MTR Corporation Limited

Shatin to Central Link
Mong Kok East to Hung Hom Section

Ground-borne Railway Noise
Performance Test Report

March 2022

Verified by:	Claudine Lee
Position:	Independent Environmental Checker
Date:	16 March 2022

MTR Corporation Limited

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Certified by:	Lisa Poon
Position:	Environmental Team Leader
Date:	16 March 2022

AECOM

MTR Corporation Limited

Consultancy Agreement No. C11033B

Shatin to Central Link – Mong Kok East to Hung Hom Section [SCL(MKK-HUH)] and Stabling Sidings at Hung Hom Freight Yard [SCL(HHS)]

Ground-borne Railway Noise Performance Test Report

March 2022

	Name	Signature
Prepared & Checked:	Isaac Chu	[signature]
Reviewed & Approved:	Freeman Cheung	[signature]

Version:	B	Date:	11 March 2022

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1 INTRODUCTION

1.1 Background

1.1.1 The Shatin to Central Link (SCL) is a 17km extension of the Ma On Shan Line (MOL) and East Rail Line (EAL) comprising (i) The East-West Corridor which extends the MOL from Tai Wai to Hung Hom via East Kowloon to connect with the West Rail Line (WRL) at Hung Hom Station (HUH) and Stabling Sidings at Hung Hom Freight Yard (HHS); and (ii) The North-South Corridor which is an extension of the EAL at Hung Hom across the harbour to Admiralty Station (ADM).

1.1.2 EIA Reports for SCL – Mong Kok East to Hung Hom (MKK-HUH) Section (Register No.: AEIAR - 165/2012) and SCL – Stabling Sidings at Hung Hom Freight Yard (Register No.: AEIAR – 164/2012) were approved on 17 February 2012 under the Environmental Impact Assessment Ordinance (EIAO). Following the approval of the EIA Reports, the Environmental Permit (EP) (EP No: EP-437/2012), covering the construction and operation of SCL (MKK-HUH), was granted on 22 March 2012. Variations of Environmental Permit (VEP) was subsequently applied for EP-437/2012 and the latest Environmental Permit (EP No: EP-437/2012/A) was issued by Director of Environmental Protection (DEP) on 28 November 2017.

1.1.3 Pursuant to EP Condition 2.20, at least one month before commencement of operation of the Project, the Permit Holder, MTR Corporation Ltd (MTR), shall carry out noise performance test and deposit with the Director four hard copies and one electronic copy of a Noise Performance Test Report to confirm the compliance of the operational ground-borne noise levels in accordance with the approved SCL (MKK-HUH) EIA Report (Register No. AEIAR-165/2012) and the SCL(HHS) EIA Report (Register No. AEIAR-164/2012).

1.1.4 MTR Corporation Limited (MTR) therefore has commissioned AECOM Asia Co. Ltd to carry out the operational ground-borne railway noise performance test. Operational ground-borne performance test was conducted at the selected ground-borne noise sensitive receiver (GBNSR) on 24 January 2022.

1.2 Purpose of This Plan

1.2.1 This Report presents the measurement results of the performance test at the selected measurement location, and the operational ground-borne railway noise levels evaluated based on the measurement results to demonstrate the compliance of these noise levels with the relevant noise criteria in the approved SCL (MKK-HUH) EIA Report.

1.3 Structure of This Report

1.3.1 This Report comprises the following sections:

- Section 1 presents the background information.
- Section 2 presents the train operation parameters during performance test.
- Section 3 presents the details of the performance test on operational ground-borne railway noise.
- Section 4 presents the conclusion.

2 TRAIN OPERATION PARAMETERS DURING PERFORMANCE TEST

2.1 Train Operation Parameters

2.1.1 The operation parameters for the ground-borne railway noise performance test, including train configuration and train speed, aligns with those to be implemented for future operation of SCL(MKK-HUH).

2.1.2 As stipulated in EP Condition 2.15, the maximum train frequency operating on the Project from 0700 to 2300 hours and from 2300 to 0700 hours of the following day shall not exceed 30 trains and 24 trains per hour in each direction respectively. The difference of maximum train frequency between daytime and night-time is 6 trains per hour in each direction. As the other operation factors remain constant, and the daytime railway ground-borne noise level would be about 1 dB(A) higher than that during night-time operation, while the night-time noise criterion is 10 dB(A) more stringent than daytime, the compliance of night-time criterion would also represent the compliance of day-time noise criterion. In addition, considering that the intrusive noise and vibration from background vibration induced by road traffic and human activities is expected to be higher in daytime and evening period, the measurement was therefore conducted during night-time period only. Ground-borne noise impact during night-time period was be evaluated by the adoption of appropriate correction factors to account for train frequency.

2.1.3 According to various literatures (Ref: "*Track-Based Control Measures for Ground Vibration – The Influence of Quasi-Static Loads and Dynamic Excitation*", and "*Ground Vibration Induced by Railway Traffic – The Influence of Vehicle Parameters*", Noise and Vibration Mitigation for Rail Transit System, NNFM 118, Springer 2012), train loading has little effect on vibration in audible frequency range, and thus unloaded trains were employed for performance test, same testing approach as adopted for SCL- Tai Wai to Hung Hom Section [SCL (TAW-HUH)], South Island Line (East) and Kwun Tong Line Extension.

2.2 Evaluation of Railway Noise Levels from Measurement Results of Performance Test

2.2.1 Assumptions of train operation for evaluating ground-borne railway noise from noise measurement results of performance test are same as those stipulated in EP Condition 2.15, i.e. the maximum train frequency operating in the Project from hours 0700 to 2300 shall not exceed 30 trains per hour in each direction. The maximum train frequency operating in the Project from hours 2300 to 0700 of the following day shall not exceed 24 trains per hour in each direction.

2.2.2 Details of the ground-borne railway noise performance test are presented in **Section 3** of this Report.

2.3 Implementation of Noise Mitigation Measures

2.3.1 Final Operational Ground-borne Noise Mitigation Measures Plan (OGNMMP) was deposited to DEP in accordance with Section 2.16 of the EP (EP No: EP-437/2012/A) in June 2017 and was subsequently approved by EPD. The approved OGNMMP reviewed the assumptions adopted in the approved SCL(MKK-HUH) EIA Report and updated the ground-borne noise prediction based on the measured LSR results. The ground-borne noise levels predicted in the Final OGBNMMP have been reviewed (**Appendix A** refers) and the predicted ground-borne railway noise levels ($L_{eq,30min}$) at the representative GBNSR (i.e. Wing Fung Building) are below 45dB(A) during daytime and night-time periods, comparing with the daytime noise criteria of 55dB(A) and night-time noise criteria of 45dB(A), no mitigation measures are therefore required.

3 OPERATIONAL GROUND-BORNE RAILWAY NOISE PERFORMANCE TEST

3.1 Operational Ground-borne Railway Noise Criteria

3.1.1 With reference to the Technical Memorandum for the Assessment of Noise from Places other than Domestic Premises, Public Places or Construction Sites (IND-TM) under the Noise Control Ordinance (NCO), the criteria for noise transmitted primarily through the structural elements of the building or buildings should be 10dB(A) less than the relevant acceptable noise level (ANL). The same criteria are applied to all residential buildings, schools, clinics, hospitals, temples and churches.

