J.E. COULTER ASSOCIATES LIMITED

Consulting Engineers in Acoustics, Noise & Vibration

PRESIDENT
John E. Coulter, B.A.Sc., P.Eng.

VICE-PRESIDENT
Howard R. Patlik, C.E.T.

Suite 211
1210 Sheppard Avenue East
Toronto, Ontario M2K 1E3
Tel: (416) 502-8598
Fax: (416) 502-3473
www.jecoulterassoc.com

June 3rd, 2020

1820839 Ontario Limited
950 Shoreview Drive
Innisfil, ON
L9S 5A7

Attention: Wayne Ezekiel

Re: GROUND VIBRATION MONITORING OF INNISFIL EXECUTIVE ESTATES PHASE 2 DRAFT PLAN OF SUBDIVISION COMMUNITY OF STROUD, TOWN OF INNISFIL

J.E. Coulter Associates Limited was retained by 1820839 Ontario Limited to conduct on-site vibration monitoring for the Innisfill Executive Estates Phase 2 proposed residential subdivision. The site is legally described as Block 39 & 41 R.P. 51M-1045, Town of Innisfil, County of Simcoe. The proposed subdivision is located in the community of Stroud and is situated between Sunnybae Avenue to the west and the Metrolinx railway corridor which abuts the site to the east.

Metrolinx requires a vibration study for any developments within 75m of their ROW. The vibration study is to compare the vibration produced by the current train activity to the 0.14mm/s Level outlined in the “Guidelines for New Development in Proximity to Railway Operations” document (attached).

A vibration monitor was situated at the site, approximately 30m from the western edge of the Metrolinx R-O-W in near the area to be designated as Lot 7. The accelerometer (vibration pickup) was mounted 10cm below surface grade on undisturbed soil. The vibration monitoring was conducted on Tuesday December 31, 2019 from 3:00pm to 8:00pm. During this period, 5 Northbound GO train pass-bys were observed, the results of which are summarized in the table, below.

Table #1 - Barrie Railway Corridor Vibration Monitoring Summary

Time	Train Type	Maximum Vibration Level (mm/s)
4:30PM	GO Passenger Train	0.03mm/s
5:15PM	GO Passenger Train	0.04mm/s
6:15PM	GO Passenger Train	0.05mm/s
6:41PM	GO Passenger Train	0.04mm/s
7:41PM	GO Passenger Train	0.04mm/s

It is clear from the results above that none of the train movement generated vibration levels that were high enough to invoke any attenuation measures as all events were below the level of perception of 0.14mm/sec RMS velocity. Even with any feasible increases in operating speeds, the 0.14mm/s criterion will not be exceeded.

J.E. Coulter Associates Limited hereby concludes that no vibration isolation measures are required for any of the lots of Phase 2 of the Innisfil Executive Estates subdivision.

We trust the above will assist in expediting the project's approval process. Should there be any questions, please do not hesitate to contact the undersigned.

