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Noise and Vibration Feasibility Study
Proposed Mixed-Use/Residential Building
219 & 231 Dundas Street East
City of Toronto, Ontario

Prepared for:

Dundas MEP Developments Inc.

Prepared by

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Reviewed by

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S. PAUL
PROVINCE OF ONTARIO

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1 Introduction & Summary

Howe Gastmeier Chapnik Limited (HGC Engineering) was retained by Dundas MEP Developments Inc. to conduct a noise and vibration feasibility study for a proposed mixed-use residential development to be located at 219 – 231 Dundas Street East, in the City of Toronto, Ontario. The proposed development will include one 29-storey mixed-use/residential building, with commercial/retail uses on the ground floor and 4 level of underground parking. Areas surrounding the proposed development are commercial/retail and residential. The study is required by the City of Toronto as part of the rezoning application.

The primary traffic noise sources in the area impacting the proposed development are road traffic on Dundas Street East and streetcars along Dundas Street East. Secondary noise sources include road traffic from Sherbourne Street and Jarvis Street. Relevant traffic data for Dundas Street East, Jarvis Street and streetcar on Dundas Street East was obtained from the City of Toronto and Toronto Transit Commission. Road traffic data on Sherbourne Street was obtained from LEA Consulting. The data was used to predict future traffic sound levels at the locations of the proposed building facades. The predicted sound levels were compared to the guidelines of the Ministry of Environment and Climate Change (MOECC) and the City to develop noise control recommendations for the proposed development.

The sound level predictions indicate that noise control measures should be incorporated into the building envelope design such that indoor sound levels can comply with the MOECC noise criteria. The recommended noise control measures include appropriate wall and window glazing assemblies, and air-conditioning of residential suites so that windows can be kept closed. Noise associated with nearby commercial facilities are not anticipated to impact the site to any significant extent. Warning clauses are also recommended to inform the residents of the building of the traffic noise impacts and the presence of nearby commercial/office/retail facilities.

The impact of vibration from the streetcars on Dundas Street East has been assessed. Site measurements indicate that vibration from the streetcars is unlikely to exceed the threshold of tactile perceptibility in the building by any significant margin. However, predicted re-radiated sound levels are above the suggested design targets, and low-level re-radiated sound will be audible in the new building unless isolation materials are introduced into the design of the foundation. With suitable isolation measures integrated into the design of the foundation and wall structure, it is expected that sound and vibration from the streetcars impacting the building can be reduced to reasonable levels for residential occupancies.

As this project is at an early stage of development, a review should be conducted to verify and/or refine the acoustic recommendations when more detailed floor plans and elevations are available. In addition, an acoustical consultant should review the mechanical drawings and details of demising constructions, when available, to help ensure that the noise impact of the development on the environment, and of the development on itself, are maintained within acceptable levels.

2 Site Description & Noise Sources

The site is located on the east side of George Street and south of Dundas Street East, specifically at 219 – 231 Dundas Street East, in the City of Toronto, Ontario. Figure 1 shows an aerial photo illustrating the location of the subject site. A proposed site plan of the development prepared by Turner Fleischer Architects Inc. dated March 16, 2016, is shown in Figure 2. Figure 2 also indicates the sound level prediction locations [A] to [E] for reference purposes. The proposed development will consist of one 29-storey mixed-use/residential building, along with 6 levels of underground parking. Retail/commercial uses are proposed on the ground floor, fronting on Dundas Street East.

A site visit was made by HGC Engineering personnel in February 2016 to conduct vibration measurements of the streetcars passing by the site, to make observations of the acoustical environment and to identify the significant noise sources in the vicinity. The area is considered to be Class I (urban) in terms of its acoustical environment. Road traffic on Dundas Street East was confirmed to be the dominant noise source. Secondary noise sources impacting the site are road traffic on Sherbourne Street and Jarvis Street.

The site currently consists of parking area and a building that was partially burned. These will be removed. The surrounding lands are existing commercial/retail/residential uses. In general, sounds from the commercial facilities or activities were not discernible over the traffic sounds during the site visit. Nevertheless, due to the proximity of the site to a variety of existing commercial/office/retail uses, it is recommended that a noise warning clause to identify that such commercial/retail uses may be audible at times be included in the property and tenancy agreements, as described in Section 6.3.

3 Noise Level Criteria

3.1 Road Traffic Noise

Guidelines for acceptable levels of road traffic noise impacting residential developments are given in the MOECC publication NPC-300, "Environmental Noise Guideline, Stationary and Transportation Sources – Approval and Planning", release date October 21, 2013, and are listed in Table I below. The values in Table I are energy equivalent (average) sound levels [L_{EQ}] in units of A-weighted deciBels [dBA].

Table I: MOECC Road Traffic Noise Criteria (dBA)

Area	Daytime L_{EQ} (16 hour) Road	Nighttime L_{EQ} (8 hour) Road
Outside Bedroom Windows	55 dBA	50 dBA
Outdoor Living Area	55 dBA	--
Inside Living/Dining Rooms	45 dBA	45 dBA
Inside Bedrooms	45 dBA	40 dBA

Daytime refers to the period between 07:00 and 23:00, while nighttime refers to the period between 23:00 and 07:00. The term "Outdoor Living Area" (OLA) is used in reference to an outdoor patio, a backyard, a terrace, a playground, or common areas associated with high-rise multi-unit buildings where passive outdoor recreation is expected to occur. Private terraces or balconies that are less than 4 m in depth are not considered to be outdoor living areas under MOECC guidelines.

The MOECC guidelines allow the daytime sound levels in an OLA to be exceeded by up to 5 dBA, without mitigation, if warning clauses are placed in purchase and rental agreements to the property. Where OLA sound levels exceed 60 dBA, physical mitigation is recommended to reduce the OLA sound level to below 60 dBA and as close to 55 dBA as technically, economically and administratively feasible. Note that not all OLAs necessarily require protection, if there are other protected outdoor areas accessible to the residents.

Where the road traffic noise level (L_{EQ}) outside bedroom windows is greater than 60 dBA at night-time, windows must be designed to achieve the indoor sound level criterion of 40 dBA. In addition, for living/dining room and bedroom windows, where the road traffic noise level (L_{EQ}) is greater than 65 dBA during the daytime, windows must be designed to achieve the indoor sound level criterion of 45 dBA. Otherwise, any glazing meeting the Ontario Building Code is considered adequate under MOECC guidelines.

Where the predicted nighttime and daytime sound levels exceed the criteria, central air conditioning is required so that windows can remain closed against the noise.

Warning clauses to notify future residents of possible excesses are required when night-time road traffic sound levels exceed 50 dBA at the plane of the windows or when daytime sound levels exceed 55 dBA in the outdoor living area or at the plane of the windows.