3.1.2 The operational ground-borne railway noise criteria for the representative ground-borne noise sensitive receivers (GBNSRs) along the Project alignment are presented in **Table 3.1** below

Table 3.1 Operational Ground-borne Railway Noise Criteria

GBNSR Description	Ground-borne Railway Noise Criteria ($L_{eq,\ 30min}$, dB(A))					
	Day and Evening Periods (0700 to 2300 hrs)			Night-time Period (2300 to 0700 hrs)		
	A	B	C	A	B	C
Churches/temples, schools, medical clinics, libraries, courts and performing arts centres	50	55	60	(a)		
Domestic premises, hotels and hospitals	50	55	60	40	45	50

Note:
(a) No sensitive use during this period.

3.2 Ground-borne Noise Measurement Locations

3.2.1 Representative GBNSR within 300m of the Project boundary were selected and assessed in the approved SCL (MKK-HUH) EIA Report and SCL (HHS) EIA Report, and the Final Operation Ground-borne Noise Mitigation Measures Plan (OGNMMP) (June 2017), according to the criteria set out in the Annex 13 of *Technical Memorandum on Environmental Impact Assessment Process* (EIAO-TM).

3.2.2 According to Section 5.4 of the approved EM&A Manuals for SCL (MKK-HUH) and SCL (HHS), a noise commissioning test should be conducted by the ET prior to the operation of the entire SCL (MKK-HUH) Section to confirm the compliance of the operational ground-borne railway noise levels with the NCO noise criteria. The noise commissioning test should be performed at the selected GBNSR – Wing Fung Building as listed in Table 5.1 of the approved EM&A Manual for SCL (MKK-HUH) and Table 9.2 of the approved EM&A Manual for SCL (HHS).

3.2.3 The selected GBNSR for commissioning test is presented in **Table 3.2** with the location shown in **Figure No. C11033B/C/SCL/ACM/M53/036**.

Table 3.2 Measurement Location for Operational Ground-borne Railway Noise Performance Test

Measurement Station ID	NSR ID in EIA	Location	Floor with Measurement Equipment	Use	Criterion, dB(A)	
					$L_{eq,\ 30min}$ (day)	$L_{eq,\ 30min}$ (night)
GN1	HH2	Wing Fung Building	G/F (Lowest Sensitive Floor at 1/F)	Residential	55	45

3.3 Measurement Instrumentation and Procedures

3.3.1 According to the requirements of the Technical Memorandum (TM) issued under the NCO, sound level meters adopted for measurement comply with the International Electrotechnical

Commission Publications 651: 1979 (Type 1) and 804: 1985 (Type 1) specifications and other noise measuring and analysis instrumentation are of a comparable professional quality. Immediately prior to and following each noise measurement the accuracy of the sound level meter was checked using an acoustic calibrator generating a known sound pressure level at a known frequency. Measurement was accepted as valid with the difference between the calibration levels obtained before and after each noise measurement was less than 1.0 dB.

3.3.2 The measurement instruments adopted for the ground-borne noise commissioning test met the above requirements and are listed in **Table 3.3**. The calibration records of the instruments are provided in **Appendix B**.

Table 3.3 Measurement Instrumentation

Instrument	Model No.
Integrating Sound Level Meter	Svantek SVAN 958A (Serial No.: 59121)
Acoustic Calibrator	Svantek SV30A (Serial No.: 10814)
Vibration Calibrator	IMI Sensors 699B02 (Serial No.: 2775)

3.3.3 Ground-borne noise measurement was conducted indoor inside the building, with microphone and an accelerometer set up at each selected monitoring location. The microphone was placed inside Wing Fung building at around 1.2m above floor level. The vibration levels collected from accelerometer were used to determine the train passby. Photograph showing measurement setup at Wing Fung Building is provided in **Appendix C**.

3.4 Measurement Parameters

3.4.1 Noise levels (including L_{eq}) and vibration levels were measured and logged at 1 second interval for the necessary periods at GBNSR location. The periods need to cover at least three passbys of uptrack trains, three passbys of downtrack trains (i.e. no less than 6 passbys in total) and representative background noise level before/after each passby. Site observation was carried out during background and train passby noise measurement in order to detect whether the noise measurements were affected by other extraneous noise and to determine the representative of the measured noise levels.

3.4.2 Typically, train passby duration including head-tail period was determined when train noise was being perceived. However, if noise of train passby could not be perceived, it would be determined when there was an increase of vibration levels recorded by the accelerometer placed at the testing location. Vibration levels above background generally indicate train passby and its duration was checked against the train running schedule provided by MTR. Vibration levels were therefore extracted for identification of train passby time and duration when train noise could not be perceived.

3.5 Data Analysis and Evaluation of Ground-borne Railway Noise Impact

3.5.1 The collected noise data of train passbys and the evaluation of ground-borne noise impact ($L_{eq,30min}$) followed the steps as presented below.

i. Train passby data was extracted according to the recorded vibration levels and train running schedule provided by MTR. Noise level during a passby event was considered representative if the noise measurement was not affected by other extraneous noise.

ii. Background noise level was determined from averaging the noise level of over a representative period that was not affected by train GBN and extraneous noise.

iii. As the measured event noise levels would be used for further evaluation of $L_{Aeq,30min}$ to check against the relevant noise criteria, the measured event noise level should be corrected to account for the contribution from background. If the difference between the noise level during a passby event and the corresponding background noise level is equal to or greater than 3.0 dB(A), the measurements indicate that the event noise level is equal to or above the background noise level. In this case, the background corrected noise level could be determined by the following equation:

$$L_{eq,passby} = 10 \times log\left(10^{Leq,during\ passby/10} - 10^{Leq,background/10}\right)$$

Where $L_{eq,during\ passby}$ is the noise level during train passby, dB(A)
$L_{eq,background}$ is the background noise level, dB(A)
$L_{eq,passby}$ is the background corrected noise level, dB(A)

If the difference between the noise level during the passby event and the background noise level is less than 3.0 dB(A), the measurements indicate that the event noise level is below the background noise level and the accuracy of the above equation would be reduced and any background correction, if made, should only be regarded as approximate. In such case, as a conservative approach, no background correction would be applied for the measured noise level during the passby event.

iv. Sound Exposure Level (SEL) for uptrack and downtrack trains in 30 minutes was determined by the following equation:

$$SEL_{Up} = L_{eq,passby,Up} + 10 \times log\left(T_{Up}\right) + 10 \times log\left(N_{Up}\right)$$
$$SEL_{Down} = L_{eq,passby,Down} + 10 \times log(T_{Down}) + 10 \times log(N_{Down})$$

Where $T_{up/Down}$ is the train passby duration, second
$N_{Up/Down}$ is number of train passby in 30 minutes

v. Ground-borne railway noise level ($L_{eq,30min}$) for compliance check was determined by the following equations:

$$L_{eq,30min} = 10 \times log\left(10^{SEL_{Up}/10} + 10^{SEL_{Down}/10}\right) - 10 \times log(1800)$$

vi. A floor-to-floor attenuation of 2 dB reduction per floor should be applied to the predicted ground-borne railway noise level ($L_{eq,30min}$) for the measurement was not conducted at the lowest noise sensitive floor.