Yours truly,

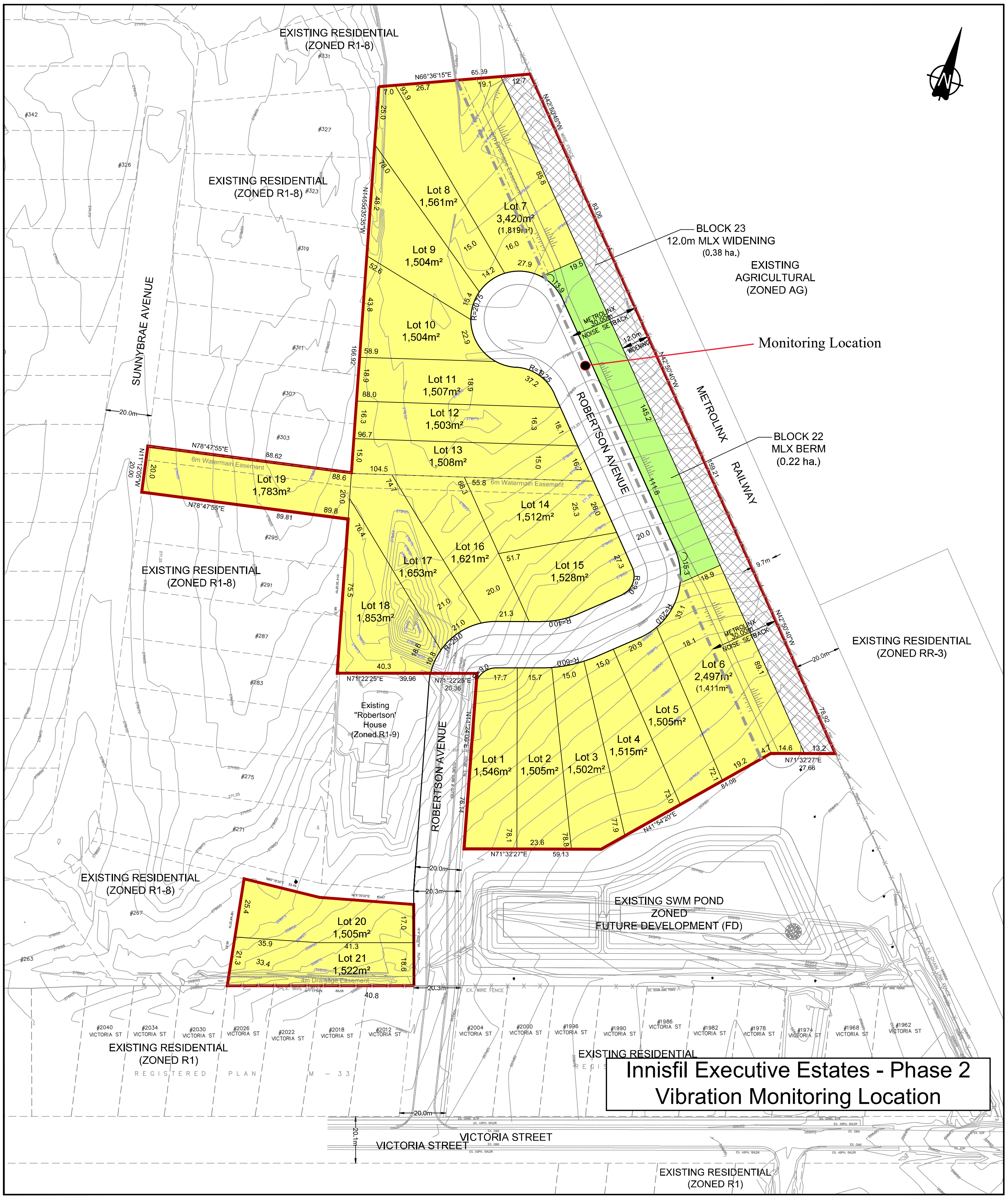
J.E. COULTER ASSOCIATES LIMITED

2020/06/05

John E. Coulter, B.A.Sc., P.Eng.

Tobin Cooper, C.E.T.

JEC:TC:



Innisfil Executive Estates - Phase 2
Vibration Monitoring Location

GUIDELINES

for New Development in Proximity to Railway Operations

PREPARED FOR
THE FEDERATION OF CANADIAN MUNICIPALITIES
AND THE RAILWAY ASSOCIATION OF CANADA

May 2013

DIALOG®

J.E. COULTER
ASSOCIATES
LIMITED

In particular, commercial and industrial properties in proximity to railway operations, and in some cases the buildings situated on those properties, are increasingly being converted to residential uses. At the same time, both the passenger and freight operations of railways are growing steadily, leading to an increasing potential for conflicts between rail operations and adjacent land uses.

Areas in proximity to railway operations are challenging settings for new development, and in particular, for residential development. It is often difficult to reconcile the expectation and concerns of residents with railway operations. For this reason, developments must be carefully planned so as not to unduly expose residents to railway activities as well as not to interfere with the continued operation of the corridor itself, or the potential for future expansion, as railways play an important economic role in society that must be safeguarded.

