REPORT

ESTONIAN CULTURAL CENTRE (DRAFT)

9 & 11 MADISON AVENUE, TORONTO

NOISE & VIBRATION FEASIBILITY STUDY
RWDI # 1801349
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SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI has been retained to conduct a noise and vibration feasibility study for the proposed Estonian Cultural Centre development to be located at 9 and 11 Madison Avenue, in Toronto, Ontario. This assessment was completed to support Site Plan Application (SPA).

The objective of this assessment was to determine the feasibility of the proposed development near existing and proposed noise sensitive (residential) land uses, and due to potential vibration impact of the TTC subway train and LRT passes.

The proposed development site is located on the east side Madison Avenue, approximately 50m north of Bloor Street West. The proposed development will include the existing three storey detached house at 11 Madison Avenue, with the new construction mainly at 9 Madison Avenue (currently a parking lot).

The sound levels due to road-traffic sources are predicted to have an insignificant impact on the proposed development. The predicted sound levels meet the MOECC NPC-300 limit; and as such, specialized noise mitigation design of the façade and glazing is not required.

Vibration measurements conducted at the site of the proposed development indicate that vibration levels exceed the levels set out in the applicable MOEE/TTC Protocol for Noise and Vibration Assessment and the Railway Association of Canada guidelines. Mitigation measures are required at the development to reduce the vibration levels to meet the applicable limits. Vibration isolation of the proposed building to meet acceptable levels within the building is considered feasible; however, we note that implementation of a detailed vibration isolation in the structural and architectural design will be required.

Sound levels due to stationary sources at the proposed development were predicted at points of reception (PORs) located on properties with noise-sensitive land uses. At the date of this report, the mechanical and electrical design were in very early stages, and therefore only the major equipment has been included in the assessment. The results of the analysis indicate that the roof-top units and generator are predicted to require noise controls to achieve the noise criteria at the PORs. The range of attenuation required is considered to be feasible by implementation of standard noise control measures such as silencers, mufflers, rooftop barriers and/or mechanical room structures including acoustic louvres.

The feasibility study is based on assumptions regarding building configuration and construction and therefore the resulting recommendations are broad. As such, a detailed design review is recommended to ensure that appropriate noise and vibration control measures have been incorporated into the detailed design.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

VERSION HISTORY

Index	Date	Pages	Author
1	2018-02-23	All	MJT

1 INTRODUCTION

RWDI has been retained to conduct a noise and vibration feasibility study for the proposed Estonian Cultural Centre development to be located at 9 and 11 Madison Avenue, in Toronto, Ontario. This assessment was completed to support Site Plan Application (SPA).

The Ontario Ministry of the Environment and Climate Change (MOECC) NPC-300 (MOECC,2013) noise guidelines are adopted to assess noise impacts and to determine the appropriate noise control measures, if any. The relevant sources of sound considered for the noise impact assessment are as follows:

- Transportation-related sources, in this case road traffic due to Bloor Street West and Spadina Road.
- Stationary sources, proposed as part of the development. The mechanical equipment (rooftop units, exhaust fans and the emergency generator) will be designed to achieve the maximum allowable sound power level limits detailed within this report to achieve compliance with MOECC guidelines at surrounding noise sensitive receptors.

The draft MOEE/TTC Protocol for Noise and Vibration Assessment (MOECC/TTC, 1993) guideline was adopted to assess the impacts of ground-borne vibration on the proposed development. The relevant sources of vibration on the proposed development are as follows:

- The underground Toronto Transit Commission (TTC) Line 1 (Yonge-University) and Line 2 (Bloor-Danforth) subway lines.
- The underground LRT loop at Spadina Station.

The objective of this assessment was to determine the feasibility of the proposed development near existing and proposed noise sensitive (residential) land uses, and due to potential vibration impact of the TTC subway train and LRT passes. This assessment was based on the preliminary drawings received on January 15, 2018. In the absence of detailed information, assumptions regarding building design are made for the assessment, and as such, the resulting recommendations are conceptual. Detailed noise and vibration control design are recommended as the design develops.