3.6 Evaluation Results of Performance test

3.6.1 As discussed in **Section 3.5.1 (iii)**, correction for background noise would generally be adopted to account for the contribution of background noise. During the course of measurement, train noise could not be perceived at the measurement locations during train passby. As shown in the time history and noise measurement results recorded at the measurement location (**Appendix D** refers), the measured noise levels during train passby were in general similar to the background noise levels. In such cases, the change of noise levels during train passby were likely due to fluctuation of background noise instead of the ground-borne railway noise. Since all measured noise levels during train passby were less than 3 dB(A) above the background noise levels, as a conservative approach, all the measured noise levels during train passby were not corrected for background noise in evaluating the ground-borne railway noise level (i.e. with inclusion of background noise) for noise criteria compliance check. It is anticipated that the actual operational ground-borne railway noise levels at the GBNSR would be substantially lower than the evaluation results. Based on this conservative approach, the evaluated operational ground-borne railway noise levels, with the inclusion of background noise, Wing Fung Building comply with the noise criteria in both daytime/evening and night-time periods.

3.6.2 The evaluation results during daytime/evening and night-time periods are summarised in **Table 3.4** and **Table 3.5** respectively. Measurement results and detailed calculations are provided in **Appendix D**.

Table 3.4 Ground-borne Railway Noise Calculation Results during Daytime/Evening Period (0700-2300 hrs)

Measurement Station ID. / NSR ID in EIA	Location	Train Frequency per 30 minutes	Ground-borne Railway Noise Level(1)(2), $L_{eq\ 30min}$, dB(A)	Noise Criterion, $L_{eq\ 30min}$, dB(A)	Compliance (Y/N)
GN1 / HH2	Wing Fung Building	15 up and 15 down	<44 (3)	55	Y

Notes:

(1) Train passby data was extracted according to the recorded vibration levels and train running schedule provided by MTR. Noise level during a passby event was considered representative if the noise measurement was not affected by other extraneous noise. Background noise level was determined from averaging the noise levels of a representative period (approx. 1 minute) before or after the train passby that was not affected by train GBN and extraneous noise. Since all measured noise levels during train passby were less than 3dB(A) above the background noise levels, as a conservative approach, all the measured noise levels during train passby were not corrected for background noise in evaluating the $L_{eq,\ 30min}$. It is therefore anticipated that the actual operational ground-borne railway noise levels at the GBNSRs would be substantially lower than the evaluation results.

(2) A worst-case scenario with the adoption of maximum SEL measured for prediction has been considered.

(3) The ground-borne noise level was measured on G/F while 1/F is the lowest sensitive floor. 2 dB(A) floor to floor attenuation was applied.

Table 3.5 Ground-borne Railway Noise Calculation Results during Night-time Period (2300 – 0700 hrs)

Measurement Station ID. / NSR ID in EIA	Location	Train Frequency per 30 minutes	Ground-borne Railway Noise Level(1)(2), $L_{eq\ 30min}$, dB(A)	Noise Criterion, $L_{eq\ 30min}$, dB(A)	Compliance (Y/N)
GN1 / HH2	Wing Fung Building	12 up and 12 down	<43 (3)	45	Y

Notes:

(1) Train passby data was extracted according to the recorded vibration levels and train running schedule provided by MTR. Noise level during a passby event was considered representative if the noise measurement was not affected by other extraneous noise. Background noise level was determined from averaging the noise levels of a representative period (approx. 1 minute) before or after the train passby that was not affected by train GBN and extraneous noise. Since all measured noise levels during train passby were less than 3dB(A) above the background noise levels, as a conservative approach, all the measured noise levels during train passby were not corrected for background noise in evaluating the $L_{eq,\ 30min}$. It is therefore anticipated that the actual operational ground-borne railway noise levels at the GBNSRs would be substantially lower than the evaluation results.

(2) A worst-case scenario with the adoption of maximum SEL measured for prediction has been considered.

(3) The ground-borne noise level was measured on G/F while 1/F is the lowest sensitive floor. 2 dB(A) floor to floor attenuation was applied.

3.7 Cumulative Ground-borne Railway Noise Impact

3.7.1 Based on the performance test results in **Tables 3.4** and **3.5** above, the cumulative ground-borne railway noise levels at Wing Fung Building have been evaluated to check the compliance of noise criteria and the prediction results are presented in **Table 3.6**.

Table 3.6 Cumulative Ground-borne Railway Noise Calculation

Time Period	Location	Ground-borne Railway Noise Level, $L_{eq\ 30min}$, dB(A)		Predicted Cumulative Noise Level, dB(A)	NCO Noise Criteria, dB(A) (ANL)	Compliance (Y/N)
		SCL (MKK-HUH)	SCL (TAW - HUH) + SCL(HHS) + KTE			
Daytime/ Evening (0700-2300 hrs)	Wing Fung Building	<45 (1)	<45(2)	<55(1)	55	Y

Time Period	Location	Ground-borne Railway Noise Level, $L_{eq\ 30min}$, dB(A)		Predicted Cumulative Noise Level, dB(A)	NCO Noise Criteria, dB(A) (ANL)	Compliance (Y/N)
		SCL (MKK-HUH)	SCL (TAW - HUH) + SCL(HHS) + KTE			
Night-time (2300-0700hrs)		<43 (1)	<42(2)	<45(1)	45	Y

Notes:

(1) Since the measured noise levels during train passby were less than 3dB(A) above the background noise levels, as a conservative approach, the measured noise levels during train passby were not corrected for background noise in evaluating the Leq, 30min. It is therefore anticipated that the actual operational ground-borne railway noise levels and the actual cumulative noise levels would be substantially lower than the evaluation results and comply with the NCO noise criteria.

(2) Reference is made to the approved Ground-borne Railway Noise Performance Test Report for SCL(TAW-HUH) and SCL(HHS). Based on the findings presented in this Test Report, the actual operational ground-borne railway noise level was substantially lower than the evaluation results.

4 CONCLUSION

4.1.1 Ground-borne noise performance test was conducted at Wing Fung Building in January 2022.

4.1.2 The results show that ground-borne railway noise levels at Wing Fung Building comply with the stipulated noise criteria in daytime/evening and night-time periods. Based on the findings of the ground-borne railway noise performance test, there would be no adverse railway noise impact arising from the operation of the Project.

