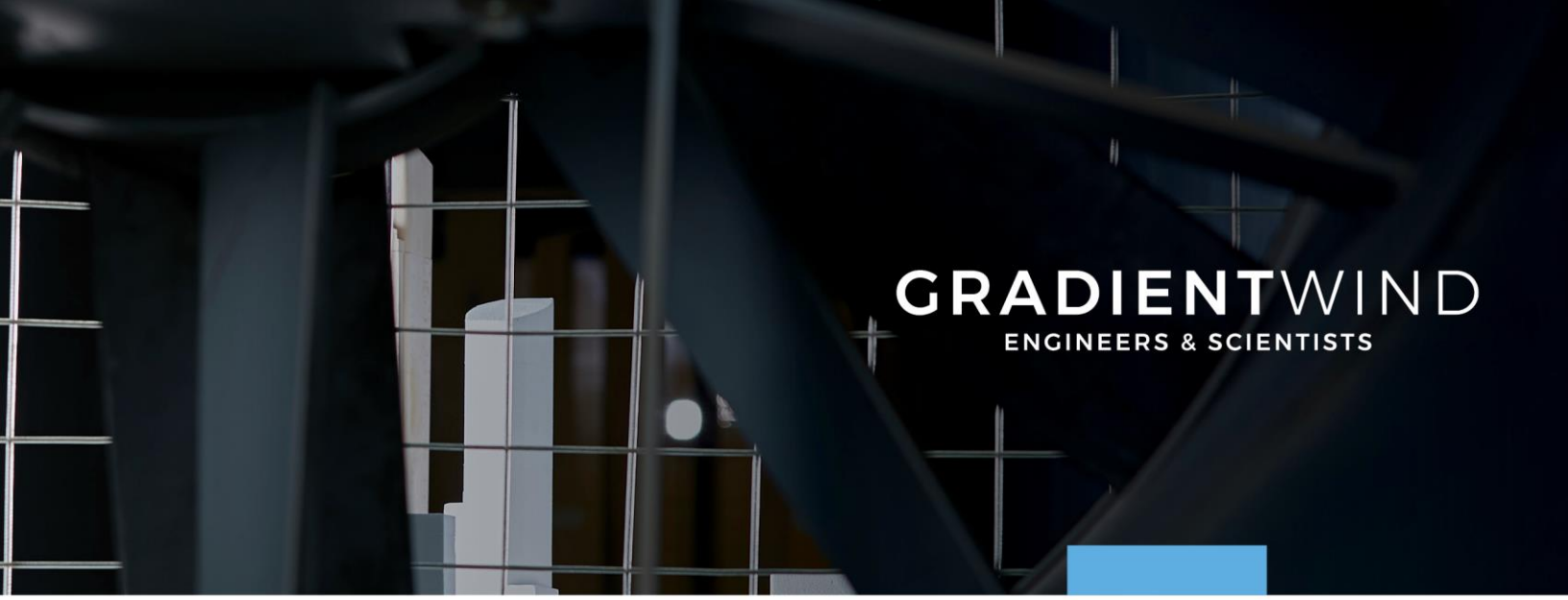

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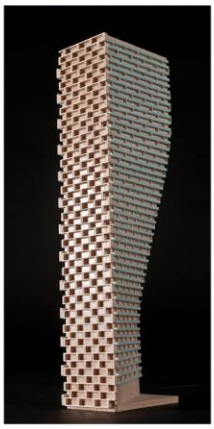
ROADWAY TRAFFIC NOISE ASSESSMENT

6173 Renaud Road
Ottawa, Ontario

REPORT: GWE19-255 – Traffic Noise



March 27, 2020

PREPARED FOR

The Stirling Group
Attn: Alison Stirling
Development Initiatives

PREPARED BY

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

127 WALGREEN ROAD, OTTAWA, ON, CANADA K0A 1L0 | 613 836 0934
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EXECUTIVE SUMMARY

This report describes a detailed roadway traffic noise assessment undertaken in support of site plan application for a proposed residential development located at 6173 Renaud Road in Ottawa, Ontario. The proposed development comprises two blocks of sixteen back-to-back townhomes with outdoor parking spaces. The primary sources of roadway noise associated with the development are Renaud Road and Navan Road. 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 Rosaline J. Hill Architect Inc. dated March 18, 2020.

