically and administratively feasible. Further analysis investigated the noise mitigating impact of including a solid 1.1-meter-tall perimeter guard surrounding the OLA. Results of the investigation proved that noise levels can be reduced to 56 dBA. Reducing the noise levels below 55 dBA would require excessive barrier heights that would impede terrace views. Table 4 summarizes the results of the barrier investigation. The location of the recommended noise barrier is illustrated in Figure 4. As noise levels remain between 55 and 60 dBA, a 'Type B' Warning Clause will be required, as summarized in Section 6.

Receptor Number	Receptor Height Above Grade (m)	Receptor Location	STAMSON 5.04 Noise Level (dBA)	
			No barrier	1.1-meter barrier
5	25.5	OLA – 9th Floor Terrace (South Side)	60	56

6. CONCLUSIONS AND RECOMMENDATIONS

The results of the current analysis indicate that traffic noise levels will range between 39 and 68 dBA during the daytime period (07:00-23:00) and between 55 and 61 dBA during the nighttime period (23:00-07:00). The highest noise level (68 dBA) occurs at the south façade, which is nearest and most exposed to Richmond Road. 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, or a similar ventilation system, which will allow occupants to keep windows closed and maintain a comfortable living environment. The following 'Type D' Warning Clause will also be required in all Lease, Purchase and Sale Agreements, as summarized below:

> *"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."*

Traffic noise levels at the Level 9 private terraces (Receptor 5) are expected to approach 60 dBA during the daytime period. Further analysis investigated the noise mitigating impact of including a solid 1.1-meter-tall perimeter guard surrounding the OLA. Results of the investigation proved that noise levels can be reduced to 56 dBA. Reducing the noise levels below 55 dBA would require excessive barrier heights that would impede terrace views. The location of the recommended noise barrier is illustrated in Figure 4. As traffic noise levels remain between 55 and 60 dBA at the Level 9 private terraces, the following 'Type B' Warning Clause will be required on all Lease, Purchase and Sale Agreements for the dwelling units featuring these terraces, 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 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."

The perimeter guard must be constructed from materials having a minimum surface density of 20 kg/m^2 (STC rating of 30) and contain no gaps. Design will conform to the requirements outlined in Part 5 of the ENCG. 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.

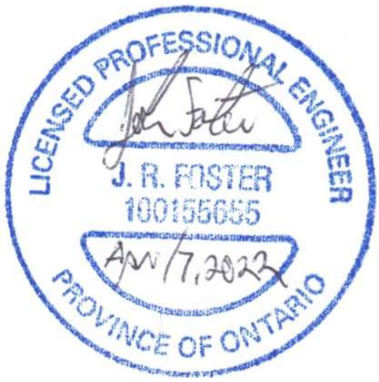
Roadway traffic noise levels at all other terraces were found to fall below the ENCG criteria.

Stationary noise assessment results indicate that stationary noise levels at all nearby points of reception are expected to fall below ENCG criteria, provided our assumptions for noise control outlined in Sections 4.3.2 and 4.3.3 are followed during detailed design process. It is recommended that the maximum permissible noise levels be used within the design, where noted, to ensure noise levels meet the criteria outlined in ENCG. This can be achieved by incorporating quieter units, installing silencers or noise barriers where required. Exterior rooftop equipment should be located toward the centre of the rooftop area, avoiding direct line of sight with noise-sensitive areas if possible.

This concludes our environmental 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,

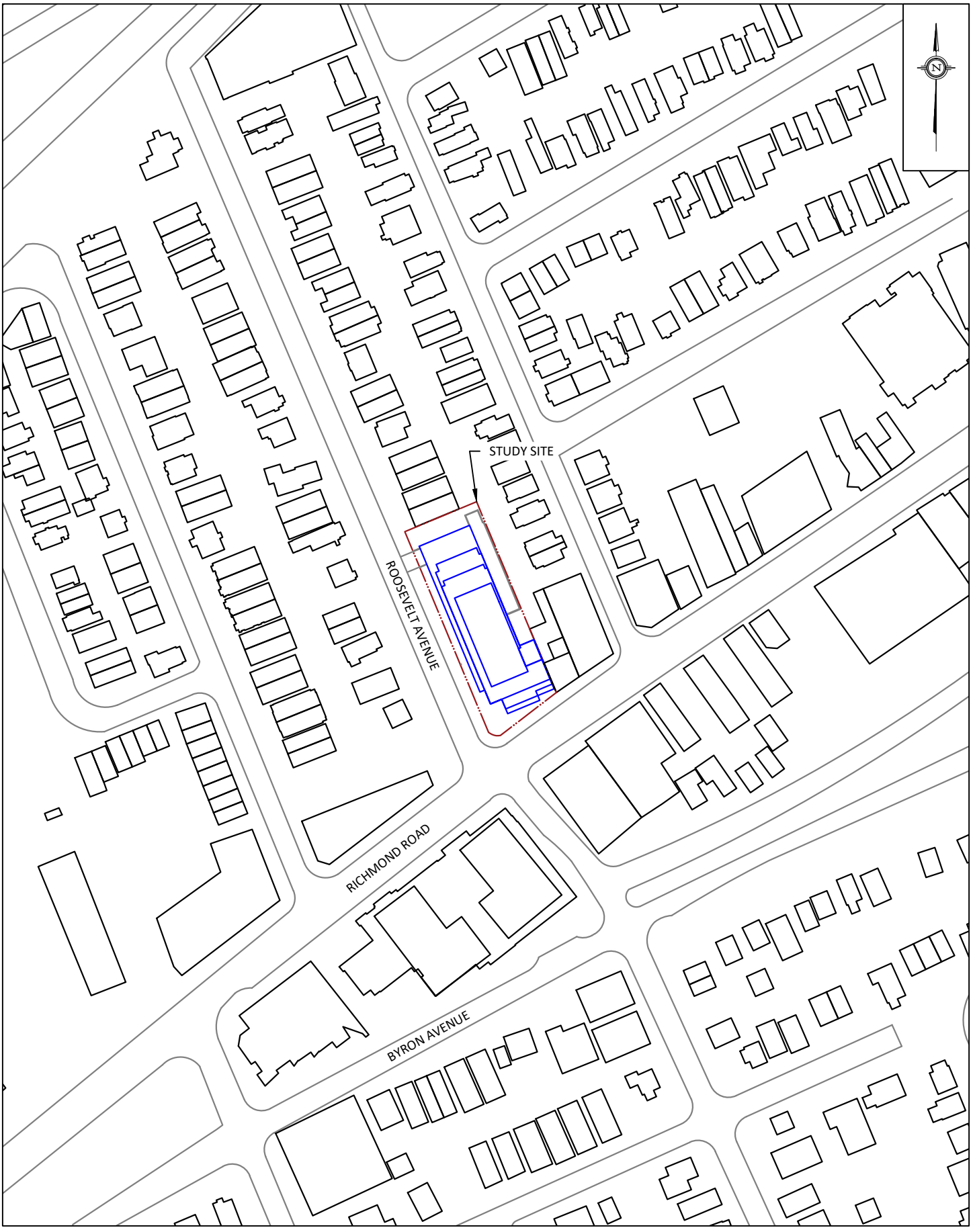
Gradient Wind Engineering Inc.



