Central Station Main Works

Construction Noise and Vibration Monitoring Program Report

August 2022 – January 2023

Document and Revision History

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1. Introduction

1.1 Background

Sydney Metro City & Southwest – Chatswood to Sydenham Project is a new 30km metro line extending metro rail from the end of Sydney Metro Northwest at Chatswood under Sydney Harbour, through new CBD stations and southwest to Bankstown. It is due to open in 2024 with the capacity to run a metro train every two minutes each way through the centre of Sydney. The Central Station Main Works Project (CSMW) forms part of the Sydney Metro City & Southwest – Chatswood to Sydenham Project. The works are undertaken by Laing O'Rourke.

The CSMW include the installation of new platforms that will be constructed using sophisticated excavation techniques to create a cavern with an island platform, beneath Central Station's existing heavy-rail platforms 13, 14 and 15. The works include new infrastructure and the adjustments to existing infrastructure at Central Station to construct, operate and maintain the Metro Station Works. The key feature of the Central Station works include:

- a new north-south concourse for Central Station which will link the new metro station with the existing northern entrance and north concourse, a new east concourse, and the existing southern baggage tunnel; and
- adjustments to the existing Grand Concourse, Olympic Tunnel, Northern Concourse and northern entrance to Central Station.

The Central Walk works include the provision of infrastructure to provide improved connectivity and other operational enhancements throughout Central Station. The key features of the Central Walk works include:

- a new eastern entrance for Central Station on Chalmers St;
- a new east concourse for Central Station beneath existing platforms 16 to 23, which will link the new eastern entrance, the new north south concourse, existing platforms 16 to 23 and the existing Eastern Suburbs Railway (ESR) concourse; and
- provisions to enable the future construction (by others) of an extension of the Central Walk through a new west concourse and a new western entrance for Central Station.

1.2 Planning Requirements

In accordance with Minister's Condition of Approval (CoA) - C9, the Construction Monitoring Program was developed in consultation with the City of Sydney Council and the Environmental Protection Authority during the Construction Environmental Management Plan (CEMP) consultation and approval phase. Each construction monitoring program has been incorporated into the relevant CEMP sub-plan. The results of the Construction Monitoring Program will be submitted to the Secretary and relevant regulatory agencies for information. This Construction Noise and Vibration Monitoring Report covers the monitoring period from August 2022 to January 2023. The applicable CoA are shown in Table 1-1 and the applicable Environmental Protection Licence (EPL) Conditions are shown in Table 1-2 below.

Table 1-1: SSI 7400 Conditions relating to the Construction Monitoring Program

Condition	Requirement	Reference
C9	The following Construction Monitoring Programs must be prepared in consultation with the relevant government agencies identified for each Construction Monitoring Program to compare actual performance of construction of the CSSI against predicted performance. Required Construction Monitoring Programs Relevant government agencies to be consulted for each Construction Monitoring Program Noise and Vibration - EPA and Relevant Council(s) Blasting - EPA and Relevant Council(s) Water Quality - EPA and Relevant Council(s) Groundwater - DPI Water/NRAR	Noise and Vibration – refer to the Construction Noise and Vibration Management Plan Blasting – Not applicable Water Quality – refer to the Construction Soil and Water Management Plan Groundwater - refer to the Construction Groundwater Management Plan
C16	The results of the Construction Monitoring Programs must be submitted to the Secretary for information, and relevant regulatory agencies, for information in the form of a Construction Monitoring Report at the frequency identified in the relevant Construction Monitoring Program	The Construction Groundwater and Water Quality Monitoring Report will be submitted separately. The results of the Construction Noise and Vibration Monitoring Program are discussed in Section 3. In accordance with CoA C16, this report will be submitted to the following agencies for information: Department of Planning Industry and Environment NSW Environment Protection Authority City of Sydney Council The Independent Environmental Representative will review the reports prior to submission.

Table 1-2: EPL 21148 Monitoring and reporting requirements

Condition	Requirement	Reference
M7.1	Any noise monitoring must be undertaken in accordance with Australian Standard AS 2659.1 – 1998: Guide to the use of sound measuring equipment – portable sound level meters, or any revisions of that standard which may be made by Standards Australia, and the compliance monitoring guidance provided in the NSW Industrial Noise Policy.	Refer to the Construction Noise and Vibration Management Plan. Refer to S 2 for methodology and Appendix A of this report for Noise monitoring result summary.
M7.2	Any vibration monitoring must be undertaken in accordance with the technical guidance provided in the Environmental Noise Management Assessing Vibration: A Technical Guideline (DECC, 2006). All vibration monitoring results may be assessed and reported against the acceptable values of human exposure to vibration set out in Tables 2.2 and 2.4 of the guideline.	Refer to the Construction Noise and Vibration Management Plan. Refer to S 2 for methodology and Appendix B of this report for Vibration monitoring result summary.

1.3 Submission Requirements

In accordance with condition C16, this report will be submitted to the following agencies for information:

- Department of Planning and Environment

- NSW Environment Protection Authority
- City of Sydney Council

The Independent Environmental Representative and Acoustic Advisor will be provided with the report for information prior to submission.

1.4 Criteria

Standard Construction Hours

7:00am to 6:00pm Monday to Friday

8:00am to 6:00pm Saturday (as of 30/06/2022)

1.5 Noise

The LAeq15min is the conventional unit of measure for construction noise impact. It is the continuous average energy over a 15-minute period, measured in decibels (dB). The LAeq15min can be either airborne or ground borne.

In accordance with the EPA's Interim Construction Noise Guideline (ICNG) and the Project's Construction Noise and Vibration Impact Statement (CNVIS), the Highly Noise Affected Management Level (HNML) of 75 dBA will apply to residential (dwelling) receptors.

Table 1-3: Internal Noise Criteria

Area	Receptor type	Condition of Approval (CoA)	Time Period	Criteria
Identified Precincts in the CNVIS	All	E37/38	0700-2000	Leq, 15 minute 60 dBA internal, If more than 50% of time (6.5 hours total) Leq, 15 minute 55 dBA internal, more than 25% of time (3.25 hours total)

CoA E37 - The Proponent must identify all receivers likely to experience internal noise levels greater than Leq(15 minute) 60 dB(A) inclusive of a 5 dB penalty, if rock breaking or any other annoying activity likely to result in regenerated (ground-borne) noise or a perceptible level of vibration is planned (including works associated with utility adjustments), between 7am – 8pm at Central.

CoA E38 - The Proponent must consult with all receivers identified in accordance with Condition E37 with the objective of determining appropriate hours of respite so that construction noise (including ground-borne noise), does not exceed internal noise levels of:

(a) Leq(15 minute) 60 dB(A) inclusive of a 5 dB penalty if rock breaking or any other annoying activity likely to result in ground-borne noise or a perceptible level of vibration is planned between 7am – 8pm for more than 50 percent of the time; and
(b) Leq(15 minute) 55 dB(A) inclusive of a 5 dB penalty if rock breaking or any other annoying activity likely to result in ground-borne noise or a perceptible level of vibration is planned between 7am – 8pm for more than 25 percent of the time;

unless an agreement is reached with those receivers. This condition does not apply to noise associated with the cutting surface of a TBM as it passes under receivers.

Note: This condition requires that noise levels be less than Leq(15 minute) 60 dB(A) for at least 6.5 hours between 7am and 8pm, of which at least 3.25 hours must be below Leq(15 minute) 55 dB(A). Noise equal to or above Leq(15 minutes) 60 dB(A) is allowed for the remaining 6.5 hours between 7am and 8pm.

1.6 Vibration Criteria

Peak particle velocity (PPV) mm/s is the conventional unit of measure for construction vibration impacts for structural and cosmetic damage and can be applied to determine human comfort.