3.2 Ground-borne Vibration from Streetcars

Vibration from the passage of the streetcars may be transmitted via the ground and then transferred up through the structure. Vibration intrusions that are potentially unacceptable in the residential suites could take the form of either vibration which is clearly perceptible to the touch and/or which produces radiated noise levels in excess of the ambient acoustic environment. From a vibration impact perspective, the residential suites on lower floors are the critical receptors.

Vibration levels are typically measured in terms of oscillatory velocity or acceleration. The levels discussed in this report are presented in dBG, which refers to decibels of acceleration relative to the acceleration due to gravity, as a function of one-third octave band frequencies (Hz). The levels have been plotted against American National Standards Institute (ANSI) criteria and International Standards Organization (ISO) criteria – ANSI-S3.29/ISO-2631-2 – for human perception of tactile vibration while seated. Conformance with these criteria does not guarantee that vibration levels will be imperceptible to all individuals under all conditions, but is nonetheless a reasonable standard for acceptability. Note that these criteria are for the base structure only and do not account for amplification by lightweight structures, finishes, furniture, etc.

The ANSI/ISO criteria do not address noise; vibrations at frequencies over 20 Hz are also of concern for re-radiated noise, even at levels below the tactile perceptibility threshold. Experience suggests that while the streetcar pass-bys may be audible in the building to some extent, if the levels are confined to about NC-30 (35 dBA) or lower in the residential building, the audibility of the pass-bys may be considered reasonable. This criterion level is similar to what is used by the TTC to assess the potential for intrusions from future undertakings (subway expansions), and similar to criteria used by the US Federal Transit Administration to assess ground-borne noise intrusions from subways and trains. The commercial portion of the building is located on the ground floor closer to the roadway and is expected to be less sensitive to noise from streetcar pass-bys than the residential suites; a target of NC-40 or more (depending on the specific uses) would typically be considered reasonable for such spaces.

4 Traffic Noise Assessment

4.1 Road Traffic Data

Road traffic data for Dundas Street East and Jarvis Street was obtained from the City of Toronto, in the form of 8 hour turning movement counts for the year 2015, and is provided in Appendix A. For Dundas Street East, an AADT of 14 318 vehicles per day was applied. A commercial vehicle percentage of 2% for medium trucks and 3% for heavy trucks was applied. Similarly, for Jarvis Street, an AADT of 21 268 vehicles per day was applied. A commercial vehicle percentage of 0.6% for medium trucks and 2.6% for heavy trucks was applied. A posted speed limit of 50 km/h and a 90%/10% day/night volume split were applied to the roadways.

Road traffic data for Sherbourne Street was obtained from the LEA Consulting, in the form of peak hour turning movement counts for the year 2015, and is provided in Appendix A. For Sherbourne Street, an AADT of 7 030 vehicles per day was applied. A commercial vehicle percentage of 2.7 for medium trucks and 2% for heavy trucks was applied. A posted speed limit of 40 km/h and a 90%/10% day/night volume split were applied to the roadways.

Traffic volumes for all roadways were conservatively assumed to grow at a typical rate of 2.5% per year to the year 2026. Table II summarizes the traffic volume data used in this study.

Table II: Projected Road Traffic Data (2026)

Road Name		Cars	Medium Trucks	Heavy Trucks	Total
Dundas Street East	Daytime	16 062	338	507	16 908
	Nighttime	1 785	38	56	1 879
	Total	**17 847**	**376**	**564**	**18 786**
Sherbourne Street	Daytime	7 911	224	166	8 302
	Nighttime	879	25	18	922
	Total	**8 790**	**249**	**184**	**9 224**
Jarvis Street	Daytime	24 412	50	653	25 115
	Nighttime	2 712	6	73	2 791
	Total	**27 124**	**56**	**726**	**27 905**

4.2 Streetcar Data

Streetcar data on Dundas Street East was obtained from the Toronto Transit Commission (TTC) website in the form of daily daytime and nighttime volumes, as provided in Appendix A. Traffic volumes were conservatively assumed to grow at a typical rate of 2.5% per year to the year of 2026. The operating speed used is 30 km/h on Dundas Street East. Table III summarizes the traffic volumes used in the analysis.

Table III: Projected Streetcar Traffic Data (2026)

Streetcar	Daytime	Nighttime	Speed kph
Dundas Street East	402	84	30

4.2 Traffic Noise Predictions

To assess the levels of traffic noise which will impact the site in the future, predictions were made using STAMSON version 5.04, a computer algorithm developed by the MOECC. Sample STAMSON output is included in Appendix B.

The setback distance of the building indicated on the proposed site plan was used in the analysis, along with an aerial photo to determine the distances to Dundas Street East, Sherbourne Street, and Jarvis Street. Prediction locations were chosen around the development to obtain a good representation of the future sound levels at the building façades with exposure to roadways. The worst case prediction locations were chosen at the top floors of the building to investigate ventilation and building façade construction requirements. The results of these predictions are summarized in Table IV.

Table IV: Predicted Road Traffic Sound Levels [dBA]

Prediction Location	Description	Daytime – $L_{EQ(16)}$	Nighttime – $L_{EQ(8)}$
[A]	North façade, 28th floor	70+	64+
[B]	West façade, 28th floor	65	59
[C]	South façade, 28th floor	56	50
[D]	East façade, 28th floor	64	58
[E]	Outdoor amenity area, 2nd Floor	<55	--

+Adjusted for distance

5 Traffic Noise Recommendations

The predictions indicate that the future traffic sound levels are high enough at facades with exposure to Dundas Street East, Sherbourne Street and Jarvis Street to warrant certain minimum noise control features. The following discussion outlines recommendations for air conditioning, upgraded building façade constructions, and warning clauses to achieve the noise criteria stated in Table I.

5.1 Outdoor Living Areas & Acoustic Barriers

From a review of the preliminary floor plans, the majority of residential units will have balconies less than 4 m in depth. These balconies are not considered as outdoor living areas under MOECC guidelines, and therefore are exempt from traffic noise assessment. Physical mitigation will not be required.

There is an outdoor amenity area located on the 2nd floor at the south side of the building. The predicted sound level in this area will be less than 55 dBA as it is shielded by the building. Further physical mitigation is not required.

There are no other outdoor amenities areas indicated on the drawings provided.

5.2 Indoor Living Areas & Ventilation Requirements

The predicted future sound levels outside the planes of the bedroom or living/dining room windows on the north façade of the building, facing Dundas Street East, will exceed 65 dBA during daytime hours and 60 dBA during nighttime hours. To address these traffic noise levels, the MOECC guidelines recommend that all residential units be equipped with central air conditioning to allow windows to remain closed. Associated warning clauses are also recommended.