The results of the current analysis indicate that noise levels will range between 57 and 67 dBA during the daytime period (07:00-23:00) and between 49 and 59 dBA during the nighttime period (23:00-07:00). The highest noise level (67 dBA) occurs at the South façade of Block 1 which is nearest and most exposed to Renaud Road.

Building components with a higher Sound Transmission Class (STC) rating will be required for the southernmost units of Block 1 where exterior noise levels exceed 65 dBA, as indicated in Figure 6. Results of the calculations also indicate that these blocks will require central air conditioning. Additionally, the northeastern and northwestern units for Block 1 as well as the southernmost units for Block 2 will require forced air heating system with provisions for central air conditioning as shown in Figure 7. Both mitigation strategies will allow occupants to keep windows closed and maintain a comfortable living environment. Warning Clauses[1] will also be required in all Lease, Purchase and Sale Agreements as stipulated in Section 6.

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

TABLE OF CONTENTS

1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by The Stirling Group to undertake a detailed roadway traffic noise assessment in support of site plan application for a proposed residential development located at 6173 Renaud 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[2] and Ministry of the Environment, Conservation and Parks (MECP)[3] guidelines. Noise calculations were based on site plan drawings prepared Rosaline J. Hill Architect Inc. dated March 18, 2020, 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 development located at 6173 Renaud Road in Ottawa, Ontario. The study site is located on a nearly rectangular parcel of land near the intersection of Penency Terrace and Renaud Road. The site is bound by Renaud Road to the south, residential lands to the east and west, and Trailsedge Way to the north. Surrounding the site are low-rise residential buildings.

The proposed development comprises two blocks of sixteen back-to-back townhomes, for a total of thirty-two residential units that feature 3.5-storeys each. As the townhomes are back-to-back there are no rear yard or amenity space associated with the individual dwellings. The development does not have any associated outdoor living areas due to the lack our communal outdoor spaces. The primary sources of roadway traffic noise on the development are Renaud Road to the south and Navan Road to the southwest. Figure 1 illustrates a complete site plan with surrounding context.

As the building design progresses, the stationary noise impacts of the building on the surroundings would be considered. Stationary noise sources associated with the development are expected to comprise of

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

internal heat pump or DX Split Air Conditioning units. These sources are not expected to be a concern at noise sensitive spaces and surrounding properties, provided the following are considered in the design: judicious selection of the equipment, locating the equipment on a high roof away from nearby residential receptors, and where necessary, installing silencers or noise screens. Installation of the equipment should be done in accordance with NPC-216 Residential Air Conditioning Devices.

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	Leq (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 normally triggers the need for central air conditioning. Where noise levels exceed 65 dBA daytime and 60 dBA nighttime, building components will require higher levels of sound attenuation[7].

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

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

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.
- Absorptive and reflective intermediate ground surfaces based on specific source-receiver path ground characteristics. Generally, POW receptors considered hard-ground due to paved surfaces between the sources and receivers.
- Topography was assumed to be a flat/gentle slope surrounding the study building.
- Receptor height was taken to be 8.5 metres above grade at the 2nd floor for the plane of the window (POW).
- For select sources where appropriate, receptors considered the surrounding buildings as a barrier partially or fully obstructing exposure to the source as illustrated by exposure angles in Figures 3-5.
- Noise receptors were strategically placed at 4 locations around the study area (see Figure 2).
- Receptor distances and exposure angles are illustrated in Figures 3-5.

4.2.3 Roadway Traffic Volumes

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

[8] 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
Renaud Road	2-Lane Urban Collector (2-UCU)	50	**8,000**
Navan Road	2-Lane Urban Arterial (2-UAU)	60	**15,000**

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 residentially sided exterior wood stud walls have around STC 35. Standard good quality double-glazed non-operable windows can have STC ratings ranging from 25 to 40, depending on the window manufacturer, pane thickness and inter-pane spacing. As previously mentioned, the windows are the known weak point in a partition.