1.7 Vibration impacts for structural and cosmetic damage

The Sydney Metro Construction Noise and Vibration Strategy (CNVS) provides a conservative vibration damage screening level per receiver type given below:

- Reinforced or framed structures: 25.0 mm/s
- Unreinforced or light framed structures: 7.5 mm/s

This screening criteria relates Building Damage Vibration Management Levels (BS 7385) provided below.

Table 1-4: Building Damage Vibration Management Levels (BS 7385)

Line	Type of Building	PPV (mm/s) in the Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz & Above
L1	Reinforced or framed structures Industrial and heavy commercial buildings	50mm/s at 4 Hz and above	
L2	Unreinforced or light framed structures Residential or light commercial type buildings	15mm/s at 4 Hz increasing to 20mm/s at 15 Hz	20mm/s at 15 Hz increasing to 50mm/s at 40 Hz and above

Source: BS 7385, CNVS

The building damage management level (BS 7385) has been presented in graph form to help with interpretation. The higher the frequency (x axis), the less stringent the criteria for velocity becomes (y-axis) up to 50mm/s. In the example below, all data points fall below both the Line 1 (L1) (less stringent) and the Line 2 (L2) (more stringent) criteria. An exceedance would be observed if data point were to be observed above the L1 or L2 lines on the graph below.

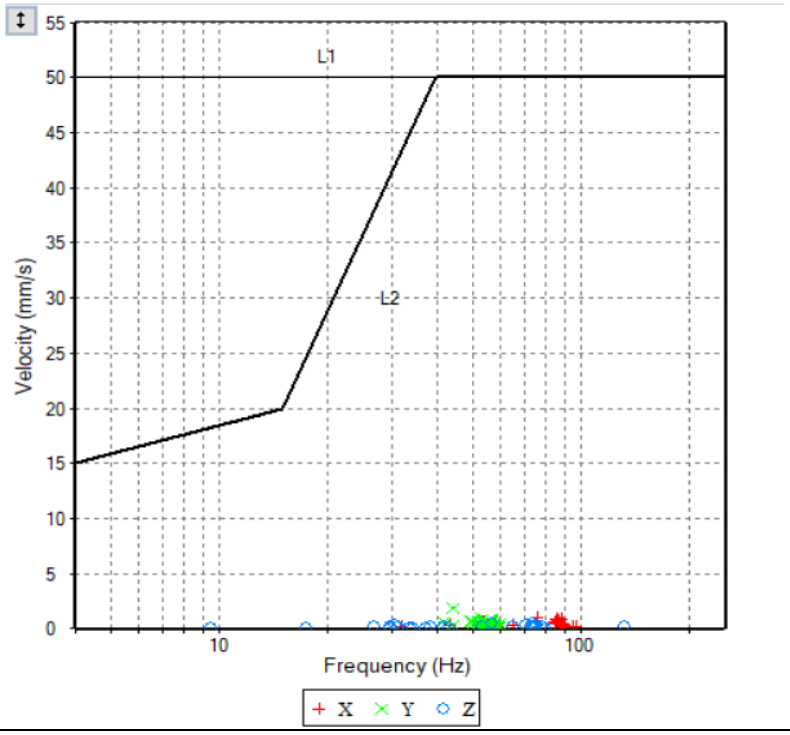

Figure 1: Example of criteria graphed. Note: All structures in the zone of potential construction impact of the Bounce Hotel demolition works are framed or reinforced, hence L1 criteria applies (50mm/s for all frequencies).

1.8 Human Comfort Criteria

The NSW Vibration Guideline provides guidance for assessing human exposure to vibration. The publication is based on British Standard BS 6472:1992.

Table 1-5: Building Damage Vibration Management Levels (BS 7385)

Place	Time	Preferred PPV (mm/s)	Max PPV (mm/s)
Continuous Vibration			
Residences	Day	0.28	0.56
	Night	0.2	0.4
Offices	Day or night	0.56	1.1
Workshops	Day or night	1.1	2.2
Impulsive Vibration			
Residences	Day	8.6	17.0
	Night	2.8	5.6
Offices	Day or night	18.0	36.0
Workshops	Day or night	18.0	36.0

Values given for the most critical frequency range >8Hz assuming sinusoidal motion. Source - Table C1.1 – The *Assessing Vibration: A technical guideline, NSW Department of Environment and Conservation*

Vibration and its associated effects are usually classified as continuous, impulsive or intermittent as follows:

- Continuous vibration continues uninterrupted for a defined period (usually throughout daytime and/or night-time).
- Impulsive vibration is a rapid build up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds.
- Intermittent vibration can be defined as interrupted periods of continuous (e.g. a drill) or repeated periods of impulsive vibration (e.g. a pile driver), or continuous vibration that varies significantly in magnitude. It may originate from impulse sources (e.g. pile drivers and forging presses) or repetitive sources (e.g. pavement breakers), or sources which operate intermittently, but which would produce continuous vibration if operated continuously (for example, intermittent machinery, railway trains and traffic passing by). Assessing Vibration: a technical guideline, DEC NSW, February 2006. (Applicable for Vibration Dose Value (VDV)).

Vibration from the works can be subjectively considered as continuous or intermittent. Conservatively and based on site observations and on what the receivers may experience, the vibration has been classified as continuous. As identified in Table 1.6 above, continuous vibration is measured in PPV. PPV is the preferred parameter for measuring vibration impacts as it can be obtained in real time, whereas VDV is more of a retrospective measure based on time exposure over a prolonged period of operation (i.e. 8hrs or 16hrs).

1.9 Perception relating to human comfort

An individual's perception of motion or response to vibration depends very strongly on previous experience and expectations, and on other associations with the perceived source of the vibration. An indication of the human tactile perception of vibration of random motion is given in the table below.

Table 1-6: The human perception of vibration based on vibration level

Approximate Vibration Level	Degree of Perception
0.10 mm/s	Not Felt
0.20 mm/s	Threshold of Perception
0.35 mm/s	Barely Noticeable
1.0 mm/s	Noticeable
2.2 mm/s	Easily Noticeable
6.0 mm/s	Strongly Noticeable

Source: German Standard DIN 4150: Part 2-1975 - Note: These approximate vibration levels (in floors of buildings) are for vibration having a frequency content in the range of 8 Hz to 80 Hz.

The table above suggests that most people will be just able to feel continuous floor vibration at levels of about 0.20 mm/s, and that the motion becomes "noticeable" at a level of approximately 1.0 mm/s. The threshold for visible movement of susceptible building contents (e.g. plants, hanging pictures, blinds, etc) is approximately 0.5 mm/s and the audible rattling of loose objects (e.g. crockery) generally occurs at levels of about 0.9 mm/s.

These levels are considerably lower than the BS 7385 criterion of 15mm/s and well below the cited 12.5 mm/s level corresponding to a near-zero probability of damage (refer Sydney Metro CNVS section 5.4.3).

In any premises, day-to-day activities (e.g. footfalls, doors closing, etc) will cause levels of vibration in floors and walls that exceed 1 mm/s (sometimes by quite considerable margins), and therefore visible movement and rattling are often observed. In most instances, however, such movement is considered normal and vibration levels of even much greater magnitude do not result in damage to the objects or building contents.

Because people can "feel" very low levels of vibration (even though they may not be disturbed by the motion), it is common to associate building damage with perceptible vibration, particularly when the source of vibration is outside the building and out of the occupants' control. This largely subjective response is particularly accentuated when perceptible vibration is accompanied by high noise levels, or if there are other adverse effects associated with the source of vibration (e.g. inconvenience, dust, etc).

The *Assessing Vibration: A technical guideline, NSW Department of Environment and Conservation* provides guidance for assessing human exposure to vibration. The publication is based on British Standard BS 6472:1992.

2. Methodology

The Construction Noise and Vibration Monitoring Program is designed to compare actual performance of construction of the CSSI against predicted performance and to assess the effectiveness of the mitigation measures applied during construction of the CSMW Project. The program has been executed in accordance with Section 10 of the Construction Noise and Vibration Management Plan (CNVMP) and recording requirements as specified in Section 10.2. The Construction Monitoring Program commenced 3 August 2018 and will continue for the duration of the project.