2 DESCRIPTION OF PROJECT AND SITE

The proposed development site is located on the east side Madison Avenue, approximately 50m north of Bloor Street West. The proposed development will include the existing three storey detached house at 11 Madison Avenue, with the new construction mainly at 9 Madison Avenue (currently a parking lot).

The proposed development is for a three-storey tall (plus mechanical penthouse) cultural centre building, with a floor area in the range of 30,000 to 35,000 SF. The centre will include a 5,000 SF multi-purpose hall, offices, classrooms, retail space, café, and gallery areas. A rooftop terrace is shown on the current plans.

The proposed development location is considered a Class 1 (urban) acoustic environment, meaning the acoustic environment in the area is influenced by sounds of human activity, often referred to as “urban hum”.

The development site is located above the TTC line 1 and line 2 subway tunnels, approximately 50m to the east of Spadina Station where subway trains may operate approximately between 5:50 am to 2 am at intervals as short as 2-3 minutes during the rush hours. The Spadina Station underground LRT loop also passes near to the site.

The location of the proposed development in relation to its surroundings is illustrated in Figure 1.

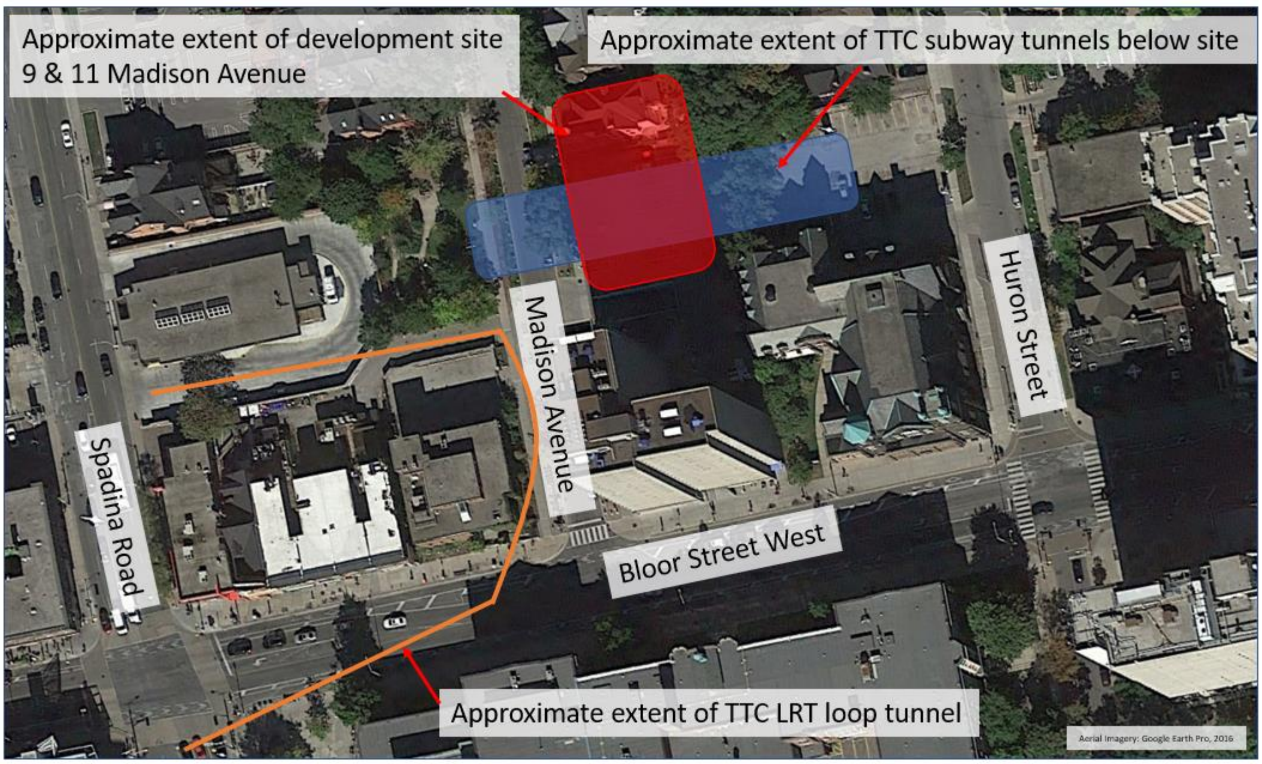

Figure 1: Location of the proposed development

3 SOUND ON THE PROPOSED DEVELOPMENT

The detailed evaluation of transportation-related sources affecting the development were assessed using the MOECC guidelines, as defined in Publication NPC-300. The relevant section of the guideline is Part C – Land Use Planning.

3.1 Road-Traffic Noise Assessment

3.1.1 Road-Traffic Noise Assessment Criteria

The assessment of road and rail traffic-related sound under MOE Publication NPC-300 does not usually consider retail and office spaces, as these are not normally considered noise sensitive. However, Publication NPC-300 provides supplementary sound level criteria for information and good design practice. These sound level criteria are provided in Table 1. These limits are applied indoors.

Table 1: NPC-300 Road-Traffic Source Sound Level Criteria (Indoors)

Type of Space	Time of Day	Road (L_{EQ} 16hr) Sound Level Limit
General offices, reception areas, retail stores, etc.	07:00-23:00	50 dBA
Living/dining areas of residences, hospitals, schools, nursing/retirement homes, daycare centres, theatres, places of worship, libraries, individual or semi-private offices, conference rooms, reading rooms, etc.	07:00-23:00	45 dBA