5.3 Minimum Building Facade Constructions

Future road traffic sound levels at the north facade of the proposed building, closest to Dundas Street East, will be greater than 65 dBA and 60 dBA during daytime and nighttime hours, respectively. MOECC guidelines recommend that windows, walls and doors be designed so that indoor sound levels comply with MOECC noise criteria.

The detailed building plans were not yet available for review by HGC Engineering at the time of this report, but preliminary calculations have been performed to determine the building envelope constructions likely to be required to maintain indoor sound levels within MOECC guidelines. The calculation methods were developed by the National Research Council (NRC). They are based on the predicted future sound levels at the building facades, and the anticipated areas of the facade components (walls, doors and windows) relative to the floor area of the adjacent room.

5.3.1 Exterior Wall Constructions

In this analysis, it has been assumed that sound transmitted through elements other than the glazing elements is negligible in comparison. Thus the exterior walls should have sufficient acoustical insulation value such that the noise transmitted through the walls is negligible in comparison with the windows. The exterior walls may include spandrel glass or metal panels within an aluminum window system. Sufficient sound insulation can typically be achieved by using a drywall assembly on separate framing behind the spandrel panels. The recommended assembly depends on the details of the exterior spandrel panels as well as the relative wall areas versus the window areas in a given room. Further input regarding the design of the exterior walls can be provided during design development, if required.

5.3.2 Exterior Doors

There may be glazed exterior doors (sliding or swing) for entry onto the balconies from living/dining rooms and some bedrooms. The glazing areas on the doors should be counted as part of the total window glazing area. All exterior doors should include good weather seals to reduce air (and noise) infiltration to the minimum achievable levels.

5.3.3 Acoustical Requirements for Glazing

For the purposes of this preliminary analysis, typical window-to-floor areas were assumed to be 70% (i.e. 50% fixed, 20% operable including glazed sliding patio doors). Based upon these assumptions, it was determined that the glazing along the north side of the development must achieve a sound transmission class (STC) rating of at least 33 in order to achieve the target indoor sound level criteria. However, in an urban environment such as this, we do not typically recommend less than STC-34, which can be achieved using standard glazing assemblies. Awning windows, and swing or sliding doors to balconies should have tight seals sufficient to achieve similar acoustical performance ratings.

The remaining facades will have daytime sound levels that are less than 65 dBA and 60 dBA during nighttime. Thus, any exterior wall, and double glazed window construction meeting the minimum requirements of the Ontario Building Code (OBC) will provide adequate sound insulation for the dwelling units.

When detailed floor plans and elevations are available, the glazing requirements should be refined based on actual window to floor area ratios.

6 Vibration Assessment

6.1 Site Measurements and Assessment

Ground-borne vibration measurements were conducted at the location of the closest façade of the proposed mixed-use building during several streetcar passbys. The approximate location of the closest façade is approximately 10 m to the centerline of the eastbound and 16 m to the centerline of the westbound streetcar tracks along Dundas Street East. The vibration measurement location is shown on Figure 2. These measurements were conducted on February 17, 2016, during a busy afternoon period, for several streetcar pass-bys.

The vibration data was analyzed and compared to criteria outlined in Section 3 of this report. Some additional predictions were also undertaken, adjusting the measured levels to account for the different factors likely to affect the vibration path in the new development. These adjustments include floor-to-floor attenuation up to the first residential level (3rd floor), amplification due to suspended structures, and higher foundation losses due to coupling of the soil to the new heavier building foundation (i.e., assumed to be poured concrete on caissons).

Measured maximum vibration levels are shown in Figure 3 (Vibration vs. Criteria). A curve is plotted on each figure representing the ANSI criteria for human perception of vibration in structures, up to a frequency of 63 Hz, and NC curves for audible sound at frequencies above that. When vibrations were at a maximum, they were dominated by energy content in the 1/3 octave bands between 63 Hz and 80 Hz. Measured vibration levels were below the ANSI/ISO tactile perceptibility threshold at the measurement location.

In the Figure 3, Vibration vs. Criteria, the measured vibrations have been extrapolated to project the impact on the nearest retail floor and the nearest residential floors of the development (3rd floor). Re-radiated sound levels on the residential floors are expected to be between NC-30 and NC-40 target. On the ground retail floor, re-radiated noise is expected to approach the NC-50 target, which would only be of concern for sensitive retail uses.

6.2 Vibration Control

To further reduce the impact of the TTC's streetcar passbys on Dundas Street East on the proposed building, consideration could be given in design to including isolation measures for the north foundation wall along Dundas Street East (possibly returning for some distance along the perpendicular foundation walls) to help reduce vibration transmitted by streetcar pass-bys into the building structure. With respect to isolation methods, one possible approach is to use bridge bearing pads to separate the parking slabs from the foundation wall, suitably designed to provide a reasonable degree of isolation while at the same time resisting the horizontal and vertical loads at the foundation wall. This approach requires additional columns at the perimeter to support the slab edge. Another approach that could be considered is to place a resilient sheet materials (e.g., 75 mm thick Ethafoam slabs or similar) between the foundation wall and the shoring wall up to a certain depth. This latter method is generally more effective where the shoring system includes a caisson wall and the parking levels are not deep. In either case, the pads or the resilient sheet materials will have to be carefully selected based on the soil and structural loading to ensure that the proper stiffness is achieved and that they are not crushed. Selected measures can be developed further, as required, during detail design.

Structural drawings should be reviewed for conformance with our noise study. As outlined above, the criteria for both sound and vibration are considered to be reasonable standards for acceptability. However, conformance with these standards does not imply that vibration levels will be imperceptible and/or sound levels will be inaudible. Therefore, consideration should be given to including warning clauses in all sales or rental agreements, and in development agreements with the municipality.

6.3 Warning Clauses

MOECC guidelines recommend that appropriate warning clauses be used in the Development Agreements and in purchase, sale and lease agreements (typically by reference to the Development Agreements), to inform future owners and occupants about noise concerns from transportation sources in the area. The following clauses are recommended:

(a) 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 occasion interfere with some activities of the dwelling occupants as the sound levels exceed the sound level limits of the City and the Ministry of the Environment and Climate Change.

(b) This dwelling unit has been supplied with a central air conditioning system which will allow windows and exterior doors to remain closed, thereby ensuring that the indoor sound levels are within the sound level limits of the City and the Ministry of Environment and Climate Change.

(c) This development is located in close proximity to the Toronto Transit Commission's streetcar tracks along Dundas Street East. Noise and vibration from streetcar operations may occasionally be perceptible and/or audible in the dwelling units.

(d) Purchasers/tenants are advised that due to the proximity of the nearby commercial/office/retail facilities, sound from those facilities may at times be audible.