2.1 Sensitive Receivers

The CSMW Construction Noise and Vibration Impact Statement (CNVIS) assessed 50 sensitive receivers potentially affected by construction noise. The receiver locations are seen in the figure below.

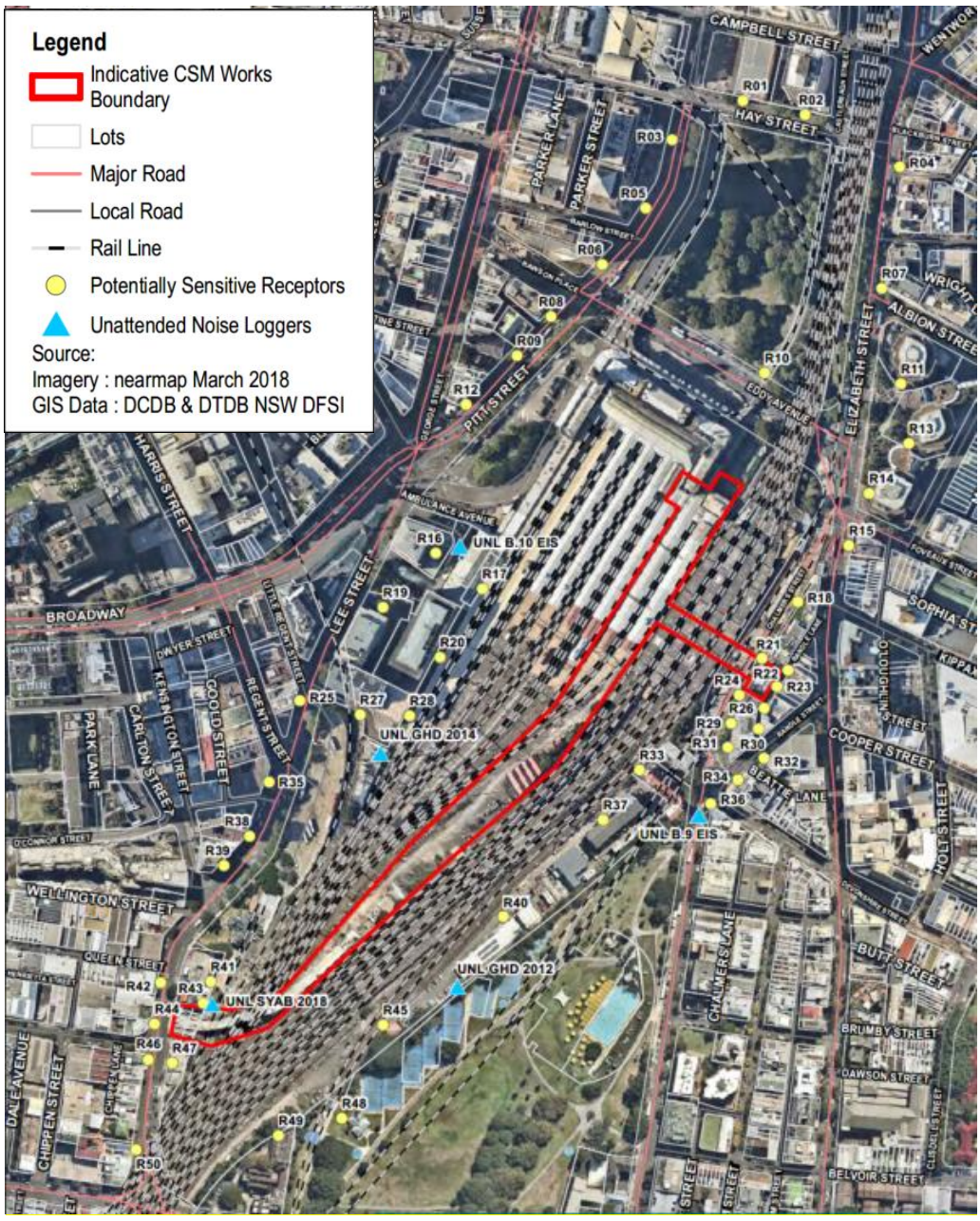

Figure 2-1: Location of Sensitive Receivers

In accordance with CoA E33, ongoing consultation with sensitive receivers is undertaken as the project progresses based on the scenarios identified in the Construction Noise and Vibration Impact Statement (CNVIS). The scenarios are reviewed and refined with the input of construction detail to determine the potential impact and appropriate mitigation. All consultation with potentially affected receivers is undertaken prior to the start of the relevant portion of works. Additional mitigation measures are then tailored based on the consultation feedback.

2.2 Key Noise Monitoring Locations

Based on planned construction work, the area's most regularly impacted by construction noise and vibration during the reporting period are shown in Table 2-1 below:

Table 2-1: Estimated RBLs for Residential Receivers and NMLs for Non-Residential Receiver

Sensitive Receiver Category	Estimated RBLs (dBA)		
Residential	Daytime	Evening	Night-Time
30 Chalmers St (R24)	56	53	45
38 Chalmers St (R29)	56	53	45
1 Randle St (R22)	56	53	45
54 Regent St (R43)	50	50	44
Non- Residential	Daytime	Evening	Night-Time
Dental Hospital _ A (north) - 2 Chalmers St (R18) *	55	55	55

** Internal noise levels*

2.3 Monitoring

In accordance with CoA C11 unattended real-time noise and vibration monitoring will be the focus of monitoring however attended noise and vibration monitoring is undertaken where specific circumstances warrant. Real-time noise loggers were installed at:

- the rear of 20-28 Chalmers St on 26 June 2022 (the closest to traffic movements on Randle Lane)
- on the hoarding at the 20-28 Chalmers Street on 31 January 2022 (being the closest to the proximity of the Eastern Entrance works and Central Walk works)

A real-time vibration logger was installed at:

- Sydney Dental Hospital southern stairwell at the façade of 20-28 Chalmers St on 20 January 2022, decommissioned 4 May 2022.

The noise and vibration impact due to construction has progressively tapered off as the site activities transition from demolition, excavation to building and installation. Through extensive assessment and in consultation with the Acoustic Advisor, it was determined that some of the continuous monitoring was no longer warranted as described above. Attended monitoring will continue as required.

As per CoA C11 real time monitoring data was made available to the LOR construction team, Sydney Metro, the Environmental Representative (ER), the Acoustic Advisor (AA), the Department of Planning and Environment (DPE) and the Environment Protection Authority (EPA) via the project website https://centralstationmetro.com/documents/.

Impacts from vibration are considered both in terms of effects on building occupants (human comfort) and the effects on the building structure (structural / cosmetic damage). Of these considerations, the human comfort limits are the most stringent. Therefore, for occupied buildings, if compliance with human comfort limits is achieved, it will follow that compliance will be achieved with the building damage objectives. In accordance with CoA E28 and the requirements of the CNVIS, the vibration limits have been set in accordance with the British Standard BS 7385-2:1993. Where it has been identified that specific construction activities are likely to exceed the relevant noise or vibration goals (as is the case for select project works), noise or vibration monitoring is conducted at a nominated representative location (typically the nearest receptor where more than one receptor has been identified). Monitoring is also conducted in the event of a complaint being received or during OOHW where the Additional Mitigation Measures Matrix (AMMM) has identified monitoring as a requirement. In addition to monitoring required by the CoA and CNVMP, monitoring is conducted throughout Central Railway Station to assess the impact of construction activities on commuters and station staff with the results reported through a separate stakeholder management process. In the event of an exceedance of a predicted noise level, an investigation is undertaken followed by corrective actions as specified in the CNVIS and CNVMP if the exceedance was determined to be related to the project.

The results of the monitoring are communicated to relevant personnel when the noise or vibration goal is being approached so that work methodology or equipment being used can be altered, and/or additional management measures may be implemented where reasonable and feasible.