3.1.2 **Road-Traffic Data**

The transportation sources with the greatest potential to influence the proposed development are road traffic along Bloor Street West and Spadina Road. Traffic data for Bloor Street West and Spadina Road were obtained from The City of Toronto website (see Appendix A). The "Average Weekday 24 Hour Traffic Volume (2005-2013)" data was used as the basis for the analysis. A summary of the traffic data is provided with Table 2.

The traffic data did not include all the information required for the analysis; as such the following assumptions were made:

- Commercial traffic was assumed to be 5% medium trucks and 8% heavy trucks.
- 90% / 10% daytime/nighttime volume split.
- Road traffic average speed of 50 km/h
- Future traffic projections are used for the analysis assuming a 0.5% traffic increase per year for 10 years (i.e. to 2028).

Table 2: Road Traffic Data (based on 24 Hour Traffic Volumes)

Roadway Link	AADT [1]		Daytime / Nighttime Split	Percent Commercial Traffic		Speed (km/h)
	(Year)	2028 [2]		Medium	Heavy	
Bloor Street West	27,868 (2012)	30,183	90 / 10	5%	8%	50
Spadina Road	16,363 (2009)	17,991				

[1] AADT – Annual Average Daily Traffic.
[2] Forecasted assuming a 0.5% growth per annum.

3.1.3 Road Traffic Modeling Results

A single worst-case receptor was used to assess the sound levels at the façade of the development:

- NR-01 – Southwest corner façade, third floor

This receptor was selected for modeling due the close proximity to the surrounding major roadway sources and is considered to exhibit the worst-case sound levels.

Sound levels due to road traffic were predicted using a spreadsheet implementation of ORNAMENT (MOE, 1989) at NR-01. A sample calculation is included with Appendix B. The results of the noise modeling with respect to the noise level criteria is summarized in Table 2.

Table 2: Results of ORNAMENT Modelling for the Road Traffic Noise Assessment (Daytime $L_{eq,16hr}$)

Receptor	Predicted Façade Road-Traffic Sound Exposure (dBA)	Predicted Indoor Road-Traffic Sound Exposure (dBA) [1]	Indoor Sound Level Limit (dBA)	Meets Criteria? (Yes/No)
NR-01	61	33	45 - 50	Yes

[1] Predicted indoor sound levels include a 28 dB reduction which estimates the loss through closed window constructions that meet the minimum Ontario Building Code (OBC) requirement,
[2] Based on the 2028 horizon road traffic volumes

The predicted sound levels meet the MOECC NPC-300 limit; and as such, specialized noise mitigation design of the façade and glazing is not required.