Figure

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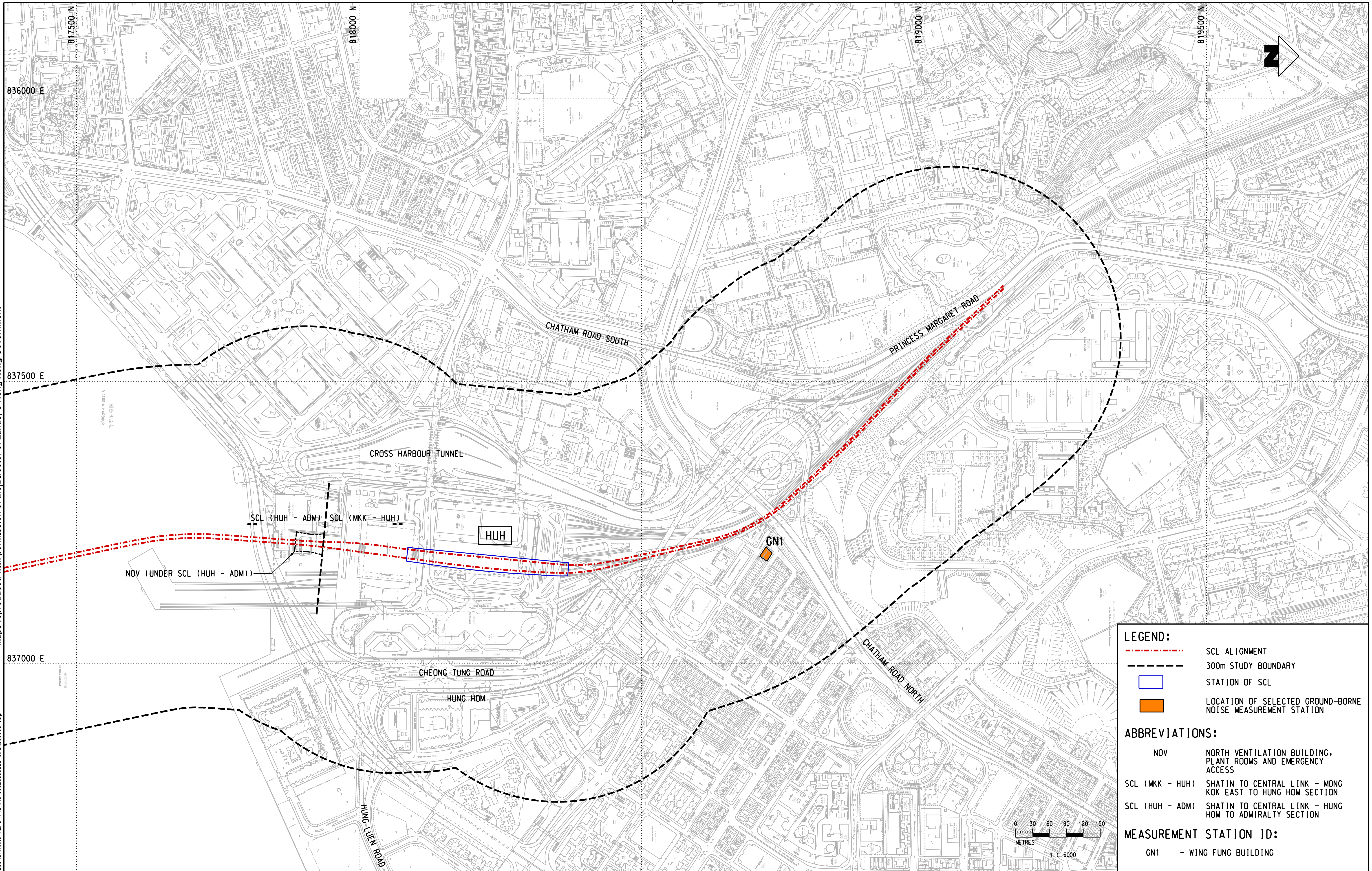

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MTR

SHATIN TO CENTRAL LINK

ORIGINATOR

AECOM

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TITLE

C11033B

SCL (MKK-HUH)

MEASUREMENT LOCATION FOR OPERATIONAL GROUND-BORNE RAILWAY NOISE PERFORMANCE TEST

SCALE 1 : 6000 (A3)

FIGURE NO. C11033B/C/SCL/ACM/M53/036

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Appendix A

Excerpt of Final Operation Ground-borne Noise Mitigation Measures Plan (June 2017)

3 Review of Operational Ground-Borne Noise PREDICTION

3.1 LSR Adopted in the Approved EIA Report

3.1.1 The LSR determines the vibration levels or attenuation in the ground as a function of distance caused by an incoherent line source of unit force point impacts.

3.1.2 The LSR values adopted in ground-borne noise assessment of SCL (MKK-HUH) EIA Report were referenced from the data of the West Island Line (WIL) EIA Study (EIA Register No. AEIAR-126/2008). The LSR for WIL EIA Study was determined based on the results of borehole impact tests performed in rock, soil and close to the rock head both on the soil side and the rock side, with receiver vibration data taken on surface at various setback distances.

3.2 Review of LSR Values

3.2.1 The test carried out at the footpath adjoining International Funeral Parlour was specifically aimed at determining the LSR values for vibration propagating through the ground of soil type.

3.2.2 The LSR values determined at the footpath adjoining International Funeral Parlour are compared with those used in the SCL EIA study for the area of same ground type conditions (i.e. WIL D095 Rockhead Depth = 23m, Hole Depth = 10.4m). The EIA PSR values are shown in **Appendix F**. To allow a better comparison, **Appendix G** shows the LSR values determined at measurement locations at a distance similar to EIA study. A summary of observation is presented in **Table 3.1**.

Table 3.1 Comparison between Measurement Data and WIL Data

ID	Location	LSR data adopted in EIA Study	Observation
N/A	Footpath adjoining International Funeral Parlour	WIL D095 Rockhead Depth=23m Hole Depth=10.4m	Measured LSR values at both 42m & 46m are about 15dB lower than the EIA LSR values at most frequency bands.

3.2.3 It should be noted that the WIL EIA LSR was measured in the borehole while the current test was measured inside the tunnel. The decoupling effect of vibration propagation between the media of tunnel structure and the ground soil, i.e. the tunnel coupling loss (TCL), would be different to that between the media of borehole casing and the ground soil. Thus the LSR result measured in the impact test should comprise the loss due to decoupling of the actual tunnel structure. The factor of tunnel coupling loss applied in the EIA prediction for the structure at the NSR HH2 was -3dB. Therefore, apart from different testing method and geological profile at WIL D095 and this measurement, such 3dB tunnel coupling loss also accounts for difference between the LSR adopted in the EIA Report and measured LSR.

3.3 Operational Ground-borne Noise Prediction

3.3.1 Ground-borne noise assessment has been updated at HH2, at which the highest noise levels (i.e. $L_{eq,30min}$ 19.6dB(A) as shown in Appendix 7.6 of SCL(MKK-HUH) EIA Report) were predicted in the EIA stage, according to the LSR measurement results at the footpath adjoining International Funeral Parlour. Assessment methodology follows the prediction methodology recommended by the FTA Manual, which was adopted in the EIA Reports. The prediction results are summarised in **Table 3.2**. Sample calculation is given in **Appendix H**.

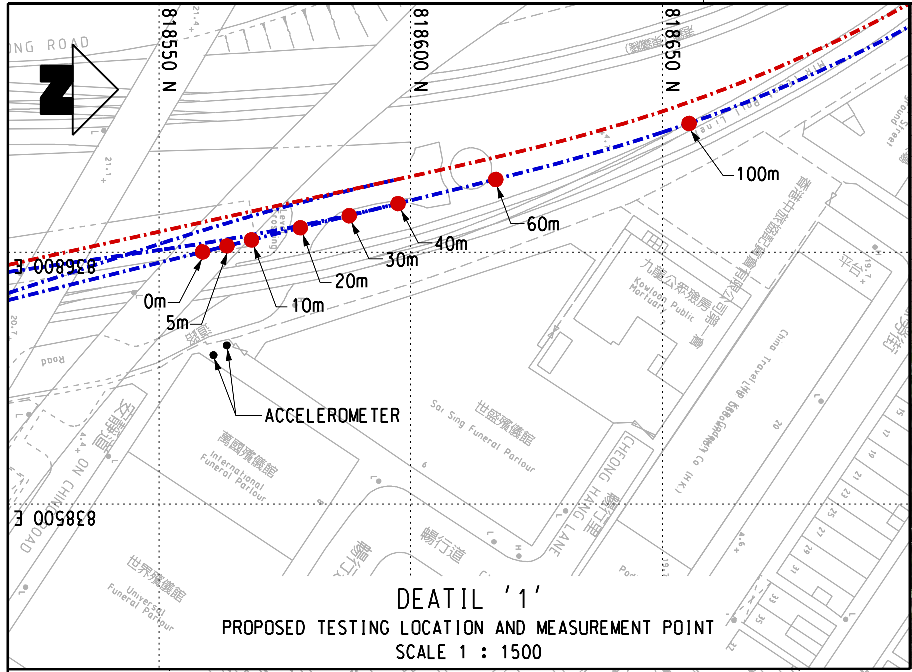
Table 3.2 Ground-borne Noise Prediction Results (Night-time Period)

