Railway Vibration Study

28-60 Bronte Street North

Proposed Mixed-Use Development

Town of Milton

November 8, 2018
Project: 118-0109

Prepared for

2183271 Ontario Inc.

Prepared by

Richard Qiang Li, Ph.D., P.Eng.

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John Emeljanow, B.Eng., P.Eng.

VALCOUSTICS
Canada Ltd.

Version History

Version #	Date	Comments
1.0	November 8, 2018	Issued to Client

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Railway Vibration Study

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EXECUTIVE SUMMARY

Valcoustics Canada Ltd. (VCL) was retained to prepare a Railway Vibration Study for the proposed mixed-use development to support the Official Plan Amendment (OPA) and Zoning By law Amendment (ZBA) application submissions to the Town of Milton and the Regional Municipality of Halton.

The proposed development will consist of two residential towers at 19 and 21-storeys on top of 6-storey podiums, with ground floor retail and two levels of underground parking.

The only significant source of environmental vibration in the vicinity of the site is the rail traffic on the Canadian National Railway (CN) Halton Subdivision. On-site measurements of ground-borne vibration from train pass-bys were done. The measured vibration velocities at locations representing the closest proposed building structure to the rail line exceeded the applicable vibration guideline limits. Therefore, vibration mitigation measures are required for this development.

1.0 INTRODUCTION

VCL was retained to prepare a Railway Vibration Study to support the Official Plan Amendment (OPA) and Zoning By-law Amendment (ZBA) application submissions to the Town of Milton and the Regional Municipality of Halton. On-site measurements of railway induced ground-borne vibration were done to determine whether vibration isolation of the proposed building foundations is warranted, relative to the vibration guidelines recommended by the Federation of Canadian Municipalities (FCM) and Railway Association of Canada (RAC).

1.1 THE SITE AND SURROUNDING AREA

The site is located to the northwest of the intersection of Bronte Street North and Main Street West in the Town of Milton. The site is bounded by:

- Bronte Street North, with existing residential and business uses beyond, to the east;

- Main Street West, with existing residential and business uses beyond, to the south;
- CN Halton Subdivision, with existing residential dwellings and vacant land beyond, to the west; and
- Existing vacant land for future phase, with existing business use beyond, to the north.

The existing TSC Store on site will be demolished as part of the development.

A Key Plan is included as Figure 1. The study is based on the architectural drawing set, prepared by KNYMH Inc., received October 2, 2018. The Site Plan and underground plan from the drawing set are included as Figure 2, overlaid on the Google Earth Map of the area.

1.2 THE PROPOSED DEVELOPMENT

The proposed mixed-use development will consist of two residential towers at 19 and 21-storeys on top of 6-storey podiums, with ground floor retail and two levels of underground parking. We also understand that the existing commercial buildings on the site will be demolished and Phase 1 will be built on that portion of the site.

1.3 RAIL TRAFFIC

Rail traffic data applicable to the year 2018 for the CN Halton Subdivision was obtained directly from CN. CN rail traffic consists of freight trains on this corridor. Rail traffic data correspondence is included as Appendix A.

2.0 VIBRATION GUIDELINES

At the present time, there are no railway vibration guidelines in the land use approvals process in Ontario. However, in May 2013, the FCM and the RAC jointly released "Guidelines for New Development in Proximity to Railway Operations". The FCM/RAC guideline recommends a maximum vibration threshold of 0.14 mm/sec root-mean-square (RMS) (using a one second averaging time) between 4 Hz and 200 Hz.

For the non-residential uses (Retail, Business and Office, etc.), FCM/RAC does not provide specific guidance; but does reference other documents such as ISO Standard ISO-2631. ISO 2631 recommends a maximum vibration limit of 0.4 mm/seconds (RMS – with 1 second averaging) for office use. In addition to this, CN previously provided guidance for maximum vibration limits for non-residential structures. For non-residential developments adjacent to a railway line, CN advocated a maximum overall vibration velocity of 0.4 mm/s (RMS – with 1 second averaging).

3.0 MEASUREMENT LOCATIONS

Vibration measurements were done at four (4) locations labelled as A, B, C and D on Figure 2.

Locations A and B, 6 m and 1 m respectively north of the rail right of way (ROW), represent the closest portion of the proposed development to the rail line, i.e. the south foundation wall for the storage/underground parking level.

Locations C and D, approximately 32 m north of the rail ROW, correspond to the south facades of the proposed two towers, closest part of the above-grade building structure to the rail line.

4.0 TRANSDUCER PLACEMENT

Geophone transducers were used to measure the ground-borne vibration generated by the train pass-bys.

At Locations A, B and C, the transducers were placed into a small hole dug into the ground, approximately 200 mm below grade such that it was resting on compacted soil, and was securely anchored with metal ground spikes. At Location D, the transducer was placed on the concrete ground floor in the existing building.

5.0 DATA ACQUISITION

Five (5) freight train pass-bys were monitored on August 15, 2018, from 10:00 to 17:00. The vibration signals for Pass-by #1 were recorded simultaneously at Locations A, B and D. The vibration signals for Pass-bys 2 to 5 were recorded simultaneously at Locations A, B, C and D. The triaxial signals (vertical, transversal and longitudinal) from each of the geophones were recorded digitally using MetricPro Model MPV3C21 vibration data acquisition and analysis systems. The monitors recorded vibration velocity, in mm/s.

At each location, the vibration data acquisition system recorded the ground borne vibration continuously throughout the monitoring period, using a sampling rate of 1000 samples per second.

6.0 DATA ANALYSIS

Time histories of the vibration velocity produced by each train pass-by were band-pass filtered between 4 Hz and 200 Hz and were plotted using an RMS (root-mean-square) averaging routine with a time constant of one second. The analysis procedure conforms with the FCM/RAC, CN and ISO guidelines.

7.0 RESULTS

Table 1 summarizes details of the five (5) CN train pass-bys, as well as the maximum measured vibration velocity (1 second RMS) for each pass-by. Appendix B contains the time histories of measured vibration velocities for the three train pass bys.