4 VIBRATION ON THE PROPOSED DEVELOPMENT

The TTC Line 1 and Line 2 tunnels are located below the development site, and the Spadina Station LRT loop tunnel runs nearby to the west of the site. As such, the vibration impact of the subway train and LRT pass-by were considered.

Attended vibration measurements were conducted during the morning of February 2, 2018. Measurements were conducted over an approximate one-hour period at four locations on-site, all of which are estimated to be at approximately 3-5m from the TTC tunnels below. Over thirty subway train passes were recorded. Vibration due to LRT passes in the nearby tunnel loop could not be identified at surface level, and as such are considered negligible compared to the subway train passes.

The results of the vibration measurements are included in Table 3.

Table 3: Measured vertical RMS vibration velocity ($L_{max, slow}$) in relation to limit

Source	Average (mm/s, RMS)	Range (mm/s, RMS)	Limit [1] (mm/s, RMS)	Meets Criteria? (Yes/No)
TTC subway train	0.07	0.03 - 0.13	0.1	No [2]

[1] RMS vertical vibration velocity limit as defined in the MOE-TTC Protocol for Noise and Vibration Assessment and vibration velocity human perceptibility limits detailed in the Railway Association of Canada guidelines.
[2] The vibration limit was exceeded during approximately 10% of the measured subway train passes

The measured maximum vibration level due to subway train passes on lines 1 and 2 exceed the 0.1 mm/s vibration velocity human perceptibility limits; therefore, vibration mitigation measures are recommended for the proposed development.

4.1.1 Addressing Excess Vibration

As shown above in Table 3, vibrations due to subway train passes exceed the 0.1 mm/s perceptibility limit, and as such, vibration mitigation measures are recommended.

Adequate vibration mitigation may be achieved by lining the foundation columns/walls with a propriety commercial resilient layer (e.g. vinyl or foam layer such as "Ethafoam"). The lining must be soft but able to withstand the lateral soil pressures present on the foundation columns/walls.

Alternatively, the building base may be vibration isolated using specifically designed elastomer bearing pads, similar to bridge bearing pads, provided at the foundation. A variety of commercial products for building base vibration isolation are available, for example from CDMca, Regupol and Getzner.

Vibration mitigation of the proposed building to meet acceptable vibration levels within the building is considered feasible; however, we note that the design will require a detailed vibration isolation design to be incorporated in the structural and architectural design. The potential for structure-borne noise transmission to the building due to subway train passes should also be considered in the vibration mitigation design.

5 IMPACT DUE TO THE PROPOSED DEVELOPMENT

5.1 Stationary Source Noise Assessment

5.1.1 Point of Reception Summary

Sound levels due to sources at the proposed development were determined at points of reception (PORs) located on properties with noise-sensitive land uses. Noise-sensitive land uses are defined in the MOECC's environmental noise guideline, Publication NPC-300 as the property of a person that accommodates a dwelling, a noise-sensitive commercial building or a noise-sensitive institutional building. In some cases, a vacant lot may be considered noise-sensitive, provided it is zoned to allow a sensitive use. A noise-sensitive land use may have one or more POR.

PORs are those locations where sound from the facility is received and assessed against the applicable limits. Sound levels may be assessed at the façade of the building and/or outdoor areas, depending on the type of sensitive land use assessed. Outdoor PORs are only assessed for dwellings and are not assessed for commercial and institutional noise-sensitive land uses. Outdoor PORs are not assessed during the nighttime period.

5.1.2 Modelled Points of Reception

Based on an occupancy analysis of the area, and aerial photography, several noise-sensitive land uses have been identified surrounding the development. Three worst-case points of reception (PORs), in relation to the proposed development, were modelled and are illustrated in Figure 2. The modelled PORs are described as:

POR-01: 480 Huron Street - Two PORs were used to assess the sound level at the nearby house represented by POR-01: the second floor façade (POR-01f) and the ground level backyard outdoor area (POR-01out).