Table 2-2: Monitoring Equipment

Unit	Serial	Calibration Type	Frequency	Last calibration
SiteHive Hexanode (noise logger)				
Chalmers St	41	Factory	Biennial	22/11/2022
Svantek 977 (noise logger)				
Svantek 977 (handheld noise logger)	36834	Factory	Biennial	24/06/2022
Svantek SV33 (calibration unit)	43175	Factory	Biennial	24/06/2022
Randle Lane	59643	Factory	Biennial	24/06/2022
Svantek 958A (vibration logger)				
Svantek 958A (vibration logger)	59157	Factory	Biennial	28/05/2021
Svantek SV84 (transducer)	E3496	Factory	Biennial	28/05/2021

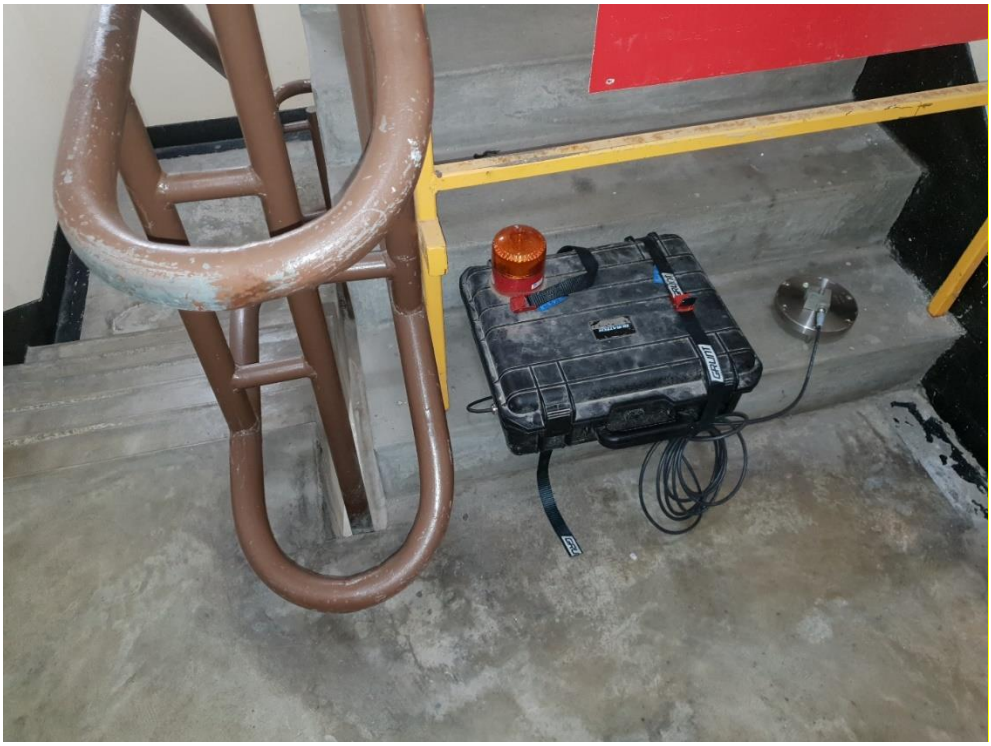

Figure 2-2: Unattended vibration Logger set up at the Sydney Dental Hospital southern stairwell

Figure 2-3: Attended noise logger setup on Chalmers St

Figure 2-4: Real time noise logger setup at 20-28 Chalmers St (Randle Lane side)

Figure 2-5: Real time noise logger Chalmers St used at different locations during the reporting period.