These sample clauses are provided by the MOECC as examples and can be modified by the owner's legal representative, in consultation with the City, as required.

7 Impact of the Development on the Environment

It is expected that any increase in local traffic associated with the development will not be substantial enough to affect noise levels significantly.

Sound levels from stationary (non-traffic) sources of noise such as rooftop air-conditioners, cooling towers, exhaust fans, etc. should not exceed the minimum one-hour L_{EQ} ambient (background) sound level from road traffic, at any potentially impacted residential point of reception, to comply with City of Toronto municipal code 591. Based on the levels observed during our site visit, the typical minimum ambient sound levels in the area are expected to be in the range of 55 dBA or more during the day and 50 dBA or more at night. Thus any electro-mechanical equipment associated with this development (e.g. emergency generator testing, fresh-air handling equipment, etc.) should be designed with these targets in mind such that they do not result in noise impact beyond these ranges.

8 Impact of the Development on Itself

Section 5.9.1 of the Ontario Building Code (OBC) specifies the minimum required sound insulation characteristics for demising partitions, in terms of Sound Transmission Class (STC) values. In order to maintain adequate acoustical privacy between separate suites in a multi-tenant building, inter-suite walls must meet or exceed STC-50. Walls separating a suite from a noisy space such as a refuse chute, or elevator shaft, must meet or exceed STC-55. In addition, it is recommended that the floor/ceiling constructions separating suites from any amenity or commercial spaces also meet or exceed STC-55. Tables 1 and 2 in Section SB-3 of the Supplementary Guideline to the OBC provide a comprehensive list of constructions that will meet the above requirements.

Tarion's Builder Bulletin B19R requires the internal design of condominium projects to integrate suitable acoustic features to insulate the suites from noise from each other and amenities in accordance with the OBC, and limit the potential intrusions of mechanical and electrical services of the buildings on its residents. If B19R certification is needed, an acoustical consultant is required to review the mechanical and electrical drawings and details of demising constructions and mechanical/electrical equipment, when available, to help ensure that the noise impact of the development on itself is maintained within acceptable levels.

9 Conclusions & Summary of Recommendations

Measurements and modelling have been undertaken to assess the noise and vibration impact of surrounding sources on the proposed development. Road traffic on Dundas Street East generates moderate levels of noise, which can readily be addressed by standard glazing elements. Recommendations for suitable building constructions are provided in Section 5 above. Warning clauses are recommended to advise residents of future road traffic noise.

Vibration from streetcar pass-bys on the Dundas Street East produces some moderate levels at the closest façade of the future mixed use building adjacent to Dundas Street East.

The following list summarizes the recommendations made in this report:

1. Central air conditioning systems are required for the residential units.
2. Certain minimum building and glazing constructions are recommended, as indicated in Section 5.3.3. When detailed floor plans and building elevations are available, a review should be conducted to verify required glazing assemblies based on actual window to floor area ratios.
3. Noise warning clauses should be included in the property and tenancy agreements and offers of purchase and sale for the residential suites to inform future residents of potential noise intrusions from the roads and the streetcars, and of the presence of the nearby commercial/office/retail uses in the area. Recommended wording for these clauses is provided in Section 6.3. Such clauses are often included by reference to the Development Agreements in which they are contained.
4. Vibration levels from streetcar pass-bys are expected to be below the tactile vibration threshold on the nearest residential floors, but are expected to be above the suggested design criteria for re-radiated noise. Consideration could be given to including isolation measures against the north foundation wall along Dundas Street East, returning for some distance along the east and west foundation walls, to reduce associated intrusions.

5. Demising assemblies must be selected to meet the minimum requirements of the Ontario Building Code (OBC). If B19R certification is needed, an acoustical consultant is required to review the mechanical and electrical drawings and details of demising constructions and mechanical/electrical equipment, when available, to help ensure that the noise impact of the development on itself are maintained within acceptable levels. Outdoor sound emissions should also be checked to ensure compliance with the City of Toronto noise by-law (Toronto Municipal Code, Chapter 591).