As shown in Appendix B, the maximum vertical, transverse and longitudinal vibration velocity magnitudes produced by the train pass-bys were measured as 0.32, 0.39 and 0.43 mm/s respectively, occurring at Location A during the CN train pass-by #1. These exceed the 0.14 mm/s limit of FCM/RAC guidelines. The longitudinal vibration also exceeds the 0.40 mm/s ISO/CN guideline limit for non-residential development.

8.0 DISCUSSION

Several of the train pass-bys produced vibration magnitudes in excess of the recommended residential vibration guideline limit, at locations along south foundation wall for the storage/underground parking level.

The railway induced vibration magnitudes at Locations C and D, representing the residential units closest to the rail track, were measurement below the FCM/RAC limit. It is expected there would be a lower vibration attenuation through the future building structure than the soil ground between the south foundation wall (Locations A and B) and the south facades of two towers (Locations C and D). The specific degree of attenuation cannot be predicted at this early stage of the design, prior to the details of the proposed structure being developed.

Notwithstanding the above, without mitigation, noise from the train pass-bys may also be audible within the building. This is because, even with lower magnitude vibrations, the building structure itself can efficiently transfer vibration energy that would be re-radiated as noise.

Thus, it is recommended that the specific vibration mitigation requirements be evaluated once a detailed building design is available. A large concrete building, such as what is being proposed, will be somewhat resistant to vibration impacts. Thus, it is possible that extensive vibration isolation of the building structure may not be needed depending on the final design.

9.0 CONCLUSION

The ground-borne vibration velocity magnitudes due to railway trains on the CN Halton Subdivision, measured at the closest building underground structure to the railway tracks, exceed the FCM/RAC and ISO/CN guidelines. Therefore, vibration mitigation measures for this development need to be reviewed once detailed building designs are available.

10.0 REFERENCES

1. “Guidelines for New Development in Proximity to Railway Operations”, Prepared for The Federation of Canadian Municipalities and the Railway Association of Canada, May 2013.

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TABLE 1: MEASURED OVERALL MAXIMUM VIBRATION VELOCITY MAGNITUDES

Pass-by #	Time Period	Train Details				Axis	Maximum Vibration Velocity(1) (mm/s)			
		Train Type	Direction	# of Locomotives	# of Cars	Vertical (Z), Transversal (X), Longitudinal (Y)	Location A(2)	Location B(2)	Location C(2)	Location D(2)
1	10:42 – 10:47	Freight	Westbound	3	209	Z	0.32	0.10	–	0.06
						X	0.39	0.13	–	0.06
						Y	0.43	0.19	–	0.06
2	11:58 – 12:04	Freight	Westbound	3	176	Z	0.20	0.14	0.03	0.05
						X	0.20	0.16	0.05	0.05
						Y	0.26	0.17	0.04	0.05
3	13:35 – 13:36	Freight	Westbound	2	12	Z	0.15	0.09	0.01	0.03
						X	0.15	0.13	0.03	0.03
						Y	0.21	0.14	0.02	0.03
4	14:11 – 14:13	Freight	Eastbound	2	55	Z	0.26	0.25	0.03	0.05
						X	0.33	0.24	0.05	0.05
						Y	0.41	0.30	0.04	0.06
5	16:17 – 16:18	Freight	Eastbound	2	11	Z	0.22	0.10	0.02	0.04
						X	0.21	0.13	0.04	0.04
						Y	0.26	0.14	0.03	0.03

Notes:

(1) Maximum overall vibration velocity occurring for the entire pass-by; one second RMS averaging between 4 Hz and 200 Hz.

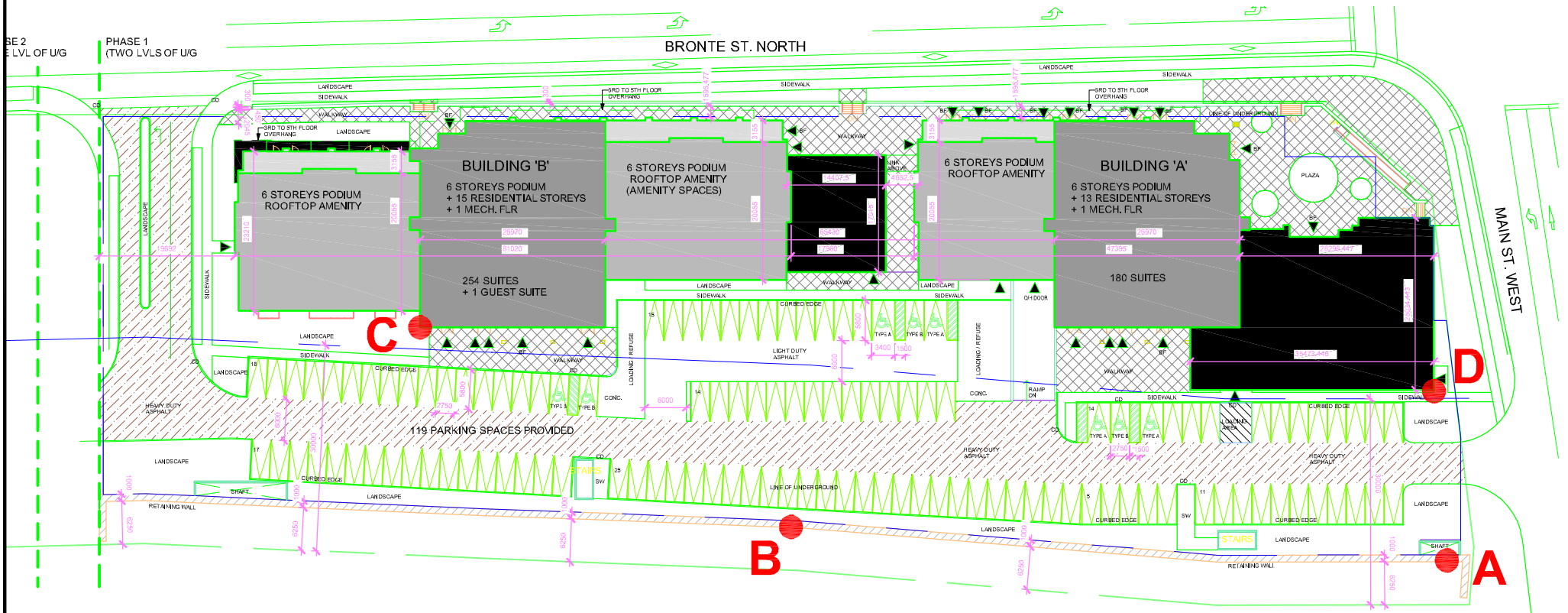
(2) See Figure 2.

