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Tivoli Condominiums

Hamilton, Ontario

Noise Impact Study

RWDI # 1401113
November 7, 2014

SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI AIR Inc. was retained to conduct a noise impact assessment for the proposed Tivoli Development at 108 James Street North in Hamilton, Ontario. The purpose of the noise assessment was to assess the impact of all noise sources affecting the proposed development using the applicable guidelines, and determine the appropriate control measures to mitigate noise impacts, if any.

This study assessed sound impacts due to road-traffic noise and stationary sources surrounding the Tivoli Development. Road-traffic sound levels were predicted using the Ontario Road Noise Analysis Method for Environment and Transportation algorithms, the Ontario Ministry of the Environment and Climate Change (MOECC) approved model for road-traffic sound. Sound due to stationary sources was modelled using Cadna/A, a commercially available implementation of the ISO 9613 noise propagation algorithms.

The sound levels modelled for the road-traffic noise and stationary sources assessment were assessed using the MOECC Publication NPC-300. Per the guideline, the impact from road-traffic noise and stationary sources were assessed separately.

Sound due to road-traffic sources exceed the Publication NPC-300 sound level limits at the Tivoli Development. This report outlines methods for addressing the excess sound and which Warning Clauses must apply to purchase or rental agreements. The Tivoli Development can meet the requirements of NPC-300 with the implementation of Warning Clauses and sound control measures installed at the proposed development, such as a noise barrier.

The results of the stationary source assessment indicate that sound levels at the Tivoli Development will exceed the Publication NPC-300 sound level limits. The developer or land owner are required to ensure that sound levels due to surrounding stationary sources do not exceed the sound level limits at the Tivoli Development. This report outlines several mitigation options for stationary sources. With the mitigation of surrounding stationary sources the Tivoli Development is anticipated to meet the requirements of Publication NPC-300.

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1. INTRODUCTION

RWDI AIR Inc. (RWDI) was retained to conduct a noise impact assessment for the proposed Tivoli Development at 108 James Street North in Hamilton, Ontario. The City of Hamilton has requested that a noise assessment be conducted as part of the Rezoning Application for the Tivoli Development. This report is in support of the Rezoning application and satisfies the requirements of the City of Hamilton.

The purpose of the study is to assess the impact of all noise sources affecting the proposed development. Ontario Ministry of the Environment and Climate Change (MOECC) noise guidelines are used to assess impacts and to determine the appropriate noise control measures, if any. The relevant sources of sound for a noise impact assessment are as follows:

- transportation-related sources, such as sound due to road traffic; and
- stationary sources, such as existing heating ventilation and air-conditioning (HVAC) equipment on surrounding buildings.

The scope of this study did not include evaluation of noise from stationary sources proposed as part of the Tivoli development.

2. DESCRIPTION OF PROJECT AND SITE

The Tivoli Development site is located on the east side of James Street North, just north of York Boulevard / Wilson Street in downtown Hamilton. The proposed 22-storey building will be located between a three-storey office building to the north, a one-storey retail building to the south and the historic two-storey Tivoli Theatre to the east. The development will consist of commercial spaces on the first three floors, and condominium units from the 4th to 22nd floors.

The Tivoli Development is considered a Class 1 (urban) acoustic environment, meaning the acoustic environment in the area is influenced by sounds of road traffic, human activity and existing stationary sources. As an infill development in the vicinity of existing noise sources, the development is eligible to be designated as a Class 4 area, which allows for higher sound level limits and the use of on-building noise control measures. Per NPC-300, “formal confirmation from the land use planning authority” is required in order to designate an area as Class 4.

York Boulevard/Wilson Street and James Street North are the nearest sources of road traffic noise. There are no other transportation-related sources in close proximity to the Tivoli Development, such as rail lines or airports. The buildings adjacent to the Tivoli Development are considered to be potential sources of stationary sound.

There are no significant sources of vibration in the area of the proposed developments so a detailed vibration assessment was therefore not required.

3. APPLICABLE GUIDELINES

The detailed evaluation of transportation-related and stationary sources affecting the Tivoli Development were assessed using the MOECC guidelines, as defined in Publication NPC-300 (2013). The relevant section of the guideline is Part C – Land Use Planning. Publication NPC-300 specifies that transportation-related and stationary sources are to be assessed separately.

3.1 NPC-300 Part C - Land Use Planning

3.1.1 Road-Traffic Sources

For assessing sound originating from road-traffic sources, Publication NPC-300 defines sound level criteria for two types of locations: outdoor living areas (OLAs), and indoor areas of sensitive uses.

An OLA is defined as an outdoor area easily accessible from the building and designed for the quiet enjoyment of the outdoor environment. Courtyards, terraces and balconies (with a depth of more than four metres) are considered noise-sensitive OLAs. The daytime sound level limit for an OLAs is an equivalent sound level of 55 dBA averaged over the daytime hours (07:00 to 23:00h). Publication NPC-300 does not define a nighttime sound level limit for OLAs.

Indoor spaces have daytime and nighttime sound level limits relating to the type of usage, such as living/dining rooms or bedrooms. Indoor living areas within the proposed developments include dining/living rooms and bedrooms. The sound level criteria are based on all windows and doors being closed to the environment. The daytime sound level limit for indoor spaces is an L_{EQ} of 45 dBA averaged over 07:00 to 23:00h. The nighttime sound level limits for indoor spaces are L_{EQ}s of 45 and 40 dBA averaged over 23:00 to 07:00h, for an indoor living area and sleeping quarters, respectively.

The NPC-300 sound level criteria for transportation-related sources are summarized in Table 1.

Table 1: NPC-300 Transportation-related Source Sound Level Criteria for Sensitive Land Uses

Assessment Location	Time of Day	Time Period	Sound Level Limit[1]
Outdoor Living Area	Daytime	07:00 – 23:00h	55 dBA
Indoor Living Area	Daytime	07:00 – 23:00h	45 dBA
	Nighttime	23:00 – 07:00h	45 dBA
Sleeping Quarters	Daytime	07:00 – 23:00h	45 dBA
	Nighttime	23:00 – 07:00h	40 dBA

1. The average sound level over the time period at the assessment location must not exceed the sound level limit.

3.1.2 Stationary Sources

For assessing sound originating from stationary sources, Publication NPC-300 defines sound level criteria for Points of Reception (PORs). Outdoor amenity areas and windows/doors leading to sensitive indoor spaces are both defined as PORs. There are distinct assessment criteria for outdoor amenity areas, and PORs on the building façade.

The assessment criteria for all PORs is the higher of either the exclusion limit per Publication NPC-300 or the minimum background sound level that occurs or is likely to occur at a POR. Where the background sound level in the environment exceeds the exclusion limits, the background sound level is the applicable sound level limit. The exclusion limit is the lowest sound level limit that may be used for an assessment. The applicable exclusion limit is determined based on the level of urbanization or "Class" of the area. The Tivoli development is considered to be in a Class 1 (Urban) area.

Outdoor PORs such as large balconies or terraces that are shared amenity areas are assessed based on the worst-case one-hour equivalent sound level. The daytime (07:00 to 19:00h) and evening (19:00 to 23:00h) exclusion limits for an outdoor POR in a Class 1 area are both 50 dBA. Outdoor PORs are not assessed during the nighttime (23:00 to 07:00h).

Façade PORs, such as windows/doors leading to sensitive indoor spaces, are also assessed based on the worst-case one-hour equivalent sound level. The assessment of sound at façade PORs assumes that all windows and doors are open to the environment, unlike the road-traffic criteria, which assumes the windows are closed. The daytime (07:00 to 19:00h), evening (19:00 to 23:00h) and nighttime (23:00 to 07:00h) exclusion limits for a façade POR in a Class 1 area are 50 dBA, 50 dBA and 45 dBA, respectively.

The NPC-300 sound level criteria for stationary sources are summarized in Table 2.

Table 2: NPC-300 Stationary Source Sound Level Criteria for Sensitive Land Uses

Assessment Location	Time of Day	Time Period	Exclusion Limit[1]
Outdoor Point of Reception	Daytime	07:00 – 19:00h	50 dBA
	Evening	19:00 – 23:00h	50 dBA
Façade Point of Reception	Daytime	07:00 – 19:00h	50 dBA
	Evening	19:00 – 23:00h	50 dBA
	Nighttime	23:00 – 07:00h	45 dBA

1. The sound level averaged over a one-hour time period at the assessment location must not exceed the exclusion limit or background sound level, whichever is higher.

4. NOISE RECEPTORS

The selection of receptors is based on drawings dated February 3, 2014, which show the locations of windows and terraces, and the intended use of areas within the proposed building. The current designs for the Tivoli Development include several terraces and balconies, some of which have a depth of more than four metres, meaning they must be assessed as PORs. There are no other types of outdoor receptors associated with the development that require analysis. Two worst-case outdoor receptors were selected for modelling:

- R01 - a west-facing private balcony on the fourth storey, and
- R02 - an east facing public terrace on the third storey.

Two-worst case locations were used to assess the sound levels at the façade of Tivoli Development:

- R03 - a south-facing window of sleeping quarters located on the fourth storey, and
- R04 - a west-facing window of living quarters on the fourth storey.

These modelled receptors will have the worst-case sound levels of any PORs on the proposed building. The location of R02 is shown in Figure 1 and the locations of R01, R03 and R04 are shown in Figure 2.