As per Section 4.2, when daytime noise levels (from road and rail sources) at the plane of the window exceed 65 dBA, calculations must be performed to evaluate the sound transmission quality of the building components to ensure acceptable indoor noise levels. The calculation procedure[9] 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

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

- Indoor sound level criteria, which varies according to the intended use of a space

Based on published research[10], 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).

5. RESULTS AND DISCUSSION

5.1 Roadway Traffic Noise Levels

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

TABLE 3: EXTERIOR NOISE LEVELS DUE TO ROAD TRAFFIC

Receptor Number	Receptor Height Above Grade (m)	Receptor Location	STAMSON 5.04 Noise Level (dBA)	
			Day	Night
1	8.5	POW – Block 1 – West Façade	58	51
2	8.5	POW – Block 1 – South Façade	67	59
3	8.5	POW – Block 1 – East Façade	63	55
4	8.5	POW – Block 2 – South Façade	57	49

The results of the current analysis indicate that noise levels will range between 57 and 67 dBA during the daytime period (07:00-23:00) and between 49 and 59 dBA during the nighttime period (23:00-07:00). The highest noise level (67 dBA) occurs at the South façade of Block 1 which is nearest and most exposed to Renaud Road.

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

5.2 Noise Control Measures

The noise levels predicted due to roadway traffic exceed the criteria listed in Section 4.2 for building components. As discussed in Section 4.3, the anticipated STC requirements for windows have been estimated based on the overall noise reduction required for each intended use of space (STC = outdoor noise level – targeted indoor noise levels). As per city of Ottawa requirements, detailed STC calculations will be required to be completed prior to building permit application for each unit type. The STC requirements for the windows are summarized below for various units within the development (see Figure 6):

For Block 1 (Southern Units):

- **Bedroom Windows**

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

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

- **Living Room Windows**

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

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

- **Exterior Walls**

(i) Exterior wall components on the south façade will require a minimum STC of 45, which will be achieved with brick cladding or an acoustical equivalent according to NRC test data[11]

The STC requirements apply to windows and doors. Exterior wall components on these façades are recommended to have a minimum STC of 45. A review of window supplier literature indicates that the specified STC ratings can be achieved by a variety of window systems having a combination of glass thickness and inter-pane spacing. We have specified an example window configuration, however several manufacturers and various combinations of window components, such as those proposed, will offer the necessary sound attenuation rating. It is the responsibility of the manufacturer to ensure that the specified window achieves the required STC. This can only be assured by using window configurations that

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

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 dwellings will require internal acoustic mitigation methods as a result of traffic noise. Blocks with dwellings expected to require central air conditioning are the southernmost units of Block 1 as sound pressure levels are expected to exceed 65 dBA. These dwellings are outlined in Figure 7 by the hatched areas. Blocks with dwellings expected to forced air heating with provisions for central air conditioning include the units at the northeast and north west corner of Block 1 as well as the southernmost units of Block 2 as sound pressure levels are expected to be between 55 dBA and 65 dBA. This 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.

6. CONCLUSIONS AND RECOMMENDATIONS

The results of the current analysis indicate that noise levels will range between 57 and 67 dBA during the daytime period (07:00-23:00) and between 49 and 59 dBA during the nighttime period (23:00-07:00). The highest noise level (67 dBA) occurs at the South façade of Block 1 which is nearest and most exposed to Renaud 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 6.

Results of the calculations also indicate that units closest to Renaud Road will require central air conditioning, which will allow occupants to keep windows closed and maintain a comfortable living environment. The following Warning Clause[12] will also be required on all Lease, Purchase and Sale Agreements for the southernmost units of Block 1 exceeding 65 dBA, as summarized below:

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

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

Conservation and Parks. To help address the need for sound attenuation, this development includes:

- *STC rated multi-pane glazing elements*
  - *South façade bedroom/living room: 30/25*
- *STC rated exterior walls*
  - *South façade: STC 45*

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

This dwelling unit has also been supplied with a central air conditioning system and other measures 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 City and the Ministry of Environment, Conservation and Parks."