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

Joshua Foster, P.Eng.
Lead Engineer

Gradient Wind File #20-174-Traffic Noise



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PROJECT	403 RICHMOND ROAD, OTTAWA ENVIRONMENTAL NOISE ASSESSMENT
SCALE	1:2000 (APPROX.)
DRAWING NO.	GWE20-174-1
DATE	FEBRUARY 16, 2022
DRAWN BY	T.M.F.

DESCRIPTION

FIGURE 1:
SITE PLAN AND SURROUNDING CONTEXT

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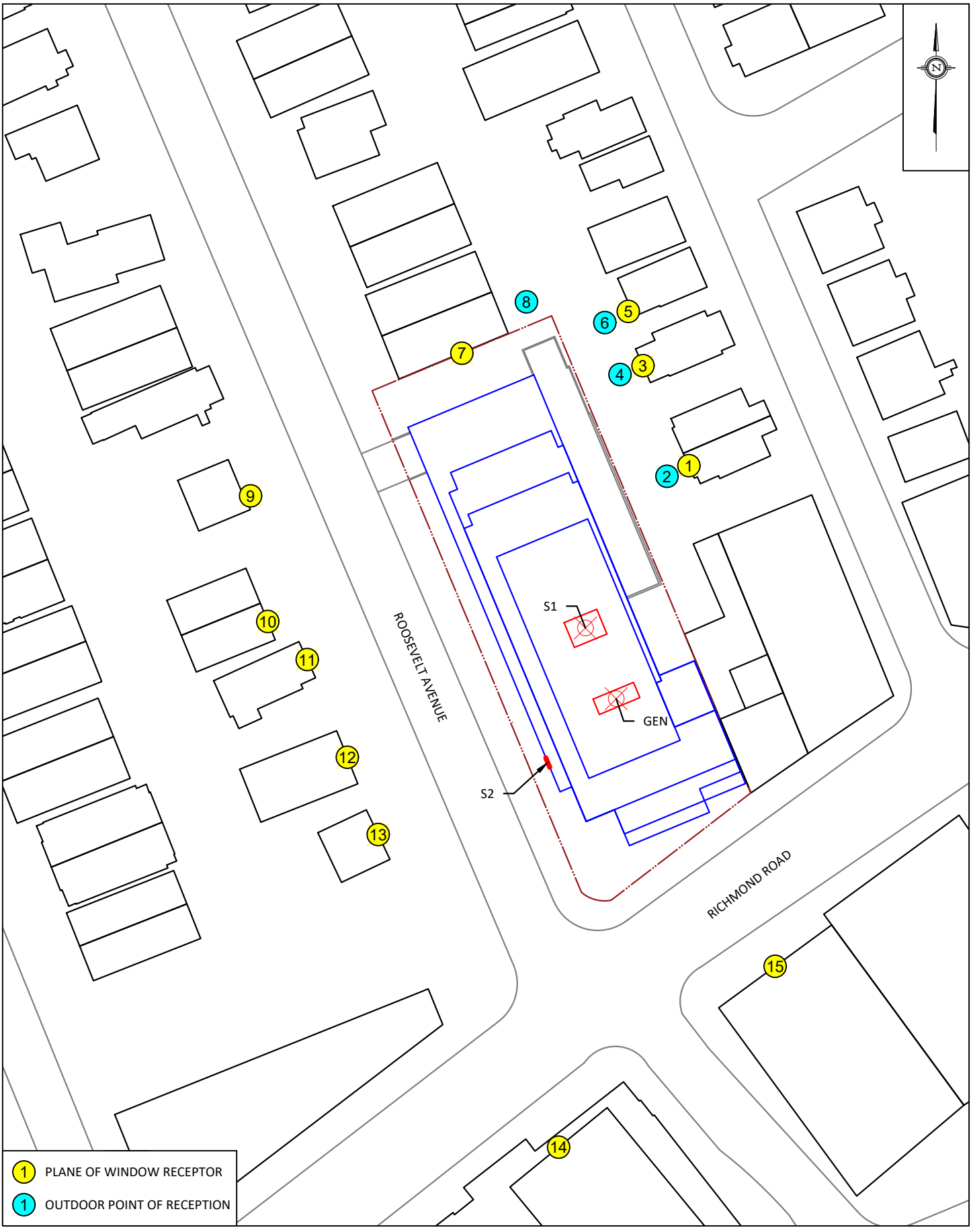
PROJECT	403 RICHMOND ROAD, OTTAWA ENVIRONMENTAL NOISE ASSESSMENT		DESCRIPTION
SCALE	1:500 (APPROX.)	DRAWING NO.	GWE20-174-2A
DATE	MARCH 7, 2022	DRAWN BY	T.M.F.

FIGURE 2A:
TRAFFIC NOISE RECEPTOR LOCATIONS



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PROJECT	403 RICHMOND ROAD, OTTAWA ENVIRONMENTAL NOISE ASSESSMENT
SCALE	1:800 (APPROX.)
DRAWING NO.	GWE20-174-2B
DATE	MARCH 8, 2022
DRAWN BY	T.M.F.

DESCRIPTION

FIGURE 2B:
STATIONARY NOISE IMPACTS ON SURROUNDINGS
SOURCE AND RECEPTOR LOCATIONS

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PROJECT	403 RICHMOND ROAD, OTTAWA ENVIRONMENTAL NOISE ASSESSMENT
SCALE	1:500 (APPROX.)
DRAWING NO.	GWE20-174-3
DATE	FEBRUARY 17, 2022
DRAWN BY	T.M.F.
DESCRIPTION	FIGURE 3: WINDOW STC REQUIREMENTS

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PROJECT	403 RICHMOND ROAD, OTTAWA ENVIRONMENTAL NOISE ASSESSMENT
SCALE	1:500 (APPROX.)
DRAWING NO.	GWE20-174-4
DATE	FEBRUARY 17, 2022
DRAWN BY	T.M.F.