For the road noise assessment, sound was assessed at receptor locations R01 and R02 as OLAs, at R03 as sleeping quarters, and at R04 as an indoor living area. Sound levels for R03 and R04 were predicted at the exterior of the building and assuming a closed window; however, the relevant criteria provide an indoor sound level limit. As such, for the road-traffic noise assessment, the sound levels were predicted at the exterior of the windows and a 20 dB reduction in sound level from the exterior to interior was assumed due to the window being closed and minimum Ontario Building Code (OBC) construction. This closed window sound level reduction is consistent with MOECC Publication NPC-300 estimates for OBC construction, based on comparisons of indoor and outdoor sound level criteria tables.

For the stationary source assessment, receptor locations R02 was assessed as an outdoor POR and receptor location R03 was assessed as a façade POR. The other receptor locations were not modelled as R02 and R03 are anticipated to have the worst-case impacts due to stationary sources.

5. NOISE ASSESSMENT

5.1 Road-Traffic Noise Assessment

The two roadways that have potential to influence the Tivoli Development site are York Boulevard / Wilson Street and James Street North. Road-traffic noise modelling was carried out using the Ontario Road Noise Analysis Method for Environment and Transportation (ORNAMENT) (MOECC, 1989) algorithms.

5.1.1 Traffic Data

Traffic data for York Boulevard / Wilson Street and James Street North were obtained in April 2014 from the City of Hamilton.

Hourly traffic counts were used to determine the percentage of traffic occurring during the daytime (07:00 – 23:00h) and nighttime (23:00 – 07:00h) hours. A ratio of AM-peak hour sound level to daily average sound level was also calculated.

Turning Movement Counts (TMCs) provided detailed count data for the two time periods: 07:15 to 10:00 and 14:15 to 18:00. The TMCs were used to determine the traffic volume and types of vehicles on each link during the AM-peak. The traffic data were provided for the year 2011 and was increased at a rate of 2% per year to represent predicted traffic volumes in 2024. Average daily traffic volumes and vehicle breakdowns for each link were calculated by applying the AM-peak factor to the 2024 TMC data.

A summary of the traffic data are provided in Table 3. See Appendix A for copies of the traffic data and sample calculations.

Table 3: Road Traffic Data for Transportation-related Source Assessment

Roadway Link	Daily Average[1]	Daytime / Nighttime Split (%Day / %Night)	Percent Commercial Traffic	Medium / Heavy Split (%MM / %HH)	Speed (km/h)
Wilson Street (East of James St N)	22,409	92.5 / 7.5	4.3%	30 / 70	50
York Boulevard (West of James St N)	18,862		3.5%	24 / 76	
James Street N (North of York Boulevard / Wilson Street)	13,869		5.4%	50 / 50	
James Street N (South of York Boulevard / Wilson Street)	11,340		6.2%	60 / 40	

1. AADT – Annual Average Daily Traffic.

5.1.2 Noise Modelling Results

Sound levels due to road traffic were predicted using ORNAMENT at R01 through R04. The sound level calculations are provided in Appendix B. Table 4 summarizes the predicted road-traffic sound levels and the applicable NPC-300 sound level criteria for each receptor.

Table 4: Results of ORNAMENT Modelling for Traffic-Noise Assessment

Receptor	Outdoor / Indoor	Predicted Road-Traffic Sound Exposures (dBA)		Sound Level Limit (dBA)		Meets Criteria? (Yes/No)
		Daytime $L_{EQ,16hr}$	Night-time $L_{EQ,8hr}$	Daytime $L_{EQ,16hr}$	Night-time $L_{EQ,8hr}$	
R01	Outdoor	66 dBA	N/A	55 dBA	N/A	No
R02	Outdoor	63 dBA	N/A	55 dBA	N/A	No
R03	Indoor	44 dBA[1]	36 dBA	45 dBA	40 dBA	Yes
R04	Indoor	46 dBA[1]	38 dBA	45 dBA	45 dBA	No

1. Predicted indoor sound levels include a 20 dB reduction in sound level due to construction of the closed window.

Sound levels predicted at R03 are representative of south-facing windows in the Tivoli Development. Sound levels at R03 are within the Publication NPC-300 limits. Sound levels within sensitive spaces on the east-facing façade and north-facing façade are anticipated to be lower than the levels at R03 due to less exposure to road-traffic noise. Therefore, east- and north-facing facades are predicted to be within the Publication NPC-300 sound level limits as well.

Sound levels are predicted to exceed sound level limits at R01, R02 and R04. Mitigation measures will be required to address the excess sound at these receptors.

5.1.3 Addressing Excess Sound

Noise control measures in this section are recommended to bring the sound levels into compliance with the criteria, where possible. According to NPC-300, where mitigation measures become infeasible to appropriately lower sound levels to the criteria, an excess up to 5 dB may be permitted subject to justification and use of a Warning Clauses.

The sound level at R02 during the daytime is predicted to be in excess of the limits by 5 dB. As such, mitigation measures are recommended for the east-facing terrace. Mitigation measures for R02 may include but are not limited to a fully enclosed barrier and elevated glass railing on the terrace. Where sound levels cannot be reduced to below 55 dBA, Warning Clause A (see Section 5.1.4) must be affixed to all purchase or rental agreements.

The sound level at R04 is predicted to exceed the daytime limit by 1 dB. As such, mitigation measures are recommended for the west-facing windows on the Tivoli Development. Mitigation measures for R04 may include a window with an Outdoor-Indoor Transmission Class (OITC) greater than 21. Window construction such as 1/4" glass - 1/2" air space - 1/4" glass typically achieves an OITC of 28 and would be an acceptable means of achieving appropriate sound levels. Where sound levels cannot be reduced to below 45 dBA, Warning Clause C (see Section 5.1.4) must be affixed to all units with west-facing windows leading to sensitive spaces.

Sound levels at R01 exceed the sound level limits by 11 dB. As such, mitigation measures must be included in the design. Mitigation measures for R01 may include but are not limited to fully enclosed barriers and elevated glass railings on balconies and terraces. The exact dimensions of each barrier should be determined once the building design has been finalized. Where noise mitigation is not feasible, and/or sound levels remain above 55 dBA, Warning Clause B (see Section 5.1.4) must be affixed to all purchase or rental agreements.

5.1.4 Warning Clauses

Warning Clauses must be included on all development agreements, offers of purchase and agreements of Purchase and Sales or Lease as indicated in Section 5.1.3. The following Warning Clauses are applicable:

Type A: "Purchases/tenants are advised that sound levels due to increasing road traffic may occasionally interfere with some activities of the dwelling occupants as the sound levels exceed the sound level limits of the Municipality and the Ministry of the Environment and Climate Change"

Type B: "Purchasers/tenants are advised that despite the inclusion of noise control features in the development and within the building units, sound levels due to increasing road traffic may on occasions interfere with some activities of the dwelling occupants as the sound levels exceed the Municipality's and the Ministry of the Environment and Climate Change's noise criteria."

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

5.2 Stationary Source Noise Assessment

The buildings to the west, north and east of the Tivoli Development are not anticipated to be a significant contributor of sound. The one-storey plaza to the south has thirteen rooftop air-conditioning units on the roof located a short distance from the Tivoli development. These sources are anticipated to be the most significant contribution of stationary-source sound at the Tivoli Development.

5.2.1 Sound Data used for Noise Modelling

At the time of assessment, no information about model number or sound levels of the packaged rooftop units were available. Sound data for a similar sized unit on file at RWDI were selected and modelled as proxy. Sound data for the proxy rooftop units are provided in Appendix C. Sound levels from the actual

units must be determined through direct measurement or from manufacturer's specifications to confirm the results presented herein.

The rooftop air-conditioning units were assumed to have the potential operate twenty-four hours a day and seven days a week.

5.2.2 Background Sound Levels

Receptors R02 and R03 are anticipated to have background sound levels that exceed the NPC-300 exclusion limits. As discussed in section 3.1.2, elevated background sound levels replace the exclusion limits at these receptors. Traffic modelling was conducted to assess existing background level. Note that this modelling differs from the modelling discussed in Section 5.1 in that there is no increase in modelled volumes to account for future years, and the predicted sound levels are one-hour averages rather than 8- and 16-hour averages.

The lowest traffic volumes for the daytime, evening and nighttime were determined from the 2011 hourly data obtained from the City of Hamilton. ORNAMENT (MOECC, 1989) was used to model the sound levels at R02 and R03 for the daytime, evening and nighttime periods. The background sound level for each time period was determined to be above the exclusion limits presented in Table 2. The sound levels in Table 5 replace the exclusion limits as the relevant sound level limits for assessing stationary source sound. Copies of the traffic data and sample calculations can be found in Appendix A; ORNAMENT calculations for the background sound level calculations can be found in Appendix D.

Table 5: Stationary Source Limits at R02 and R03

Receptor	Time of Day	Time Period	Sound Level Limit[1]
R02	Daytime	07:00 – 19:00h	59 dBA
	Evening	19:00 – 23:00h	59 dBA
R03	Daytime	07:00 – 19:00h	59 dBA
	Evening	19:00 – 23:00h	60 dBA
	Nighttime	23:00 – 07:00h	51 dBA

1. R02 is an outdoor point of reception and is not assessed during the nighttime.

5.2.3 Noise Modelling Results

Detailed noise modelling was carried out using the Cadna/A software package, a commercially available implementation of the ISO 9613 (ISO, 1994 and ISO, 1996) algorithms. The predicted sound level at R02 and R03 are 62 and 60 dBA, respectively, at all times of day.