GBNSR	Descrip-tion	EIA Prediction (unmitigated scenario), $L_{eq,30min}$ dB(A)	Updated Prediction[(1)] (unmitigated scenario , based on measured LSR data), $L_{eq,30min}$ dB(A)	Difference Between EIA and Updated Prediction, $L_{eq,30min}$ dB(A)	Ground-borne Noise Levels, $L_{eq,30min}$ dB(A)	Night-time Noise Criterion, $L_{eq,30min}$ dB(A)
HH2	Wing Fung Building	20	7	-13	38[(2)]	45

Note:
(1) Prediction results are based on the LSR results obtained at the footpath adjoining International Funeral Parlour.
(2) According to Table 4.7 of Supporting Document for Application of VEP (Application No. VEP-370/2012) (June 2012), the predicted cumulative ground-borne noise level at HH2 (i.e. HUH-1-3) is 38dB(A). The update of ground-borne noise level at HH2 due to the Project from 20dB(A) to 7dB(A) remains to be insignificant and would not have contribution to the cumulative noise level (i.e. 38dB(A)), and thus the cumulative ground-borne noise level at HH2 as shown in Table 4.7 of Supporting Document for Application of VEP (Application No. VEP-370/2012) (June 2012) remains valid.

3.3.2 As mentioned in **Section 3.2.3**, the measured LSR comprises of tunnel couple loss which is about 3dB as adopted in the EIA prediction. The updated calculation therefore excluded the tunnel coupling loss in the calculation to avoid double count of the effect.

3.3.3 Results indicate that the measured LSR values at actual ground condition would give lower ground-borne noise levels than EIA predictions which are well below the noise criteria. In addition, other assumptions such as Building Coupling loss, Speed and Turnout Adjustment as adopted in the EIA Report have been reviewed and there are no changes in these assumptions. It is therefore expected that the ground-borne noise levels at other NSRs would also be subject to the noise levels as predicted in the EIA and thus are well below the noise criteria, and noise mitigation measures are not required.



DEATIL '1'

PROPOSED TESTING LOCATION AND MEASUREMENT POINT

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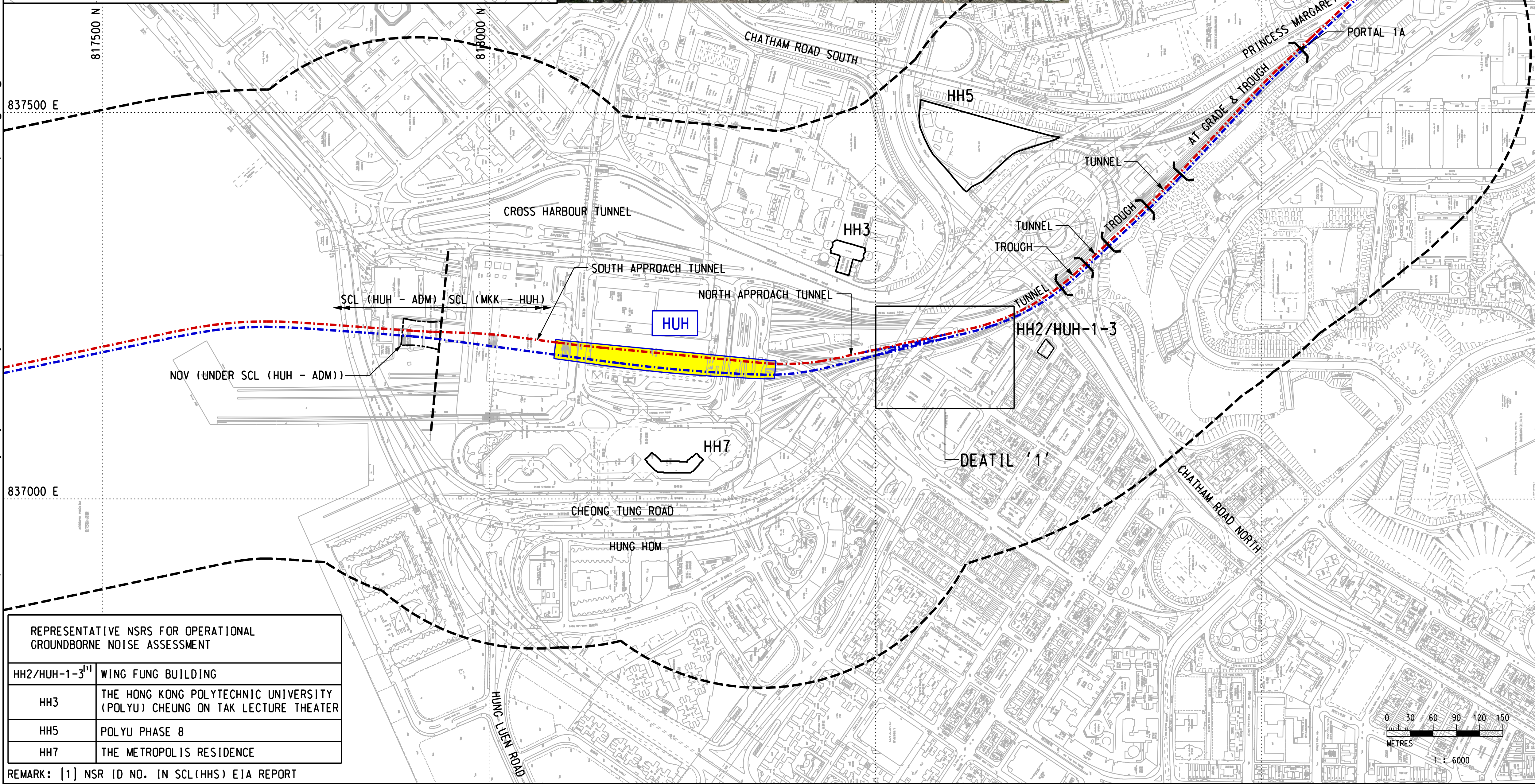

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REPRESENTATIVE NSRS FOR OPERATIONAL GROUNDBORNE NOISE ASSESSMENT	
HH2/HUH-1-3[1]	WING FUNG BUILDING
HH3	THE HONG KONG POLYTECHNIC UNIVERSITY (POLYU) CHEUNG ON TAK LECTURE THEATER
HH5	POLYU PHASE 8
HH7	THE METROPOLIS RESIDENCE

REMARK: [1] NSR ID NO. IN SCL(HHS) EIA REPORT

LEGEND:

(blue dash-dot line)	SCL ALIGNMENT (DOWN TRACK)
(red dash-dot line)	SCL ALIGNMENT (UP TRACK)
•	ACCELEROMETER
(red dot)	IMPACT POINTS
(dashed line)	300m STUDY AREA
(yellow box)	PROPOSED STATION OF SCL
HH7	NSRS FOR OPERATIONAL GROUNDBORNE NOISE ASSESSMENT

ABBREVIATIONS:

NOV	NORTH VENTILATION BUILDING, PLANT ROOMS AND EMERGENCY ACCESS
SCL (MKK - HUH)	SHATIN TO CENTRAL LINK - MONG KOK EAST TO HUNG HOM SECTION
SCL (HUH - ADM)	SHATIN TO CENTRAL LINK - HUNG HOM TO ADMIRALTY SECTION