DESCRIPTION

FIGURE 4:
1.1-METER-TALL NOISE BARRIER LOCATION

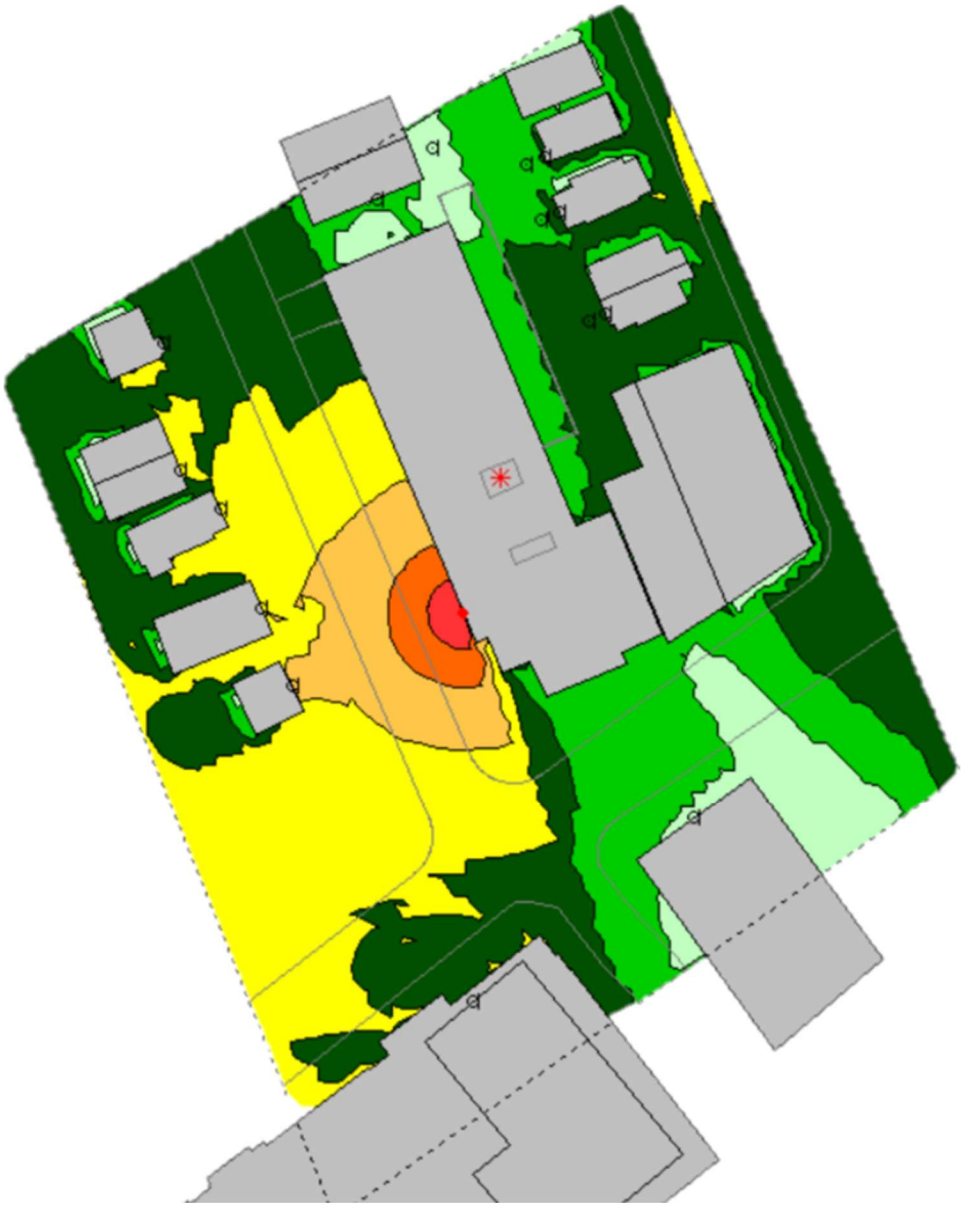


FIGURE 5: DAYTIME STATIONARY NOISE LEVELS 4.5 M ABOVE GRADE - HVAC SOURCES

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

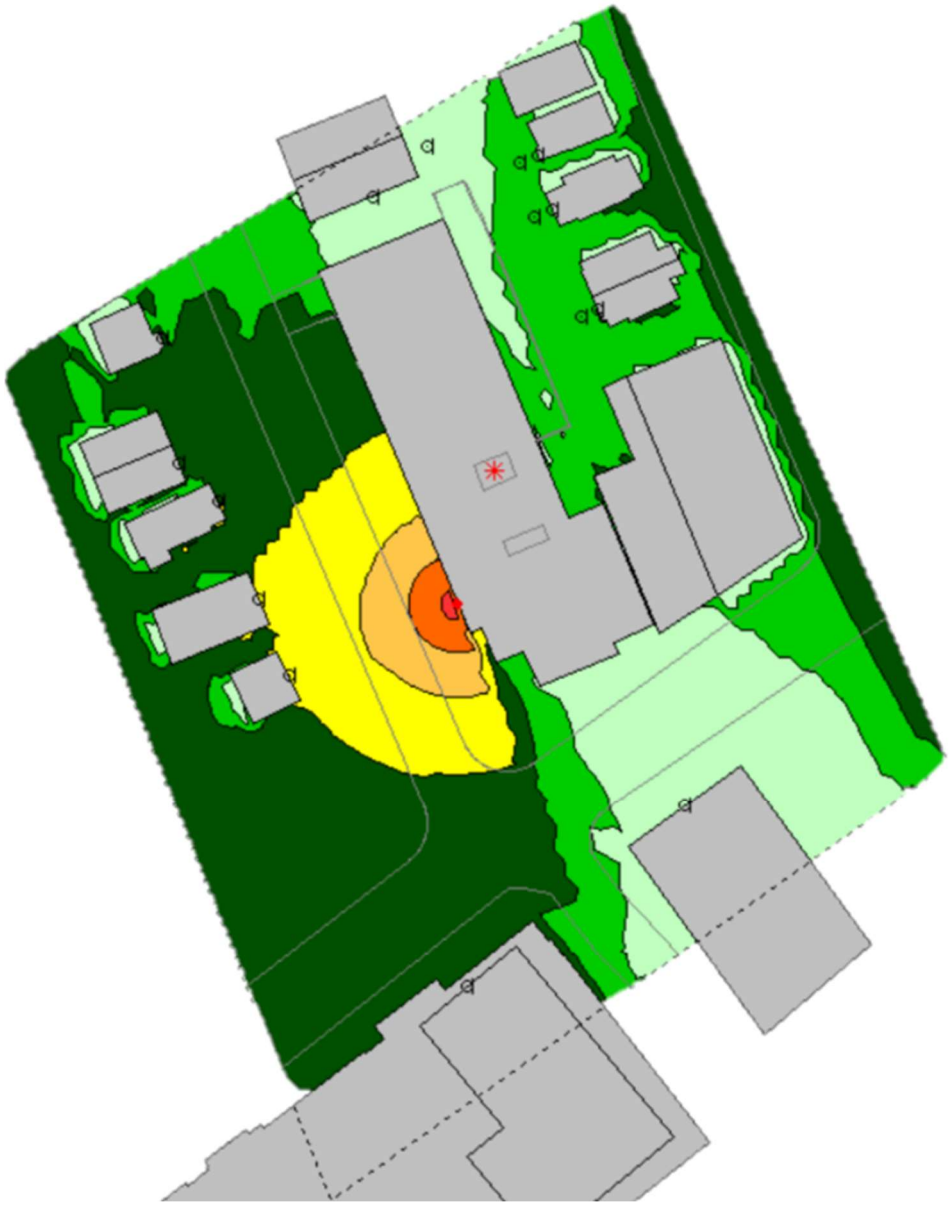
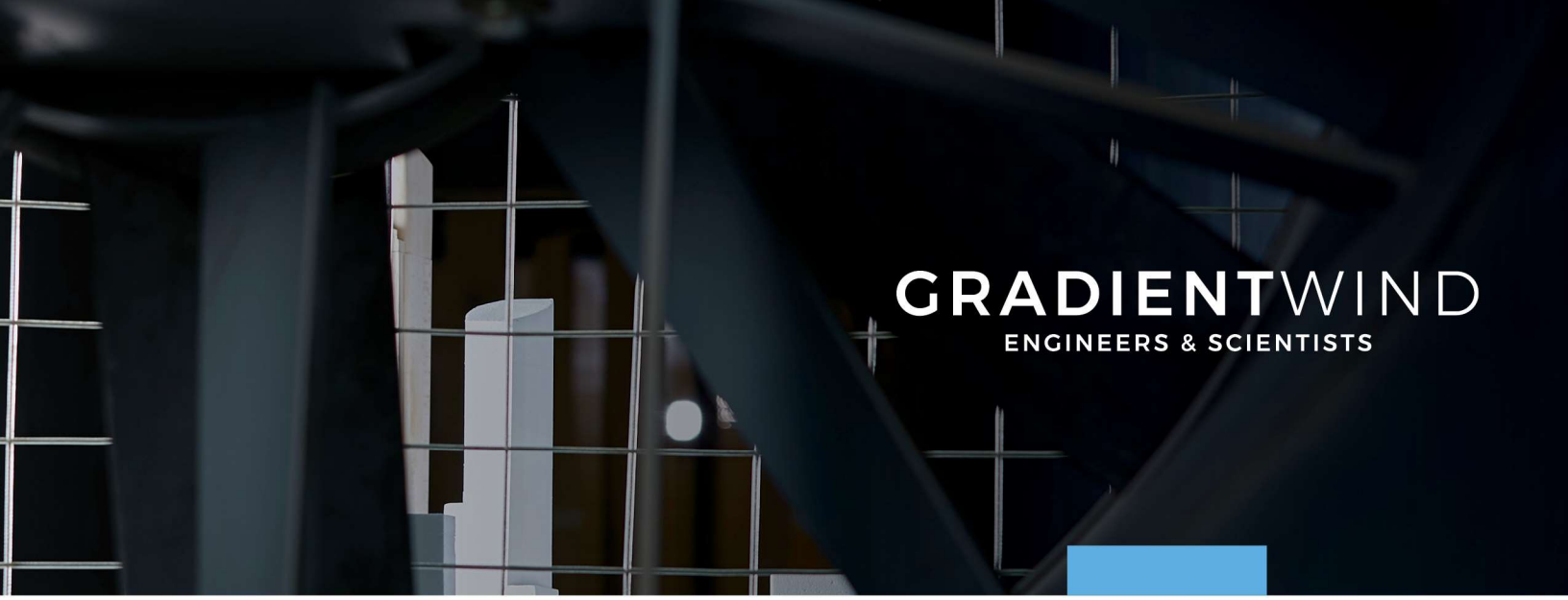


FIGURE 6: NIGHTTIME STATIONARY NOISE LEVELS 4.5 M ABOVE GRADE - HVAC SOURCES

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

FIGURE 7: STATIONARY NOISE LEVELS 4.5 M ABOVE GRADE - EMERGENCY GENERATOR