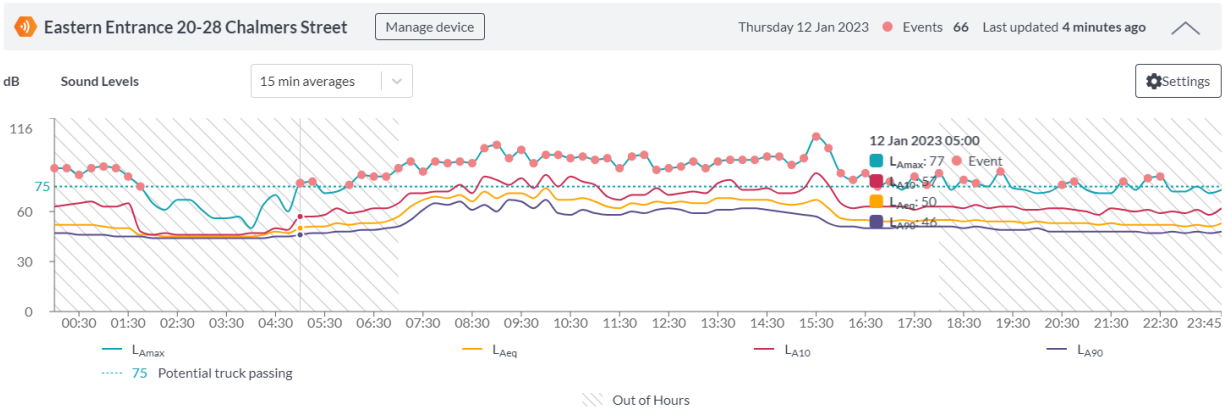

Figure 2-6: Example of real time noise monitoring data

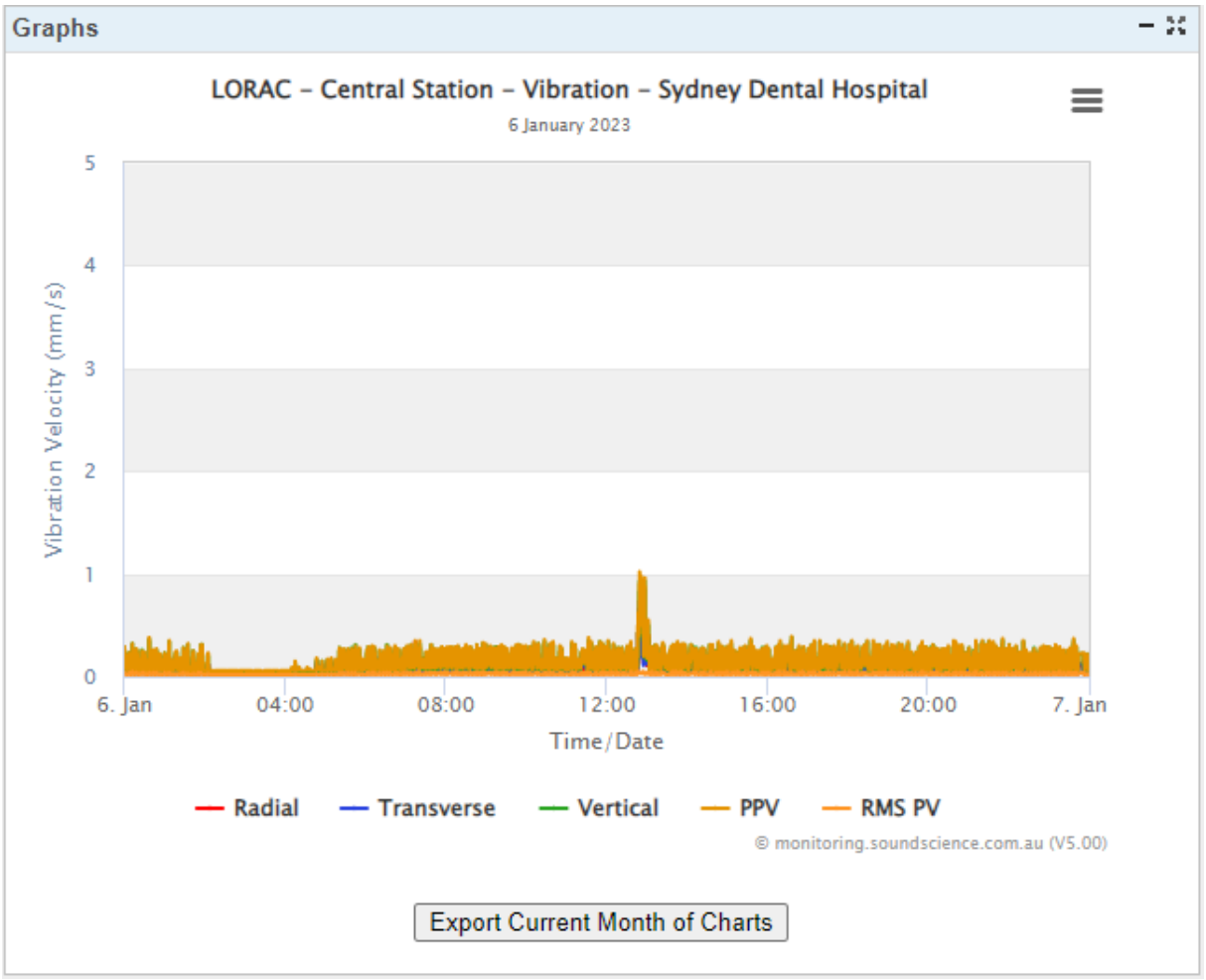

Figure 2-7: Example of real time vibration data. Graph showing general background vibration levels.

Note: general background level slightly elevated due to repositioning geophone to ground level where it is more readily influenced by heavy and light rail movements.

2.4 Noise Monitoring Frequency

Activities were assessed in the CNVIS under the following scenarios. During detailed planning of the activities to be conducted around rail possessions some of the activities were conducted concurrently. The potential noise impacts were reassessed on a monthly basis. Where the works are subject to an EPL, the Out of Hours Work Protocol as per CoA E47 is not applicable. To demonstrate due diligence and establish appropriate additional mitigation measures, the CSM Out of Hours works are assessed and documented on a monthly basis.

Table 2-3: Monitoring requirements for construction scenarios.

ID	Description	Frequency (as per AMMM)
SCN 01	Platforms & Sydney Yard: Stage 6 – Installing Services/Wiring	During OOH works
SCN 02	Platforms & Sydney Yard: Stage 7 – Installing Services / Hoarding / Offices	Daytime standard construction hours
		During OOH works
SCN 03	Platforms & Sydney Yard: Stage 7, 9 & 11 - Combine Services Route / Demolition of Sydney Yard Buildings / Salvage Canopy/ Remove Track / Remove Waste	During OOH work
SCN 04	Platforms & Sydney Yard: Stage 8 & 10 - OHW on Platform 11/12 / Replace Track Country End 12/13 / Installing CSR	During OOH works
SCN 05	Stage 12 - Piling Works / Removing Track	During OOH works
SCN 06	Platforms & Sydney Yard: Stage 13	Daytime standard construction hours/ During OOH work
SCN 07	Platforms & Sydney Yard: Stage 14, 16, 18 & 20	Daytime standard construction hours/ During OOH work
SCN 08	Platforms & Sydney Yard: Stage 15,17 & 19	Daytime standard construction hours/ During OOH work
SCN 09	Metro Box: Piling for the box perimeter and the plunge columns	Daytime standard construction hours/ During OOH work
SCN 10	Metro Box: FRP Capping Beam	Daytime standard construction hours/ During OOH work
SCN 11	Metro Box: Excavation to underside of Intercity Slab	Daytime standard construction hours/ During OOH work
SCN 12	Metro Box: FRP Platform and Intercity slab	Daytime standard construction hours
SCN 13	Metro Box: Excavation to underside of Metro Concourse	During OOH works
SCN 14	Metro Box: Ongoing Logistical support of Box Construction	During OOH works
SCN 15	Central Walk: Site investigation Works (Tracks 16-23)	Daytime standard construction hours/ During OOH work
SCN 16A	Central Walk: Construction of Olympic Stairs (Temp) - Platform 20/21 and 22/23	During OOH works
SCN 16B		
SCN 16C		
SCN 16D		
SCN 17	Central Walk: Construction of the new Standby Guards Rooms / demolition of existing standby guards' rooms	Daytime standard construction hours
		During OOH works

ID	Description	Frequency (as per AMMM)
SCN 18	Central Walk: Construction of Platform Canopy Support System to Platforms 16 to 23 and Excavation of Launch Chambers	During OOH works
SCN 19	Central Walk: Platform works including works below the top slab	During OOH works
SCN 20	Central Walk: Platform Remodelling works including platform canopy modifications	During OOH works
SCN 21	ESR: Construction of Shaft to ESR Ghost Platform	Daytime standard construction hours
SCN 22	ESR: Surface Works and Underground works	During OOH works
SCN 23	East Entrance: Demolition of the Bounce Hotel	Daytime standard construction hours
SCN 24	East Entrance: Piling for East Entrance	Daytime standard construction hours
SCN 25	East Entrance: Excavation of East Entrance	Daytime standard construction hours
SCN 26	East Entrance: Excavation of Adit to ESR Concourse including Canopy Tube installation	Daytime standard construction hours
SCN 27	East Entrance: FRP works to East Entrance	Daytime standard construction hours
SCN 28	East Entrance: East Entrance Works and Underground Works	Daytime standard construction hours
SCN 29	Grand Concourse: Piling in Grand Concourse	During OOH works
SCN 30	Grand Concourse: FRP Pile caps	Daytime standard construction hours
		During OOH works
SCN 31	Grand Concourse: Removal of Existing Canopies	During OOH work
SCN 32	Grand Concourse: Installation of precast / in situ columns and arches	Daytime standard construction hours
		During OOH works
SCN 33	Grand Concourse: Installation of Roof Structure	Daytime standard construction hours/ During OOH work
SCN 34	Northern Concourse & North Entry: Demolition Southern Half	Daytime standard construction hours
SCN 35	Northern Concourse & North Entry: FRP of Structure (Floor, retaining wall, Columns)	Daytime standard construction hours
SCN 36	Northern Concourse & North Entry: Demolition Northern Half	Daytime standard construction hours
SCN 37	Northern Concourse & North Entry: FRP of Structure (Floor, retaining wall, Columns)	Daytime standard construction hours
SCN 38	Northern Concourse & North Entry: Installation of remaining precast columns and Arches	Daytime standard construction hours
SCN 39	Sydney Yard Access Bridge: Heavy Vehicle Traffic on the SYAB	Daytime standard construction hours
		During OOH works

The activities in the OOH were assessed against the scenarios in the CNVIS as show in Table 2-3 above through the OOH assessment process.

2.5 Out of Hours Works Summary

Generally, OOHW at Central Station are scheduled either when trains stop running or electrical isolation has been provided. OOHW are required to provide safe access for personnel and plant to the rail corridor to complete the required works. Additional Mitigation and Management Measures (AMMM) are adopted as required. OOHW are governed by the CoA and reflected in the EPL as required by Part 3.1 Section 45 (i). An EPL (EPL 21148) was issued for the Project on 28 November 2018. The LOR Environmental Manager provides internal approval for any Out of Hours Work (OOHW) conducted under the project EPL.

3. Monitoring Results

3.1 Noise

Construction noise levels for some CSM work activities are predicted in the CNVIS to exceed the external noise management level at times, particularly during works outside of standard hours. Attended and unattended real time noise monitoring was undertaken during the reporting period as required for OOHW, particularly during possessions where noise modelling predicted exceedance of noise management levels.

As identified by modelling in the CNVIS, the majority of noise impacts have occurred at the closest sensitive receivers predominantly on Chalmers Street. Standard mitigation measures were implemented as per Section 8 of the CNVMP and Section 8 of the CNVIS. Additional mitigation and management measures were implemented as per the OOHW approvals. Additional respite periods during high noise activities were provided to Sydney Trains staff and commuters by not undertaking high noise impact activities during peak hours as well as using one of three noisy work programs:

1) Working three hours on and one hour off, and then repeating this cycle, or;
2) Working 45 minutes on with 15 minutes off for three hours, followed by one-hour break and then repeating this cycle.
3) Working one hour on, half hour off

Specific respite periods were also negotiated with the Sydney Dental Hospital.