REV	DESCRIPTION	BY	DATE	APPROVED	REV	DESCRIPTION	BY	DATE	APPROVED

DRAWN	ZFX
DESIGNED	---
CHECKED	LCR
APPROVED	---
DATE	30/NOV/2016

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MTR

SHATIN TO CENTRAL LINK

ORIGINATOR

AECOM

CADD REF. C11033B_C_SCL_ACM_M53_011A.dgn

TITLE

C11033B
SCL (MKK-HUH)
LOCATIONS OF NOISE SENSITIVE RECEIVERS (GROUNDBORNE) AND PROPOSED LSR MEASUREMENT LOCATION

SCALE 1 : 6000 (A3)

FIGURE NO. C11033B/C/SCL/ACM/M53/011

REV. A

PLOT DRV: v:\ustnset\MTR\PLOTDRIVER\WINDOWS\A3 COLOUR.plt
MODELNAME: Default
FILENAME: P:\projects\60280233\DRAWING\REPORT\ENV\C11033B_C_SCL_ACM_M53_011A.dgn
PRINTED BY: ZENGFX 2017/1/3 16:46:26

Appendix B

Calibration Certificates of Monitoring Equipment

MAXLAB

CALIBRATION CERTIFICATE

Certificate Information

Date of Issue	31-Oct-2020	**Certificate Number**	MLCN202867S

Customer Information

Company Name	Wilson Accoustics Limited
Address	Unit 601, Block A, Shatin Industrial Centre, Yuen Shun Circuit, Shatin, N. T., Hong Kong

Equipment-under-Test (EUT)

Description	Sound & Vibration Analyser
Manufacturer	Svantek
Model Number	SVAN 958A
Serial Number	59121
Equipment Number	--

Calibration Particular

Date of Calibration	31-Oct-2020		
Calibration Equipment	4231(MLTE008) / AV200063 / 23-Jun-2023		
Calibration Procedure	MLCG00, MLCG15		
Calibration Conditions	Laboratory	Temperature	23 °C ± 5 °C
		Relative Humidity	55% ± 25%
	EUT	Stabilizing Time	Over 3 hours
		Warm-up Time	10 minutes
		Power Supply	Internal battery
Calibration Results	Calibration data were detailed in the continuation pages.		

Approved By & Date

K.O. Lo 31-Oct-2020

Statements

* Calibration equipment used for this calibration are traceable to national / international standards.
* The results on this Calibration Certificate only relate to the values measured at the time of the calibration and the uncertainties quoted will not include allowance for the EUT long term drift, variation with environmental changes, vibration and shock during transportation, overloading, mishandling, misuse, and the capacity of any other laboratory to repeat the measurement.
* MaxLab Calibration Centre Limited shall not be liable for any loss or damage resulting from the use of the EUT.
* The copy of this Certificate is owned by MaxLab Calibration Centre Limited. No part of this Certificate may be reproduced without the prior written approval of MaxLab Calibration Centre Limited.

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MaxLab Calibration Centre Limited
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Unit B, 9/F., Boldwin Industrial Bldg., 16-18 Wah Sing Street, Kwai Chung, N.T., Hong Kong Tel: (852) 2116 1380 Fax: (852) 2264 6480 Email: info@maxlab.com.hk

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Certificate No. MLCN202867S

Calibration Data

Channel / Mode	Filter / Detector	Range	EUT Reading	Standard Reading	EUT Error	Calibration Uncertainty
CH4 / Sound	A / FAST (1 kHz Input)	105 dB	94.0 dB	94.0 dB	0.0 dB	0.2 dB
		130 dB	94.0 dB	94.0 dB	0.0 dB	0.2 dB
			114.0 dB	114.0 dB	0.0 dB	0.2 dB
	C / FAST (1 kHz Input)	105 dB	94.0 dB	94.0 dB	0.0 dB	0.2 dB
		130 dB	94.0 dB	94.0 dB	0.0 dB	0.2 dB
			114.0 dB	114.0 dB	0.0 dB	0.2 dB
	LIN / FAST (1 kHz Input)	105 dB	94.0 dB	94.0 dB	0.0 dB	0.2 dB
		130 dB	94.0 dB	94.0 dB	0.0 dB	0.2 dB
			114.0 dB	114.0 dB	0.0 dB	0.2 dB
	A / SLOW (1 kHz Input)	105 dB	94.0 dB	94.0 dB	0.0 dB	0.2 dB
		130 dB	114.0 dB	114.0 dB	0.0 dB	0.2 dB
	C / SLOW (1 kHz Input)	105 dB	94.0 dB	94.0 dB	0.0 dB	0.2 dB
		130 dB	114.0 dB	114.0 dB	0.0 dB	0.2 dB
	LIN / SLOW (1 kHz Input)	105 dB	94.0 dB	94.0 dB	0.0 dB	0.2 dB
		130 dB	114.0 dB	114.0 dB	0.0 dB	0.2 dB
	A / IMPULSE (1 kHz Input)	105 dB	94.0 dB	94.0 dB	0.0 dB	0.2 dB
		130 dB	114.0 dB	114.0 dB	0.0 dB	0.2 dB
	C / IMPULSE (1 kHz Input)	105 dB	94.0 dB	94.0 dB	0.0 dB	0.2 dB
		130 dB	114.0 dB	114.0 dB	0.0 dB	0.2 dB
	LIN / IMPULSE (1 kHz Input)	105 dB	94.0 dB	94.0 dB	0.0 dB	0.2 dB
		130 dB	114.0 dB	114.0 dB	0.0 dB	0.2 dB

- END -

Calibrated By : Dan
Date : 31-Oct-2020

Checked By : K.O. Lo
Date : 31-Oct-2020

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CALIBRATION CERTIFICATE

Certificate Information

Date of Issue	28-Sep-2021	**Certificate Number**	MLCN212726S

Customer Information

Company Name	Wilson Accoustics Limited
Address	Unit 601, Block A, Shatin Industrial Centre, Yuen Shun Circuit, Shatin, N. T., Hong Kong

Equipment-under-Test (EUT)

Description	Acoustic Calibrator
Manufacturer	Svantek
Model Number	SV 30A
Serial Number	10814
Equipment Number	--

Calibration Particular

Date of Calibration	28-Sep-2021		
Calibration Equipment	4231(MLTE008) / AV200063 / 23-Jun-23 1351(MLTE049) / MLEC21/06/02 / 5-Jun-22		
Calibration Procedure	MLCG00, MLCG15		
Calibration Conditions	Laboratory	Temperature	23 °C ± 5 °C
		Relative Humidity	55% ± 25%
	EUT	Stabilizing Time	Over 3 hours
		Warm-up Time	Not applicable
		Power Supply	Internal battery
Calibration Results	Calibration data were detailed in the continuation pages. All calibration results were within EUT specification.		

Approved By & Date

K.O. Lo 28-Sep-2021

Statements

* Calibration equipment used for this calibration are traceable to national / international standards.
* The results on this Calibration Certificate only relate to the values measured at the time of the calibration and the uncertainties quoted will not include allowance for the EUT long term drift, variation with environmental changes, vibration and shock during transportation, overloading, mishandling, misuse, and the capacity of any other laboratory to repeat the measurement.
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Certificate No. MLCN212726S

Calibration Data

EUT Setting	Standard Reading	EUT Error from Setting	Calibration Uncertainty	EUT Specification
94 dB	94.0 dB	0.0 dB	0.15 dB	± 0.3 dB
114 dB	114.0 dB	0.0 dB	0.15 dB	± 0.3 dB

- END -

Calibrated By : Dan
Date : 28-Sep-21

Checked By : K.O. Lo
Date : 28-Sep-21

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~ Calibration Certificate ~

Model Number: 699B02

Serial Number: 2775

Description: Portable Handheld Shaker

Manufacturer: IMI

Customer:

P.O. :

Method : Back-to-Back Comparison (AT701-1)

Calibration Data

Operating Frequency: 159.3 Hz.