VALCOUSTICS Canada Ltd. consulting acoustical engineers	Title: **KEY PLAN**	Date: **Oct 15, 2018**	Figure: **1**
	Project Name: **28-60 Bronte Street North, Milton - Railway Vibration Study**	Project No.: **118-0109**	

Date Plotted: 15.10.18

LEGEND

● Vibration Measurement Location



BASE DRAWING BY KNYMH Inc.

No.	Revision/Issue	Date
1		

VALCOUSTICS Canada Ltd.

30 Wertheim Court, Unit 25
Richmond Hill, Ontario
Canada L4B 1B9
solutions@valcoustics.com
Phone: (905) 764-5223
Fax: (905) 764-6813

Title	Project No.	Date
SITE PLAN	118-0109	Nov. 2, 2018
Project Name 28-60 Bronte Street North, Milton – Railway Vibration Study	**Scale** N.T.S.	**Figure** 2

APPENDIX A
RAIL TRAFFIC

System Engineering
Engineering Services

1 Administration Road
Concord, ON, L4K 1B9
T: 905.669.3264
F: 905.760.3406

Train Count Data

TRANSMITTAL

To: *Destinataire :*	Valcoustics Canada Ltd 30 Wertheim Court, Unit 25, Richmond Hill, ON L4B 1B9	*Project :*	HAL – 35.62 – Main St E/Bronte St N Milton, ON
Att'n:	Seema Nagaraj	*Routing:*	seema@valcoustics.com
From: *Expéditeur :*	Michael Vallins	*Date:*	2018/06/14
Cc:	Adjacent Development CN via e-mail		

☐ Urgent ☐ For Your Use ☐ For Review ■ For Your Information ☐ Confidential

Re: Train Traffic Data – CN Halton Subdivision near Main St E/Bronte St N in Milton, ON

Please find attached the requested Train Traffic Data; this data does not reflect GO Metrolinx Traffic. The application fee in the amount of **$500.00** +HST will be invoiced.

Should you have any questions, please do not hesitate to contact the undersigned at 905-669-3264.

Sincerely,
CN Design & Construction

Michael Vallins P.Eng
Manager of Public Works
public_works_gld@cn.ca

Date: 2018/06/14 Project Number: HAL – 35.62 – Main St E/Bronte St N Milton, ON

Dear Seema Nagaraj

Re: Train Traffic Data – CN Halton Subdivision near Main St E/Bronte St N in Milton, ON

The following is provided in response to Seema's 2018/05/30 request for information regarding rail traffic in the vicinity of Main St E/Bronte St N in Milton, ON at approximately Mile 35.62 on CN's Halton Subdivision.

Typical daily traffic volumes are recorded below. However, traffic volumes may fluctuate due to overall economic conditions, varying traffic demands, weather conditions, track maintenance programs, statutory holidays and traffic detours that when required may be heavy although temporary. For the purpose of noise and vibration reports, train volumes must be escalated by 2.5% per annum for a 10-year period.

Typical daily traffic volumes at this site location are as follows:

***Maximum train speed is given in Miles per Hour**

	0700-2300			
Type of Train	Volumes	Max.Consist	Max. Speed	Max. Power
Freight	13	140	50	4
Way Freight	0	25	50	4
Passenger	0	10	50	2

	2300-0700			
Type of Train	Volumes	Max.Consist	Max. Speed	Max. Power
Freight	5	140	50	4
Way Freight	0	25	50	4
Passenger	0	10	50	2

The volumes recorded reflect westbound and eastbound freight and passenger operations on CN's Halton Subdivision.

Except where anti-whistling bylaws are in effect, engine-warning whistles and bells are normally sounded at all at-grade crossings. There are no at-grade crossing in the immediate vicinity of the study area at Mile 36.62 Main St E/Bronte St N. Anti-whistling bylaws are not in effect at this crossing. Please note that engine warning whistles may be sounded in cases of emergency, as a safety and or warning precaution at station locations and pedestrian crossings and occasionally for operating requirements.

With respect to equipment restrictions, the gross weight of the heaviest permissible car is 286,000 lbs.

The double mainline track is considered to be continuously welded rail throughout the study area.

The Canadian National Railway continues to be strongly opposed to locating developments near railway facilities and rights-of-way due to potential safety and environmental conflicts. Development adjacent to the Railway Right-of-Way is not appropriate without sound impact mitigation measures to reduce the incompatibility. For confirmation of the applicable rail noise, vibration and safety standards, Adjacent Development, Canadian National Railway Properties at Proximity@cn.ca should be contacted directly.

I trust the above information will satisfy your current request.