The following Warning Clause[13] will also be required on all Lease, Purchase and Sale Agreements of the northwest and northeast units of Block 1 as well as the southernmost units of Block 2, as summarized below:

"Purchasers/tenants are advised that sound levels due to increasing road traffic may, on occasion, interfere with some activities of the dwelling occupants, as the sound levels exceed the sound level limits of the City and the Ministry of the Environment, Conservation and Parks.

This dwelling unit has also been designed with forced air heating with provisions for central air conditioning at the occupant's discretion. These noise measures will allow windows and exterior doors to remain closed, thereby ensuring that the indoor sound levels are within the sound level limits of the City and the Ministry of Environment, Conservation and Parks.

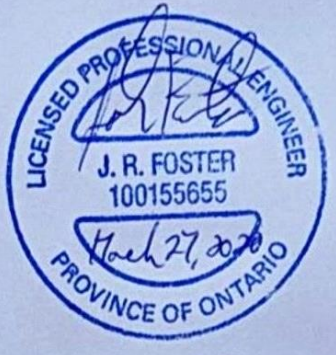
[13] City of Ottawa Environmental Noise Control Guidelines, January 2016

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

This concludes our 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.
Principal

Gradient Wind File #19-255 – Traffic Noise

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PROJECT	6173 RENAUD ROAD, OTTAWA ROADWAY TRAFFIC NOISE ASSESSMENT		DESCRIPTION
SCALE	1:1000 (APPROX.)	DRAWING NO.	GWE19-255-1
DATE	JANUARY 30, 2020	DRAWN BY	G.G.

FIGURE 1:
SITE PLAN AND SURROUNDING CONTEXT

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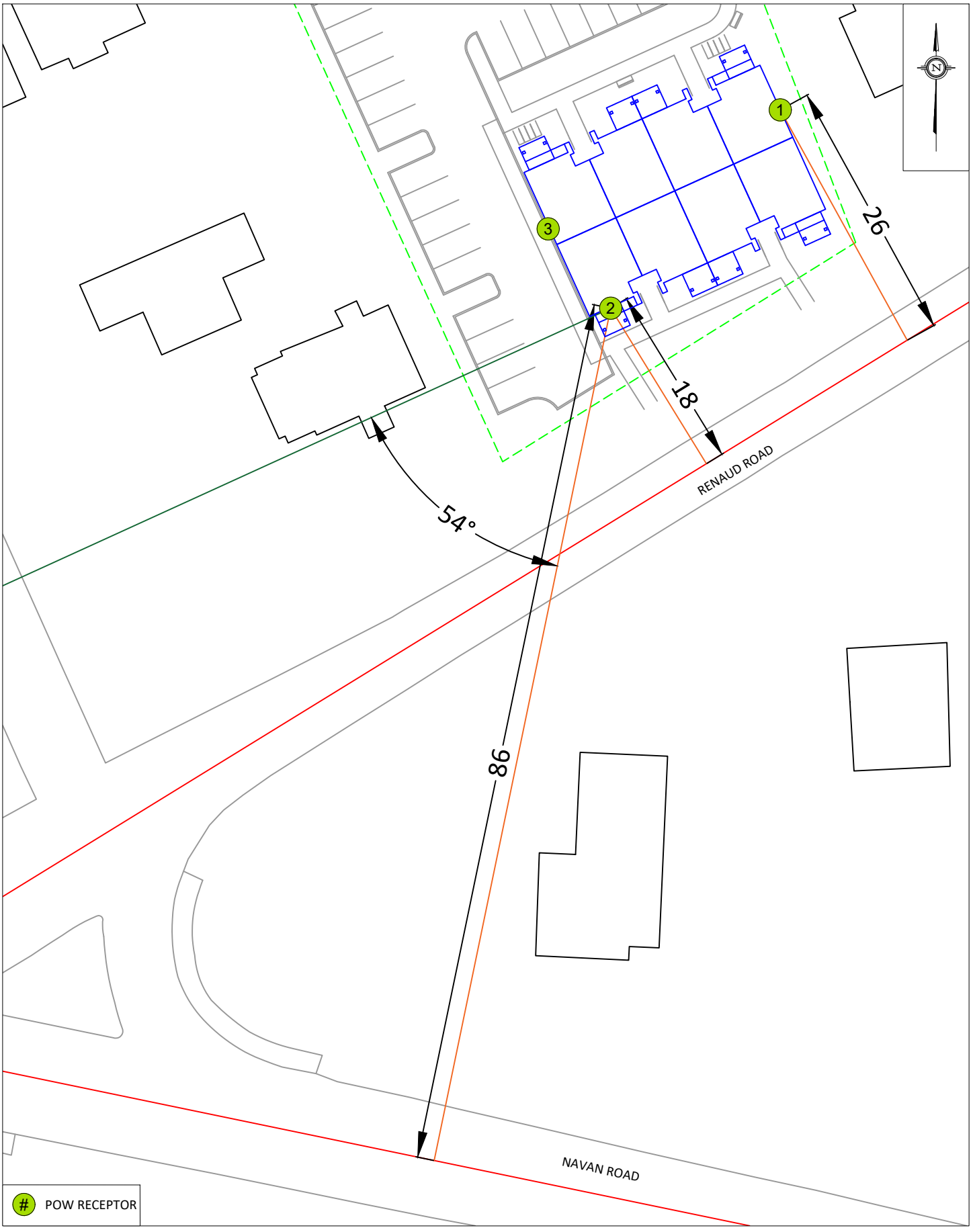
SCALE	1:500 (APPROX.)
DRAWING NO.	GWE19-255-2
DATE	JANUARY 30, 2020
DRAWN BY	G.G.