POR-02: 300 Bloor Street West - Currently Bloor Street United Church; however, a planning application for a mixed-use high rise building has been submitted to The City. A potential future residential POR at the ninth floor west facing façade has been evaluated as due diligence.

POR-03: 310 Bloor Street West - Tartu College student residence. A worst-case POR at the north facing fifth floor façade has been evaluated.

Figure 2: Stationary Source Assessment – Modelled Sources and PORs

5.1.1 Stationary Source Assessment Criteria

The assessment criteria for sound levels at 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.

The sound level limits for testing of emergency equipment, in this case the emergency generator, is 5 dB greater than for regular continuous sources of sound. This equipment is assessed separately from other continuous sources of sound. The exclusion limits for both continuous and emergency sources at points of reception is presented below in Table 4.

Table 4: NPC-300 Stationary Source Sound Level Criteria for Sensitive Land Uses

Assessment Location	Time of Day	Time Period	Class 1 Exclusion Limit [1] $L_{EQ\text{-}1hr}$	
			Continuous	Emergency Equipment Testing
Outdoor Point of Reception	Daytime	07:00-23:00h	50 dBA	55 dBA
	Evening	19:00-23:00h	50 dBA	55 dBA
	Daytime	07:00-23:00h	50 dBA	55 dBA

Assessment Location	Time of Day	Time Period	Class 1 Exclusion Limit [1] $L_{EQ\text{-}1hr}$	
			Continuous	Emergency Equipment Testing
Façade Point of Reception	Evening	19:00-23:00h	50 dBA	55 dBA
	Nighttime	23:00-07:00h	45 dBA	50 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.

The background sound level due to road traffic at the off-site representative receptors (PORs) is expected to be higher than the NPC-300 exclusion limits provided in Table 4. As such, the current background sound level due to road traffic was calculated, with projected traffic volumes to the current year, 2018. Refer to Section 3.1.2 for a summary of the assumptions made for road traffic volume projections.

The applicable stationary source sound level limits for the PORs are presented in Table 5. The noise level limit is taken as the quietest one-hour period during the daytime, evening and nighttime, assuming an hourly traffic distribution according to the Institute of Transportation Engineers (ITE, 2010), or the NPC-300 exclusion limit, whichever is higher. A sample calculation is included with Appendix B.

Table 5: Stationary Source Sound Level Limits at Offsite PORs

Receiver	Daytime 07:00-23:00h	Evening 19:00-23:00h	Nighttime 23:00-07:00h	Emergency Sources (Daytime + 5 dB)
POR-01f	54 dBA	53 dBA	45 dBA	59 dBA
POR-01out	54 dBA	53 dBA	n/a	59 dBA
POR-02f	63 dBA	62 dBA	51 dBA	68 dBA
POR-03f	58 dBA	57 dBA	46 dBA	63 dBA

5.1.2 Stationary Source Assessment & Addressing Excess Sound

At the date of this report, the mechanical and electrical design were in very early stages. The major outdoor noise emitting equipment was identified to be two roof top air handling units and a small 35 kW natural gas emergency generator (the small generator may be required to power a sprinkler system pump). An exhaust fan has been assumed on the rooftop boiler room. The stationary sources assumed for the assessment are indicted on Figure 2. Where available, sound level data provided for equipment proposed by the design team were used for the analysis. Where sound level data was not available, proxy data was assumed.

The major mechanical and electrical equipment has been modelled using the Cadna/A software package, a commercially available implementation of the ISO 9613 algorithms. As part of the analysis, it was conservatively assumed that during the worst-case nighttime hour all stationary sources (except the generator) will run at full capacity (i.e. no duty cycle). It was assumed that the generator would be tested during the daytime period.

The results of the analysis indicate that the roof-top units and generator are predicted to require noise controls to achieve the noise criteria at the PORs. Noise control measures are expected to be in the form of packaged-noise attenuation, roof-top barriers, and silencers in order to meet the noise level limit.