This report strongly recommends that municipalities should take a proactive approach to identifying and planning for potential conflicts between rail operations and new developments in proximity to railway corridors. Prior to the receipt of an application for a specific project, the municipality should have already have identified key sites for potential redevelopment, conversion, or future rail crossings, and will have generated site-specific policies to manage such future change.

To further assist municipalities and other stakeholders, this report provides a comprehensive set of guidelines for use when developing on lands in proximity to railway operations. The intent of the guidelines is to:

- promote awareness around the issues (noise, vibration, safety) and mitigation measures associated with development near railway operations, particularly those associated with residential development;
- promote greater consistency in the application of relevant standards across the country;
- establish an effective approvals process for new residential development, infill, and conversions from industrial/commercial uses that allows municipal planners to effectively evaluate such proposals with an eye to ensuring that appropriate sound, vibration, and safety mitigation is secured; and
- enhance the quality of living environments in close proximity to railway operations.

The report builds on the 2004 FCM/RAC Proximity Guidelines and is intended for use by municipalities and provincial governments, municipal staff, railways, developers, and property owners when new developments in proximity to railway operations are proposed. Information has been assembled through a comprehensive literature/best practices review from national and international sources as well as a consultation process involving planners, architects, developers, and other professionals from across Canada, the USA, and Australia, as well as members of RAC and FCM.

In addition to the detailed guidelines, the report offers a set of implementation tools and recommendations that are meant to establish a clear framework for the dissemination, promotion, and adoption of the guidelines; as well as suggested improvements to the development approval process. A key recommendation is for a new development assessment tool, called a Development Viability Assessment, which will allow municipal planners to better evaluate proposals for residential development in areas where standard mitigation cannot be accommodated due to site constraints.

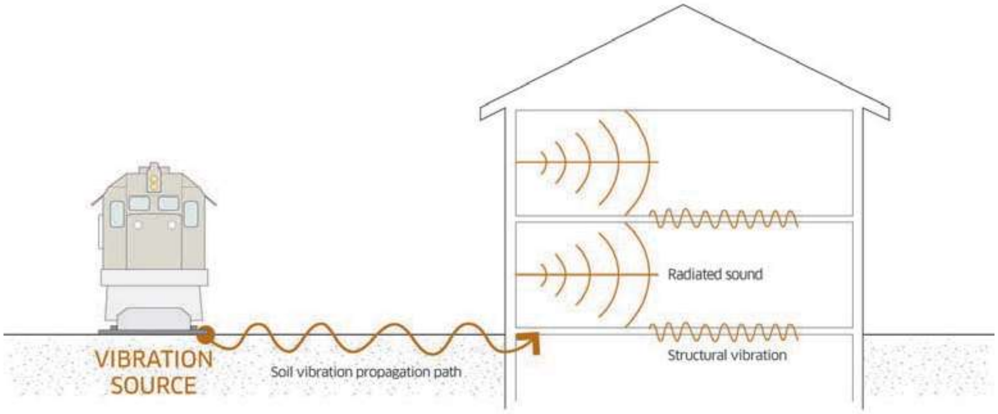


FIGURE 22 // GROUND-BORNE VIBRATION PROPAGATION (SOURCE: ADAPTED FROM FIGURE 7-1 IN TRANSIT NOISE AND VIBRATION IMPACT ASSESSMENT BY THE FEDERAL TRANSIT ADMINISTRATION).

AC.2 // VIBRATION

Vibration caused by passing trains is an issue that affects the structure of a building as well as the liveability of the units inside. In most cases, structural integrity is not a factor. Like sound, the effects of vibration are site-specific and are dependent on the soil and subsurface conditions, the frequency of trains and their speed, as well as the quantity and type of goods they are transporting.

Vibration is caused by the friction of the wheels of a train along a track, which generates a vibration energy that is transmitted through the track support system, exciting the adjacent ground and creating vibration waves that spread though the various soil and rock strata to the foundations of nearby buildings. The vibration can then disseminate from the foundation throughout the remainder of the building structure. Experience has shown that vibration levels only slightly above the human perception threshold are likely to result in complaints from residents.