Table 6: Results of Cadna/A Modelling for Stationary Source Assessment

Receptor	Outdoor / Indoor	Time Period	Predicted Sound Level (dBA)	Sound Level Limit (dBA)	Meets Criteria? (Yes/No)
R02	Outdoor	Daytime	62 dBA	59 dBA	No
		Evening	62 dBA	59 dBA	No
R03	Indoor	Daytime	60 dBA	59 dBA	No
		Evening	60 dBA	60 dBA	Yes
		Nighttime	60 dBA	51 dBA	No

Sound levels at R03 comply with the applicable sound level limit during the evening. However, at all other times sound levels at R03 are predicted to exceed the background sound level. Sound levels at R02 exceed the applicable limit.

5.2.4 Addressing Excess Sound

Where the noise impact exceeds the applicable sound level limits, mitigation is required in order to meet the MOECC applicable sound level limits. Potential mitigation measures for stationary sources include:

- Source based noise control measures;
- Receptor based outdoor noise control measures;
- Receptor based on-building noise control measures, under the condition that the noise sensitive land use is classified as a Class 4 area; or
- Receptor based site configuration noise control measures.

The use of receptor based outdoor noise control measures, such as barriers, is acceptable in a Class 1 area. Barriers located around the south end of the terrace, represented by R02, would be capable of reducing sound levels to a suitable level. In the case of the façade points of reception represented by receptor R03, a barrier between source and receptor would have little effect due to the geometry between source and receptor.

A reconfiguration of the sensitive spaces within and on the façade of the Tivoli Development such that they are not on the south-façade is another potential mitigation option. This would remove the need to assess sound levels at R03.

To achieve compliance at the building façade, source-based mitigation is the most feasible option, and the one typically preferred by the MOECC. To affect source-based mitigation, NPC-300 requires that the developer enter into an agreement with the stationary source (plaza) owner. The agreement would ensure sound levels are reduced to an appropriate level to meet the applicable limits as presented in Table 5.

In order to enter into an agreement for source based mitigation, a detailed mitigation plan will need to be developed in consultation with the owner of the stationary source. Mitigation strategies may include replacement or relocation of the packaged rooftop units, or strategies to reduce noise from the fans and compressor(s) of the existing units. It is recommended that the first step in the consultation be detailed measurements of the existing equipment in order to determine the level of sound reduction required and the diurnal variation in the operation of the equipment.

Alternatively, if the development were to be classified as a Class 4 area then on-building noise control measures would be an acceptable mitigation option. On-building mitigation options could include an enclosed noise buffer as described in NPC-300. By installing an enclosed noise buffer on a balcony this would reduce sound levels experienced at the façade of the building (behind the noise buffer). The on-building noise control measures would be necessary for all south-facing balconies to be compliant with the requirements of NPC-300. However, additional mitigation would still be required for windows leading to sensitive spaces on the south façade of the Tivoli Development.

The use of on-building noise control measures triggers the need for a noise mitigation agreement between the Tivoli Development, the stationary source (plaza) owner and the land use planning authority. The requirements of such an agreement are outlined in NPC-300. Obtaining Class 4 status would require formal approval from the land use planning authority and a copy of the approved noise impact study should be supplied to owners of the stationary sources. Prospective purchasers should be informed that this dwelling is located in a Class 4 area through the use of Warning Clause F.

Type F: "Purchasers/tenants are advised that the sound levels due to the adjacent industry (facility) (utility) are required to comply with sound level limits that are protective of indoor areas and are based on the assumption that windows and exterior doors and closed. This dwelling unit has been supplied with a ventilation/air conditioning system which will allow windows and exterior doors to remain closed."

6. CONCLUSION

RWDI conducted a detailed noise impact study to assess the impact of all noise sources affecting the Tivoli Development. Road-traffic noise and stationary sources on the adjacent plaza were identified as the primary sources of sound affecting the Tivoli Development. The sound emissions were assessed at the proposed development using MOECC Publication NPC-300.

Road-traffic noise was predicted to exceed the guideline limits at all modelled receptors. With the implementation of appropriate window construction and inclusion of Warning Clauses (as described in Section 5.1.4), the facility meets the requirements of NPC-300 for road-traffic sources.

Sound due to surrounding stationary sources on the adjacent plaza is predicted to exceed the applicable guideline limits at the Tivoli Development. With the implementation of either a source-based mitigation

plan and/or the installation of enclosed noise buffers (provided the Tivoli Development is a Class 4 area) the Tivoli Development meets the requirements of NPC-300 for stationary sources.

7. REFERENCES

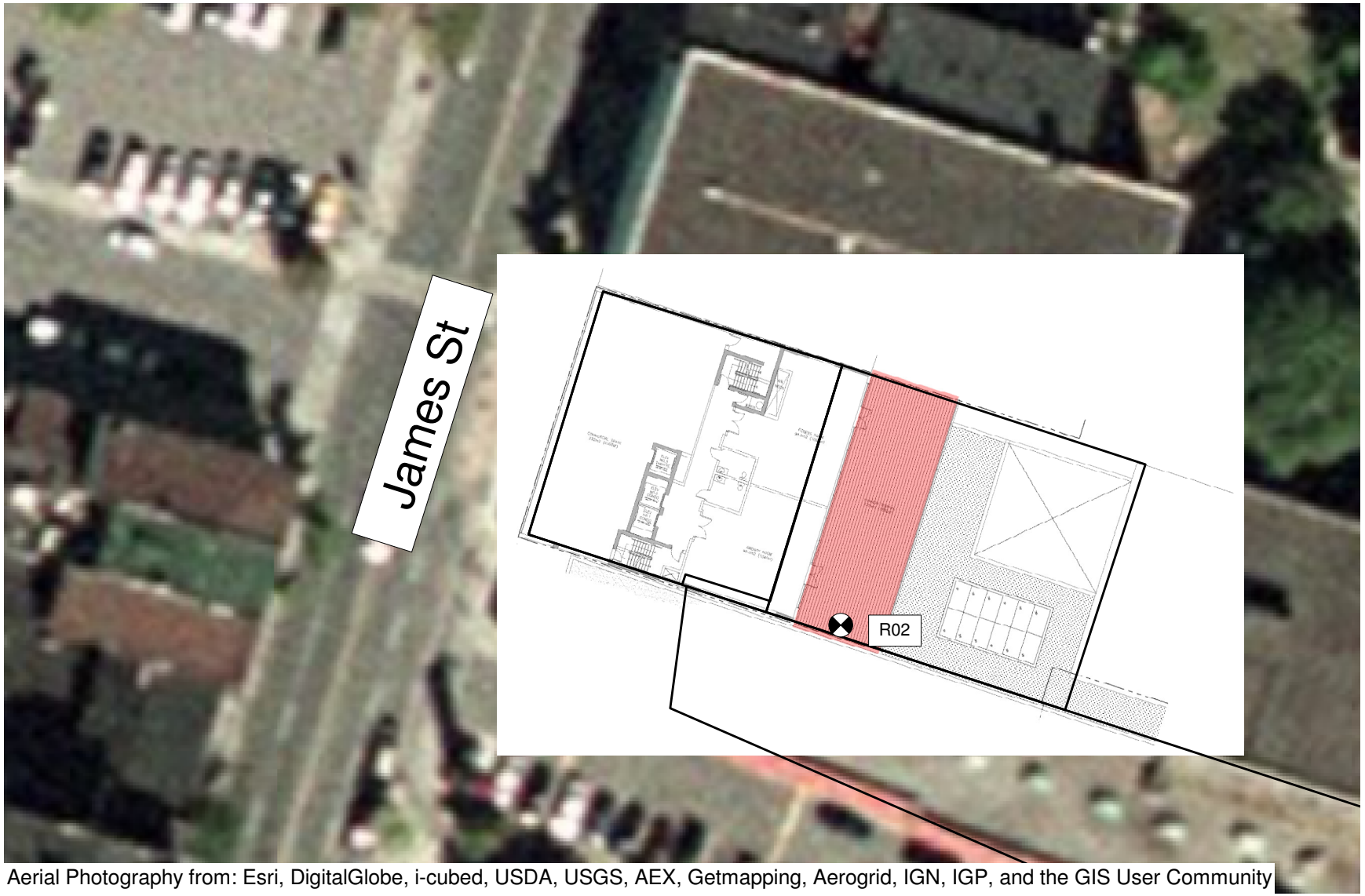
Ontario Ministry of the Environment and Climate Change (MOECC), August 2013, Publication NPC-300, *Environmental Noise Guideline Stationary and Transportation Sources – Approval and Planning*

Ontario Ministry of the Environment and Climate Change (MOECC), 1989, *ORNAMENT Ontario Road Noise Analysis Method for Environment and Transportation, Technical Publication*

International Organization for Standardization (ISO), 1994b, International Standard ISO 9613-1:1994, *Acoustics –Attenuation of Sound during propagation outdoors. Part 1: Calculation of the absorption of sound by the atmosphere.*

International Organization for Standardization (ISO), 1996, International Standard ISO 9613-2:1996, *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation*