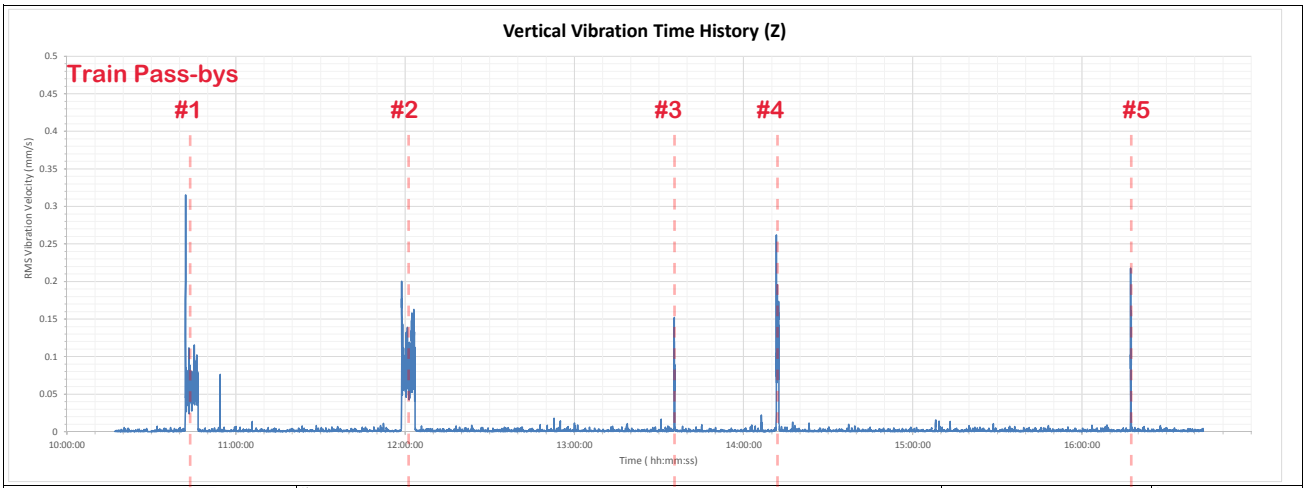
Sincerely,

Michael Vallins P.Eng
Manager of Public Works
public_works_gld@cn.ca

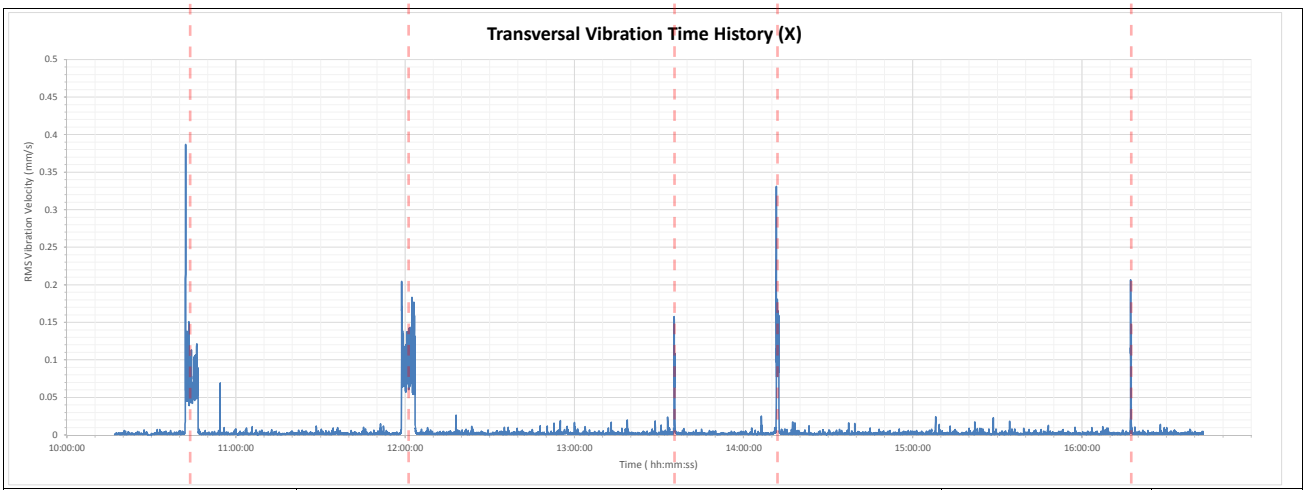
APPENDIX B

VIBRATION VELOCITY TIME HISTORIES DUE TO TRAIN PASS-BYS

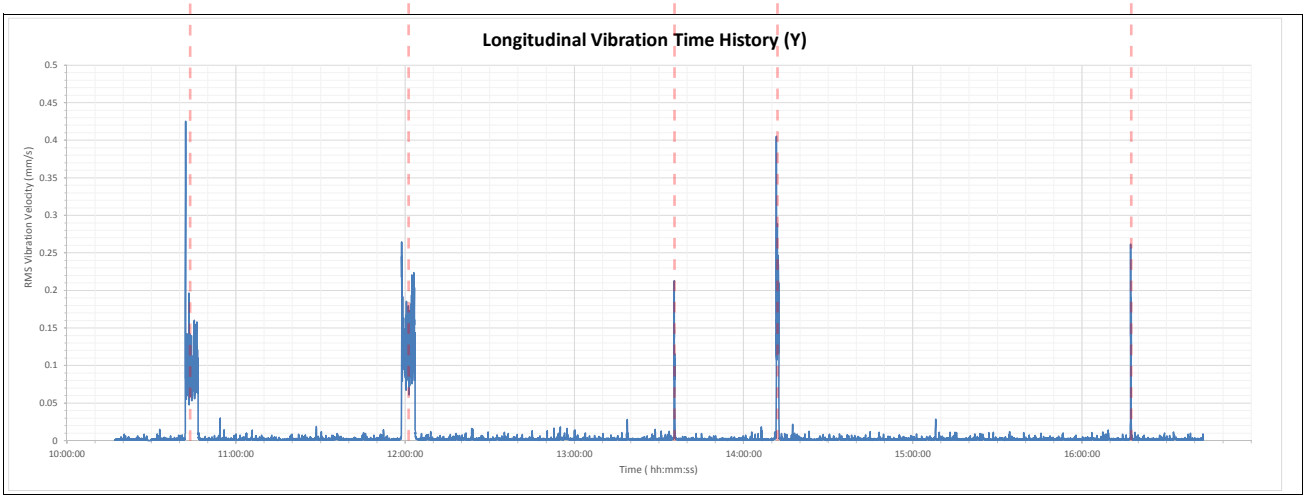
Vibration Measurement — Location A



VALCOUSTICS Canada Ltd.	Title: Railway Vibration Measurements at Location A - Vertical (Z) Vibration Time History	Measurement Date: Aug 15, 2018	Figure: A-1
	Project Name: 28-60 Bronte Street North — Vibration	Project No.: 118-0109	