6. In summary, the proposed development is considered to be feasible from a noise and vibration impact perspective.

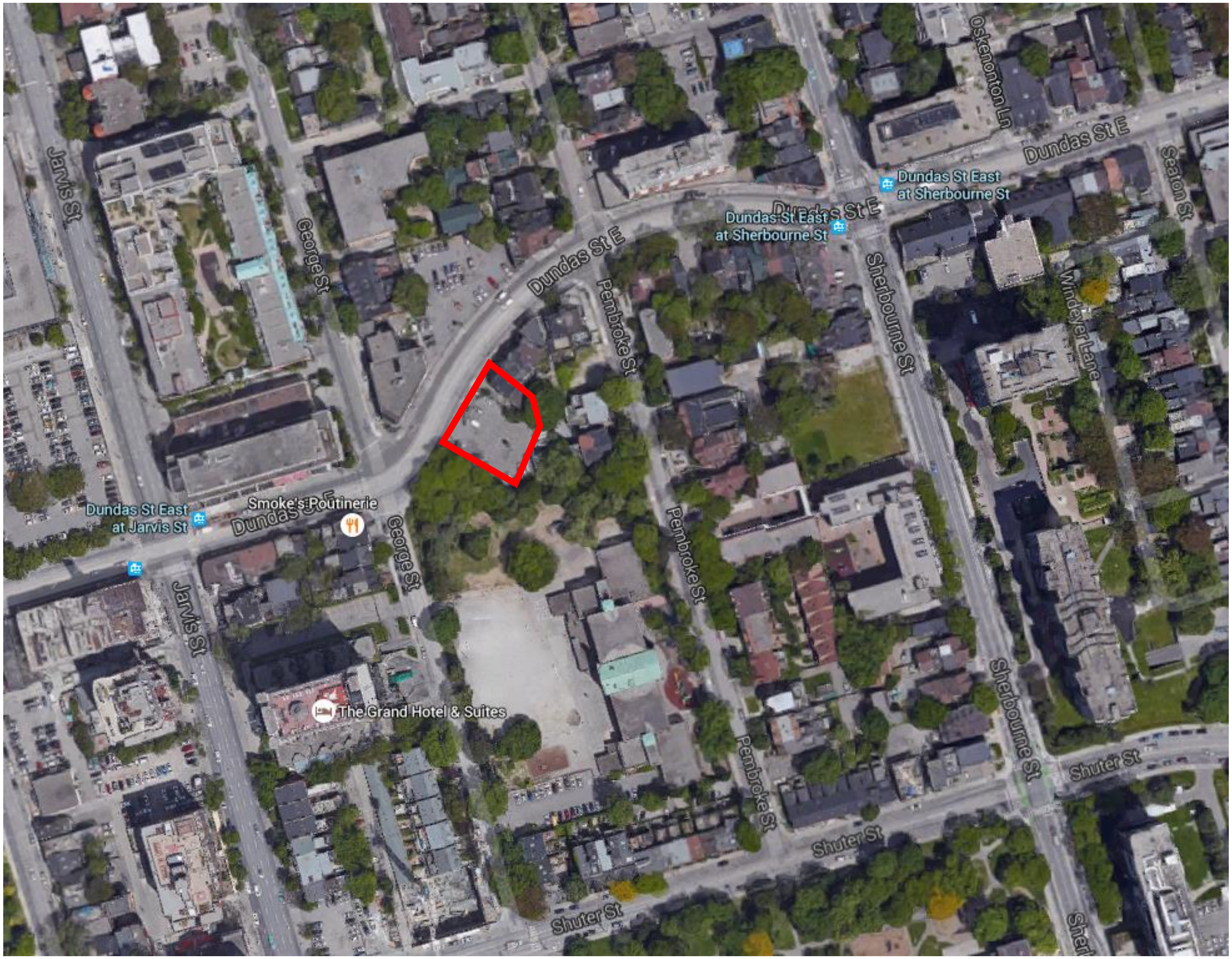


Figure 1: Aerial Photo of Site

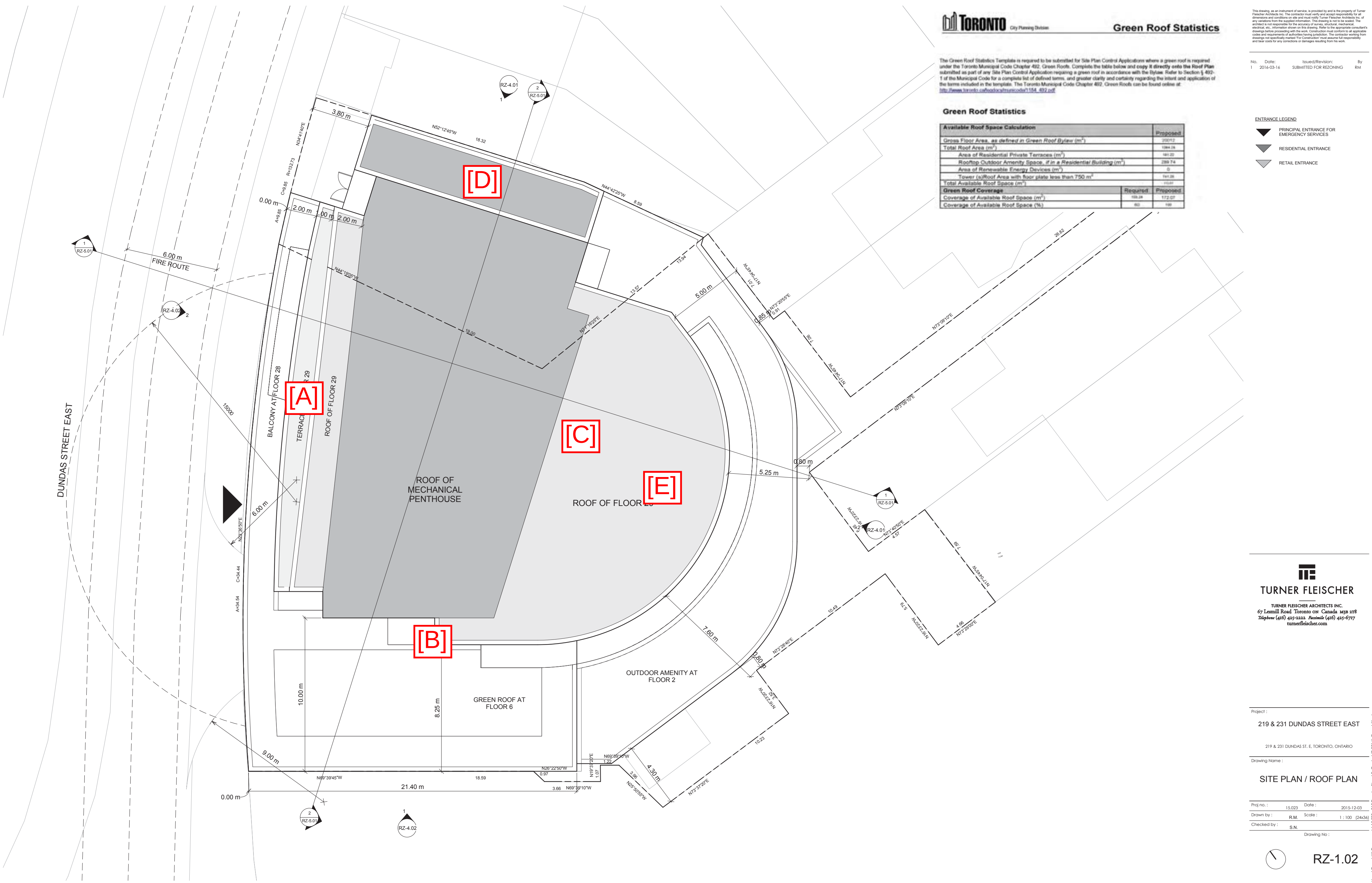


Figure 2: Site Plan Showing Prediction Locations

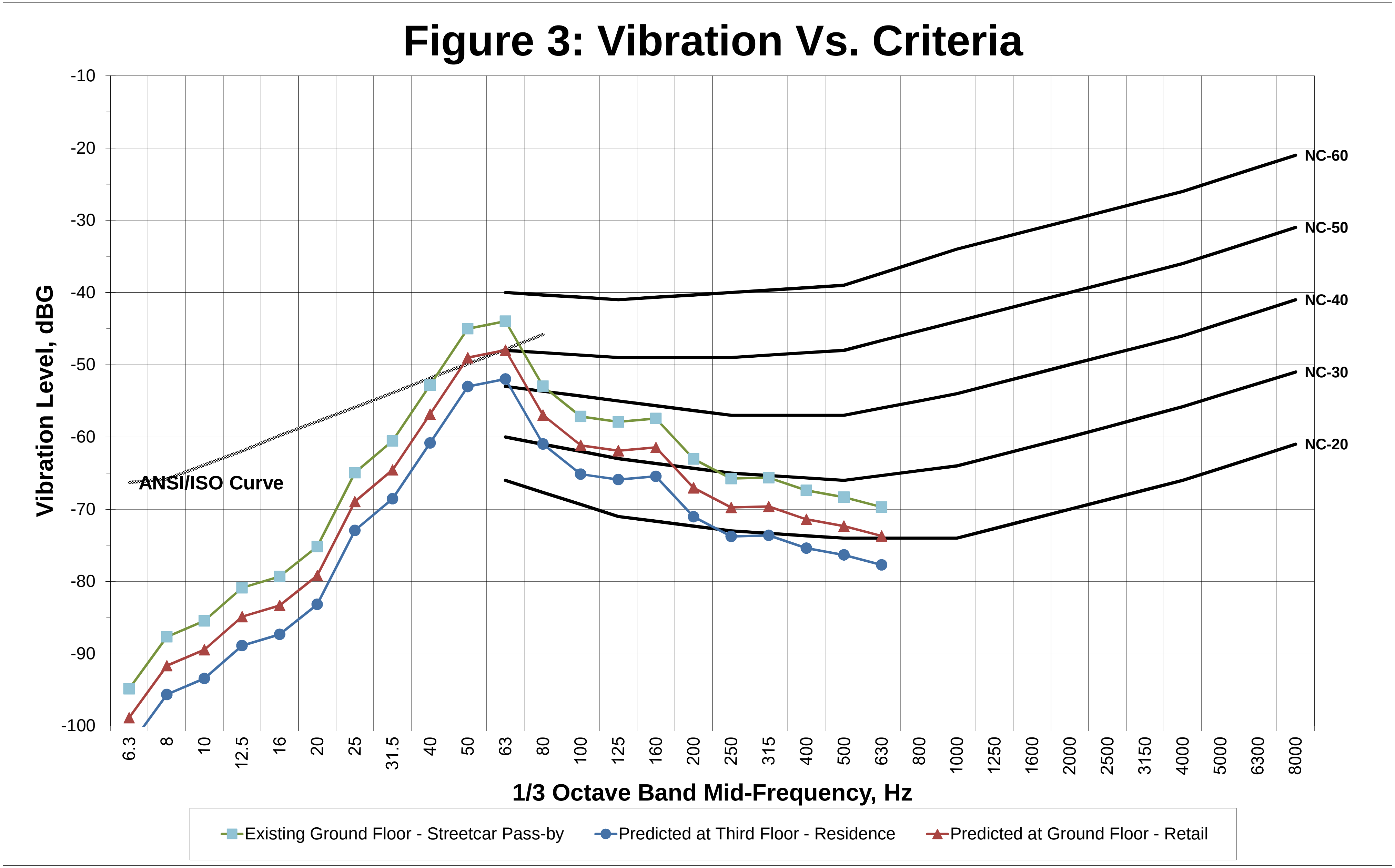


Figure 3: Vibration Vs. Criteria
Vibration Level, dBG
1/3 Octave Band Mid-Frequency, Hz
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
6.3
8
10
12.5
16
20
25
31.5
40
50
63
80
100
125
160
200
250
315
400
500
630
800
1000
1250
1600
2000
2500
3150
4000
5000
6300
8000
NC-60
NC-50
NC-40
NC-30
NC-20
ANSI/ISO Curve
Existing Ground Floor - Streetcar Pass-by
Predicted at Third Floor - Residence
Predicted at Ground Floor - Retail

APPENDIX A

Road Traffic Data

TORONTO

City of Toronto - Traffic Safety Unit

Turning Movement Count Summary Report

DUNDAS ST AT JARVIS ST (PX 8)

Survey Date: 2015-Apr-13 (Monday)

Survey Type: Routine Hours

Time Period	Vehicle Type	NORTHBOUND Exits	NB Left	NB Thru	NB Right	NB Total	EASTBOUND Exits	EB Left	EB Thru	EB Right	EB Total	SOUTHBOUND Exits	SB Left	SB Thru	SB Right	SB Total	WESTBOUND Exits	WB Left	WB Thru	WB Right	WB Total		Peds	Bike	Other
08:00-09:00	CAR	644	0	534	31	565	331	37	299	45	381	1,127	1	1,045	110	1,156	595	37	485	73	595	N	314	12	0
	TRK	20	0	16	4	20	8	1	4	3	8	14	0	9	0	9	10	2	10	3	15	S	255	0	0
AM PEAK	BUS	3	0	2	0	2	11	1	11	0	12	2	0	2	0	2	9	0	9	0	9	E	239	117	0
																						W	223	34	0
	TOTAL:	**667**	**0**	**552**	**35**	**587**	**350**	**39**	**314**	**48**	**401**	**1,143**	**1**	**1,056**	**110**	**1,167**	**614**	**39**	**504**	**76**	**619**				
17:00-18:00	CAR	1,056	0	875	38	913	693	119	655	47	821	635	0	541	82	623	349	47	267	62	376	N	370	9	0
	TRK	8	0	6	2	8	7	1	5	0	6	7	0	6	1	7	3	1	2	1	4	S	327	11	0
PM PEAK	BUS	5	0	5	0	5	9	0	9	0	9	0	0	0	0	0	8	0	8	0	8	E	220	38	0
																						W	209	99	0