DESCRIPTION

FIGURE 2:
RECEPTOR LOCATIONS



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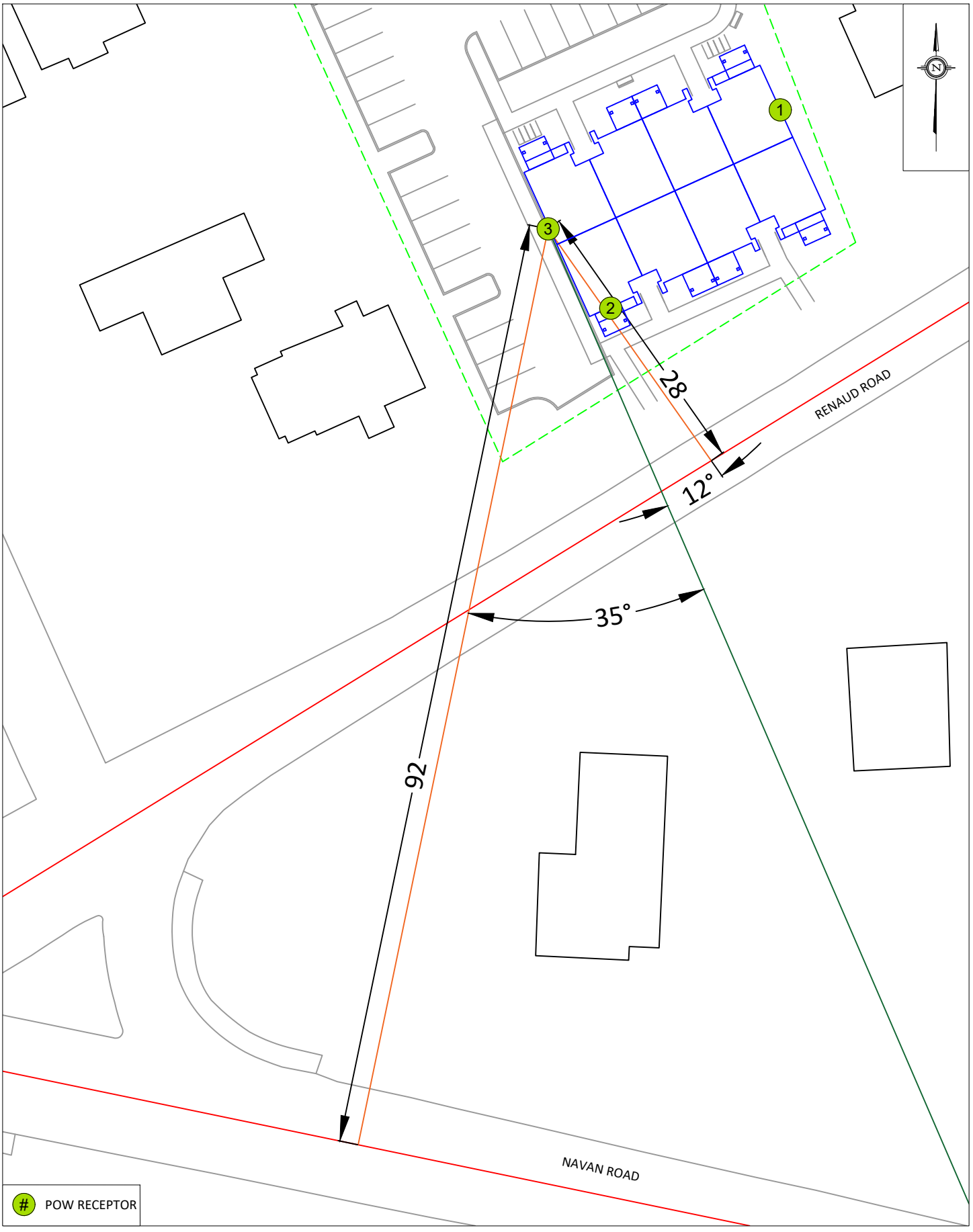
PROJECT	6173 RENAUD ROAD, OTTAWA ROADWAY TRAFFIC NOISE ASSESSMENT
SCALE	1:500 (APPROX.)
DRAWING NO.	GWE19-255-3
DATE	JANUARY 30, 2020
DRAWN BY	G.G.

