Roadway Traffic Noise Feasibility Assessment

Conservancy Subdivision

Ottawa, Ontario

REPORT: GWE17-151 - Traffic Noise

Prepared For:

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EXECUTIVE SUMMARY

This document describes a roadway traffic noise feasibility assessment performed for a proposed residential subdivision. The study site is situated in the southwest area of Barrhaven in Ottawa, Ontario. The initial concept plan being considered for draft plan of subdivision applications, comprises residential developments. However, the road network and arrangement of land uses may be subject to change through the development approval process. The major sources of roadway noise affecting the development are roadway traffic along two proposed collectors, a minor collector located west, and a major collector located north of the development.

The assessment is based on: (i) theoretical noise prediction methods that conform to the Ministry of the Environment and Climate Change (MOECC) 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) architectural drawings received from NAK Design Strategies.

As the site plan may be subject to change, GWE took the approach to establish noise contours around the site with a general massing consideration for the townhouses and single homes. The contours, based on the City of Ottawa noise criteria, were used to determine what level of noise control for various areas on site would be required. The results of the current study indicate that noise levels due to roadway traffic over the site will range between approximately 61 and 66 dBA during the daytime period (07:00-23:00). The highest roadway traffic noise levels will occur nearest to the intersection of the two collectors.

Results of the roadway traffic noise calculations also indicate that outdoor living areas having direct exposure to the noise sources that are within approximately 40 metres of the proposed major collector and minor collector, may require noise control measures depending on final site orientation. These measures are in Section 5.2, with the aim to reduce the L_{eq} to as close to 55 dBA as technically, economically and administratively feasible.

Once the final site plan configuration has been established, at the time of site plan approval, future detailed noise studies would be performed to determine site specific noise mitigation and appropriate warning clauses.

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1. INTRODUCTION

Gradient Wind Engineering Inc. (GWE) was retained by Barrhaven Conservancy East Inc. to undertake a roadway traffic noise feasibility assessment of the proposed residential subdivision situated in the southwest area of Barrhaven in Ottawa, Ontario. This report summarizes the methodology, results and recommendations related to a roadway traffic noise feasibility assessment, and was prepared in support of the client's draft plan of subdivision applications. GWE's scope of work involved assessing exterior noise levels throughout the site, generated by local roadway traffic. The report also quantitatively addresses any potential noise impacts. The assessment was performed on the basis of theoretical noise calculation methods conforming to the City of Ottawa[1] and Ministry of the Environment and Climate Change[2] guidelines. Noise calculations were based on an initial concept plan received from NAK Design Strategies, 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 feasibility assessment is a proposed subdivision concept plan in Ottawa, currently comprising single homes and townhouse units. The townhouse units will contain rear lanes and are located at the west and east side of the site, with the remaining space dedicated to single homes. The development is expected to contain outdoor living areas in the rear yards of each unit. The study area is bordered on the north by a major collector running east – west, and a collector running north south to the west side of the development. Strandherd Drive is located approximately 525 metres north of the development while Greenbank Road is located approximately 700 metres east of the development. The major sources of roadway noise are the proposed major and minor collectors running north and west of the site, as per the Land Use Concept Plan. The site is surrounded by vacant land designated for with residential developments to the north, and open land space west, east, and south of the development. A river runs south of the site plan, and a storm water ponds to east of the site. Figure 1 illustrates the site location with surrounding context.

Due to the current state of the development, the final site configuration is uncertain and may be subject to change. Therefore, GWE took the approach to establish noise contours around the site as per the

[1] City of Ottawa Environmental Noise Control Guidelines, January 2016
[2] Ontario Ministry of the Environment and Climate Change – Publication NPC-300

current plans. The contours, based on the City of Ottawa noise criteria, were used to determine what level of noise control for various areas on site would be required.

3. OBJECTIVES

The principal objective of this work is to calculate the future noise levels on the study site produced by local roadway traffic and explore potential for noise mitigation where required.

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 vehicle traffic, 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 Outdoor Living Area (OLA) noise limit is 55 dBA during the daytime period. OLA do not need to be considered during the nighttime period.

Predicted noise levels at the outdoor living area dictate the action required to achieve the recommended sound levels. According to the ENCG, if an area is to be used as an outdoor living area (OLA), noise control measures are required to reduce the L_{eq} to 55 dBA. This is typically done with noise control measures outlined in Section 5.2. When noise levels at these areas exceed the criteria, specific Warning Clause requirements may apply. As this is a preliminary assessment, noise control recommendations are of a general nature; specific mitigation requirements would be the work of a future study.