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



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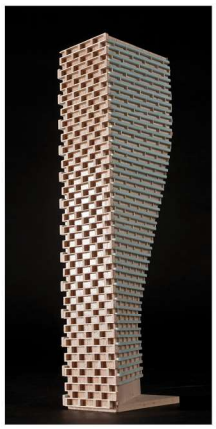

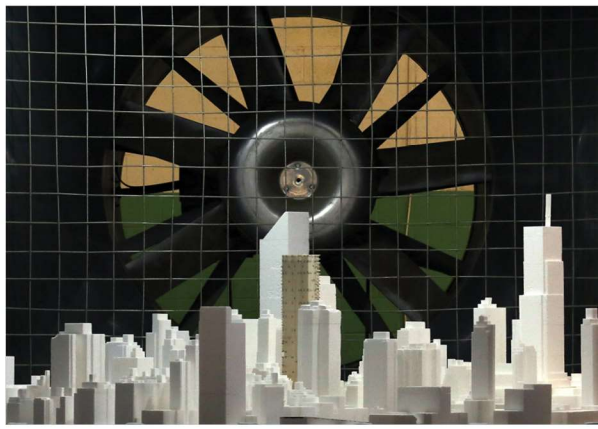

APPENDIX A

STAMSON 5.04 – INPUT AND OUTPUT DATA

127 WALGREEN ROAD, OTTAWA, ON, CANADA K0A 1L0 | 613 836 0934
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```
STAMSON 5.0        NORMAL REPORT        Date: 17-02-2022 09:58:43
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