FIGURES



Modelled Sensitive Receptor Locations

Third Storey

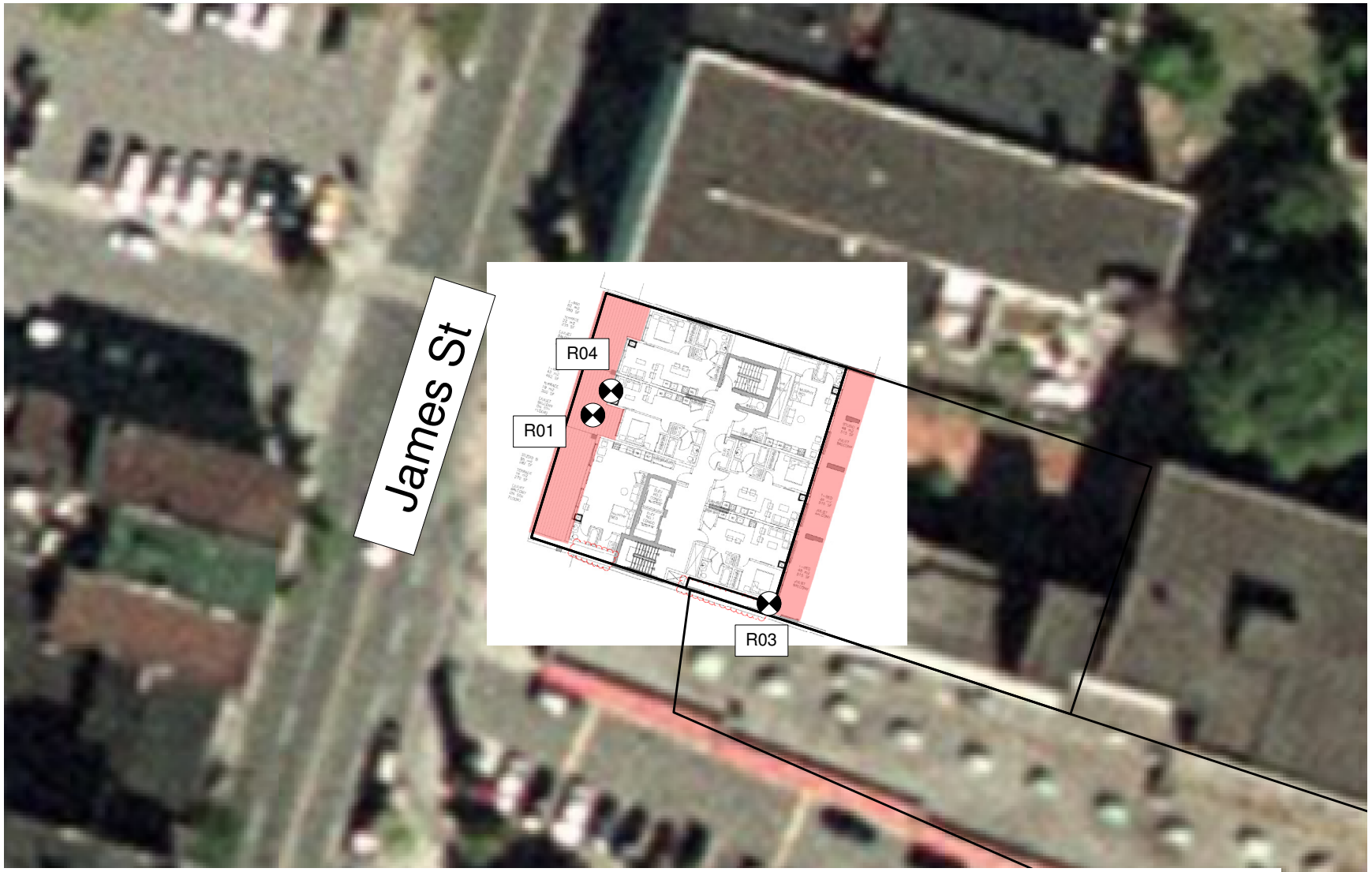
Tivoli Development - Hamilton, Ontario

True North

Project #1401113

Drawn by: GDDA	Figure: **1**
Scale:	1:500
Date:	Nov 4, 2014

RWDI



Modelled Sensitive Receptor Locations

Fourth Storey

Tivoli Development - Hamilton, Ontario

True North

Project #1401113

Drawn by: GDDA	Figure: **2**
Scale:	1:500
Date:	Nov 4, 2014

RWDI

APPENDIX A

Data from Midblock 2013 - York Blvd VOLUME data from City of Hamilton

	06-Oct-13		07-Oct-13		08-Oct-13		09-Oct-13		10-Oct-13		11-Oct-13	
Hour	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB
1:00	204	13	105	2	134	3	122	2	139	5	140	1
2:00	157	2	58	3	54	1	55	3	76	5	87	3
3:00	107	5	35	3	37	2	42	0	49	3	58	1
4:00	94	4	44	2	33	2	53	2	48	1	39	3
5:00	48	2	31	1	45	0	45	1	57	0	55	3
6:00	63	1	142	2	150	5	128	7	118	6	132	5
7:00	97	1	345	19	343	30	372	31	395	21	347	20
8:00	136	3	780	24	766	30	756	24	779	26	678	27
9:00	172	13	1365	45	1339	56	1388	43	1311	49	1198	48
10:00	328	13	975	48	1022	36	865	35	1198	36	866	27
11:00	463	18	810	28	777	29	667	31	1082	45	764	44
12:00	497	26	803	52	830	44	729	33	1050	42	891	63
13:00	681	33	881	39	867	43	798	30	1151	65	930	51
14:00	789	51	871	47	878	55	859	31	1124	56	847	65
15:00	758	54	918	39	921	52	862	61	1075	42	850	79
16:00	677	29	1047	50	1014	50	991	77	1143	50	1024	67
17:00	709	35	1203	52	1130	69	1178	49	1220	58	1090	54
18:00	634	23	1188	55	1165	45	1195	57	1230	62	1052	62
19:00	557	26	867	21	974	30	987	41	939	38	924	48
20:00	488	14	550	30	634	23	660	31	793	21	818	46
21:00	359	16	394	19	421	26	501	9	511	20	595	27
22:00	276	9	348	11	365	9	408	13	401	21	429	26
23:00	212	4	227	6	255	18	292	7	253	17	645	43
0:00	151	7	183	2	215	6	200	6	212	3	385	17

City of Hamilton **T U R N I N G M O V E M E N T C O U N T** Loc. Code: 1

Intersection: **York Blvd / Wilson St** **at** **James St** Total Vehicles: 11,824 Date: Thursday
Direction: (East/West) (North/South) M.V.E./Year: 7.960 Dec 15, 2011
Road Condition: Wet Weather: Rain AWDT Factor: 1.98 Period: 7 hours
Comments:

TOTAL VEHICLES

15 mins. Ending	North Bd. on N/S			East Bd. on E/W			South Bd. on N/S			West Bd. on E/W				Pedestrians			
(Pk.Hr.*)	L	S	R	L	S	R	L	S	R	L	S	R	Total Veh's	N side	E side	S side	W side
7:15	0	23	4	9	79	12	4	30	0	0	1	0	162	1	0	0	0
7:30	2	35	2	17	127	22	0	46	0	3	5	1	260	0	0	0	5
7:45	0	37	7	15	155	26	5	57	1	1	10	2	316	0	0	0	2
8:00	0	41	7	22	215	31	9	70	1	1	15	2	414	0	0	0	2
8:15	0	50	5	20	206	34	5	66	1	0	12	4	403	0	0	0	0
8:30 *	0	59	5	18	238	67	8	86	2	5	19	3	510	1	1	0	1
8:45 *	0	35	9	20	233	68	11	102	0	0	35	6	519	4	3	0	6
9:00 *	0	58	14	15	244	56	12	97	7	1	31	5	540	9	7	13	0
9:15 *	0	46	13	16	271	51	3	97	4	3	14	3	521	4	2	2	6
9:30	0	49	9	20	179	59	11	79	0	0	18	3	427	4	4	4	5
9:45	0	55	11	12	148	37	8	72	1	1	9	1	355	5	3	7	15
10:00	0	33	13	14	163	45	9	56	0	1	7	3	344	1	5	5	13
14:15 *	0	63	15	23	144	37	14	69	1	7	17	1	391	14	0	14	0
14:30 *	0	54	9	21	163	35	15	97	1	9	7	0	411	34	0	12	0
14:45 *	0	75	10	25	147	41	21	85	2	2	16	8	432	19	0	3	5
15:00 *	0	70	9	23	154	42	14	96	2	2	12	4	428	31	2	6	0
15:15	1	57	18	21	191	34	18	106	1	3	15	5	470	38	5	16	0
15:30	0	59	14	14	179	36	25	80	2	2	13	6	430	26	2	17	0
15:45	0	60	12	17	190	24	23	70	0	6	10	8	420	12	0	0	0
16:00	0	64	9	18	154	29	5	78	0	3	7	5	372	19	2	12	8
16:15	0	61	14	21	200	38	16	75	0	8	9	2	444	6	0	7	8
16:30	0	52	12	26	210	24	23	76	0	2	12	8	445	26	0	16	0
16:45	0	50	11	13	183	33	32	77	0	8	7	5	419	13	0	21	0
17:00 *	0	60	15	17	258	44	20	90	2	8	14	2	530	7	5	5	0
17:15 *	0	78	13	22	203	43	20	101	0	6	13	10	509	13	1	7	0
17:30 *	0	70	10	18	188	23	15	78	0	6	9	7	424	6	0	1	0
17:45 *	0	55	6	16	196	59	14	104	0	3	7	2	462	32	0	33	0
18:00	0	69	16	31	192	21	16	96	1	3	15	6	466	20	0	14	0
TOTAL	3	1,518	292	524	5,210	1,071	376	2,236	29	94	359	112		345	42	215	76
APPR.		1,813			6,805			2,641			565		11,824			678	