	TOTAL:	**1,069**	**0**	**886**	**40**	**926**	**709**	**120**	**669**	**47**	**836**	**642**	**0**	**547**	**83**	**630**	**360**	**48**	**277**	**63**	**388**				
OFF HR AVG	CAR	536	1	447	44	492	413	46	366	52	464	586	3	501	65	569	309	33	243	43	319	N	273	6	0
	TRK	15	0	12	2	14	16	1	13	3	17	27	1	20	2	23	10	4	8	2	14	S	223	4	0
	BUS	1	0	1	0	1	10	0	10	0	10	1	0	1	0	1	8	0	8	0	8	E	178	40	0
																						W	148	28	0
	TOTAL:	**552**	**1**	**460**	**46**	**507**	**439**	**47**	**389**	**55**	**491**	**614**	**4**	**522**	**67**	**593**	**327**	**37**	**259**	**45**	**341**				
07:30-09:30	CAR	1,208	0	987	58	1,045	643	76	583	87	746	2,088	2	1,926	199	2,127	1,082	75	883	145	1,103	N	569	23	0
	TRK	33	0	28	8	36	20	2	12	7	21	35	0	26	0	26	14	2	14	3	19	S	507	5	0
2 HR AM	BUS	7	0	5	0	5	25	2	25	0	27	5	0	4	1	5	21	1	20	0	21	E	447	200	0
																						W	423	53	0
	TOTAL:	**1,248**	**0**	**1,020**	**66**	**1,086**	**688**	**80**	**620**	**94**	**794**	**2,128**	**2**	**1,956**	**200**	**2,158**	**1,117**	**78**	**917**	**148**	**1,143**				
16:00-18:00	CAR	1,954	0	1,584	76	1,660	1,324	225	1,248	102	1,575	1,231	0	1,009	135	1,144	692	120	557	145	822	N	730	19	0
	TRK	24	0	20	3	23	13	1	10	2	13	19	0	12	2	14	12	5	10	3	18	S	654	15	0
2 HR PM	BUS	6	0	6	0	6	18	0	18	0	18	2	0	2	0	2	17	0	17	0	17	E	424	64	0
																						W	418	175	0
	TOTAL:	**1,984**	**0**	**1,610**	**79**	**1,689**	**1,355**	**226**	**1,276**	**104**	**1,606**	**1,252**	**0**	**1,023**	**137**	**1,160**	**721**	**125**	**584**	**148**	**857**				
07:30-18:00	CAR	5,303	5	4,357	309	4,671	3,617	485	3,296	397	4,178	5,663	12	4,939	592	5,543	3,007	327	2,410	461	3,198	N	2,392	66	0
	TRK	118	0	97	20	117	97	6	75	19	100	159	2	116	9	127	64	24	55	15	94	S	2,051	36	0
8 HR SUM	BUS	16	0	14	0	14	82	2	82	1	85	10	0	8	1	9	71	1	70	0	71	E	1,583	425	0
																						W	1,432	341	0
	TOTAL:	**5,437**	**5**	**4,468**	**329**	**4,802**	**3,796**	**493**	**3,453**	**417**	**4,363**	**5,832**	**14**	**5,063**	**602**	**5,679**	**3,142**	**352**	**2,535**	**476**	**3,363**				