The real time noise data was reviewed at the time of potential high noise impact works by site supervisors. The playback function allowed for differentiation of construction noise from ambient noise levels. Notable high ambient noise levels were recorded during attended noise monitoring sessions and from playback recordings downloaded from the real time loggers at Chalmers Street, and Randle Lane. Common extraneous noise sources include:

- Other construction works on Chalmers and Elizabeth Streets, particularly maintenance works
- Residences or pedestrians near the measurement position
- Wind-blown vegetation and insects
- Road traffic on public roads, particularly applicable at 54 Regent Street
- A street sweeper going past on Chalmers St
- Light rail on Chalmers St
- Noise from fauna; specifically, cockatoos and seagulls – the latter of which are often active throughout the night.

Noise monitoring results are detailed in Appendix A. Monthly noise data tables have been prepared for each sensitive receiver. The objective of the data tables is to validate the predictions for the specific activities as documented in the CNVIS. To obtain a greater understanding of the noise environment the 'adjusted' (10*log of the attribute) and 'non-adjusted' values are analysed. This is explained further below, and a quick reference table is provided in Table 3-1.

Table 3-1: 10*log (attribute) quick reference table

Attribute: % Contribution of magnitude	10*log(attribute) Reduction in dB	Attribute: Event duration (x mins per 15min measure)	10*log (attribute) Reduction in dB
5	-13	1	-12
10	-10	2	-9
15	-8	3	-7
20	-7	4	-6
25	-6	5	-5
30	-5	6	-4
35	-5	7	-3
40	-4	8	-3
45	-3	9	-2
50	-3	10	-2
55	-3	11	-1
60	-2	12	-1
65	-2	13	-1
70	-2	14	0
75 to 85	-1	15	0
90 to 100	0		

Note 1: The Decibel (dB) is a relative unit of measurement corresponding to one tenth of a bel. It is expressed on a logarithmic scale, hence the ratio between decibels also needs to be quantified logarithmically.

Note 2: The % Contribution of magnitude is a relatively subjective measure. To keep the methodology repeatable as is required by scientific method, only 5%, 50% and 100% contributions are used in the assessment.

Example: A noise file was reviewed that captured saw cutting. The unadjusted $L_{Aeq15min}$ was 64dB. When in operation the contribution of the saw was 50% to the noise environment due to the distance and use of noise attenuating screens. The other 50% was construction noise confirmed not to be associated with CSM. The saw cutting lasted for 6 minutes over the 15-minute period.

64dB + [10*log(0.5)] + [10*log(6/15)] = 57dB.

Therefore the 'unadjusted $L_{Aeq15min}$' is 64dB and the 'adjusted $L_{Aeq15min}$' is 57dB.

In this example regardless of the 7dB difference, the mitigation for the impact remains the same.

A precautionary approach is used as follows:

- The 'unadjusted $L_{Aeq15min}$' measure is used to determine potential noise impact in real time to adjust works in real time accordingly. The next $L_{Aeq15min}$ period can be improved from the last.

- The 'adjusted $L_{Aeq15min}$' measure is used as an indicative noise level. It is a tool used to better understand the noise impact contribution of the project on the surrounding noise environment. The adjusted measure was particularly useful when separating CSM works from rail operational noise, and other construction work in the local area not associated with the project.
- It is difficult to assign a percentage of magnitude, so typically 5% is assigned for no magnitude, 50% if other works or noises are still contributing, or 100% if no other works or impacts can be heard at the time of use of that equipment.
- Not all files are 'adjusted' as the corrections are not always applicable due to the dominant nature of the activity, or the works are considered inaudible.
- The $L_{Aeq15min}$ of highest noise period is selected for assessment.
- The data table is prepared to ensure results can be verified.

The real time data is reviewed by the night supervisors by smart phone at the time of a noisy activity with the potential to impact the community. This allows for a review of the $L_{Aeq15min}$ period against predictions. If required, the work methodology is adjusted where feasible. During scheduled rail possessions, options such as amending construction practices and schedules to reduce noise impacts by carrying out the works during less noise sensitive times is not feasible due to a large majority of complex works occurring in limited track and platform possession windows. Additional respite offers have been in the form of customised noise attenuating ear plugs and extensive communications.

Generally, exceedances of predicted noise levels were typically attributed to extraneous noise rather than construction activities (comparing adjusted to non-adjusted). Zero non-conformances were raised during the reporting period for general construction activities.

3.1.1 Possession based noise monitoring

During this reporting period between August 2022 and January 2023 8 rail possessions were executed The works included:

- WE24: Tiling on Platform 22/23 (225m2), painting platform 22/23 balustrades, painting platform fascia on Platform 19 to 23, platform re-leveling works, and strip and paint enclosure
- WE29: Platform relevelling works, tiling on Platform 18/19 (339m2), painting platform 18/19 balustrades, re-leveling works, strip and paint enclosure, and Platform 14 canopy works
- WE34: Tiling on Platform 20/21 (170m2), strip and paint enclosure, install access hatch on Platform 20/21
- WE37: Central Walk finishes works, stair handrail works, tiling works, ceiling works, VE steel install in public zones (primarily around lifts and stairs)
- WE39: Northern concourse final cleaning and sealing of GNC tiles, flashing works on Platform 8 with EWP Hi-Rail
- WE42: Relevelling Works: tiling on Platform 20/21 (150m2)
- WE44: Platforms 18/19 Relevelling Works: Platform 18/19 tile sealing
- WE45: Platforms 16/17 Works: air conditioning replacement in Guard room, Guard room recladding, drainage connection, painting on Platform 16/17, removal of redundant cables, Hazmat works on stair enclosure, and removal of Concrete ULX

The possessions likely to be associated with the greatest impact were associated with platform resurfacing/relevelling and drainage works within the Suburban platforms (refer Scenario 18 and 22 in the CNVIS). Platform relevelling works improve drainage, accessibility of the platforms by commuters moving between the platforms and trains, as well as improve the overall aesthetic of the platform surfaces. Re-levelling works typically comprise the removal of the upper layer of the platform surface (concrete, screed and tile) and coping edge, followed by the placement of a newly graded surface comprising concrete, screed and new tiles, as well as drainage channels and pits. The scope of works occurred in several stages across this reporting period, and required wall saws, road saws and excavators with hammer attachments to remove the entire platform surface.

To achieve this, the following was conducted prior to each noisy possession:

- Proactively engage with residents in advance / during cumulative noisy activities to address any specific requirements of sensitive receivers.
- Help residents to understand the reasoning why the work is undertaken out of hours. (due to strict staged program)
- Help residents understand the future benefits (end state) of Central Walk construction.

- Number of residential places/businesses spoken to:
    - Quarterly letter goes to +19,000 letterboxes
    - Bi-monthly letter goes to +3,500 letterboxes
    - Each specific notification has been distributed to about 150 letterboxes adjacent to the site (businesses & residents),
    - Weekly email reminder to a distribution list of 2,250 email addresses.

The outcome of the objectives was measured as there were no complaints received during the reporting period relating to noise and/or vibration from possession works.

Generally, exceedances of predicted noise levels were typically attributed to extraneous noise rather than construction activities (comparing adjusted to non-adjusted).

The possession monitoring results demonstrate that there were no exceedances of predictions associated with CSM works at sensitive receivers.

4. Complaints

There was one complaint received during the reporting period relating to noise The source was found to be a loud conversation of the security personnel at the SYAB boom gate at 60 Regent St. The security personnel have been briefed regarding OOH behaviour and surrounding residents.

The table 4-1 summarised actions undertaken following complaints over the past reporting periods, as well as proactive actions undertaken to minimise the number of complaints.