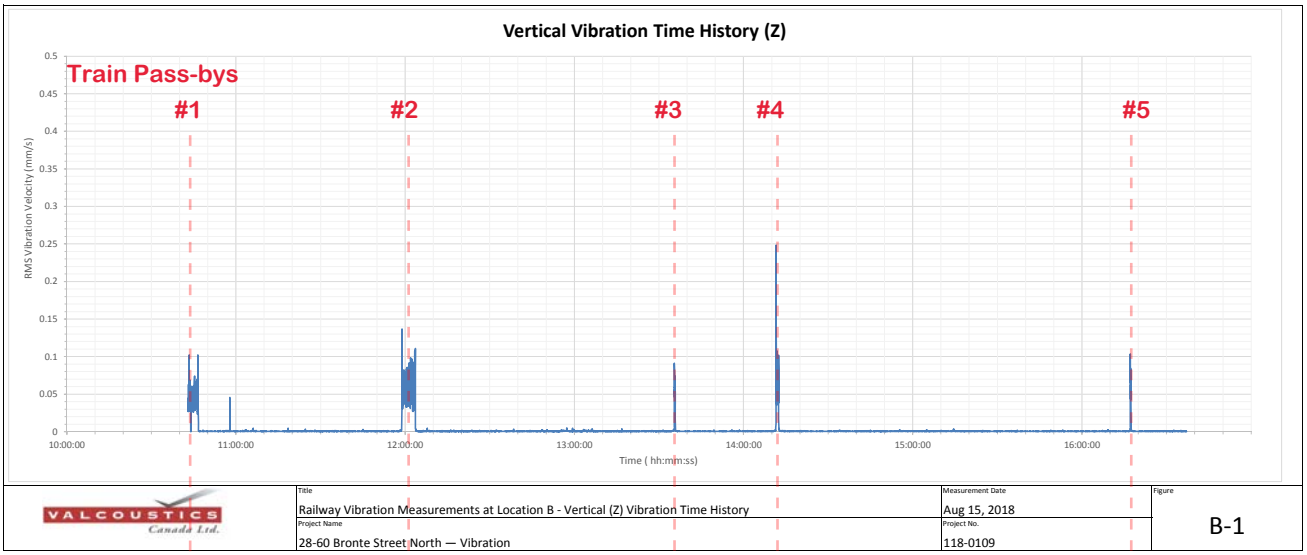
VALCOUSTICS Canada Ltd.	Title: Railway Vibration Measurements at Location A - Transversal (X) Vibration Time History	Date: Aug 15, 2018	Figure: A-2
	Project Name: 28-60 Bronte Street North — Vibration	Project No.: 118-0109	



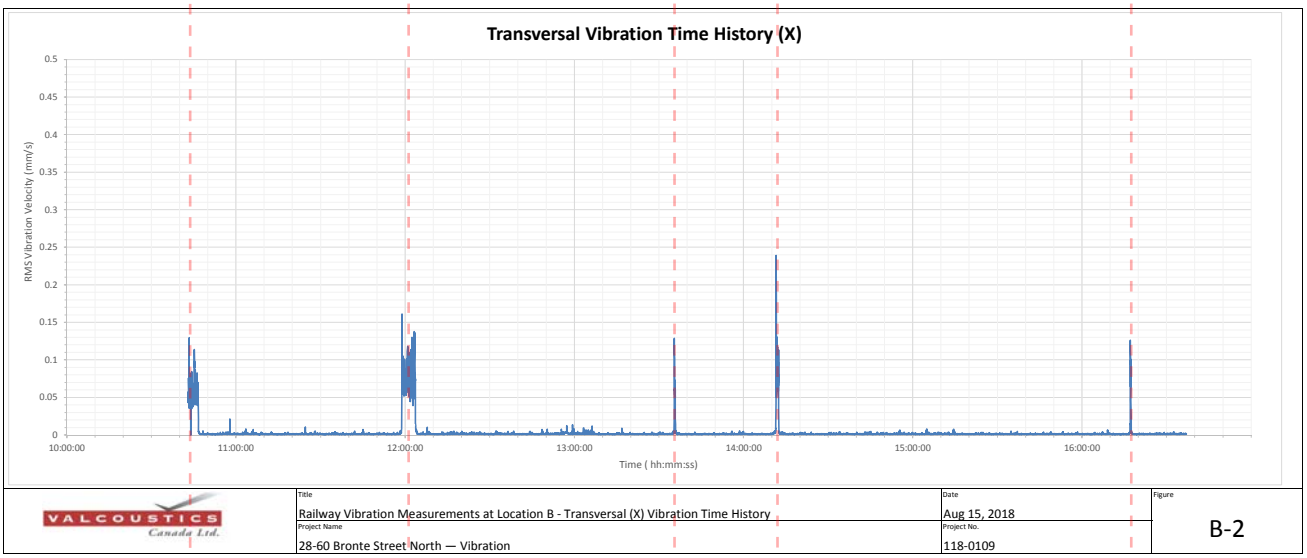
VALCOUSTICS Canada Ltd.	Title: Railway Vibration Measurements at Location A - Longitudinal (Y) Vibration Time History	Date: Aug 15, 2018	Figure: A-3
	Project Name: 28-60 Bronte Street North — Vibration	Project No.: 118-0109	

\\10.7.11.12\Jobs\2018\118010\000\Analysis\Vibration\[Time Histories_CPR_2018-08-15.xlsx]Location A