DESCRIPTION

FIGURE 3:
RECEPTOR 1 AND 2 STAMSON INPUT PARAMETERS



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PROJECT	6173 RENAUD ROAD, OTTAWA ROADWAY TRAFFIC NOISE ASSESSMENT		DESCRIPTION
SCALE	1:500 (APPROX.)	DRAWING NO. GWE19-255-4	FIGURE 4: RECEPTOR 3 STAMSON INPUT PARAMETERS
DATE	JANUARY 30, 2020	DRAWN BY G.G.	

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PROJECT	6173 RENAUD ROAD, OTTAWA ROADWAY TRAFFIC NOISE ASSESSMENT
SCALE	1:500 (APPROX.)
DRAWING NO.	GWE19-255-5
DATE	JANUARY 30, 2020
DRAWN BY	G.G.

DESCRIPTION

FIGURE 5:
RECEPTOR 4 STAMSON INPUT PARAMETERS

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SCALE	1:500 (APPROX.)	DRAWING NO.	GWE19-255-6
DATE	JANUARY 30, 2020	DRAWN BY	G.G.

FIGURE 6:
WINDOW STC REQUIREMENTS

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SCALE	1:500 (APPROX.)	DRAWING NO.	GWE19-255-7
DATE	JANUARY 30, 2020	DRAWN BY	G.G.

FIGURE 7:
VENTILATION REQUIREMENTS

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        COMPREHENSIVE REPORT        Date: 22-01-2020 13:00:01
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Renaud Rd (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 # 1: Renaud Rd (day/night)
--------------------------------------------
Angle1   Angle2           : -90.00 deg   0.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  26.00 / 26.00  m
Receiver height           :   8.50 / 8.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00


Segment # 1: Renaud Rd (day)
-----------------------------

Source height = 1.50 m

ROAD (0.00 + 58.19 + 0.00) = 58.19 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90      0   0.45  65.75   0.00  -3.46  -4.09   0.00   0.00   0.00  58.19
-------------------------------------------------------------------------------

Segment Leq : 58.19 dBA

Total Leq All Segments: 58.19 dBA


Segment # 1: Renaud Rd (night)
-------------------------------

Source height = 1.50 m

ROAD (0.00 + 50.60 + 0.00) = 50.60 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
```

```
-------------------------------------------------------------------------------
   -90      0   0.45  58.16   0.00  -3.46  -4.09   0.00   0.00   0.00  50.60
-------------------------------------------------------------------------------