4.3 Roadway Noise Assessment

4.3.1 Theoretical Roadway Traffic Noise Predictions

Noise predictions were determined by computer modelling using two programs. To provide a general sense of noise across the site, the software program *Predictor-Lima*, which incorporates the United States Federal Highway Administration's (FHWA) Transportation Noise Model (TNM) 2.5. This computer program is capable of representing three-dimensional surface and first reflections of sound waves over a suitable spectrum for human hearing. A receptor grid with 5 × 5 m spacing was placed across the study site, along with a number of discrete receptors at key sensitive areas. This program outputs noise contours, however, is not the approved model for roadway predictions by the City of Ottawa. Therefore, the results were confirmed by performing discrete noise calculations with the Ministry of the Environment and Climate Change's (MOECC) computerized noise assessment program, STAMSON 5.04, at key receptor locations coinciding with receptor locations in Predictor as shown in Figure 2. Appendix A includes the STAMSON 5.04 input and output data.

Roadway noise calculations were performed by treating each road segment as separate line sources of noise. In addition to the traffic volumes summarized in Table 1, 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 was taken to be 92% / 8% respectively for all streets
- Absorptive/reflective ground surface
- The study site was treated as having flat or gently sloping topography
- No massing considered as potential noise screening elements

4.3.2 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[3] (TMP) which provides additional details on future roadway expansions. Average Annual Daily Traffic (AADT) volumes are then based on data in Table B1 of the ENCG for each roadway classification. Upon review of the Transportation Impact Study[4] for the development, roadway traffic data obtained from the ENCG contains higher traffic volumes resulting in higher noise levels. These values are however mandated to be used by the ENCG and future expected noise levels are expected to be lower than the results of this report. Table 1 (below) summarizes the AADT values used for each roadway included in this assessment.

TABLE 1: ROADWAY TRAFFIC DATA

Roadway	Roadway Class	Speed Limit (km/h)	Official Plan AADT
Proposed Collector A	2-Lane Collector (2-UCU)	50	**8,000**
Proposed Chapman Mills Drive (Collector)	2-Lane Major Collector (2-UMCU)	50	**12,000**

[3] City of Ottawa Transportation Master Plan, November 2013
[4] 673 River Road – Transportation Impact Study, PARSONS, June 2017

5. RESULTS AND DISCUSSION

5.1 Roadway Traffic Noise Levels

The results of the roadway traffic noise calculations for the daytime period are shown in Figures 3-5 respectively, which cover the entire study site. Discrete receptors were also placed at ground level at key locations throughout the site. The noise contours were generated using *Predictor-Lima* and verified with discrete receptors using STAMSON 5.04 as shown in Figure 2 and summarized in Table 2 below. Receptors 1-4 are located on the western side of the site, receptor 5 in the central area of the site, and receptors 6-8 on the eastern side of the site. Appendix A contains the complete set of input and output data from all STAMSON 5.04 calculations.

TABLE 2: EXTERIOR NOISE LEVELS DUE TO ROAD TRAFFIC

Receptor Number	Zone Location	STAMSON 5.04 Noise Level (dBA)	Predictor-Lima Noise Level (dBA)
		Day	Day
1	OLA – Grade Level – Rear of townhome	66	64
2	OLA – Grade Level – Rear of townhome	65	63
3	OLA – Grade Level – Rear of townhome	63	61
4	OLA – Grade Level – Rear of townhome	61	59
5	OLA – Grade Level – Rear of single home	63	61
6	OLA – Grade Level – Rear of townhome	63	60
7	OLA – Grade Level – Rear of townhome	62	59
8	OLA – Grade Level – Rear of single home	63	60

As shown above, the results calculated from *Predictor-Lima* generally have good correlation with calculations performed in STAMSON 5.04. A tolerance of 3 dBA between models is generally considered acceptable given human hearing cannot detect a change in sound level of less than 3 dBA. As stated in Section 4.3.1, no massing of proposed buildings considered as potential screening elements. Results of the roadway traffic noise calculations also indicate that outdoor living areas having direct exposure to the noise sources that are within approximately 40 metres of the proposed collectors, may require noise control measures. These measures are in Section 5.2, with the aim to reduce the L_{eq} to as close to 55 dBA as technically, economically and administratively feasible.

5.2 Summary of Noise Control Measures

The OLA noise levels predicted due to roadway traffic, at a number of receptors, exceed the criteria listed in the ENCG for outdoor living areas, as discussed in Section 4.2. Therefore, noise control measures as described below from Table 2.3a in the ENCG, in order of preference, will be required to reduce the L_{eq} to 55 dBA:

- Distance setback with soft ground
- Insertion of noise insensitive land uses between the source and sensitive points of reception
- Orientation of buildings to provide sheltered zones in rear yards
- Shared outdoor amenity areas
- Earth berms (sound barriers)
- Acoustic barriers

Examining the noise control measures listed above, not all of the OLA have the proposed buildings oriented to provide screening elements against traffic sources. The central single home blocks on the north, the townhouse blocks on the furthest west, and the single homes on the furthest east have OLA with direct exposure to the major collector and/or minor collector north and west of the development. Distance setback, insertion of non-noise sensitive land uses, and building orientation to provide sheltered zones in rear yards may not be feasible due to the requirements of the Community Development Plan. It is also not feasible to have shared outdoor amenity areas for this development with respect to rear yards as this would have a significant impact on salability. Therefore, the most feasible measures are insertion of earth berms or acoustic wall barriers between the sensitive rear yards and sources of noise. By siding lots onto the collector and arterial roadways the extent of barriers are minimized. The use of earth berms

or acoustic barriers will depend on the grading plan when it becomes available. Both options can reduce OLA noise levels to below 55 dBA.