Total 8 Hour Vehicle Volume: 18,207 **Total 8 Hour Bicycle Volume: 868** **Total 8 Hour Intersection Volume: 19,075**

Comment:

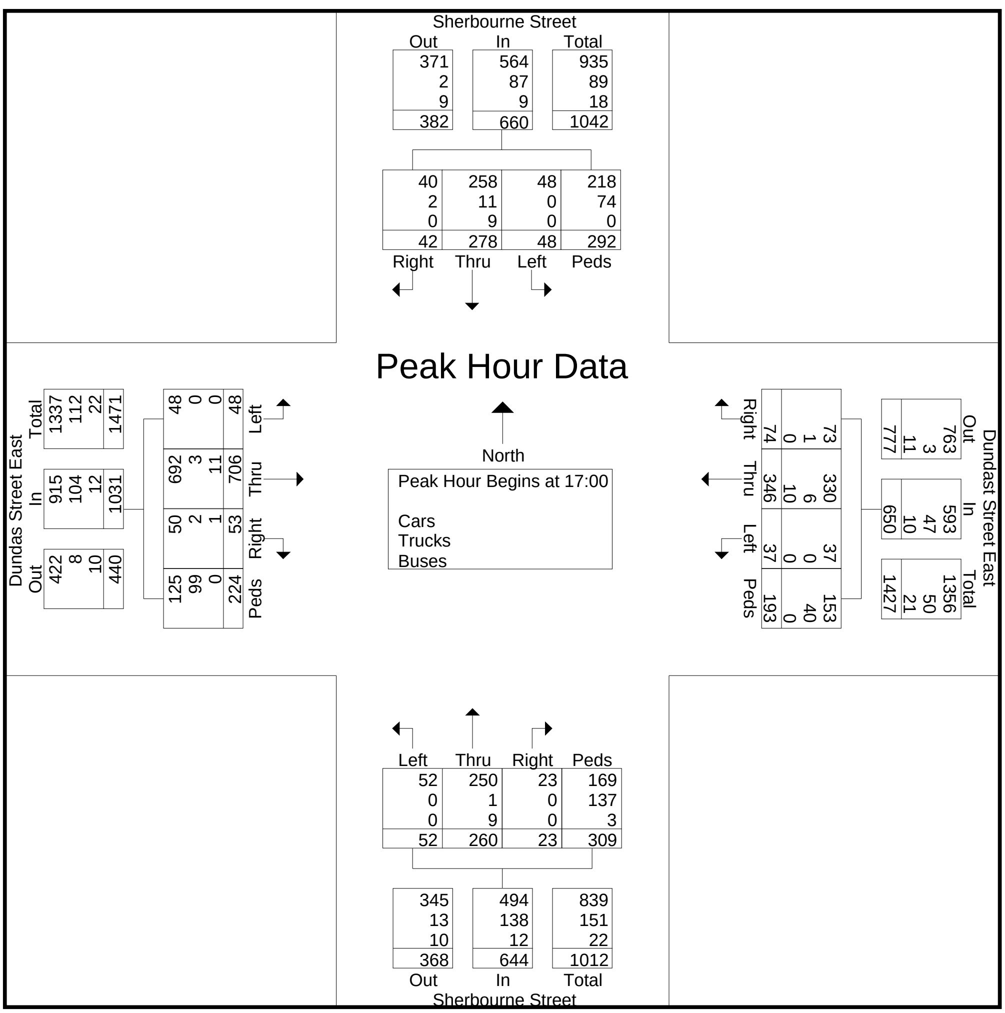
LEA CONSULTING LTD

625 Cochrane Drive 9th Floor
Markham, Ontario, L3R 9R9

Project#: 9782
Location: Dundas St E & Sherbourne St
Weather: Clear
Surveyor: Ashok / Ujwal Panda

File Name : MERGED-9782-DundasSt&SherbourneSt-PM
Site Code : 97820015
Start Date : 08/12/2015
Page No : 2

	Sherbourne Street From North					Dundast Street East From East					Sherbourne Street From South					Dundas Street East From West					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour Analysis From 16:00 to 17:45 - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 17:00																					
17:00	12	73	9	63	157	8	73	16	47	144	**16**	**75**	**8**	74	**173**	10	160	7	36	213	687
17:15	10	60	6	71	147	10	**107**	14	**54**	**185**	15	62	7	**88**	172	15	**209**	13	58	**295**	**799**
17:30	**14**	71	13	**87**	**185**	5	74	14	46	139	10	60	1	63	134	**16**	189	14	56	275	733
17:45	12	**74**	**14**	71	171	**14**	92	**30**	46	182	11	63	7	84	165	7	148	**19**	**74**	248	766
Total Volume	48	278	42	292	660	37	346	74	193	650	52	260	23	309	644	48	706	53	224	1031	2985
% App. Total	7.3	42.1	6.4	44.2		5.7	53.2	11.4	29.7		8.1	40.4	3.6	48		4.7	68.5	5.1	21.7		
PHF	.857	.939	.750	.839	.892	.661	.808	.617	.894	.878	.813	.867	.719	.878	.931	.750	.844	.697	.757	.874	.934
Cars	48	258	40	218	564	37	330	73	153	593	52	250	23	169	494	48	692	50	125	915	2566
% Cars	100	92.8	95.2	74.7	85.5	100	95.4	98.6	79.3	91.2	100	96.2	100	54.7	76.7	100	98.0	94.3	55.8	88.7	86.0
Trucks	0	11	2	74	87	0	6	1	40	47	0	1	0	137	138	0	3	2	99	104	376
% Trucks	0	4.0	4.8	25.3	13.2	0	1.7	1.4	20.7	7.2	0	0.4	0	44.3	21.4	0	0.4	3.8	44.2	10.1	12.6
Buses	0	9	0	0	9	0	10	0	0	10	0	9	0	3	12	0	11	1	0	12	43
% Buses	0	3.2	0	0	1.4	0	2.9	0	0	1.5	0	3.5	0	1.0	1.9	0	1.6	1.9	0	1.2	1.4