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

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

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

Data for Segment # 1: Richmond (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  :  15.00 / 15.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Road data, segment # 2: Byron1 (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  :    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):   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: Byron1 (day/night)
----------------------------------------
Angle1   Angle2           : -90.00 deg   -25.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  97.00 / 97.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : -25.00 deg
Barrier height            :   7.00 m
Barrier receiver distance :  66.00 / 66.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Road data, segment # 3: Byron2 (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  :    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):   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 # 3: Byron2 (day/night)
----------------------------------------
Angle1   Angle2           : -25.00 deg   19.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  97.00 / 97.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -25.00 deg   Angle2 : 19.00 deg
Barrier height            :  15.00 m
Barrier receiver distance :  63.00 / 63.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Road data, segment # 4: Byron3 (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  :    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):   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 # 4: Byron3 (day/night)
----------------------------------------
Angle1   Angle2           :  19.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  97.00 / 97.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            :  19.00 deg   Angle2 : 90.00 deg
Barrier height            :  28.00 m
Barrier receiver distance :  72.00 / 72.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

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

Source height = 1.50 m

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

Segment Leq : 68.48 dBA

Results segment # 2: Byron1 (day)
---------------------------------

Source height = 1.50 m

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

ROAD (0.00 + 41.59 + 0.00) = 41.59 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90    -25   0.00  65.75   0.00  -8.11  -4.42   0.00   0.00 -11.63  41.59
-------------------------------------------------------------------------------

Segment Leq : 41.59 dBA
```

```
Results segment # 3: Byron2 (day)
---------------------------------

Source height = 1.50 m

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

ROAD (0.00 + 31.52 + 0.00) = 31.52 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -25     19   0.00  65.75   0.00  -8.11  -6.12   0.00   0.00 -20.00  31.52
-------------------------------------------------------------------------------

Segment Leq : 31.52 dBA

Results segment # 4: Byron3 (day)
---------------------------------

Source height = 1.50 m

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

ROAD (0.00 + 34.56 + 0.00) = 34.56 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
    19     90   0.00  65.75   0.00  -8.11  -4.04   0.00   0.00 -19.04  34.56
-------------------------------------------------------------------------------

Segment Leq : 34.56 dBA

Total Leq All Segments: 68.49 dBA
```

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

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
-------------------------------------------------------------------------------
   -90     90   0.00  60.88   0.00   0.00   0.00   0.00   0.00   0.00  60.88
-------------------------------------------------------------------------------

Segment Leq : 60.88 dBA

Results segment # 2: Byron1 (night)
-----------------------------------

Source height = 1.50 m

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

ROAD (0.00 + 34.00 + 0.00) = 34.00 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90    -25   0.00  58.16   0.00  -8.11  -4.42   0.00   0.00 -11.63  34.00
-------------------------------------------------------------------------------

Segment Leq : 34.00 dBA
```

```
Results segment # 3: Byron2 (night)
----------------------------------

Source height = 1.50 m

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

ROAD (0.00 + 23.93 + 0.00) = 23.93 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -25     19   0.00  58.16   0.00  -8.11  -6.12   0.00   0.00 -20.00  23.93
-------------------------------------------------------------------------------

Segment Leq : 23.93 dBA

Results segment # 4: Byron3 (night)
----------------------------------

Source height = 1.50 m

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

ROAD (0.00 + 26.97 + 0.00) = 26.97 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
    19     90   0.00  58.16   0.00  -8.11  -4.04   0.00   0.00 -19.04  26.97
-------------------------------------------------------------------------------

Segment Leq : 26.97 dBA

Total Leq All Segments: 60.89 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 68.49
                           (NIGHT): 60.89
```

```
STAMSON 5.0        NORMAL REPORT        Date: 17-02-2022 09:59:43
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


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

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

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

Data for Segment # 1: Richmond (day/night)
-------------------------------------------
Angle1   Angle2           : -90.00 deg   14.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  17.00 / 17.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

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

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     14   0.00  68.48   0.00  -0.54  -2.38   0.00   0.00   0.00  65.55
-------------------------------------------------------------------------------

Segment Leq : 65.55 dBA

Total Leq All Segments: 65.55 dBA

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

Source height = 1.50 m

ROAD (0.00 + 57.96 + 0.00) = 57.96 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     14   0.00  60.88   0.00  -0.54  -2.38   0.00   0.00   0.00  57.96
-------------------------------------------------------------------------------

Segment Leq : 57.96 dBA

Total Leq All Segments: 57.96 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 65.55
                           (NIGHT): 57.96
```

```
STAMSON 5.0        NORMAL REPORT        Date: 17-02-2022 10:11:06
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


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

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

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

Data for Segment # 1: Richmond (day/night)
-------------------------------------------
Angle1   Angle2           :  14.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  27.00 / 27.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

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

Source height = 1.50 m

ROAD (0.00 + 62.18 + 0.00) = 62.18 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
    14     90   0.00  68.48   0.00  -2.55  -3.74   0.00   0.00   0.00  62.18
-------------------------------------------------------------------------------

Segment Leq : 62.18 dBA

Total Leq All Segments: 62.18 dBA

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

Source height = 1.50 m

ROAD (0.00 + 54.59 + 0.00) = 54.59 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
    14     90   0.00  60.88   0.00  -2.55  -3.74   0.00   0.00   0.00  54.59
-------------------------------------------------------------------------------

Segment Leq : 54.59 dBA

Total Leq All Segments: 54.59 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 62.18
                           (NIGHT): 54.59
```

```
STAMSON 5.0        NORMAL REPORT        Date: 17-02-2022 10:21:01
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


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

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

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

Data for Segment # 1: Richmond (day/night)
-------------------------------------------
Angle1   Angle2           : -51.00 deg   73.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  83.00 / 83.00  m
Receiver height           :  15.50 / 15.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -51.00 deg   Angle2 : 73.00 deg
Barrier height            :  33.50 m
Barrier receiver distance :   5.00 / 5.00   m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

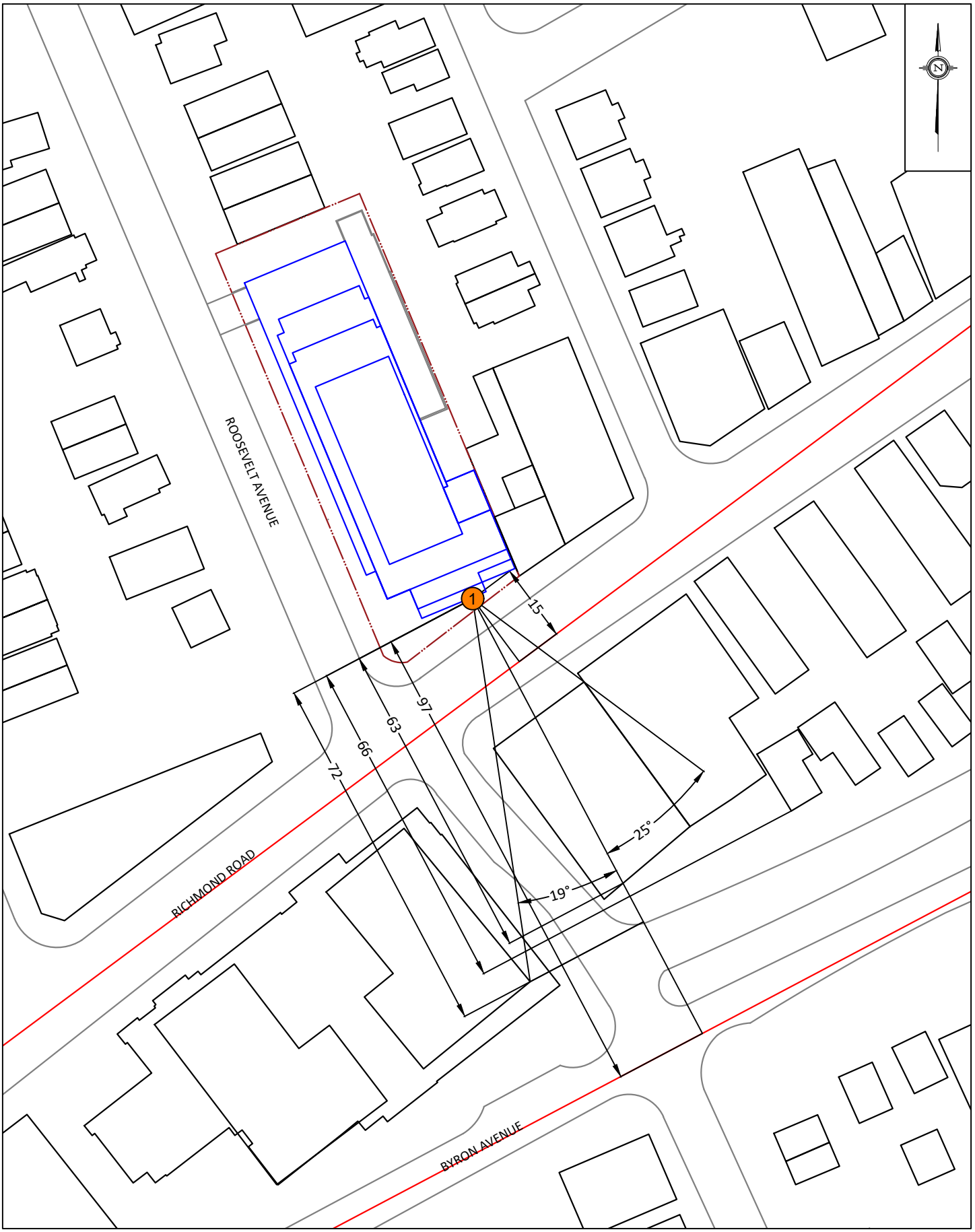
```
Results segment # 1: Richmond (day)
-----------------------------------