A summary of the equipment sound power levels assumed for the assessment, required attenuation and anticipated noise controls to achieve the required attenuation are summarized in Table 6.

Table 6: Stationary Sources and Noise Control Feasibility

Source Description	Source of Sound Level Data	Sound Power Level (L_W, dBA re 1pW)	Required Attenuation	Anticipated Noise Control for Required Attenuation
Roof Top Unit RTU-01	Provided (AAON RN-031)	95 dBA	15 dB	Barrier (approx. 4m height) Quiet condenser fans Quiet intake and exhaust fans Intake and exhaust silencers
Roof Top Unit RTU-02	Provided (AAON RN-050)	95 dBA	15 dB	Barrier (approx. 4m height) Quiet condenser fans Quiet intake and exhaust fans Intake and exhaust silencers
Exhaust Fan EF	Predicted	70 dBA	-	-
Generator	Predicted	100 dBA	5 dB	Level I or II Acoustic Enclosure

The stationary source model predicts that with implementation of some or all of the indicated noise controls to achieve the required attenuation, the noise levels at the PORs will comply with the sound level limits summarized in Table 5.

While compliance is predicted, the analysis indicates that noise attenuation in the range of 5 to 15 dB will be required for the building service equipment and the emergency generator. This range of attenuation is considered to be feasible by implementation of standard noise control measures such as silencers, mufflers, rooftop barriers and/or mechanical room structures including acoustic louvres.

The stationary source modeling is recommended to be updated as the project mechanical and electrical design develops to ensure that the sound level limits at the PORs will be met.

6 CONCLUSION

RWDI completed a noise and vibration feasibility study to assess the compatibility of the proposed Estonian Cultural Centre development with surrounding noise sensitive receptors as well as with existing sources of noise and vibration.

The sound levels due to road-traffic sources are predicted to have an insignificant impact on the proposed development. The predicted sound levels meet the MOECC NPC-300 limit; and as such, specialized noise mitigation design of the façade and glazing is not required.

Vibration measurements conducted at the site of the proposed development indicate that vibration levels exceed the levels set out in the applicable MOEE/TTC Protocol for Noise and Vibration Assessment and the Railway Association of Canada guidelines. Mitigation measures are required at the development to reduce the vibration levels to meet the applicable limits. Vibration isolation of the proposed building to meet acceptable levels within the building is considered feasible; however, we note that implementation of a detailed vibration isolation in the structural and architectural design will be required.

Sound levels due to stationary sources at the proposed development were predicted at points of reception (PORs) located on properties with noise-sensitive land uses. At the date of this report, the mechanical and electrical design were in very early stages, and therefore only the major equipment has been included in the assessment. The results of the analysis indicate that the roof-top units and generator are predicted to require noise controls to achieve the noise criteria at the PORs. Noise control measures are expected to be in the form of packaged-noise attenuation, barriers, and silencers in order to meet the noise level limit.

A summary of the equipment sound power levels assumed for the assessment, required additional attenuation and anticipated noise controls to achieve the required attenuation are provided in Table 6. The range of attenuation required is considered to be feasible by implementation of standard noise control measures such as silencers, mufflers, rooftop barriers and/or mechanical room structures including acoustic louvres.

The feasibility study is based on assumptions regarding building configuration and construction and therefore the resulting recommendations are broad. As such, a detailed design review is recommended to ensure that appropriate noise and vibration control measures have been incorporated into the detailed design.

7 REFERENCES

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

2. Ontario Ministry of the Environment (MOE, 1989), Ontario Road Noise Analysis Method for Environment and Transportation (ORNAMENT), October 1989.

3. Ontario Ministry of the Environment and Climate Change (MOECC) and Toronto Transit Commission (TTC),1993. Draft MOEE/TTC Protocol for Noise and Vibration Assessment.

4. The Railway Association of Canada (RAC), May 2013, Guidelines for New Development in Proximity to Railway Operations.

5. Institute of Transportation Engineers (ITE 2010), Traffic Engineering Handbook, 6th Edition, 2010.