Regarding Figures 3-5, the area(s) with noise levels under 55 dBA (yellow and light orange) have no ventilation or mitigation requirements. The area(s) with noise levels between 55 and 65 dBA (orange and red) require forced air heating with provision for central air conditioning with an applicable generic Warning Clause. Finally, the area(s) that represent noise levels above 65 dBA (maroon) require central air conditioning with an applicable extensive mitigation Warning Clause.

6. CONCLUSIONS AND RECOMMENDATIONS

The results of the current study indicate that noise levels due to roadway traffic over the site will range between approximately 61 and 66 dBA during the daytime period (07:00-23:00). The highest roadway traffic noise levels will occur nearest to the intersection of the two collectors.

Results of the roadway traffic noise calculations also indicate that outdoor living areas having direct exposure to the noise sources that are within approximately 40 metres of the proposed collectors, may require noise control measures. These measures are in Section 5.2, with the aim to reduce the L_{eq} to as close to 55 dBA as technically, economically and administratively feasible.

A detailed roadway traffic noise study will be required at the time of site plan approval to determine specific noise control measures for the development.

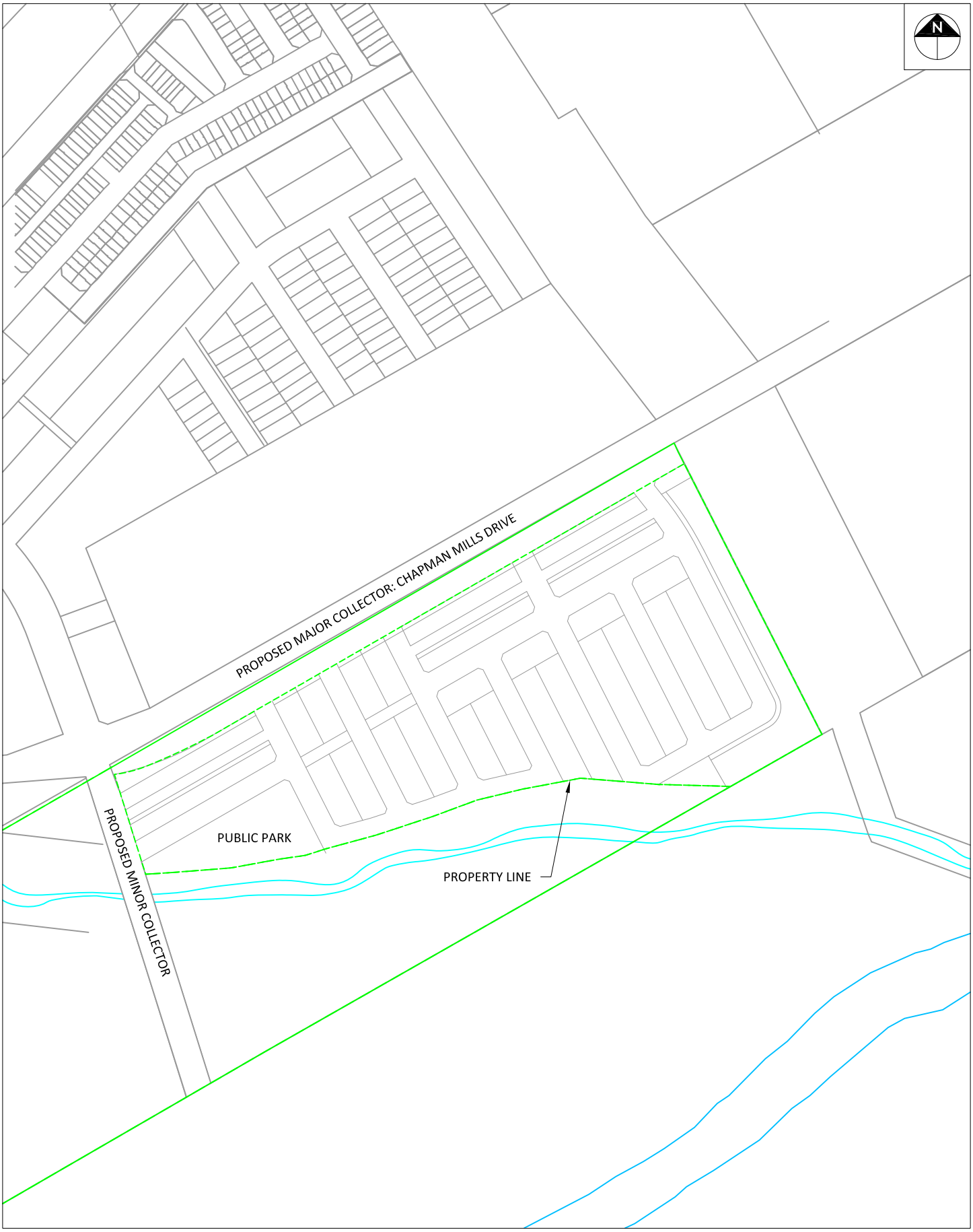
This concludes our assessment and report. If you have any questions or wish to discuss our findings, please advise us. In the interim, we thank you for the opportunity to be of service.