TRUCKS & BUSES

15 mins. Ending	North Bd. on N/S			East Bd. on E/W			South Bd. on N/S			West Bd. on E/W			
(Pk.Hr.*)	L	S	R	L	S	R	L	S	R	L	S	R	Total
7:15	0	1	0	0	1	2	1	5	0	0	0	0	10
7:30	0	1	0	0	9	1	0	7	0	0	0	0	18
7:45	0	1	0	1	6	2	0	4	0	0	0	0	14
8:00	0	0	0	2	3	1	0	5	0	0	0	0	11
8:15	0	1	0	0	10	2	0	7	0	0	0	0	20
8:30 *	0	0	0	1	11	3	1	7	0	0	1	0	24
8:45 *	0	0	0	2	5	3	0	13	0	0	0	1	24
9:00 *	0	0	0	3	8	2	0	9	3	0	0	0	25
9:15 *	0	1	0	0	13	5	0	3	0	1	0	0	23
9:30	0	0	0	0	13	5	1	7	0	0	0	0	26
9:45	0	0	0	0	13	2	0	6	0	0	0	0	21
10:00	0	0	0	0	15	4	0	6	0	0	2	1	28
14:15 *	0	1	0	1	10	0	2	2	0	0	2	0	18
14:30 *	0	1	0	1	19	2	3	11	0	0	0	0	37
14:45 *	0	3	1	1	13	2	0	6	0	0	1	0	27
15:00 *	0	1	0	1	3	3	0	4	0	0	1	0	13
15:15	0	0	1	4	10	5	0	6	1	0	0	0	27
15:30	0	3	1	0	5	1	0	5	0	0	0	0	15
15:45	0	1	0	0	13	4	0	2	0	1	0	0	21
16:00	0	0	0	0	7	2	0	2	0	0	0	0	11
16:15	0	0	1	1	6	3	0	7	0	0	0	0	18
16:30	0	0	0	5	5	1	0	5	0	0	0	1	17
16:45	0	4	0	0	5	2	0	5	0	0	0	0	16
17:00 *	0	0	0	1	6	3	0	7	0	0	0	0	17
17:15 *	0	0	0	0	5	5	0	1	0	0	0	0	11
17:30 *	0	1	1	1	3	2	0	6	0	0	0	0	14
17:45 *	0	0	0	1	4	4	1	4	0	0	0	0	14
18:00	0	0	1	0	4	1	0	4	0	0	2	0	12
TOTAL	0	20	6	26	225	72	9	156	4	2	9	3	
APPR.		26			323			169			14		532

TRUCKS

7:15	0	1	0	0	1	0	1	1	0	0	0	0	4
7:30	0	1	0	0	5	0	0	2	0	0	0	0	8
7:45	0	1	0	1	5	0	0	1	0	0	0	0	8
8:00	0	0	0	2	1	0	0	0	0	0	0	0	3
8:15	0	1	0	0	8	0	0	3	0	0	0	0	12
8:30 *	0	0	0	1	7	1	1	2	0	0	1	0	13
8:45 *	0	0	0	2	3	0	0	8	0	0	0	1	14
9:00 *	0	0	0	3	6	1	0	5	2	0	0	0	17
9:15 *	0	1	0	0	11	4	0	0	0	1	0	0	17
9:30	0	0	0	0	12	3	0	1	0	0	0	0	16
9:45	0	0	0	0	10	1	0	1	0	0	0	0	12
10:00	0	0	0	0	11	1	0	0	0	0	1	1	14
14:15 *	0	1	0	1	10	0	2	1	0	0	2	0	17
14:30 *	0	1	0	1	16	0	3	4	0	0	0	0	25
14:45 *	0	3	0	0	12	1	0	1	0	0	1	0	18
15:00 *	0	0	0	1	3	2	0	0	0	0	1	0	7
15:15	0	0	1	2	8	2	0	1	1	0	0	0	15
15:30	0	3	0	0	5	0	0	0	0	0	0	0	8
15:45	0	1	0	0	7	1	0	0	0	1	0	0	10
16:00	0	0	0	0	4	1	0	0	0	0	0	0	5
16:15	0	0	1	1	3	1	0	1	0	0	0	0	7
16:30	0	0	0	5	4	0	0	0	0	0	0	1	10
16:45	0	0	0	0	5	0	0	1	0	0	0	0	6
17:00 *	0	0	0	1	1	2	0	3	0	0	0	0	7
17:15 *	0	0	0	0	4	0	0	0	0	0	0	0	4
17:30 *	0	1	1	1	2	0	0	0	0	0	0	0	5
17:45 *	0	0	0	1	2	2	1	0	0	0	0	0	6
18:00	0	0	1	0	3	0	0	1	0	0	2	0	7
TOTAL	0	15	4	23	169	23	8	37	3	2	8	3	
APPR.		19			215			48			13		295

Calculation of Day/Night Split and AM-Peak to AADT Ratio

Data from Midblock 2013 - York Blvd VOLUME data from City of Hamilton

	06-Oct-13		07-Oct-13		08-Oct-13		09-Oct-13		10-Oct-13		11-Oct-13	
Hour	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB
1:00	204	13	105	2	134	3	122	2	139	5	140	1
2:00	157	2	58	3	54	1	55	3	76	5	87	3
3:00	107	5	35	3	37	2	42	0	49	3	58	1
4:00	94	4	44	2	33	2	53	2	48	1	39	3
5:00	48	2	31	1	45	0	45	1	57	0	55	3
6:00	63	1	142	2	150	5	128	7	118	6	132	5
7:00	97	1	345	19	343	30	372	31	395	21	347	20
8:00	136	3	780	24	766	30	756	24	779	26	678	27
9:00	172	13	1365	45	1339	56	1388	43	1311	49	1198	48
10:00	328	13	975	48	1022	36	865	35	1198	36	866	27
11:00	463	18	810	28	777	29	667	31	1082	45	764	44
12:00	497	26	803	52	830	44	729	33	1050	42	891	63
13:00	681	33	881	39	867	43	798	30	1151	65	930	51
14:00	789	51	871	47	878	55	859	31	1124	56	847	65
15:00	758	54	918	39	921	52	862	61	1075	42	850	79
16:00	677	29	1047	50	1014	50	991	77	1143	50	1024	67
17:00	709	35	1203	52	1130	69	1178	49	1220	58	1090	54
18:00	634	23	1188	55	1165	45	1195	57	1230	62	1052	62
19:00	557	26	867	21	974	30	987	41	939	38	924	48
20:00	488	14	550	30	634	23	660	31	793	21	818	46
21:00	359	16	394	19	421	26	501	9	511	20	595	27
22:00	276	9	348	11	365	9	408	13	401	21	429	26
23:00	212	4	227	6	255	18	292	7	253	17	645	43
0:00	151	7	183	2	215	6	200	6	212	3	385	17

Calculated

	Average			
Hour	EB	WB	Sum	%
1:00	141	4	145	1.0%
2:00	81	3	84	0.6%
3:00	55	2	57	0.4%
4:00	52	2	54	0.4%
5:00	47	1	48	0.3%
6:00	122	4	126	0.9%
7:00	317	20	337	2.3%
8:00	649	22	671	4.7%
9:00	1129	42	1171	8.1%
10:00	876	33	909	6.3%
11:00	761	33	794	5.5%
12:00	800	43	843	5.9%
13:00	885	44	929	6.5%
14:00	895	51	946	6.6%
15:00	897	55	952	6.6%
16:00	983	54	1037	7.2%
17:00	1088	53	1141	7.9%
18:00	1077	51	1128	7.8%
19:00	875	34	909	6.3%
20:00	657	28	685	4.8%
21:00	464	20	484	3.4%
22:00	371	15	386	2.7%
23:00	314	16	330	2.3%
0:00	224	7	231	1.6%
	13760	**637**	**14397**	

Volume	
Daytime (16hr)	Nighttime (8hr)
92.5%	7.5%
11.38	0.92

of AADT

multiplied by the peak

Assuming that the am peak is 0.081*AADT

Calculation of Traffic Growth and D/N Traffic Volumes on Each Link

	North Link - James St N				East Link - Wilson St				South Link - James St N				West Link			
	TMC	TMC*Growth	Daytime	Nighttime	TMC	TMC*Growth	Daytime	Nighttime	TMC	TMC*Growth	Daytime	Nighttime	TMC	TMC*Growth	Daytime	Nighttime
All	872	1,128	12,833	1,036	1,409	1,823	20,736	1,673	713	922	10,493	847	1,186	1,534	17,454	1,408
Cars	825	1,067	12,141	980	1,349	1,745	19,853	1,602	669	865	9,846	794	1,145	1,481	16,851	1,360
Buses	24	31	353	29	18	23	265	21	18	23	265	21	10	13	147	12
Trucks	23	30	338	27	42	54	618	50	26	34	383	31	31	40	456	37
Trucks & Buses	47	61	692	56	60	78	883	71	44	57	648	52	41	53	603	49