From online schedule Dec 2 2015

Streetcar Route 505

	Scheduled # of Trips*	
	Eastbound	Westbound
0700-2300	154	150
2300-0700	30	34
Tot	184	184

APPENDIX B

Sample STAMSON 5.04 Output

STAMSON 5.0 NORMAL REPORT Date: 19-02-2016 09:34:35
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT
Filename: loca.te Time Period: Day/Night 16/8 hours
Description: North Façade (Prediction Location [A])
Road data, segment # 1: dundas (day/night)

Car traffic volume : 16062/1785 veh/TimePeriod *
Medium truck volume : 338/38 veh/TimePeriod *
Heavy truck volume : 507/56 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): 14318
Percentage of Annual Growth : 2.50
Number of Years of Growth : 11.00
Medium Truck % of Total Volume : 2.00
Heavy Truck % of Total Volume : 3.00
Day (16 hrs) % of Total Volume : 90.00
Data for Segment # 1: dundas (day/night)

Angle1 Angle2 : -90.00 deg 90.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0 / 0
Surface : 1 (Absorptive ground surface)
Receiver source distance : 15.00 / 15.00 m
Receiver height : 1.50 / 1.50 m
Topography : 3 (Elevated; no barrier)
Elevation : 81.00 m
Reference angle : 0.00
Road data, segment # 2: Jarvis (day/night)

Car traffic volume : 24412/2712 veh/TimePeriod
Medium truck volume : 653/73 veh/TimePeriod
Heavy truck volume : 50/6 veh/TimePeriod
Posted speed limit : 50 km/h
Road gradient : 0 %
Road pavement : 1 (Typical asphalt or concrete)
Data for Segment # 2: Jarvis (day/night)

Angle1 Angle2 : 0.00 deg 90.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0 / 0
Surface : 1 (Absorptive ground surface)
Receiver source distance : 140.00 / 140.00 m
Receiver height : 1.50 / 1.50 m
Topography : 3 (Elevated; no barrier)
Elevation : 81.00 m
Reference angle : 0.00
Road data, segment # 3: Sherbourne (day/night)

Car traffic volume : 7911/879 veh/TimePeriod *
Medium truck volume : 224/25 veh/TimePeriod *
Heavy truck volume : 166/18 veh/TimePeriod *
Posted speed limit : 40 km/h
Road gradient : 0 %
Road pavement : 1 (Typical asphalt or concrete)
* Refers to calculated road volumes based on the following input:
24 hr Traffic Volume (AADT or SADT): 7030
Percentage of Annual Growth : 2.50
Number of Years of Growth : 11.00
Medium Truck % of Total Volume : 2.70
Heavy Truck % of Total Volume : 2.00
Day (16 hrs) % of Total Volume : 90.00
Data for Segment # 3: Sherbourne (day/night)

Angle1 Angle2 : -90.00 deg 0.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0 / 0
Surface : 1 (Absorptive ground surface)
Receiver source distance : 168.00 / 168.00 m
Receiver height : 1.50 / 1.50 m
Topography : 3 (Elevated; no barrier)
Elevation : 81.00 m
Reference angle : 0.00
Results segment # 1: dundas (day)

Source height = 1.32 m
ROAD (0.00 + 67.28 + 0.00) = 67.28 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	90	0.00	67.28	0.00	0.00	0.00	0.00	0.00	0.00	67.28

Segment Leq : 67.28 dBA
Results segment # 2: Jarvis (day)

Source height = 0.67 m
ROAD (0.00 + 53.05 + 0.00) = 53.05 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
0	90	0.00	65.76	0.00	-9.70	-3.01	0.00	0.00	0.00	53.05

Segment Leq : 53.05 dBA
Results segment # 3: Sherbourne (day)

Source height = 1.19 m

ROAD (0.00 + 47.91 + 0.00) = 47.91 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	0	0.00	61.41	0.00	-10.49	-3.01	0.00	0.00	0.00	47.91

Segment Leq : 47.91 dBA
Total Leq All Segments: 67.49 dBA
Results segment # 1: dundas (night)

Source height = 1.31 m
ROAD (0.00 + 60.74 + 0.00) = 60.74 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	90	0.00	60.74	0.00	0.00	0.00	0.00	0.00	0.00	60.74

Segment Leq : 60.74 dBA
Results segment # 2: Jarvis (night)

Source height = 0.68 m
ROAD (0.00 + 46.55 + 0.00) = 46.55 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
0	90	0.00	59.26	0.00	-9.70	-3.01	0.00	0.00	0.00	46.55

Segment Leq : 46.55 dBA
Results segment # 3: Sherbourne (night)

Source height = 1.18 m
ROAD (0.00 + 41.32 + 0.00) = 41.32 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	0	0.00	54.83	0.00	-10.49	-3.01	0.00	0.00	0.00	41.32

Segment Leq : 41.32 dBA
Total Leq All Segments: 60.95 dBA
RT/Custom data, segment # 1: Dundas (day/night)
----
1 - CLRV:
Traffic volume : 402/84 veh/TimePeriod
Speed : 30 km/h
Data for Segment # 1: Dundas (day/night)

Angle1 Angle2 : -90.00 deg 90.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0 / 0
Surface : 1 (Absorptive ground surface)
Receiver source distance : 15.00 / 15.00 m
Receiver height : 1.50 / 1.50 m
Topography : 3 (Elevated; no barrier)
Elevation : 81.00 m
Reference angle : 0.00
Results segment # 1: Dundas (day)

Source height = 0.50 m
RT/Custom (0.00 + 59.14 + 0.00) = 59.14 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq

----
-90 90 0.00 59.14 0.00 0.00 0.00 0.00 0.00 59.14

Segment Leq : 59.14 dBA
Total Leq All Segments: 59.14 dBA
Results segment # 1: Dundas (night)

Source height = 0.50 m
RT/Custom (0.00 + 55.35 + 0.00) = 55.35 dBA

Angle1	Angle2	Alpha	RefLeq	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	90	0.00	55.35	0.00	0.00	0.00	0.00	0.00	55.35

Segment Leq : 55.35 dBA
Total Leq All Segments: 55.35 dBA
TOTAL Leq FROM ALL SOURCES (DAY): 68.08
(NIGHT): 62.01