Yours truly,

Gradient Wind Engineering Inc.

Joshua Foster, P.Eng.
Principal
GWE17-151 - Traffic Noise

Omar Daher, B.Eng., EIT
Junior Environmental Analyst



127 Walgreen Road
Ottawa, Ontario
(613) 836 0934

GRADIENT WIND ENGINEERING INC

PROJECT	CONSERVANCY PROJECT - TRAFFIC NOISE FEASIBILITY ASSESSMENT
SCALE	1:4000 (APPROX.)
DRAWING NO.	GWE17-151-1
DATE	NOVEMBER 23, 2017
DRAWN BY	O.D.

DESCRIPTION

FIGURE 1:
SITE PLAN AND SURROUNDING CONTEXT

127 Walgreen Road
Ottawa, Ontario
(613) 836 0934

GRADIENT WIND ENGINEERING INC

PROJECT	CONSERVANCY PROJECT - TRAFFIC NOISE FEASIBILITY ASSESSMENT		
SCALE	1:3000 (APPROX.)	DRAWING NO.	GWE17-151-2
DATE	NOVEMBER 23, 2017	DRAWN BY	O.D.

DESCRIPTION

FIGURE 2:
RECEPTOR LOCATIONS

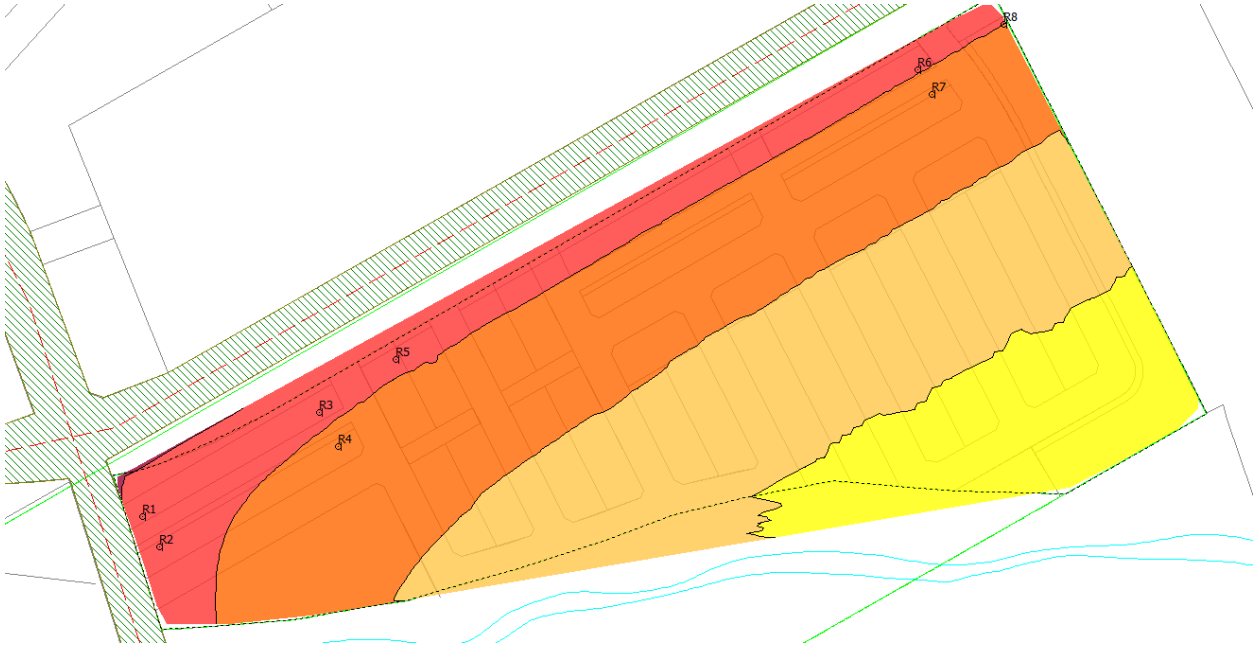
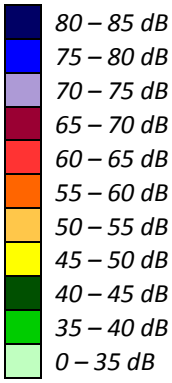


FIGURE 3: GROUND LEVEL NOISE CONTOURS FOR THE SITE (DAYTIME PERIOD)