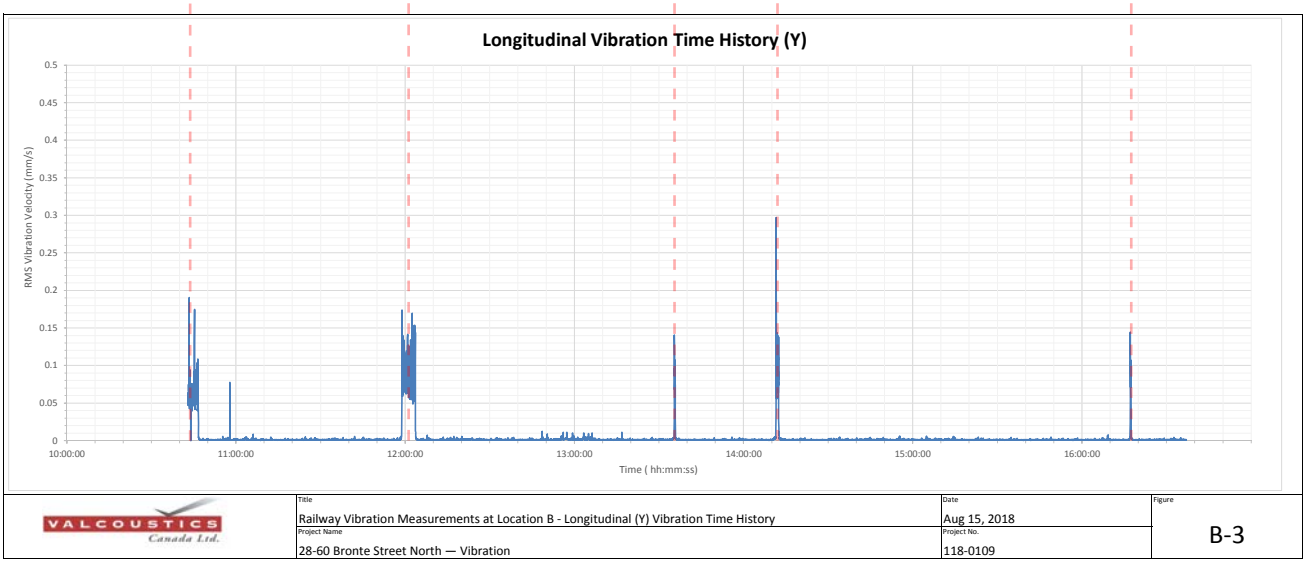
Vibration Measurement — Location B



VALCOUSTICS Canada Ltd.	Title: Railway Vibration Measurements at Location B - Vertical (Z) Vibration Time History	Measurement Date: Aug 15, 2018	Figure: B-1
	Project Name: 28-60 Bronte Street North — Vibration	Project No.: 118-0109	



VALCOUSTICS Canada Ltd.	Title: Railway Vibration Measurements at Location B - Transversal (X) Vibration Time History	Date: Aug 15, 2018	Figure: B-2
	Project Name: 28-60 Bronte Street North — Vibration	Project No.: 118-0109	



VALCOUSTICS Canada Ltd.	Title: Railway Vibration Measurements at Location B - Longitudinal (Y) Vibration Time History	Date: Aug 15, 2018	Figure: B-3
	Project Name: 28-60 Bronte Street North — Vibration	Project No.: 118-0109	

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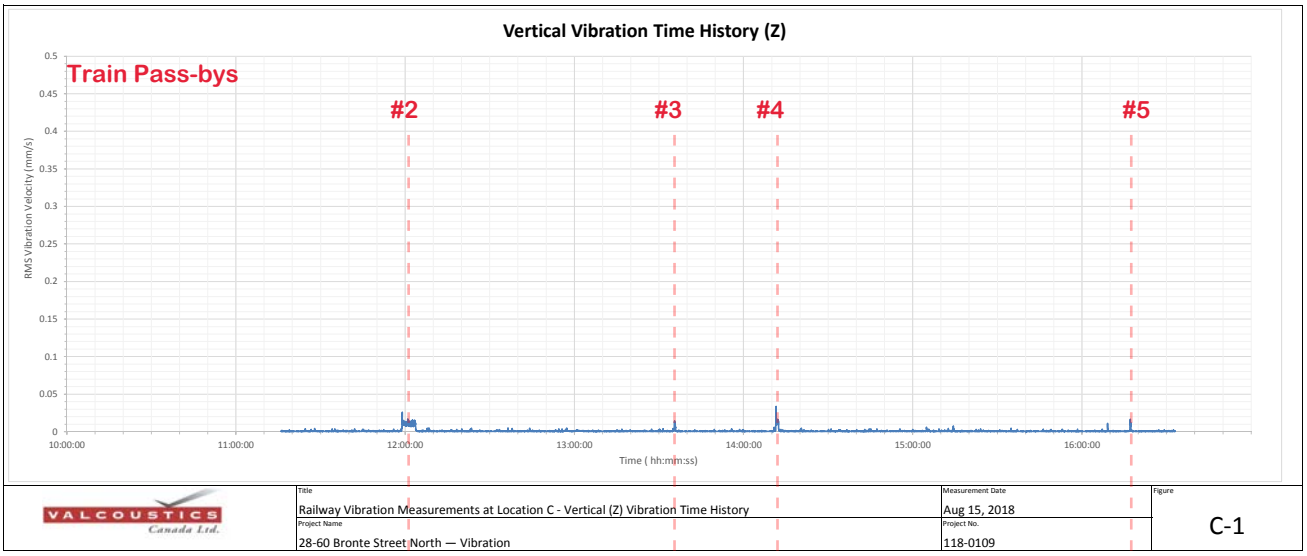
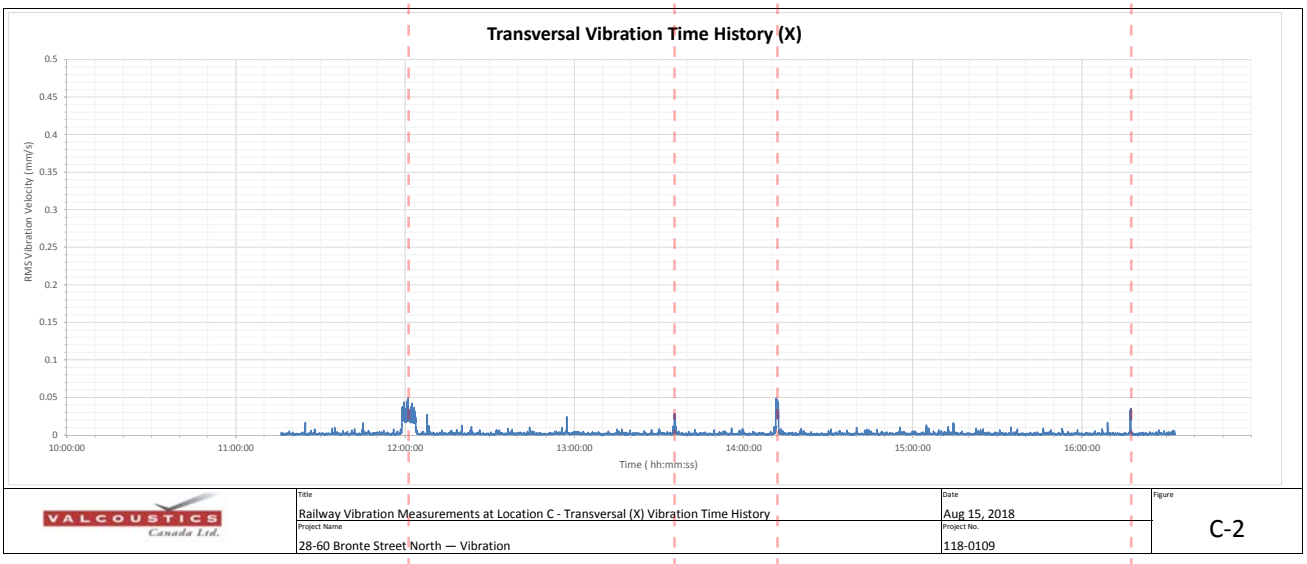
Vibration Measurement — Location C