Test Point Voltage: 101.4 mVAC

Acceleration Level: 1.00 g's rms
9.842 m/s^2

Temperature: 74 °F (23 °C)

Relative Humidity: 43 %

Condition of Unit

As Found: n/a
As Left: New Unit, In Tolerance

Notes

1. Calibration is N.I.S.T. Traceable through Project 684/O-0000000851 and PTB Traceable through Project 17016.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 10012-1, ANSI/NCSL Z540.3 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Measurement uncertainty (95% confidence level with coverage factor of 2) for amplitude at operating frequency is +/-1.6%.

Equipment Used For Calibration

Manufacturer	Description	Model#	Serial No.	Cal Date	Due Date
PCB Piezotronics	Accelerometer	353B34	NC802	4/15/2021	4/15/2022
PCB Piezotronics	ICP Signal Conditioner	442A103	NC896	10/02/2020	10/01/2021
National Instruments	Acquisition	PCI-6351	NC1428	12/21/2020	12/21/2021

Technician: *Darius Story* DS

Date: 09/10/21

Due Date:

ilac-MRA A2LA ACCREDITED
CALIBRATION CERT #1862.02

IMI SENSORS
A PCB PIEZOTRONICS DIV.

Headquarters: 3425 Walden Avenue, Depew, NY 14043
Calibration Performed At: 10869 Highway 903, Halifax, NC 27839
TEL: 888-684-0003 FAX: 716-684-3823 www.imi-sensors.com hh1 2021170733.50

Appendix C

Ground-borne Noise Measurement – Photograph of Measurement Setup

Appendix C Ground-borne Railway Noise Measurement - Photograph of Measurement Setup

GN1 – Wing Fung Building

Appendix D

Ground-borne Railway Noise Measurement Results and Detailed Calculation

Appendix D Ground-borne Railway Noise Measurement Results and Detailed Calculation

Ground-borne Noise Measurement Results and Detailed Calculation (Without Background Correction)

Measurement Location: **Wing Fung Building (G/F)**
Measurement Date and Time: **1/24/2022 02:30 to 03:20**

GBNSR	Train&Direction	Passby No.	Measured Event(2) Leq, dB(A) [A]	Background Noise Level, dB(A) [B]	[A] - [B], dB(A)	Event Duration, s	Correction for Event Duration, dB(A)	SEL(3), dB(A)	Max SEL, dB(A)
GN1	Uptrack	U6	47.6	46.4	1.2	38	15.8	63.4	64.5
		U7	47.4	47.4	0.0	38	15.8	63.2	
		U8	46.5	47.4	-(5)	38	15.8	62.3	
		U9	48.7	47.5	1.2	38	15.8	64.5	
		U10	50.3(4)	-	-	-	-	-	
		U11	46.5	48.0	-(5)	38	15.8	62.3	
	Downtrack	D1	47.1	47.2	-(5)	38	15.8	62.9	63.6
		D2	47.8	47.2	0.6	38	15.8	63.6	
		D3	47.4	47.2	0.2	38	15.8	63.2	
		D4	47.6	47.2	0.5	38	15.8	63.4	
		D5	46.6	47.0	-(5)	38	15.8	62.4	
		D6	47.4	46.7	0.6	38	15.8	63.2	

Notes:

(1) The train type adopted for the commissioning test is the same as the train type for future operation.

(2) Event duration includes the head-tail time period.

(3) As a conservative approach, the measured event noise levels without background correction were adopted to determine the SEL.

(4) The event is disregarded due to intrusive motorcycle noise.

(5) As the noise environment was dominated by traffic noise from surrounding roads, the fluctuation of traffic caused background noise levels higher than the measured event noise levels in some passby events.

Prediction of Groundborne Railway Noise Level During Daytime/Evening Time Period

GBNSR	Train & Direction	Max SEL, dB(A)	Time Period	Train Frequency per 30mins	Correction for Train Frequency, dB(A)	Conversion Factor to LAeq 30mins, dB(A)	BCF Correction(1)	Att_{floor} Correction(2)	LAeq 30mins, dB(A)
GN1	Uptrack	64.5	Daytime & Evening (0700-2300)	15	11.8	-32.6	0.0	-2.0	41.7
	Downtrack	63.6		15	11.8	-32.6	0.0	-2.0	40.8
Predicted Noise Level, LAeq 30mins, dB(A)									**<44**
GBN Criterion, dB(A)									**55**
Compliance									**Yes**

Notes:

(1) Measurement was conducted inside the building and thus there is no correction of buidling coupling factor (BCF).

(2) 1/F of GN1 is the lowest noise sensitive floor, and thus floor-to-floor attenuation of -2 dB(A) was applied to the measurement result.

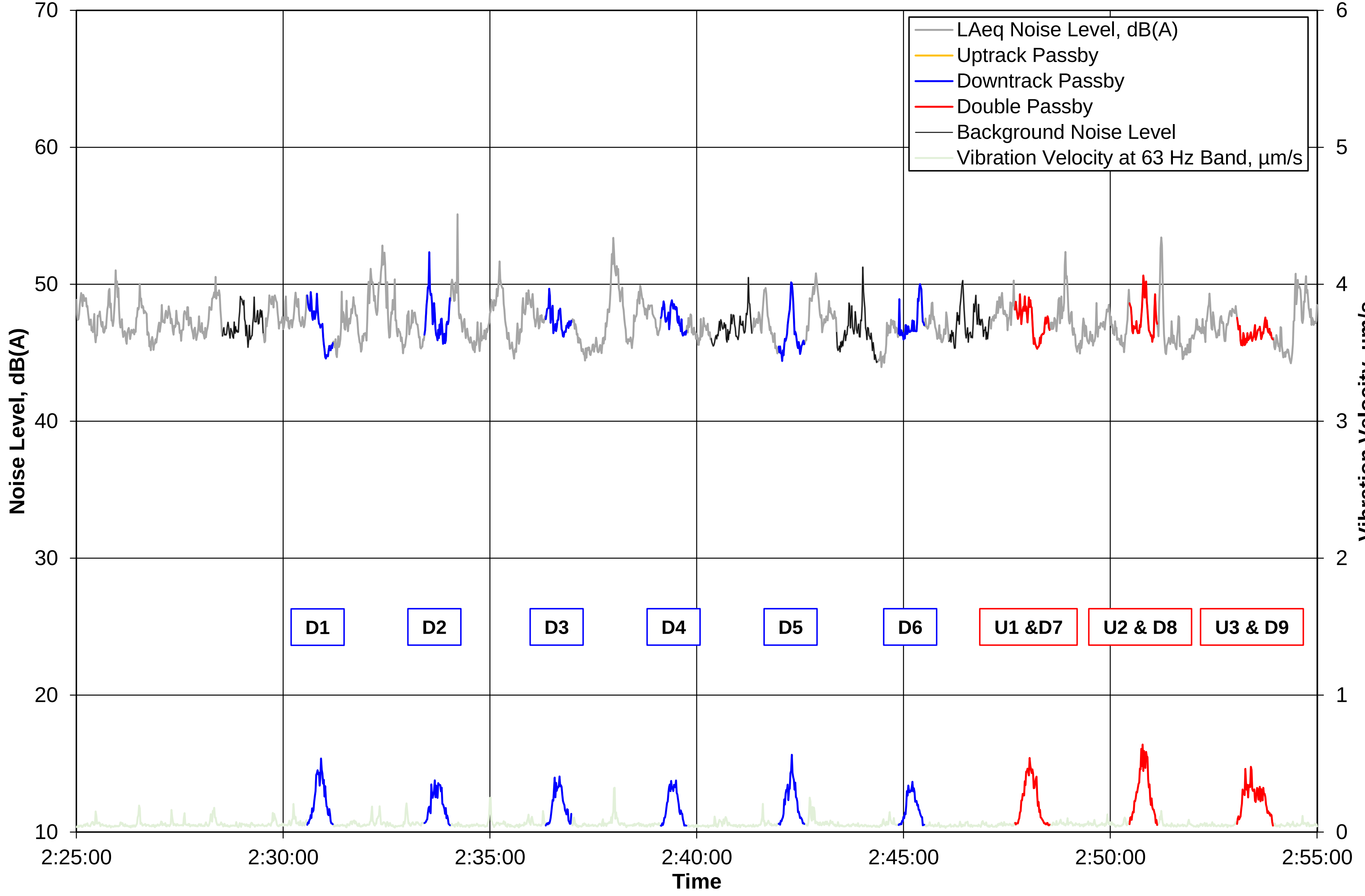
Prediction of Groundborne Railway Noise Level During Night-time Period