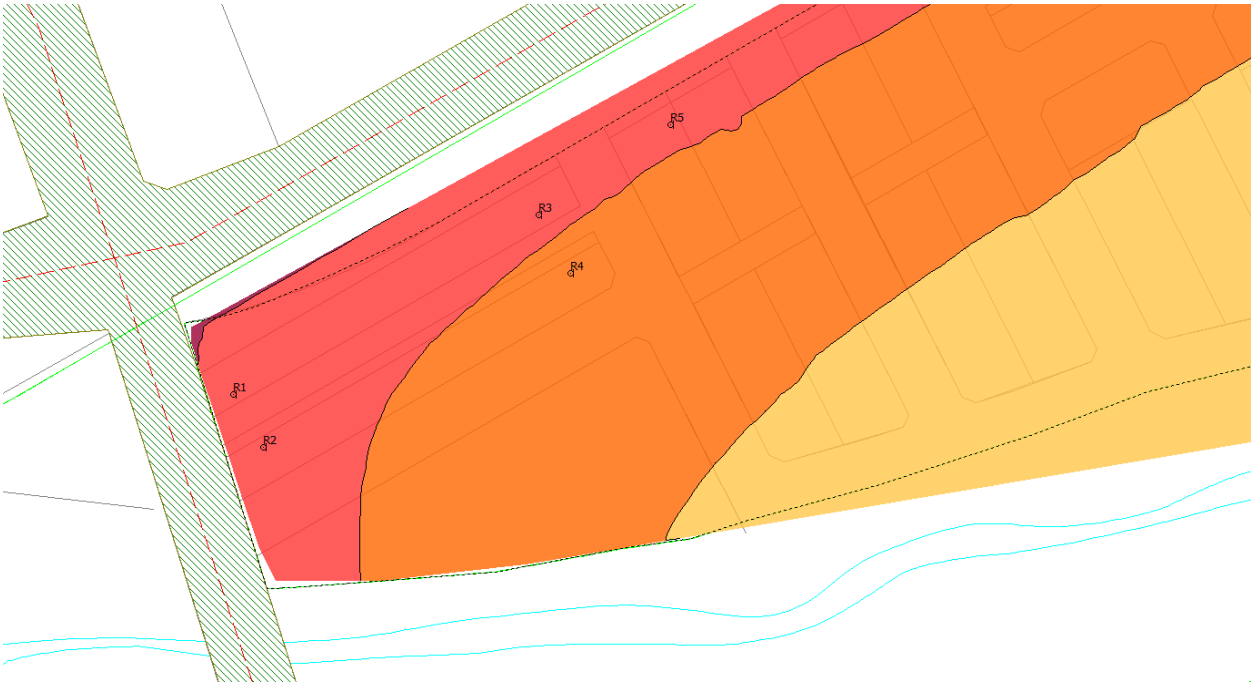
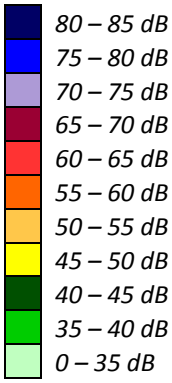


FIGURE 4: GROUND LEVEL NOISE CONTOURS FOR WESTERN HALF OF SITE (DAYTIME PERIOD)