Growth Factor: **1.29** =1.02^(13)
13 years of 1% growth from 2011 to 2024

Determining Lowest Day, Evening andNighttime Traffic Volumes Split and AM-Peak to AADT Ratio

Data from Midblock 2013 - York Blvd VOLUME data from City of Hamilton

	06-Oct-13		07-Oct-13		08-Oct-13		09-Oct-13		10-Oct-13		11-Oct-13	
Hour	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB
1:00	204	13	105	2	134	3	122	2	139	5	140	1
2:00	157	2	58	3	54	1	55	3	76	5	87	3
3:00	107	5	35	3	37	2	42	0	49	3	58	1
4:00	94	4	44	2	33	2	53	2	48	1	39	3
5:00	48	2	31	1	45	0	45	1	57	0	55	3
6:00	63	1	142	2	150	5	128	7	118	6	132	5
7:00	97	1	345	19	343	30	372	31	395	21	347	20
8:00	136	3	780	24	766	30	756	24	779	26	678	27
9:00	172	13	1365	45	1339	56	1388	43	1311	49	1198	48
10:00	328	13	975	48	1022	36	865	35	1198	36	866	27
11:00	463	18	810	28	777	29	667	31	1082	45	764	44
12:00	497	26	803	52	830	44	729	33	1050	42	891	63
13:00	681	33	881	39	867	43	798	30	1151	65	930	51
14:00	789	51	871	47	878	55	859	31	1124	56	847	65
15:00	758	54	918	39	921	52	862	61	1075	42	850	79
16:00	677	29	1047	50	1014	50	991	77	1143	50	1024	67
17:00	709	35	1203	52	1130	69	1178	49	1220	58	1090	54
18:00	634	23	1188	55	1165	45	1195	57	1230	62	1052	62
19:00	557	26	867	21	974	30	987	41	939	38	924	48
20:00	488	14	550	30	634	23	660	31	793	21	818	46
21:00	359	16	394	19	421	26	501	9	511	20	595	27
22:00	276	9	348	11	365	9	408	13	401	21	429	26
23:00	212	4	227	6	255	18	292	7	253	17	645	43
0:00	151	7	183	2	215	6	200	6	212	3	385	17

Calculated

	Average						
Hour	EB	WB	Sum	% of AADT		Volume	
						Day	Eve	Night
1:00	141	4	145	1.0%		2.3%	2.7%	0.3%
2:00	81	3	84	0.6%		0.288	0.330	0.041
3:00	55	2	57	0.4%		Mult. AM peak by above num		
4:00	52	2	54	0.4%		to get lowest hour		
5:00	47	1	48	0.3%				
6:00	122	4	126	0.9%				
7:00	317	20	337	2.3%				
8:00	649	22	671	4.7%				
9:00	1129	42	1171	8.1%	<-- AM Peak			
10:00	876	33	909	6.3%				
11:00	761	33	794	5.5%				
12:00	800	43	843	5.9%				
13:00	885	44	929	6.5%				
14:00	895	51	946	6.6%				
15:00	897	55	952	6.6%				
16:00	983	54	1037	7.2%				
17:00	1088	53	1141	7.9%				
18:00	1077	51	1128	7.8%				
19:00	875	34	909	6.3%				
20:00	657	28	685	4.8%			= lowest hour	
21:00	464	20	484	3.4%				
22:00	371	15	386	2.7%				
23:00	314	16	330	2.3%				
0:00	224	7	231	1.6%				
	13760	**637**	**14397**					

Determining Lowest Day, Evening and Nighttime Traffic Volumes for Each Link of Road

Lowest hour traffic volumes for stationary source limit calculation

	North Link - James St N				East Link - Wilson St				South Link - James St N				West Link			
	TMC	Daytime	Evening	Nighttime	TMC	Daytime	Evening	Nighttime	TMC	Daytime	Evening	Nighttime	TMC	Daytime	Evening	Nighttime
Cars	825	237	272	34	1,349	388	445	55	669	193	221	27	1,145	330	377	47
Medium	24	7	8	1	18	5	6	1	18	5	6	1	10	3	3	0
Heavy	23	7	8	1	42	12	14	2	26	7	9	1	31	9	10	1

Peak factors: Day Eve Night

0.287788215 0.329632792 0.040990606

APPENDIX B

ORNAMENT

Ontario Road Noise Analysis Method for ENvironment and Transportation

version 2.06

Job No. 1401113 Scenario R1 - West-facing Juliet Balcony

Job Name Tivoli Development Road-Traffic Noise Assessment

ROAD CHARACTERISTICS **SOURCE-RECEIVER-BARRIER-TOPOGRAPHY CHARACTERISTICS**

ID	Description	Time Period	Number of Vehicles			Speed (km/h)	Road Gradient (%)	Two Way? (y/n)	Pavement Type	Road Viewable Angle		Source-Receiver Distance (m)	Ground Type (Hard/Soft)	Topo-graphy Type	Source Height (m)	Road Elevation (m asl)	Receptor Height (m)	Receptor Elevation (m asl)	Adjustment (dB)	Reason For Adjustment	**Total Segment L_{eq} (dBA)**
			Autos	Medium	Heavy					Θ_1	Θ_2										
Daytime																					
R1_Day_N	James St N (North Link)	16	10682	311	298	50	0	y	1	-80	90	15.0	Hard	A	1.3	0.0	1.5	13.1			65
R1_Day_E	Wilson St (East Link)	16	17466	233	544	50	0	y	1	12	32	61.0	Hard	A	1.3	0.0	1.5	13.1			52
R1_Day_S	James St N (South Link)	16	8662	233	337	50	0	y	1	-88	-80	15.0	Hard	A	1.4	0.0	1.5	13.1			53
R1_Day_W	York Blvd (West Link)	16	14825	129	401	50	0	y	1	32	65	61.0	Hard	A	1.3	0.0	1.5	13.1			53
																				Total:	**66**

ORNAMENT

Ontario Road Noise Analysis Method for ENvironment and Transportation

version 2.06

Job No. 1401113
Job Name Tivoli Development

Scenario R2 - East-facing Common Terrace
Road-Traffic Noise Assessment

ROAD CHARACTERISTICS | **SOURCE-RECEIVER-BARRIER-TOPOGRAPHY CHARACTERISTICS**

ID	Description	Time Period	Number of Vehicles			Speed (km/h)	Road Gradient (%)	Two Way? (y/n)	Pavement Type	Road Viewable Angle		Source-Receiver Distance (m)	Ground Type (Hard/Soft)	Topography Type	Source Height (m)	Road Elevation (m asl)	Receptor Height (m)	Receptor Elevation (m asl)	Barrier Height (m)	Barrier Elevation (m asl)	Barrier-Reciever Distance (m)	Barrier Viewable Angle		Adjustment (dB)	Reason For Adjustment	**Total Segment L_{eq} (dBA)**
			Autos	Medium	Heavy					Θ_1	Θ_2											Θ_1	Θ_2			
Daytime																										
R2_Day_N	James St N (North Link)	16	10682	311	298	50	0	y	1	-61	74	39.0	Hard	A	1.3	0.0	1.5	9.1	73.5	0.0	3.0	-61	74			40
R2_Day_E1	Wilson St (East Link, Curved Section)	16	17466	233	544	50	0	y	1	17	55	46.0	Hard	A	1.3	0.0	1.5	9.1	73.5	0.0	8.5	41	55			54
R2_Day_E2	Wilson St (East Link, Straight Section)	16	17466	233	544	50	0	y	1	-85	-15	47.0	Hard	A	1.3	0.0	1.5	9.1								59
R2_Day_S	James St N (South Link)	16	8662	233	337	50	0	y	1	-72	-61	39.0	Hard	A	1.4	0.0	1.5	9.1	73.5	0.0	3.0	-72	-61			28
R1_Day_W	York Blvd (West Link)	16	14825	129	401	50	0	y	1	55	63	46.0	Hard	A	1.3	0.0	1.5	9.1	73.5	0.0	8.5	55	63			30
																									Total:	**60**