VALCOUSTICS Canada Ltd.	Title: Railway Vibration Measurements at Location C - Vertical (Z) Vibration Time History	Measurement Date: Aug 15, 2018	Figure: C-1
	Project Name: 28-60 Bronte Street North — Vibration	Project No.: 118-0109	



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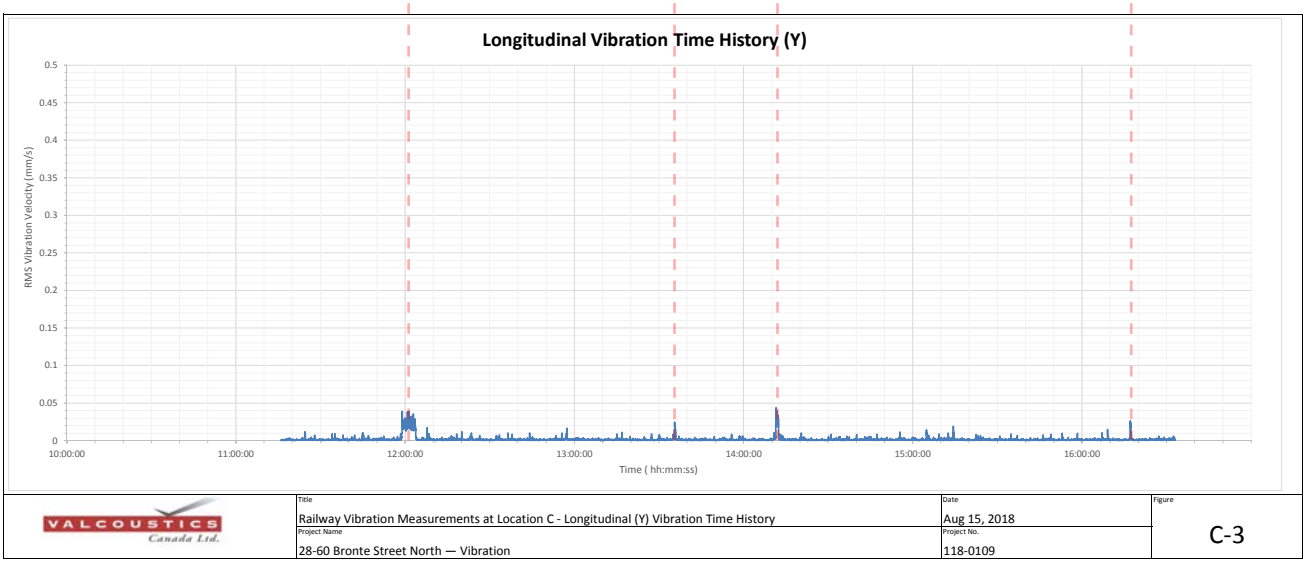
	Project Name: 28-60 Bronte Street North — Vibration	Project No.: 118-0109	



VALCOUSTICS Canada Ltd.	Title: Railway Vibration Measurements at Location C - Longitudinal (Y) Vibration Time History	Date: Aug 15, 2018	Figure: C-3
	Project Name: 28-60 Bronte Street North — Vibration	Project No.: 118-0109	