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 !       15.50 !       14.66 !        14.66

ROAD (0.00 + 39.43 + 0.00) = 39.43 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -51     73   0.00  68.48   0.00  -7.43  -1.62   0.00   0.00 -20.00  39.43
-------------------------------------------------------------------------------

Segment Leq : 39.43 dBA

Total Leq All Segments: 39.43 dBA

Results segment # 1: Richmond (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 !       15.50 !       14.66 !        14.66

ROAD (0.00 + 31.84 + 0.00) = 31.84 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -51     73   0.00  60.88   0.00  -7.43  -1.62   0.00   0.00 -20.00  31.84
-------------------------------------------------------------------------------

Segment Leq : 31.84 dBA

Total Leq All Segments: 31.84 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 39.43
                           (NIGHT): 31.84
```

```
STAMSON 5.0        NORMAL REPORT        Date: 17-02-2022 10:28:57
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


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

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

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

Data for Segment # 1: Richmond (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  :  20.00 / 83.00  m
Receiver height           :  25.50 / 15.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : 90.00 deg
Barrier height            :  24.00 m
Barrier receiver distance :   2.00 / 65.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Results segment # 1: Richmond (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 !       25.50 !       23.10 !        23.10

ROAD (0.00 + 60.32 + 0.00) = 60.32 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     90   0.00  68.48   0.00  -1.25   0.00   0.00   0.00  -6.91  60.32
-------------------------------------------------------------------------------

Segment Leq : 60.32 dBA

Total Leq All Segments: 60.32 dBA

Barrier table for segment # 1: Richmond (day)
---------------------------------------------

Barrier ! Elev of !  Road   ! Tot Leq !
Height  ! Barr Top!  dBA    !   dBA   !
--------+---------+---------+---------+
  24.00 !   24.00 !   60.32 !   60.32 !
  24.10 !   24.10 !   59.94 !   59.94 !
  24.20 !   24.20 !   59.55 !   59.55 !
  24.30 !   24.30 !   59.14 !   59.14 !
  24.40 !   24.40 !   58.74 !   58.74 !
  24.50 !   24.50 !   58.33 !   58.33 !
  24.60 !   24.60 !   57.92 !   57.92 !
  24.70 !   24.70 !   57.52 !   57.52 !
  24.80 !   24.80 !   57.12 !   57.12 !
  24.90 !   24.90 !   56.73 !   56.73 !
  25.00 !   25.00 !   56.35 !   56.35 !
  25.10 !   25.10 !   55.97 !   55.97 !