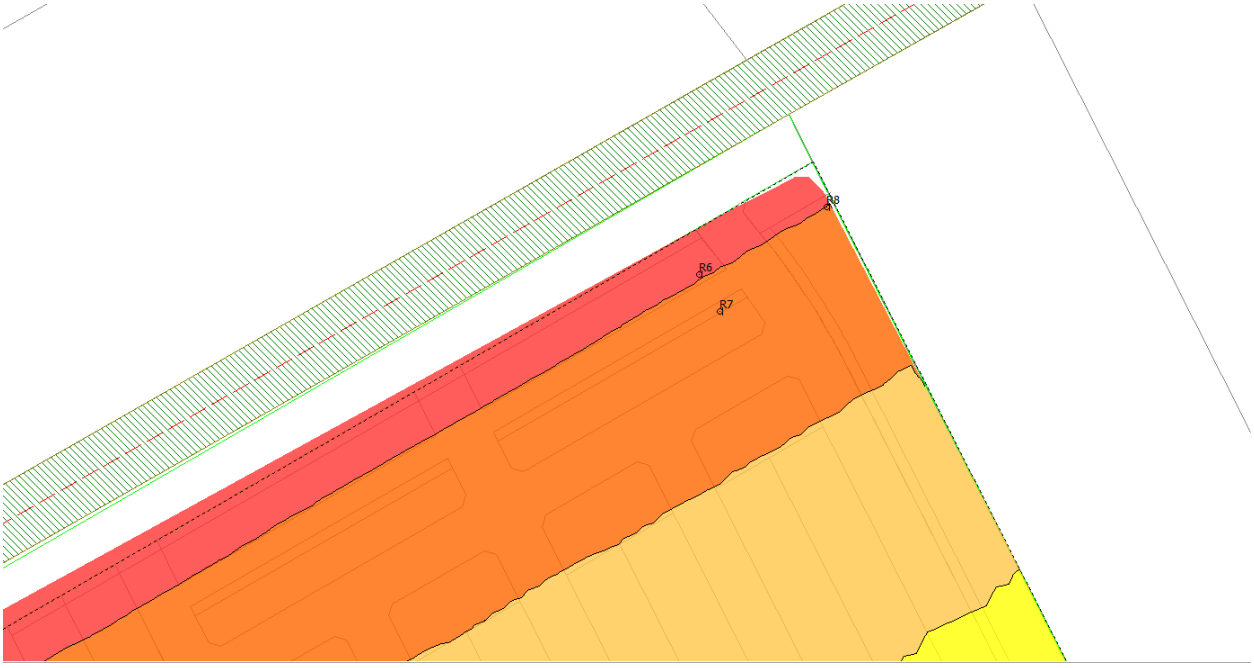


FIGURE 5: GROUND LEVEL NOISE CONTOURS FOR EASTERN HALF OF SITE (DAYTIME PERIOD)

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

APPENDIX A

STAMSON 5.04 - INPUT AND OUTPUT DATA

```
STAMSON 5.0        NORMAL REPORT        Date: 20-11-2017 11:34:20
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Minor Collec (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: Minor Collec (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  :  21.00 / 21.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Road data, segment # 2: Major Coll.1 (day/night)
-----------------------------------------------
Car traffic volume  :  9715/845   veh/TimePeriod  *
Medium truck volume :   773/67    veh/TimePeriod  *
Heavy truck volume  :   552/48    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):  12000
    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: Major Coll.1 (day/night)
-----------------------------------------------
Angle1   Angle2           : -90.00 deg   -4.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  47.00 / 47.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Road data, segment # 3: Major Coll.2 (day/night)
------------------------------------------------
Car traffic volume  :  9715/845   veh/TimePeriod  *
Medium truck volume :   773/67    veh/TimePeriod  *
Heavy truck volume  :   552/48    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):  12000
    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: Major Coll.2 (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  :  46.00 / 46.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Results segment # 1: Minor Collec (day)
---------------------------------------

Source height = 1.50 m

ROAD (0.00 + 64.29 + 0.00) = 64.29 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  -1.46   0.00   0.00   0.00   0.00  64.29
-------------------------------------------------------------------------------

Segment Leq : 64.29 dBA


Results segment # 2: Major Coll.1 (day)
---------------------------------------

Source height = 1.50 m

ROAD (0.00 + 59.34 + 0.00) = 59.34 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     -4   0.00  67.51   0.00  -4.96  -3.21   0.00   0.00   0.00  59.34
-------------------------------------------------------------------------------

Segment Leq : 59.34 dBA


Results segment # 3: Major Coll.2 (day)
---------------------------------------

Source height = 1.50 m

ROAD (0.00 + 59.01 + 0.00) = 59.01 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
    12     90   0.00  67.51   0.00  -4.87  -3.63   0.00   0.00   0.00  59.01
-------------------------------------------------------------------------------

Segment Leq : 59.01 dBA

Total Leq All Segments: 66.38 dBA


Results segment # 1: Minor Collec (night)
-----------------------------------------

Source height = 1.50 m

ROAD (0.00 + 56.70 + 0.00) = 56.70 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  -1.46   0.00   0.00   0.00   0.00  56.70
-------------------------------------------------------------------------------

Segment Leq : 56.70 dBA
```

```
Results segment # 2: Major Coll.1 (night)
-----------------------------------------

Source height = 1.50 m

ROAD (0.00 + 51.74 + 0.00) = 51.74 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     -4   0.00  59.91   0.00  -4.96  -3.21   0.00   0.00   0.00  51.74
-------------------------------------------------------------------------------

Segment Leq : 51.74 dBA


Results segment # 3: Major Coll.2 (night)
-----------------------------------------

Source height = 1.50 m

ROAD (0.00 + 51.41 + 0.00) = 51.41 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
    12     90   0.00  59.91   0.00  -4.87  -3.63   0.00   0.00   0.00  51.41
-------------------------------------------------------------------------------

Segment Leq : 51.41 dBA

Total Leq All Segments: 58.78 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 66.38
                           (NIGHT): 58.78
```

```
STAMSON 5.0        NORMAL REPORT        Date: 20-11-2017 11:37:55
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Minor Collec (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: Minor Collec (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  :  25.00 / 25.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Road data, segment # 2: Major Coll.1 (day/night)
------------------------------------------------
Car traffic volume  :  9715/845   veh/TimePeriod  *
Medium truck volume :   773/67    veh/TimePeriod  *
Heavy truck volume  :   552/48    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):  12000
    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: Major Coll.1 (day/night)
----------------------------------------------
Angle1   Angle2           : -90.00 deg   -8.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  64.00 / 64.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Road data, segment # 3: Major Coll.2 (day/night)
------------------------------------------------
Car traffic volume  :  9715/845   veh/TimePeriod  *
Medium truck volume :   773/67    veh/TimePeriod  *
Heavy truck volume  :   552/48    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):  12000
    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: Major Coll.2 (day/night)
------------------------------------------------
Angle1   Angle2           :   9.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  64.00 / 64.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00


Results segment # 1: Minor Collec (day)
---------------------------------------

Source height = 1.50 m

ROAD (0.00 + 63.53 + 0.00) = 63.53 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  -2.22   0.00   0.00   0.00   0.00  63.53
-------------------------------------------------------------------------------

Segment Leq : 63.53 dBA


Results segment # 2: Major Coll.1 (day)
---------------------------------------

Source height = 1.50 m

ROAD (0.00 + 57.80 + 0.00) = 57.80 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     -8   0.00  67.51   0.00  -6.30  -3.41   0.00   0.00   0.00  57.80
-------------------------------------------------------------------------------

Segment Leq : 57.80 dBA
```