Table 4-1: Sensitive receiver monitoring

Sensitive receivers	Monitoring undertaken	Description of action
Sydney Trains / NSW TL	As required	Ad hoc discussions with key representatives and staff. Ad hoc noise monitoring on the suburban and intercity as required by construction activities.
GF01, 30 Chalmers St (Columbus & Co Central)	Yes – ongoing	Ad hoc catch up with business owner in person or via phone calls.
GF02, 30 Chalmers St (Gou Sushi)	Yes – ongoing	Ad hoc catch up with business owner, as required by construction activity.

30 Chalmers St (Building owner/Strata company)	Yes – ongoing	Sharing noise and vibration monitoring report with the building owner/strata manager.
GF, 38 Chalmers St (City Convenience Store, open 24/7)	As required	Ad hoc discussion with business owner. Discussion with staff/owner about the status of Randle Lane and OOHW at Central Station as required.
2 Chalmers St (Dental Hospital)	Yes – ongoing	Weekly email (1WLA): Tailored email to Hospital's representative if upcoming high noise/vibration impact is scheduled.
GF, 1-5 Randle St (University Preparation College)	Yes – ongoing	Ad hoc discussions with key representatives and staff.
Lee Street buildings	As required	Tailored email summary about work activities on Platform 1 and in the Lee Street driveway.
30 Chalmers St + 38 Chalmers T + 1-5 Randle St (106 units)	Yes – real time only, attended monitoring offered as well if required	Specific notification and tailored email to provide update related to status of Randle Lane and OOHW at Central Station with the potential to generate high noise/vibration impact.
52 & 54 Regent Street	As required	Installation of specific real time noise monitoring at the start of the project and noise assessment of truck movements.

Actions listed are in addition to the monthly & quarterly notifications and email update to the overall project database. Any monitoring undertaken and listed below are in addition to the real time loggers installed around the construction site.

5. Conclusion

The requirements for noise and vibration monitoring are detailed in the CNVIS and CNVMP. A combination of both real time and attended monitoring has occurred at the closest sensitive receiver locations during this reporting period. These receivers are considered representative of the area and were used to validate the modelled construction noise. Monitoring records have validated modelled noise and are generally consistent with the predicted impact of construction activities on noise sensitive receivers. As discussed in Section 4, there was one complaint related to noise at the SYAB boom gate at 60 Regent Street was received during the reporting period.

As determined in the planning phase, the potential for physical at source mitigation was limited for platform releveling works on the suburban platforms. Over the reporting period, there were a few minor exceedances of individual $L_{Aeq15min}$ periods, which did not change the application of the AMM's given the thorough notification and community engagement strategy emplaced by the Community and Stakeholder Management Team at CSM. The communications element (governed partly by the Communications Strategy and partly by the AMM's) was the key mitigation in meeting the best achievable performance objectives of the CNVIS and community expectation. No non-conformance was raised during the reporting period.

Appendix A – Noise Monitoring Summary

Date	Time	LOR Works (potentially noisy as per diary entry)	Continuous Real Time or Attended (C or A)	CNVIS SCN	Sensitive Receiver	Observed LAeq15min (dB)	NML for sensitive receiver (dB) (NML=RBL+5dB)	Period Day / Evening / Night	LAeq15min Exceedance of NML (dB)	RBL for Sensitive Receiver	Predicted Exceedance as per OOH for particular activity (RBL)	Exceedance of Predicted OOH (adjusted)	Exceedance of Predicted OOH (non-adjusted, with HN penalty)	Comments
August 2022														
5/08/2022	23:15:00	WE06 - Works predominantly consisted of tiling on Platforms 16-18, assembling lifts, and installing services, finishes and new escalators under and within hoarded work zones on Platforms 16-18.	C	20	Chalmers St	60	50	Night	10	45	27	0	0	No exceedance. Street noise, people and rail movements audible throughout recording, but generally quiet. CSM construction works inaudible. All at source noise mitigation and required additional mitigation measures were in place. No exceedances, all AMMs in place.
6/08/2022	3:15:00	WE06 - Works predominantly consisted of tiling on Platforms 16-18, assembling lifts, and installing services, finishes and new escalators under and within hoarded work zones on Platforms 16-18.	C	20	Chalmers St	62	58	Night	4	53	19	0	0	No exceedance. Street noise, people and rail movements audible throughout recording, but generally quiet. CSM construction works inaudible. All at source noise mitigation and required additional mitigation measures were in place. No exceedances, all AMMs in place.
13/08/2022	13:30:00	EE: General station fit out works.	C	25	Chalmers St	75	61	Day	14	45	27	0	3	No exceedance. Works conducted during the standard construction hours (Sat from 8am to 6pm). Station fit out activities using hand and power tools were resulted in noisy periods. All at source noise mitigation and required additional mitigation measures were in place. Localised noise blankets and screens, respite periods, prioritising noisiest works before 6pm.
26/08/2022	0:15:00	WE09 - Works predominantly consisted of tiling on Platforms 16-18, assembling lifts, and installing services, finishes and new escalators under and within hoarded work zones on Platforms 16-18.	C	20	Chalmers St	64	50	Night	14	45	36	0	0	No exceedance. Street noise, people and rail movements audible throughout recording, but generally quiet. CSM construction works inaudible. All at source noise mitigation and required additional mitigation measures were in place. No exceedances, all AMMs in place.
27/08/2022	7:30:00	EE: General station fit out works.	C	25	Chalmers St	63	61	Day	2	56	25	0	0	Construction noise in the background. Noise levels within predictions.
September 2022														
2/09/2022	23:30:00	Works predominantly consisted of tiling on Platforms 18-21, assembling lifts, and installing services, finishes and new escalators under and within hoarded work zones on Platforms 18-21.	C	20	Chalmers St	61	50	Night	11	46	27	0	0	CSM construction works inaudible. All at source noise mitigation and required additional mitigation measures were in place. No exceedances, all AMMs in place.
3/09/2022	23:45:00	Works predominantly consisted of tiling on Platforms 18-21, assembling lifts, and installing services, finishes and new escalators under and within hoarded work zones on Platforms 18-21.	C	20	Chalmers St	62	50	Night	12	45	27	0	0	CSM construction works inaudible. All at source noise mitigation and required additional mitigation measures were in place. No exceedances, all AMMs in place.
4/09/2022	0:00:00	Works predominantly consisted of tiling on Platforms 18-21, assembling lifts, and installing services, finishes and new escalators under and within hoarded work zones on Platforms 18-21.	C	20	Chalmers St	63	50	Night	13	45	27	0	0	CSM construction works inaudible. All at source noise mitigation and required additional mitigation measures were in place. No exceedances, all AMMs in place.
4/09/2022	22:00:00	Works predominantly consisted of tiling on Platforms 18-21, assembling lifts, and installing services, finishes and new escalators under and within hoarded work zones on Platforms 18-21.	C	20	Chalmers St	58	50	Night	8	45	27	0	0	CSM construction works inaudible. All at source noise mitigation and required additional mitigation measures were in place. No exceedances, all AMMs in place.
9/09/2022	22:45:00	Works predominantly consisted of tiling on Platform 22/23, assembling lifts, and installing services, finishes and new escalators under and within hoarded work zones on Platform 22/23.	C	20	Chalmers St	63	50	Night	13	45	27	0	0	CSM construction works inaudible. All at source noise mitigation and required additional mitigation measures were in place. No exceedances, all AMMs in place.
10/09/2022	4:15:00	Works predominantly consisted of tiling on Platform 22/23, assembling lifts, and installing services, finishes and new escalators under and within hoarded work zones on Platform 22/23.	C	20	Chalmers St	67	50	Night	17	45	36	0	0	Some activities including jackhammering along with hand and power tools resulted in noisy periods. All at source noise mitigation and required additional mitigation measures were in place. No exceedances, all AMMs in place.
10/09/2022	6:30:00	EE: Road Sweeper in operation (unrelated to CSM works). SCN20 chosen as most conservative.	C	20	Randle Lane	64	50	Night	14	45	36	0	0	No CSM works audible.
October 2022														
8/10/2022	23:45:00	Works predominantly consisted of tiling on Platforms 18-21, assembling lifts, and installing services, finishes and new escalators under and within hoarded work zones on Platforms 18-21.	C	20	Chalmers St	60	50	Night	10	45	27	0	0	CSM construction works inaudible. All at source noise mitigation and required additional mitigation measures were in place. No exceedances, all AMMs in place.
9/10/2022	21:30:00	Works predominantly consisted of tiling on Platforms 18-21, assembling lifts, and installing services, finishes and new escalators under and within hoarded work zones on Platforms 18-21.	C	20	Chalmers St	61	58	Evening	3	53	19	0	0	CSM construction works inaudible. All at source noise mitigation and required additional mitigation measures were in place. No exceedances, all AMMs in place.