GBNSR	Train & Direction	Max SEL, dB(A)	Time Period	Train Frequency per 30mins	Correction for Train Frequency, dB(A)	Conversion Factor to LAeq 30mins, dB(A)	BCF Correction(1)	Att_{floor} Correction(2)	LAeq 30mins, dB(A)
GN1	Uptrack	64.5	Night-time (2300-0700)	12	10.8	-32.6	0.0	-2.0	40.7
	Downtrack	63.6		12	10.8	-32.6	0.0	-2.0	39.8
Predicted Noise Level, LAeq 30mins, dB(A)									**<43**
GBN Criterion, dB(A)									**45**
Compliance									**Yes**

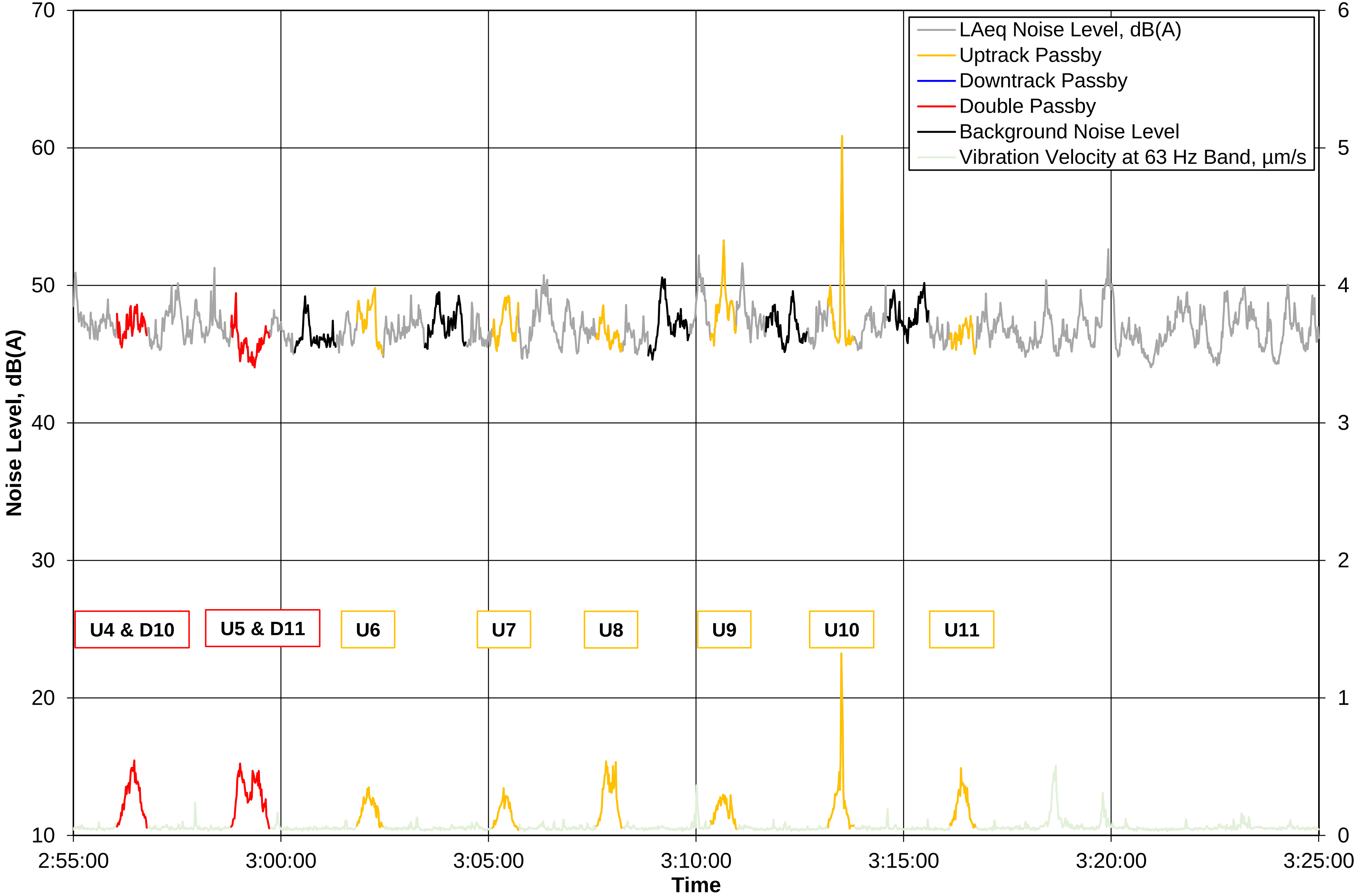
Notes:

(1) Measurement was conducted inside the building and thus there is no correction of buidling coupling factor (BCF).

(2) 1/F of GN1 is the lowest noise sensitive floor, and thus floor-to-floor attenuation of -2 dB(A) was applied to the measurement result.



LAeq Noise Level, dB(A)
Uptrack Passby
Downtrack Passby
Double Passby
Background Noise Level
Vibration Velocity at 63 Hz Band, µm/s
D1
D2
D3
D4
D5
D6
U1 &D7
U2 & D8
U3 & D9
Noise Level, dB(A)
Vibration Velocity, µm/s
Time
70
60
50
40
30
20
10
6
5
4
3
2
1
0
2:25:00
2:30:00
2:35:00
2:40:00
2:45:00
2:50:00
2:55:00


LAeq Noise Level, dB(A)
Uptrack Passby
Downtrack Passby
Double Passby
Background Noise Level
Vibration Velocity at 63 Hz Band, µm/s
Noise Level, dB(A)
Vibration Velocity, µm/s
Time
70
60
50
40
30
20
10
6
5
4
3
2
1
0
2:55:00
3:00:00
3:05:00
3:10:00
3:15:00
3:20:00
3:25:00
U4 & D10
U5 & D11
U6
U7
U8
U9
U10
U11