ORNAMENT

Ontario Road Noise Analysis Method for ENvironment and Transportation

version 2.06

Job No. 1401113 Scenario R3 - Window of Sleeping Quarters

Job Name Tivoli Development Road-Traffic Noise Assessment

ROAD CHARACTERISTICS **SOURCE-RECEIVER-BARRIER-TOPOGRAPHY CHARACTERISTICS**

ID	Description	Time Period	Number of Vehicles			Speed (km/h)	Road Gradient (%)	Two Way? (y/n)	Pavement Type	Road Viewable Angle		Source-Receiver Distance (m)	Ground Type (Hard/Soft)	Topography Type	Source Height (m)	Road Elevation (m asl)	Receptor Height (m)	Receptor Elevation (m asl)	Ground Elevation Change (m)			Barrier Height (m)	Barrier Elevation (m asl)	Barrier-Reciever Distance (m)	Barrier Viewable Angle		Adjustment (dB)	Reason For Adjustment	**Total Segment L_{eq} (dBA)**
			Autos	Medium	Heavy					Θ_1	Θ_2								Elevation Change e (m)	Hor. Dist a (m)	Hor. Dist b (m)				Θ_1	Θ_2			
Daytime																													
R3_Day_N	James St N (North Link)	16	10682	311	298	50	0	y	1	-63	90	32.0	Hard	A	1.3	0.0	14.6	0.0				73.0	0.0	21.0	0	90			58
R3_Day_E1	Wilson St (East Link, Curved Section)	16	17466	233	544	50	0	y	1	5	54	40.0	Hard	A	1.3	0.0	14.6	0.0											58
R3_Day_E2	Wilson St (East Link, Straight Section)	16	17466	233	544	50	0	y	1	-90	-27	35.0	Hard	A	1.3	0.0	14.6	0.0											59
R3_Day_S	James St N (South Link)	16	8662	233	337	50	0	y	1	-73	-63	32.0	Hard	A	1.4	0.0	14.6	0.0											49
R3_Day_W	York Blvd (West Link)	16	14825	129	401	50	0	y	1	54	75	40.0	Hard	A	1.3	0.0	14.6	0.0											53
																												Total:	**64**
Nighttime																													
R3_Night_N	James St N (North Link)	8	862	25	24	50	0	y	1	-63	90	32.0	Hard	A	1.3	0.0	14.6	0.0				73.0	0.0	21.0	0	90			50
R3_Night_E1	Wilson St (East Link, Curved Section)	8	1409	19	44	50	0	y	1	5	54	40.0	Hard	A	1.3	0.0	14.6	0.0											50
R3_Night_E2	Wilson St (East Link, Straight Section)	8	1409	19	44	50	0	y	1	-90	-27	35.0	Hard	A	1.3	0.0	14.6	0.0											51
R3_Night_S	James St N (South Link)	8	699	19	27	50	0	y	1	-73	-63	32.0	Hard	A	1.4	0.0	14.6	0.0											41
R3_Night_W	York Blvd (West Link)	8	1196	10	32	50	0	y	1	54	75	40.0	Hard	A	1.3	0.0	14.6	0.0											45
																												Total:	**56**

ORNAMENT

Ontario Road Noise Analysis Method for ENvironment and Transportation

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Job No. 1401113 Scenario R4 - West-facing window

Job Name Tivoli Development Road-Traffic Noise Assessment

ROAD CHARACTERISTICS **SOURCE-RECEIVER-BARRIER-TOPOGRAPHY CHARACTERISTICS**

ID	Description	Time Period	Number of Vehicles			Speed (km/h)	Road Gradient (%)	Two Way? (y/n)	Pavement Type	Road Viewable Angle		Source-Receiver Distance (m)	Ground Type (Hard/Soft)	Topo-graphy Type	Source Height (m)	Road Elevation (m asl)	Receptor Height (m)	Receptor Elevation (m asl)	Adjustment (dB)	Reason For Adjustment	**Total Segment L_{eq} (dBA)**
			Autos	Medium	Heavy					Θ_1	Θ_2										
Daytime																					
R4_Day_N	James St N (North Link)	16	10682	311	298	50	0	y	1	-79	90	15.0	Hard	A	1.3	0.0	1.5	13.1			65
R4_Day_E	Wilson St (East Link)	16	17466	233	544	50	0	y	1	28	38	60.0	Hard	A	1.3	0.0	1.5	13.1			49
R4_Day_S	James St N (South Link)	16	8662	233	337	50	0	y	1	-87	-79	15.0	Hard	A	1.4	0.0	1.5	13.1			51
R4_Day_W	York Blvd (West Link)	16	14825	129	401	50	0	y	1	38	69	60.0	Hard	A	1.3	0.0	1.5	13.1			52
																				Total:	**66**
Nighttime																					
R4_Night_N	James St N (North Link)	8	862	25	24	50	0	y	1	-79	90	15.0	Hard	A	1.3	0.0	1.5	13.1			57
R4_Night_E	Wilson St (East Link)	8	1409	19	44	50	0	y	1	28	38	60.0	Hard	A	1.3	0.0	1.5	13.1			41
R4_Night_S	James St N (South Link)	8	699	19	27	50	0	y	1	-87	-79	15.0	Hard	A	1.4	0.0	1.5	13.1			44
R4_Night_W	York Blvd (West Link)	8	1196	10	32	50	0	y	1	38	69	60.0	Hard	A	1.3	0.0	1.5	13.1			45
																				Total:	**58**

APPENDIX C

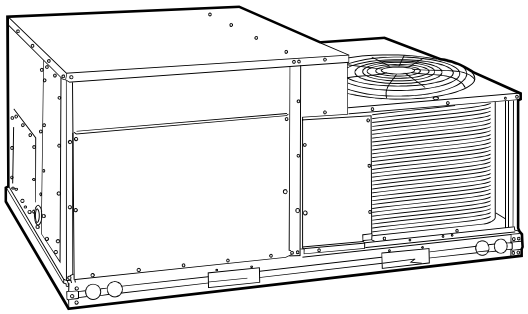
Carrier

Product Data

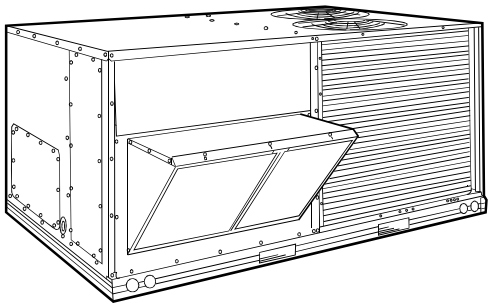
48TJ004-028
Single-Package Rooftop Units
Electric Cooling/Gas Heating

3 to 25 Nominal Tons

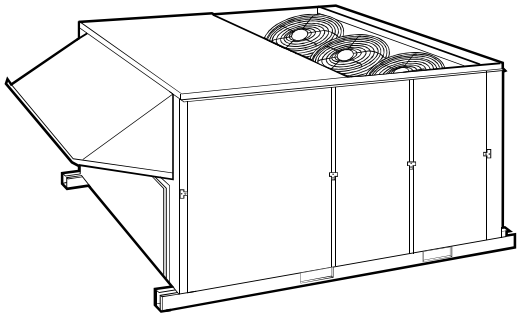
COMMERCIAL UNITARY SYSTEMS



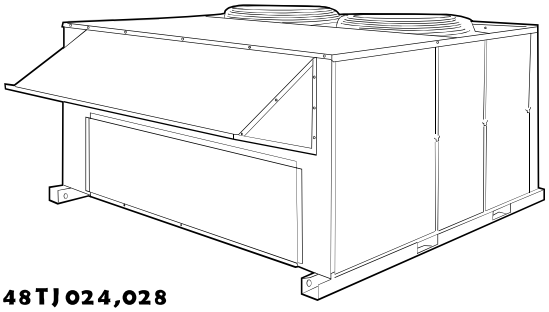
48TJ004-007



48TJ008-014



48TJ016,020



48TJ024,028

Single-Package Rooftop Units with:
- Alumagard™ heat exchanger coating
- Induced-draft fan for gas combustion
- Tubular heat exchangers
- Galvanized steel cabinet with weather-resistant coating
- Two-in. return-air filters
- Commercial strength base rails (full perimeter on sizes 004-014)
- Exclusive tool-less filter access door (sizes 004-014)
- Corrosion-resistant sloped condensate pan
- Single power entry to unit
- Commercial duty motors with permanently lubricated bearings
- Standard cooling operation at outdoor ambient temperatures as low as 25 F
- Meets ASHRAE Standard 62-89 (IAQ)
- Exclusive integrated gas control board with diagnostics

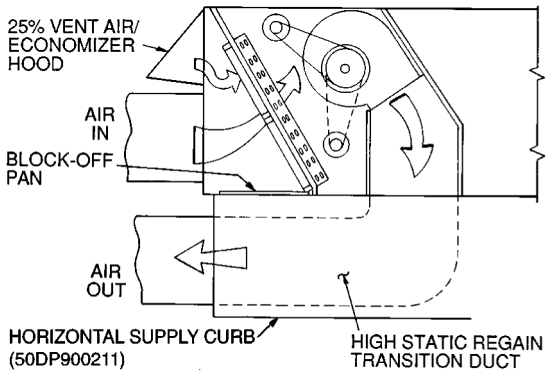
Features/Benefits

Compact, vertical discharge units convert to horizontal discharge (48TJ016-028 units require accessory curb or adapter), combining installation flexibility with efficient performance and easy maintenance.

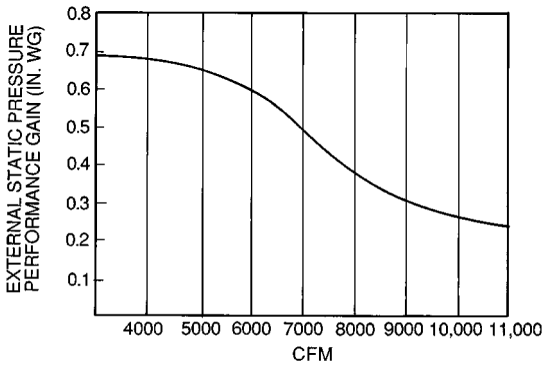
Easy installation and conversion

All units are shipped in the vertical discharge configuration for fit-up to standard roof curbs. (Two different curb sizes fit unit sizes 004-007 and 008-014, respectively, and one curb size is needed for 016-028 units.