Vibration in buildings in proximity to railway corridors can reach levels that may not be acceptable to building occupants for one or more of the following reasons:

- irritating physical sensations that vibration may cause in the human body;
- interference with activities such as sleep, conversation, and work;
- annoying noise caused by “rattling” of windowpanes, walls, and loose objects. Noise radiated from the motion of the room surfaces can also create a rumble. In essence, the room acts like a giant loudspeaker;
- interference with the proper operation of sensitive instruments (or) processes; and
- misplaced concern about the potential for structural or foundation damage.

Mitigation of vibration and ground-borne noise requires the transmission of the vibration to be inhibited at some point in the path between the railway track and the building. In some instances, sufficient attenuation of ground vibration is provided by the distance from the track (vibration is rarely an issue at distances greater than 50 metres from the track), or by the vibration 'coupling loss' which occurs at the footings of buildings. However, these factors may not be adequate to achieve compliance with the guidelines, and consideration may need to be given to other vibration mitigation measures. However, railway vibration is not normally associated with foundation damage.

AC.2.1 // GROUND-BORNE VIBRATION NOISE

Vibration is an oscillatory motion, which can be described in terms of its displacement, velocity, or acceleration. Because the motion is oscillatory, there is no net displacement of the vibration element and the average of any of the motion descriptors is zero. The response of humans, buildings, and equipment to vibration is more accurately described using velocity or acceleration. The concepts of ground-borne vibration for a rail system are illustrated in FIGURE 22.

AC.2.2 // PEAK PARTICLE VELOCITY AND THE ROOT MEAN SQUARE

The peak particle velocity (PPV) is defined as the maximum instantaneous positive or negative peak of the vibration signal. Although PPV is appropriate for evaluating the potential of building damage, it is not suitable for evaluating human responses, as it takes some time for the human body to respond to vibration signals. Because the net average of a vibration signal is zero, the root mean square (RMS) amplitude is used to describe the vibration amplitude.

The criteria for acceptable ground-borne vibration are expressed in terms of RMS velocity in decibels or mm/sec, and the criteria for acceptable ground-borne noise are expressed in terms of A-weighted sound levels.

AC.2.3 // HUMAN PERCEPTION OF GROUND-BORNE VIBRATION AND NOISE

The background vibration velocity level (typically caused by passing vehicles, trucks, buses, etc.) in residential areas is usually less than 0.03mm/sec RMS, well below the threshold of perception for humans, which is around 0.1 mm/sec RMS. In the some cases, depending on the distance, intervening soils, and type of rail infrastructure, the vibration from trains can reach 0.4mm/sec RMS or more. Even high levels of perception, however, are typically an order of magnitude below the minimum levels required for structural or even cosmetic damage in fragile buildings.

Typical levels of ground-borne vibrations are shown in FIGURE 23.

For surface heavy rail traffic, the sound made by the vibration travelling through the earth is rarely significant because of the relatively low frequency content being less audible than the higher vibration frequencies common to surface transit and subways.

The relationship between ground-borne vibration and ground-borne noise depends on the frequency content of the vibration and the acoustical absorption of the receiving room. The more acoustical absorption in the room, the lower will be the noise level. This can be used to mitigate the ground-borne noise impact, but as noted above, is rarely required.

One of the problems in developing suitable criteria for ground-borne vibration is that there has been relatively little research into human response to vibration, in particular, human annoyance with building vibration. Nevertheless, there is some information available on human response to vibration as a function of vibration characteristics: its level, frequency, and direction with respect to the axes of the human body, and duration of exposure time. However, most of the studies on which this information is based were concerned with conditions in which the level and frequency of vibration are constant. Very few studies have addressed human response to complex intermittent vibration such as that induced in buildings by railway corridors. Nonetheless, several countries have published standards that provide guidance for evaluating human response to vibration in buildings. Proponents may utilize the following standards, used internationally, as a reference:

- International Standard ISO 2631-2: 2003 (1989)
- American Standard ANSI S2.71: 2006 (Formerly ANSI S3.29-1983)
- British Standard BS 6472-1: 2008 (1984)
- Norwegian Standard NS 8176.E: 2005
- New Zealand Standard NZS/ISO 2631-2: 1989
- Australian Standard AS 2670-2: 1990