TOTAL Leq FROM ALL SOURCES (DAY): 60.32
```

```
STAMSON 5.0        NORMAL REPORT        Date: 17-02-2022 10:30:17
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


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

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

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

Data for Segment # 1: Richmond (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  :  27.00 / 83.00  m
Receiver height           :  28.50 / 15.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : 90.00 deg
Barrier height            :  27.00 m
Barrier receiver distance :   5.00 / 61.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Results segment # 1: Richmond (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 !       28.50 !       23.50 !        23.50

ROAD (0.00 + 53.43 + 0.00) = 53.43 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     90   0.00  68.48   0.00  -2.55   0.00   0.00   0.00 -12.49  53.43
-------------------------------------------------------------------------------

Segment Leq : 53.43 dBA

Total Leq All Segments: 53.43 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 53.43
```



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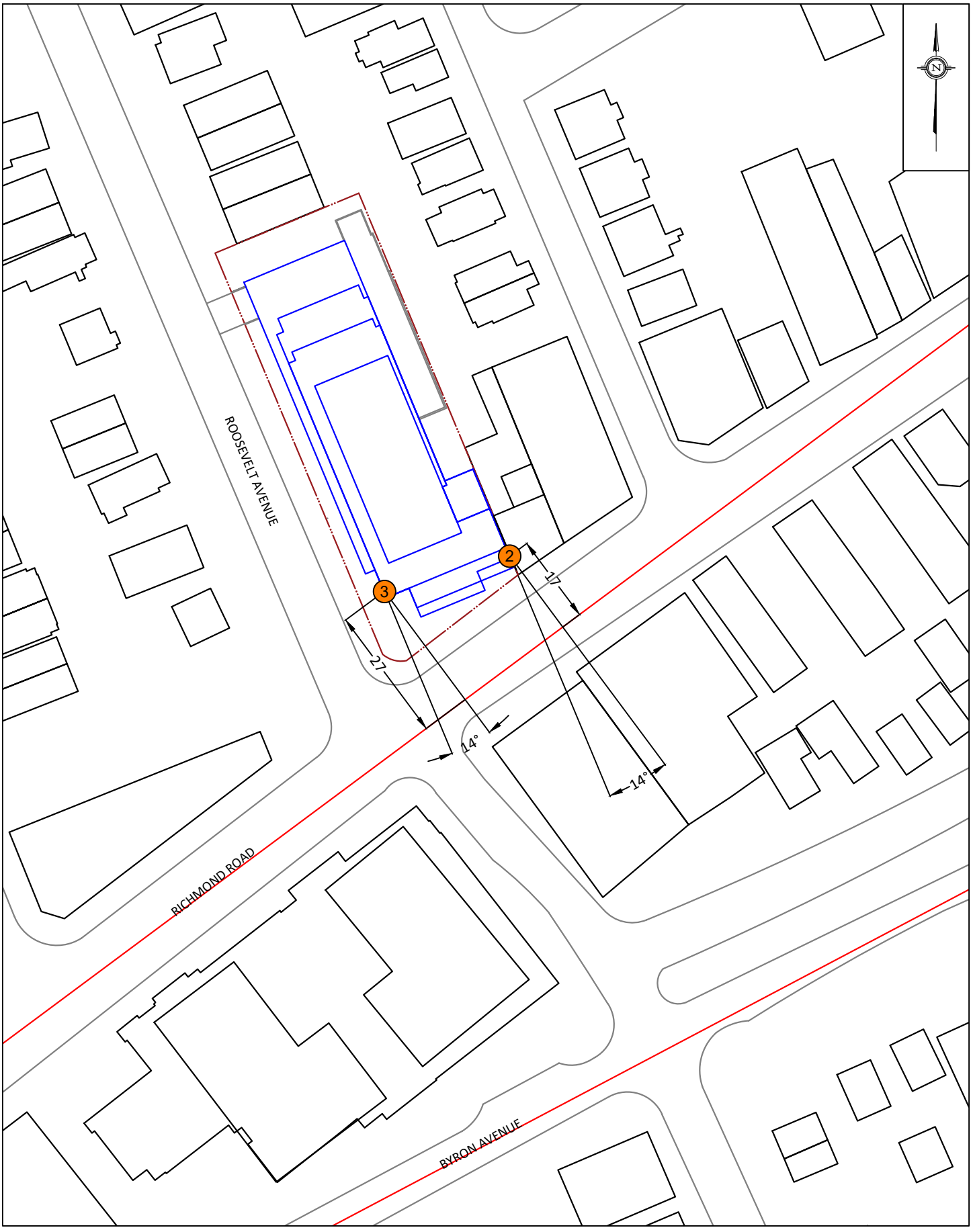
SCALE	1:1000 (APPROX.)	DRAWING NO.	GWE20-174-A1
DATE	AUGUST 6, 2020	DRAWN BY	M.L.

FIGURE A1:
STAMSON INPUT PARAMETERS - RECEPTOR 1



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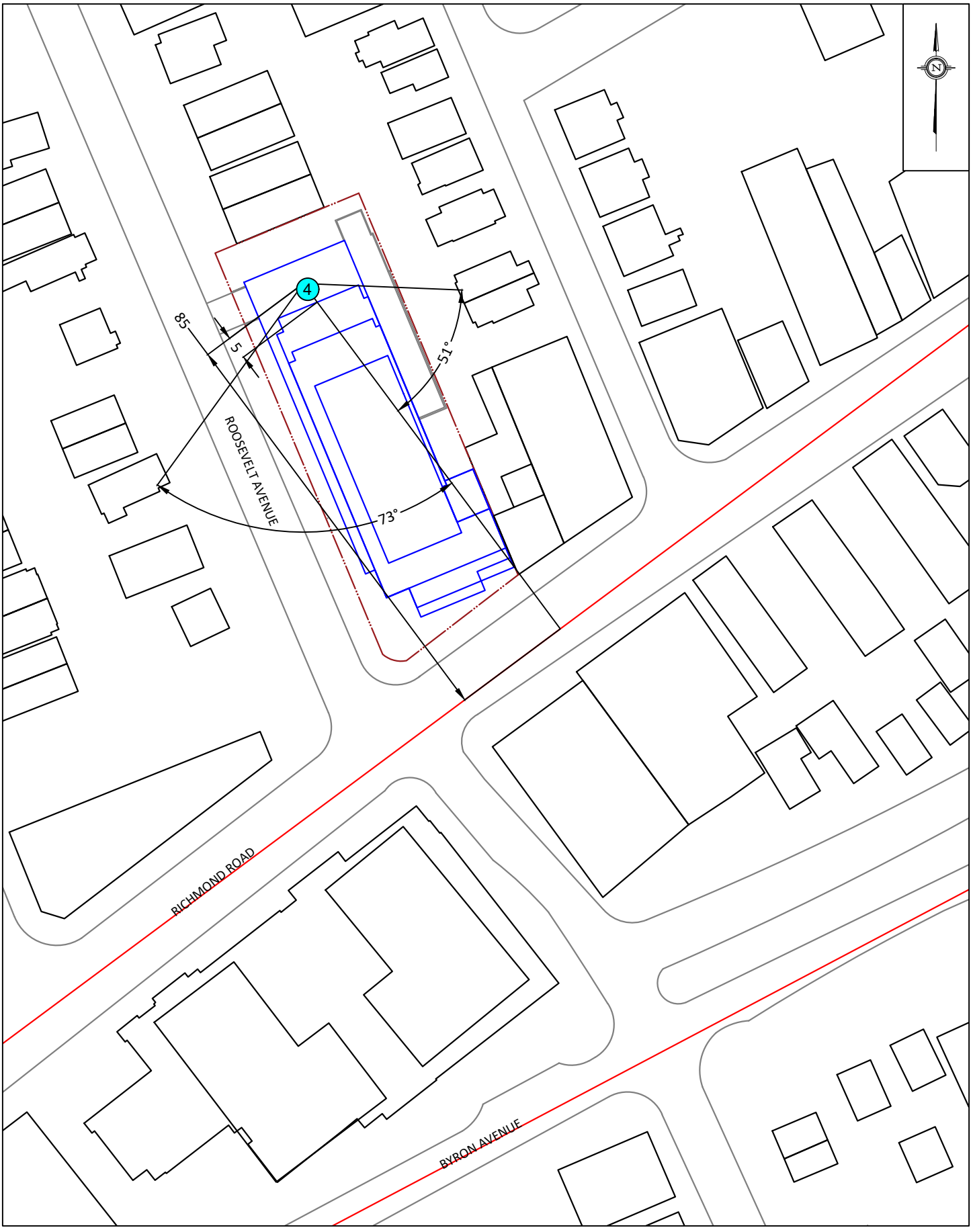
SCALE	1:1000 (APPROX.)	DRAWING NO.	GWE20-174-A2
DATE	AUGUST 6, 2020	DRAWN BY	M.L.

FIGURE A2:
STAMSON INPUT PARAMETERS - RECEPTORS 2 & 3



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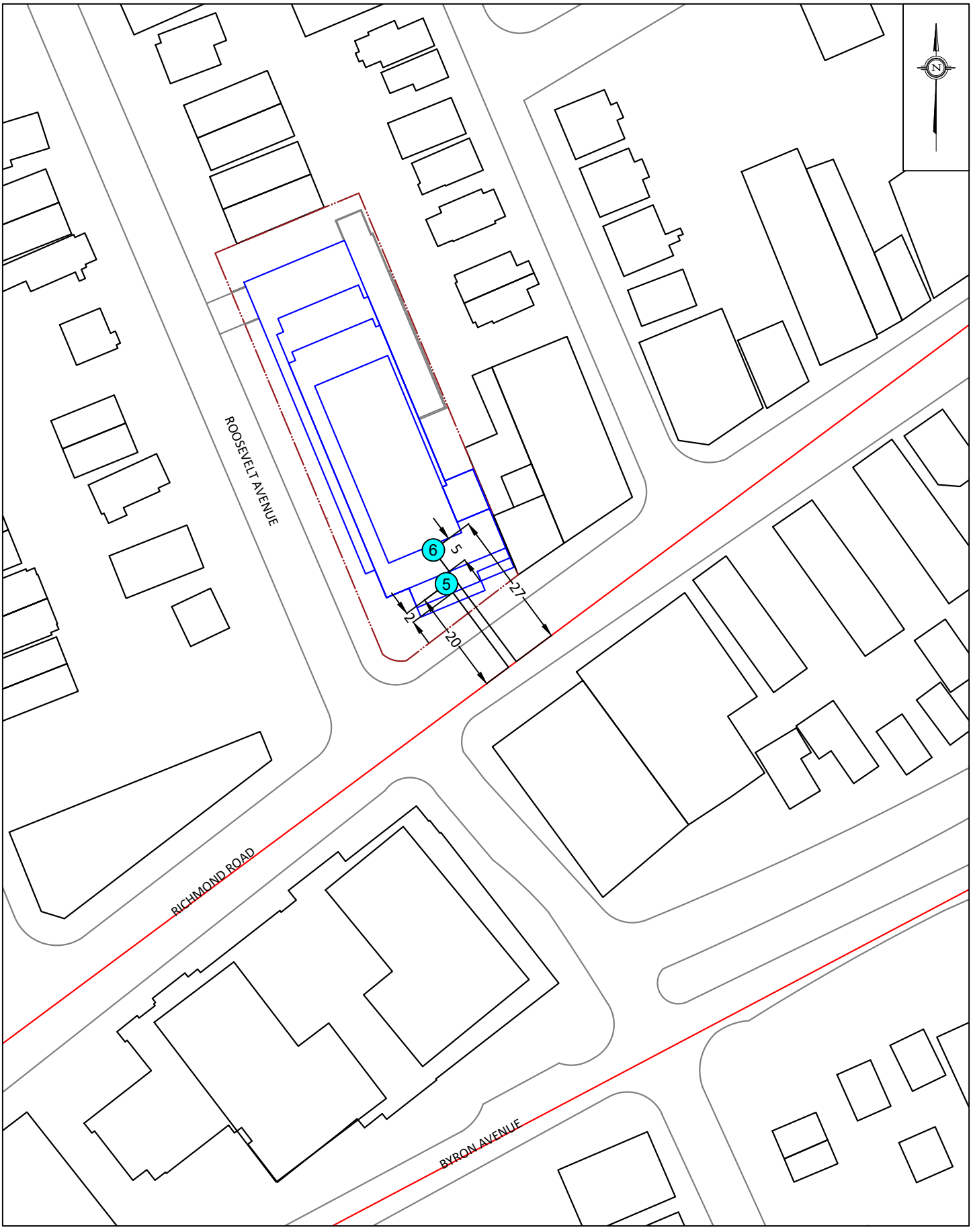
SCALE	1:1000 (APPROX.)	DRAWING NO.	GWE20-174-A3
DATE	AUGUST 6, 2020	DRAWN BY	M.L.

FIGURE A3:
STAMSON INPUT PARAMETERS - RECEPTOR 4



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PROJECT	403 RICHMOND ROAD, OTTAWA ENVIRONMENTAL NOISE ASSESSMENT		DESCRIPTION
SCALE	1:1000 (APPROX.)	DRAWING NO.	GWE20-174-A4
DATE	FEBRUARY 16, 2022	DRAWN BY	T.M.F.

FIGURE A4:
STAMSON INPUT PARAMETERS - RECEPTORS 5 & 6