Results segment # 3: Major Coll.2 (day)

Source height = 1.50 m

ROAD (0.00 + 57.74 + 0.00) = 57.74 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
9	90	0.00	67.51	0.00	-6.30	-3.47	0.00	0.00	0.00	57.74

Segment Leq : 57.74 dBA

Total Leq All Segments: 65.38 dBA

Results segment # 1: Minor Collec (night)

Source height = 1.50 m

ROAD (0.00 + 55.94 + 0.00) = 55.94 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	-2.22	0.00	0.00	0.00	0.00	55.94

Segment Leq : 55.94 dBA

```
Results segment # 2: Major Coll.1 (night)
-----------------------------------------

Source height = 1.50 m

ROAD (0.00 + 50.20 + 0.00) = 50.20 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     -8   0.00  59.91   0.00  -6.30  -3.41   0.00   0.00   0.00  50.20
-------------------------------------------------------------------------------

Segment Leq : 50.20 dBA


Results segment # 3: Major Coll.2 (night)
-----------------------------------------

Source height = 1.50 m

ROAD (0.00 + 50.14 + 0.00) = 50.14 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
     9     90   0.00  59.91   0.00  -6.30  -3.47   0.00   0.00   0.00  50.14
-------------------------------------------------------------------------------

Segment Leq : 50.14 dBA

Total Leq All Segments: 57.79 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 65.38
                           (NIGHT): 57.79
```

```
STAMSON 5.0        NORMAL REPORT        Date: 20-11-2017 11:39:02
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Major Coll. (day/night)
-----------------------------------------------
Car traffic volume  :  9715/845   veh/TimePeriod  *
Medium truck volume :   773/67    veh/TimePeriod  *
Heavy truck volume  :   552/48    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):  12000
    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: Major Coll. (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  :  45.00 / 45.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Results segment # 1: Major Coll. (day)
---------------------------------------

Source height = 1.50 m

ROAD (0.00 + 62.74 + 0.00) = 62.74 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     90   0.00  67.51   0.00  -4.77   0.00   0.00   0.00   0.00  62.74
-------------------------------------------------------------------------------

Segment Leq : 62.74 dBA

Total Leq All Segments: 62.74 dBA


Results segment # 1: Major Coll. (night)
-----------------------------------------

Source height = 1.50 m

ROAD (0.00 + 55.14 + 0.00) = 55.14 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     90   0.00  59.91   0.00  -4.77   0.00   0.00   0.00   0.00  55.14
-------------------------------------------------------------------------------

Segment Leq : 55.14 dBA

Total Leq All Segments: 55.14 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 62.74
                           (NIGHT): 55.14
```

```
STAMSON 5.0        NORMAL REPORT        Date: 20-11-2017 11:41:15
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Major Coll. (day/night)
-----------------------------------------------
Car traffic volume  :  9715/845   veh/TimePeriod  *
Medium truck volume :   773/67    veh/TimePeriod  *
Heavy truck volume  :   552/48    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):  12000
    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: Major Coll. (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  :  64.00 / 64.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Results segment # 1: Major Coll. (day)
---------------------------------------

Source height = 1.50 m

ROAD (0.00 + 61.21 + 0.00) = 61.21 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     90   0.00  67.51   0.00  -6.30   0.00   0.00   0.00   0.00  61.21
-------------------------------------------------------------------------------

Segment Leq : 61.21 dBA

Total Leq All Segments: 61.21 dBA


Results segment # 1: Major Coll. (night)
-----------------------------------------

Source height = 1.50 m

ROAD (0.00 + 53.61 + 0.00) = 53.61 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     90   0.00  59.91   0.00  -6.30   0.00   0.00   0.00   0.00  53.61
-------------------------------------------------------------------------------

Segment Leq : 53.61 dBA

Total Leq All Segments: 53.61 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 61.21
                           (NIGHT): 53.61
```

```
STAMSON 5.0        NORMAL REPORT        Date: 20-11-2017 11:42:10
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Major Collec (day/night)
-----------------------------------------------
Car traffic volume  :  9715/845   veh/TimePeriod  *
Medium truck volume :   773/67    veh/TimePeriod  *
Heavy truck volume  :   552/48    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):  12000
    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: Major Collec (day/night)
----------------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  41.00 / 41.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Results segment # 1: Major Collec (day)
---------------------------------------

Source height = 1.50 m

ROAD (0.00 + 63.14 + 0.00) = 63.14 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     90   0.00  67.51   0.00  -4.37   0.00   0.00   0.00   0.00  63.14