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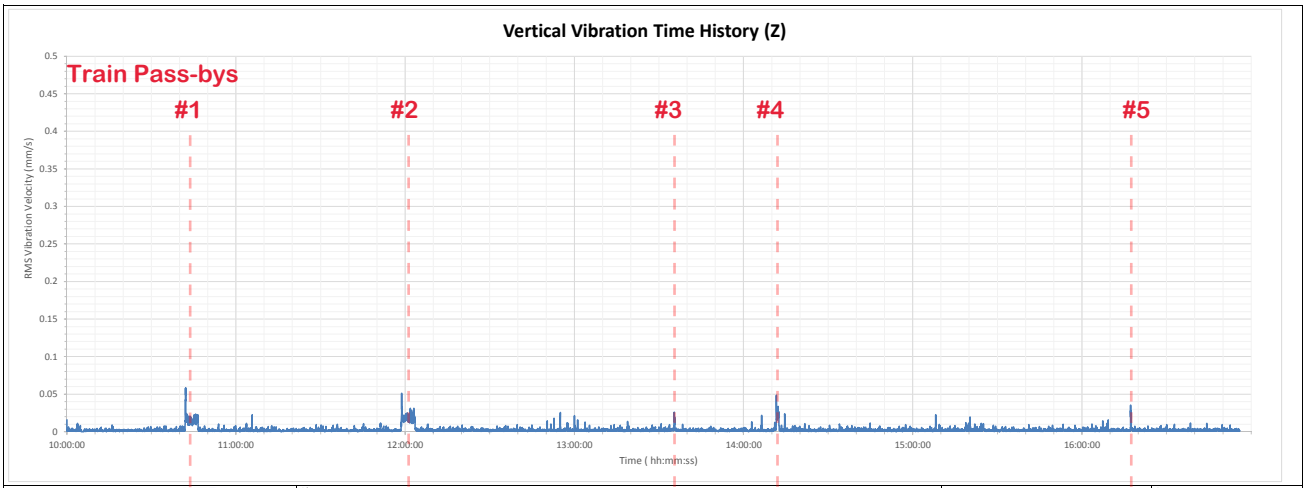
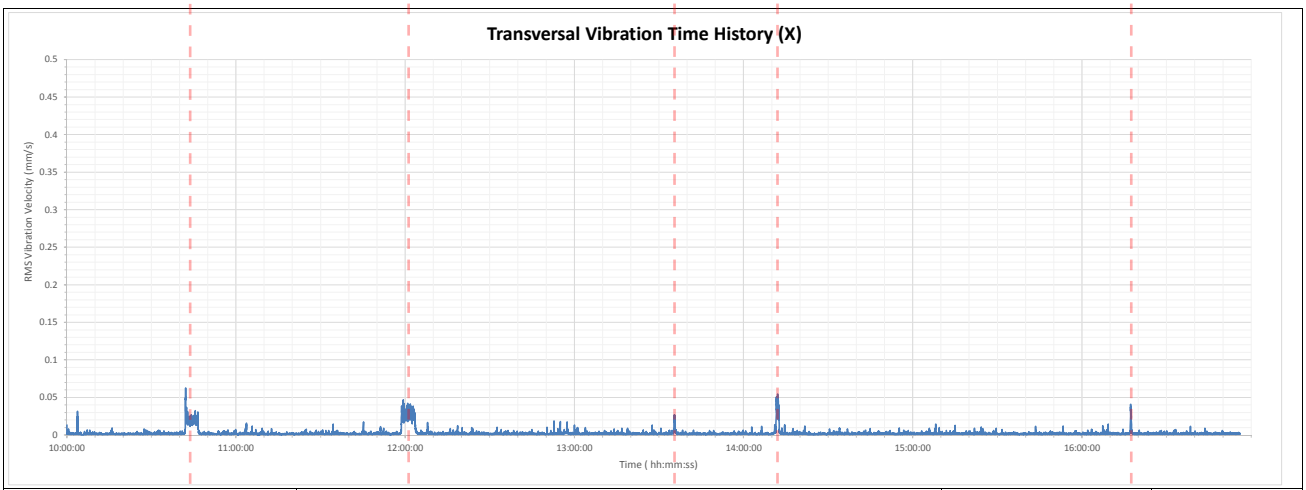
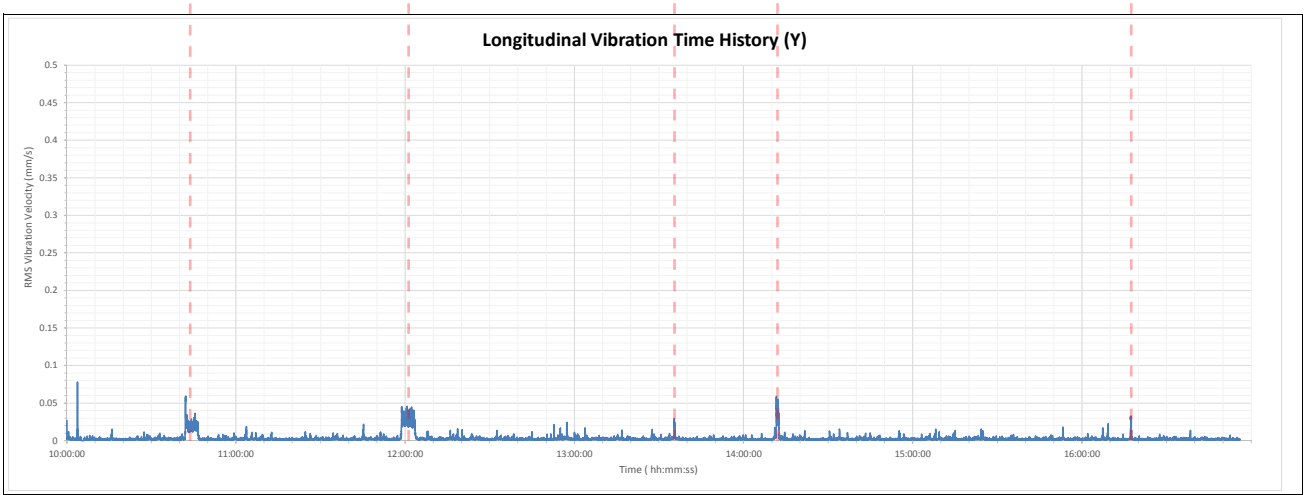
Vibration Measurement — Location D



VALCOUSTICS Canada Ltd.	Title: Railway Vibration Measurements at Location D - Vertical (Z) Vibration Time History	Measurement Date: Aug 15, 2018	Figure: D-1
	Project Name: 28-60 Bronte Street North — Vibration	Project No.: 118-0109	



VALCOUSTICS Canada Ltd.	Title: Railway Vibration Measurements at Location D - Transversal (X) Vibration Time History	Date: Aug 15, 2018	Figure: D-2
	Project Name: 28-60 Bronte Street North — Vibration	Project No.: 118-0109	



VALCOUSTICS Canada Ltd.	Title: Railway Vibration Measurements at Location D - Longitudinal (Y) Vibration Time History	Date: Aug 15, 2018	Figure: D-3
	Project Name: 28-60 Bronte Street North — Vibration	Project No.: 118-0109	

\\10.7.11.12\Jobs\2018\118010\000\Analysis\Vibration\[Time Histories_CPR_2018-08-15.xlsx]Location D