48TJ016-028 HORIZONTAL SUPPLY/RETURN FAN PERFORMANCE WITH 50DP900211 HIGH STATIC REGAIN ADAPTER CURB



NOTES:
1. Dimensions are in millimeters.
2. The 50DP900211 high static regain adapter accessories may be used to provide horizontal supply/return.



NOTE: The 50DP900211 horizontal supply/return adapter accessories improve 50TJ016-028 fan performance by increasing external static pressure by amount shown above.

AIR QUANTITY LIMITS

UNIT 48TJ	MINIMUM CFM	MAXIMUM CFM
004	900	1500
005	1200	2000
006	1500	2500
007	1800	3000
008	2250	3750
009	2550	4250

UNIT 48TJ	MINIMUM CFM	MAXIMUM CFM
012	3000	5,000
014	3750	6,250
016	4500	7,500
020	5400	9,000
024	6000	10,000
028	7000	11,250

SOUND POWER (Total Unit)

UNIT 48TJ	SOUND RATING (60 Hz)	A-WEIGHTED (dB)	OCTAVE BANDS							
			63	125	250	500	1000	2000	4000	8000
004-007	8.2 Bels	80.5	56.8	75.8	72.4	72.9	74.8	75.4	71.3	69.1
008,009	8.6 Bels	86.4	83.2	87.4	83.5	82.8	83.0	77.7	71.8	67.0
012	8.8 Bels	87.6	97.6	90.4	85.7	84.8	83.9	77.5	71.3	65.8
014	8.8 Bels	86.4	83.7	87.2	83.4	82.8	83.0	77.7	71.8	67.0
016	8.8 Bels	87.3	87.1	89.9	86.4	84.0	82.7	79.0	73.9	68.6
020	9.0 Bels	89.5	95.7	88.9	87.2	85.2	81.9	79.5	72.7	66.0
024	9.5 Bels	94.1	98.7	92.3	93.8	90.9	89.6	85.9	80.3	74.3
028	9.5 Bels	94.1	98.7	92.3	93.8	90.9	89.6	85.9	80.3	74.3

Bels — Sound Levels (1 bel = 10 decibels)

APPENDIX D

ORNAMENT

Ontario Road Noise Analysis Method for ENvironment and Transportation

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Job No. 1401113 Scenario R2 - East-facing Common Terrace

Job Name Tivoli Development Background Sound Levels Due to Traffic

ROAD CHARACTERISTICS **SOURCE-RECEIVER-BARRIER-TOPOGRAPHY CHARACTERISTICS**

ID	Description	Time Period	Number of Vehicles			Speed (km/h)	Road Gradient (%)	Two Way? (y/n)	Pavement Type	Road Viewable Angle		Source-Receiver Distance (m)	Ground Type (Hard/Soft)	Topo-graphy Type	Source Height (m)	Road Elevation (m asl)	Receptor Height (m)	Receptor Elevation (m asl)	Barrier Height (m)	Barrier Elevation (m asl)	Barrier-Reciever Distance (m)	Barrier Viewable Angle		Adjustment (dB)	Reason For Adjustment	**Total Segment L_{eq} (dBA)**
			Autos	Medium	Heavy					Θ_1	Θ_2											Θ_1	Θ_2			
Daytime																										
R2_Day_N	James St N (North Link)	1	237	7	7	50	0	y	1	-61	74	39.0	Hard	A	1.3	0.0	1.5	9.1	73.5	0.0	3.0	-61	74			35
R2_Day_E1	Wilson St (East Link, Curved Section)	1	388	5	12	50	0	y	1	17	55	46.0	Hard	A	1.3	0.0	1.5	9.1	73.5	0.0	8.5	41	55			50
R2_Day_E2	Wilson St (East Link, Straight Section)	1	388	5	12	50	0	y	1	-85	-15	47.0	Hard	A	1.3	0.0	1.5	9.1								54
R2_Day_S	James St N (South Link)	1	193	5	7	50	0	y	1	-72	-61	39.0	Hard	A	1.4	0.0	1.5	9.1	73.5	0.0	3.0	-72	-61			24
R2_Day_W	York Blvd (West Link)	1	330	3	9	50	0	y	1	55	63	46.0	Hard	A	1.3	0.0	1.5	9.1	73.5	0.0	8.5	55	63			25
																									Total:	**55**
Evening																										
R2_Eve_N	James St N (North Link)	1	272	8	8	50	0	y	1	-61	74	39.0	Hard	A	1.3	0.0	1.5	9.1	73.5	0.0	3.0	-61	74			36
R2_Eve_E1	Wilson St (East Link, Curved Section)	1	445	6	14	50	0	y	1	17	55	46.0	Hard	A	1.3	0.0	1.5	9.1	73.5	0.0	8.5	41	55			50
R2_Eve_E2	Wilson St (East Link, Straight Section)	1	445	6	14	50	0	y	1	-85	-15	47.0	Hard	A	1.3	0.0	1.5	9.1								55
R2_Eve_S	James St N (South Link)	1	221	6	9	50	0	y	1	-72	-61	39.0	Hard	A	1.4	0.0	1.5	9.1	73.5	0.0	3.0	-72	-61			24
R2_Eve_W	York Blvd (West Link)	1	377	3	10	50	0	y	1	55	63	46.0	Hard	A	1.3	0.0	1.5	9.1	73.5	0.0	8.5	55	63			26
																									Total:	**56**

ORNAMENT

Ontario Road Noise Analysis Method for ENvironment and Transportation

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Job No. 1401113 Scenario R3 - Window of Sleeping Quarters

Job Name Tivoli Development Background Sound Levels Due to Traffic

ROAD CHARACTERISTICS **SOURCE-RECEIVER-BARRIER-TOPOGRAPHY CHARACTERISTICS**

ID	Description	Time Period	Number of Vehicles			Speed (km/h)	Road Gradient (%)	Two Way? (y/n)	Pavement Type	Road Viewable Angle		Source-Receiver Distance (m)	Ground Type (Hard/Soft)	Topography Type	Source Height (m)	Road Elevation (m asl)	Receptor Height (m)	Receptor Elevation (m asl)	Ground Elevation Change (m)			Barrier Height (m)	Barrier Elevation (m asl)	Barrier-Reciever Distance (m)	Barrier Viewable Angle		Adjustment (dB)	Reason For Adjustment	**Total Segment L_{eq} (dBA)**
			Autos	Medium	Heavy					Θ_1	Θ_2								Elevation Change e (m)	Hor. Dist a (m)	Hor. Dist b (m)				Θ_1	Θ_2			
Daytime																													
R3_Day_N	James St N (North Link)	1	237	7	7	50	0	y	1	-63	90	32.0	Hard	A	1.3	0.0	14.6	0.0				73.0	0.0	21.0	0	90			53
R3_Day_E1	Wilson St (East Link, Curved Section)	1	388	5	12	50	0	y	1	5	54	40.0	Hard	A	1.3	0.0	14.6	0.0											53
R3_Day_E2	Wilson St (East Link, Straight Section)	1	388	5	12	50	0	y	1	-90	-27	35.0	Hard	A	1.3	0.0	14.6	0.0											55
R3_Day_S	James St N (South Link)	1	193	5	7	50	0	y	1	-73	-63	32.0	Hard	A	1.4	0.0	14.6	0.0											45
R3_Day_W	York Blvd (West Link)	1	330	3	9	50	0	y	1	54	75	40.0	Hard	A	1.3	0.0	14.6	0.0											48
																												Total:	**59**
Evening																													
R3_Eve_N	James St N (North Link)	1	272	8	8	50	0	y	1	-63	90	32.0	Hard	A	1.3	0.0	14.6	0.0				73.0	0.0	21.0	0	90			54
R3_Eve_E1	Wilson St (East Link, Curved Section)	1	445	6	14	50	0	y	1	5	54	40.0	Hard	A	1.3	0.0	14.6	0.0											54
R3_Eve_E2	Wilson St (East Link, Straight Section)	1	445	6	14	50	0	y	1	-90	-27	35.0	Hard	A	1.3	0.0	14.6	0.0											55
R3_Eve_S	James St N (South Link)	1	221	6	9	50	0	y	1	-73	-63	32.0	Hard	A	1.4	0.0	14.6	0.0											46
R3_Eve_W	York Blvd (West Link)	1	377	3	10	50	0	y	1	54	75	40.0	Hard	A	1.3	0.0	14.6	0.0											49
																												Total:	**60**
Nighttime																													
R3_Night_N	James St N (North Link)	1	338	10	9	50	0	y	1	-63	90	32.0	Hard	A	1.3	0.0	14.6	0.0				73.0	0.0	21.0	0	90	-10.0	For traffic*10	45
R3_Night_E1	Wilson St (East Link, Curved Section)	1	55	1	2	50	0	y	1	5	54	40.0	Hard	A	1.3	0.0	14.6	0.0											45
R3_Night_E2	Wilson St (East Link, Straight Section)	1	55	1	2	50	0	y	1	-90	-27	35.0	Hard	A	1.3	0.0	14.6	0.0											46
R3_Night_S	James St N (South Link)	1	274	7	11	50	0	y	1	-73	-63	32.0	Hard	A	1.4	0.0	14.6	0.0									-10.0	For traffic*10	36
R3_Night_W	York Blvd (West Link)	1	47	0	1	50	0	y	1	54	75	40.0	Hard	A	1.3	0.0	14.6	0.0											40
																												Total:	**51**