-------------------------------------------------------------------------------

Segment Leq : 63.14 dBA

Total Leq All Segments: 63.14 dBA


Results segment # 1: Major Collec (night)
-----------------------------------------

Source height = 1.50 m

ROAD (0.00 + 55.54 + 0.00) = 55.54 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     90   0.00  59.91   0.00  -4.37   0.00   0.00   0.00   0.00  55.54
-------------------------------------------------------------------------------

Segment Leq : 55.54 dBA

Total Leq All Segments: 55.54 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 63.14
                           (NIGHT): 55.54
```

```
STAMSON 5.0        NORMAL REPORT        Date: 20-11-2017 11:43:42
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Major Collec (day/night)
-----------------------------------------------
Car traffic volume  :  9715/845   veh/TimePeriod  *
Medium truck volume :   773/67    veh/TimePeriod  *
Heavy truck volume  :   552/48    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):  12000
    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: Major Collec (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  :  43.00 / 43.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Results segment # 1: Major Collec (day)
---------------------------------------

Source height = 1.50 m

ROAD (0.00 + 62.94 + 0.00) = 62.94 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     90   0.00  67.51   0.00  -4.57   0.00   0.00   0.00   0.00  62.94
-------------------------------------------------------------------------------

Segment Leq : 62.94 dBA

Total Leq All Segments: 62.94 dBA


Results segment # 1: Major Collec (night)
-----------------------------------------

Source height = 1.50 m

ROAD (0.00 + 55.34 + 0.00) = 55.34 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     90   0.00  59.91   0.00  -4.57   0.00   0.00   0.00   0.00  55.34
-------------------------------------------------------------------------------

Segment Leq : 55.34 dBA

Total Leq All Segments: 55.34 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 62.94
                           (NIGHT): 55.34
```

```
STAMSON 5.0        NORMAL REPORT        Date: 20-11-2017 11:47:06
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Major Collec (day/night)
-----------------------------------------------
Car traffic volume  :  9715/845   veh/TimePeriod  *
Medium truck volume :   773/67    veh/TimePeriod  *
Heavy truck volume  :   552/48    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):  12000
    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: Major Collec (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  :  58.00 / 58.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Results segment # 1: Major Collec (day)
---------------------------------------

Source height = 1.50 m

ROAD (0.00 + 61.64 + 0.00) = 61.64 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     90   0.00  67.51   0.00  -5.87   0.00   0.00   0.00   0.00  61.64
-------------------------------------------------------------------------------

Segment Leq : 61.64 dBA

Total Leq All Segments: 61.64 dBA


Results segment # 1: Major Collec (night)
-----------------------------------------

Source height = 1.50 m

ROAD (0.00 + 54.04 + 0.00) = 54.04 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     90   0.00  59.91   0.00  -5.87   0.00   0.00   0.00   0.00  54.04
-------------------------------------------------------------------------------

Segment Leq : 54.04 dBA

Total Leq All Segments: 54.04 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 61.64
                           (NIGHT): 54.04
```

```
STAMSON 5.0        NORMAL REPORT        Date: 20-11-2017 11:48:59
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Major Collec (day/night)
-----------------------------------------------
Car traffic volume  :  9715/845   veh/TimePeriod  *
Medium truck volume :   773/67    veh/TimePeriod  *
Heavy truck volume  :   552/48    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):  12000
    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: Major Collec (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  :  45.00 / 45.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Results segment # 1: Major Collec (day)
---------------------------------------

Source height = 1.50 m

ROAD (0.00 + 62.74 + 0.00) = 62.74 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     90   0.00  67.51   0.00  -4.77   0.00   0.00   0.00   0.00  62.74
-------------------------------------------------------------------------------

Segment Leq : 62.74 dBA

Total Leq All Segments: 62.74 dBA


Results segment # 1: Major Collec (night)
-----------------------------------------

Source height = 1.50 m

ROAD (0.00 + 55.14 + 0.00) = 55.14 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     90   0.00  59.91   0.00  -4.77   0.00   0.00   0.00   0.00  55.14
-------------------------------------------------------------------------------

Segment Leq : 55.14 dBA

Total Leq All Segments: 55.14 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 62.74
                           (NIGHT): 55.14
```