Segment Leq : 50.60 dBA

Total Leq All Segments: 50.60 dBA


TOTAL Leq FROM ALL SOURCES (DAY): 58.19
                           (NIGHT): 50.60
```

```
STAMSON 5.0        COMPREHENSIVE REPORT        Date: 22-01-2020 13:00:10
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Renaud Rd (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 # 1: Renaud 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  :  18.00 / 18.00  m
Receiver height           :   8.50 / 8.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00


Road data, segment # 2: Navan Rd (day/night)
---------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    60 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 2: Navan Rd (day/night)
-------------------------------------------
Angle1   Angle2           : -90.00 deg   54.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
```

```
Surface                    :      2       (Reflective ground surface)
Receiver source distance   :  86.00 / 86.00  m
Receiver height            :   8.50 / 8.50   m
Topography                 :      1       (Flat/gentle slope; no barrier)
Reference angle            :   0.00


Segment # 1: Renaud Rd (day)
----------------------------

Source height = 1.50 m

ROAD (0.00 + 64.96 + 0.00) = 64.96 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     90   0.00  65.75   0.00  -0.79   0.00   0.00   0.00   0.00  64.96
-------------------------------------------------------------------------------

Segment Leq : 64.96 dBA


Segment # 2: Navan Rd (day)
---------------------------

Source height = 1.50 m

ROAD (0.00 + 61.44 + 0.00) = 61.44 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     54   0.00  70.00   0.00  -7.58  -0.97   0.00   0.00   0.00  61.44
-------------------------------------------------------------------------------

Segment Leq : 61.44 dBA

Total Leq All Segments: 66.56 dBA


Segment # 1: Renaud Rd (night)
------------------------------

Source height = 1.50 m

ROAD (0.00 + 57.37 + 0.00) = 57.37 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     90   0.00  58.16   0.00  -0.79   0.00   0.00   0.00   0.00  57.37
-------------------------------------------------------------------------------

Segment Leq : 57.37 dBA

Segment # 2: Navan Rd (night)
-----------------------------

Source height = 1.50 m

ROAD (0.00 + 53.85 + 0.00) = 53.85 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     54   0.00  62.40   0.00  -7.58  -0.97   0.00   0.00   0.00  53.85
-------------------------------------------------------------------------------
```

```
Segment Leq : 53.85 dBA

Total Leq All Segments: 58.97 dBA


TOTAL Leq FROM ALL SOURCES (DAY): 66.56
                           (NIGHT): 58.97
```

```
STAMSON 5.0        COMPREHENSIVE REPORT        Date: 22-01-2020 13:00:18
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Renaud Rd (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 # 1: Renaud Rd (day/night)
----------------------------------------------
Angle1   Angle2           :  12.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  28.00 / 28.00  m
Receiver height           :   8.50 / 8.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00


Road data, segment # 2: Navan Rd (day/night)
----------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    60 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 2: Navan Rd (day/night)
----------------------------------------------
Angle1   Angle2           : -35.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
```

```
Surface                    :      2       (Reflective ground surface)
Receiver source distance   :  92.00 / 92.00  m
Receiver height            :   8.50 / 8.50   m
Topography                 :      1       (Flat/gentle slope; no barrier)
Reference angle            :   0.00
```

Segment # 1: Renaud Rd (day)

```
Source height = 1.50 m

ROAD (0.00 + 59.41 + 0.00) = 59.41 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
    12     90   0.00  65.75   0.00  -2.71  -3.63   0.00   0.00   0.00  59.41
-------------------------------------------------------------------------------

Segment Leq : 59.41 dBA
```

Segment # 2: Navan Rd (day)

```
Source height = 1.50 m

ROAD (0.00 + 60.54 + 0.00) = 60.54 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -35     90   0.00  70.00   0.00  -7.88  -1.58   0.00   0.00   0.00  60.54
-------------------------------------------------------------------------------

Segment Leq : 60.54 dBA

Total Leq All Segments: 63.02 dBA
```

Segment # 1: Renaud Rd (night)

```
Source height = 1.50 m

ROAD (0.00 + 51.81 + 0.00) = 51.81 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
    12     90   0.00  58.16   0.00  -2.71  -3.63   0.00   0.00   0.00  51.81
-------------------------------------------------------------------------------

Segment Leq : 51.81 dBA
```

Segment # 2: Navan Rd (night)

```
Source height = 1.50 m

ROAD (0.00 + 52.94 + 0.00) = 52.94 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -35     90   0.00  62.40   0.00  -7.88  -1.58   0.00   0.00   0.00  52.94
-------------------------------------------------------------------------------
```

```
Segment Leq : 52.94 dBA

Total Leq All Segments: 55.42 dBA


TOTAL Leq FROM ALL SOURCES (DAY): 63.02
                           (NIGHT): 55.42
```

```
STAMSON 5.0        COMPREHENSIVE REPORT        Date: 22-01-2020 13:00:26
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Renaud Rd1 (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 # 1: Renaud Rd1 (day/night)
--------------------------------------------
Angle1   Angle2           : -90.00 deg   -28.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  68.00 / 68.00  m
Receiver height           :   8.50 / 8.50   m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -66.00 deg   Angle2 : -28.00 deg
Barrier height            :   7.00 m
Barrier receiver distance :  46.00 / 46.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00


Road data, segment # 2: Renaud Rd2 (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: Renaud Rd2 (day/night)
--------------------------------------------
Angle1   Angle2           : -28.00 deg   86.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  68.00 / 68.00  m
Receiver height           :   8.50 / 8.50   m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -24.00 deg   Angle2 : 15.00 deg
Barrier height            :  11.40 m
Barrier receiver distance :  51.00 / 51.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00


Segment # 1: Renaud Rd1 (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 !        8.50 !        3.76 !         3.76

ROAD (50.43 + 41.05 + 0.00) = 50.91 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90    -66   0.00  65.75   0.00  -6.56  -8.75   0.00   0.00   0.00  50.43
-------------------------------------------------------------------------------
   -66    -28   0.00  65.75   0.00  -6.56  -6.75   0.00   0.00 -11.38  41.05
-------------------------------------------------------------------------------

Segment Leq : 50.91 dBA


Segment # 2: Renaud Rd2 (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 !        8.50 !        3.25 !         3.25

ROAD (42.65 + 32.54 + 55.15) = 55.41 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -28    -24   0.00  65.75   0.00  -6.56 -16.53   0.00   0.00   0.00  42.65
-------------------------------------------------------------------------------
   -24     15   0.00  65.75   0.00  -6.56  -6.64   0.00   0.00 -20.00  32.54
```

```
-------------------------------------------------------------------------------
    15     86    0.00   65.75    0.00   -6.56   -4.04    0.00    0.00    0.00   55.15
-------------------------------------------------------------------------------

Segment Leq : 55.41 dBA

Total Leq All Segments: 56.73 dBA

Segment # 1: Renaud Rd1 (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 !        8.50 !        3.76 !         3.76

ROAD (42.84 + 33.45 + 0.00) = 43.32 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90    -66    0.00  58.16   0.00  -6.56  -8.75   0.00   0.00   0.00  42.84
-------------------------------------------------------------------------------
   -66    -28    0.00  58.16   0.00  -6.56  -6.75   0.00   0.00 -11.38  33.45
-------------------------------------------------------------------------------

Segment Leq : 43.32 dBA


Segment # 2: Renaud Rd2 (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 !        8.50 !        3.25 !         3.25

ROAD (35.06 + 24.95 + 47.55) = 47.81 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -28    -24    0.00  58.16   0.00  -6.56 -16.53   0.00   0.00   0.00  35.06
-------------------------------------------------------------------------------
   -24     15    0.00  58.16   0.00  -6.56  -6.64   0.00   0.00 -20.00  24.95
-------------------------------------------------------------------------------
    15     86    0.00  58.16   0.00  -6.56  -4.04   0.00   0.00   0.00  47.55
-------------------------------------------------------------------------------
Segment Leq : 47.81 dBA
Total Leq All Segments: 49.13 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 56.73
                           (NIGHT): 49.13
```