25/10/2022	23:45:00	Works predominantly consisted of tiling and installing new services cables in ESR and Southern Concourse.	C	20	Chalmers St	68	50	Night	18	45	27	0	0	Some station fit out activities using hand and power tools were resulted in noisy periods. All at source noise mitigation and required additional mitigation measures were in place. Localised noise blankets and screens, respite periods, prioritising noisiest works pre 12am midnight, where practical. No exceedances, all AMMs in place. No works after the midnight.
26/10/2022	23:15:00	Works predominantly consisted of tiling and installing new services cables in ESR and Southern Concourse.	C	20	Chalmers St	68	50	Night	18	45	36	0	0	Some station fit out activities using hand and power tools were resulted in noisy periods. All at source noise mitigation and required additional mitigation measures were in place. Localised noise blankets and screens, respite periods, prioritising noisiest works pre 12am midnight, where practical. No exceedances, all AMMs in place. No works after the midnight.
29/10/2022	23:30:00	Works predominantly consisted of tiling and canopy works on Platforms 12-14.	C	20	Chalmers St	60	50	Night	10	45	36	0	0	No CSM works audible.
November 2022														
1/11/2022	1:00:00	Works predominantly consisted of tiling and installing new services cables in ESR and Southern Concourse.	C	20	Chalmers St	61	50	Night	11	45	27	0	0	Some station fit out activities using hand tools were resulted in noisy periods. All at source noise mitigation and required additional mitigation measures were in place. Localised noise blankets and screens, respite periods, prioritising noisiest works pre 12am midnight, where practical. No exceedances, all AMMs in place.
2/11/2022	0:45:00	Works predominantly consisted of tiling and installing new services cables in ESR and Southern Concourse.	C	20	Chalmers St	61	58	Evening	3	53	19	0	0	Some station fit out activities using hand tools were resulted in noisy periods. All at source noise mitigation and required additional mitigation measures were in place. Localised noise blankets and screens, respite periods, prioritising noisiest works pre 12am midnight, where practical. No exceedances, all AMMs in place.
7/11/2022	23:15:00	Works predominantly consisted of tiling and installing new services cables in ESR and Southern Concourse.	C	20	Chalmers St	60	50	Night	10	45	27	0	0	Some station fit out activities using hand tools were resulted in noisy periods. All at source noise mitigation and required additional mitigation measures were in place. Localised noise blankets and screens, respite periods, prioritising noisiest works pre 12am midnight, where practical. No exceedances, all AMMs in place.
14/11/2022	1:45:00	EE: No CSM related works as per night shift diaries. Reading potentially weather affected.	C	20	Chalmers St	69	50	Night	19	45	36	0	0	No CSM works audible.
14/11/2022	3:45:00	EE: No CSM related works as per night shift diaries. Reading potentially weather affected.	C	20	Chalmers St	69	50	Night	19	45	36	0	0	No CSM works audible.
14/11/2022	3:45:00	EE: No CSM related works as per night shift diaries. Reading potentially weather affected.	C	20	Randle Lane	67	50	Night	17	45	36	0	0	No CSM works audible.
14/11/2022	4:45:00	EE: No CSM related works as per night shift diaries. Reading potentially weather affected.	C	20	Chalmers St	69	50	Night	19	45	36	0	0	No CSM works audible.
15/11/2022	0:30:00	Works predominantly consisted of tiling and installing new services cables in ESR and Southern Concourse.	C	20	Chalmers St	60	50	Night	10	45	36	0	0	Some station fit out activities using hand tools were resulted in noisy periods. All at source noise mitigation and required additional mitigation measures were in place. Localised noise blankets and screens, respite periods, prioritising noisiest works pre 12am midnight, where practical. No exceedances, all AMMs in place.
25/11/2022	23:15:00 PM	Works predominantly consisted of tiling and installing new services cables in ESR and Southern Concourse.	C	20	Chalmers St	63	50	Night	13	45	36	0	0	Some station fit out activities using hand tools were resulted in noisy periods. All at source noise mitigation and required additional mitigation measures were in place. Localised noise blankets and screens, respite periods, prioritising noisiest works pre 12am midnight, where practical. No exceedances, all AMMs in place.
28/11/2022	23:15:00 PM	Works predominantly consisted of tiling and installing new services cables in ESR and Southern Concourse.	C	20	Chalmers St	63	50	Night	13	45	36	0	0	Some station fit out activities using hand tools were resulted in noisy periods. All at source noise mitigation and required additional mitigation measures were in place. Localised noise blankets and screens, respite periods, prioritising noisiest works pre 12am midnight, where practical. No exceedances, all AMMs in place.
December 2022														
5/12/2022	21:00:00	EE: No CSM related works as per night shift diaries. Reading potentially weather affected.	C	20	Chalmers St	64	58	Evening	6	53	19	0	0	Rain pours heavier throughout recording, likely the source of spike.
10/12/2022	2:30:00	WE24 Possession P22/23 releveling and tiling works. Breaking/saw cutting end of the P22/23.	C	20	Chalmers St	61	50	Night	11	44	27	0	0	No exceedance. Street noise, people and rail movements audible throughout recording, but generally quiet. Construction noise for a short period.
10/12/2022	5:45:00	WE24 Possession P22/23 releveling and tiling works. Breaking/saw cutting south end of P22/23.	C	20	Chalmers St	63	50	Night	13	45	27	0	0	No exceedance. Street noise, people and rail movements audible throughout recording, but generally quiet. Construction noise for a short period.
10/12/2022	4:30:00	WE24 Possession P22/23 releveling and tiling works. Breaking/saw cutting south end of P22/23.	A	20	Chalmers St	67	50	Night	17	45	27	0	0	No exceedance. Construction noise audible in background. Where required, respite offers were made to affected receivers based on the level of predicted impact. The noise levels were within the CNVIS predictions for the

														entirety of the month and did not exceed at the real time noise logger (conservatively representative of the facade of the sensitive receivers).
10/12/2022	5:45:00	WE24 Possession P22/23 releveling and tiling works. Breaking/saw cutting south end of P22/23.	C	20	Chalmers St	65	50	Night	15	45	36	0	0	No exceedance. Construction noise audible in background. Where required, respite offers were made to affected receivers based on the level of predicted impact. The noise levels were within the CNVIS predictions for the entirety of the month and did not exceed at the real time noise logger (conservatively representative of the facade of the sensitive receivers).
10/12/2022	4:45:00	WE24 Possession P22/23 releveling and tiling works. Breaking/saw cutting south end of P22/23.	A	20	Chalmers St	70	50	Night	20	45	36	0	0	No exceedance. Construction noise audible in background. Where required, respite offers were made to affected receivers based on the level of predicted impact. The noise levels were within the CNVIS predictions for the entirety of the month and did not exceed at the real time noise logger (conservatively representative of the facade of the sensitive receivers).
10/12/2022	11:45:00	EE: General station fit out works.	C	25	Chalmers St	69	61	Day	8	56	25	0	0	No exceedance. Construction noise audible in background.
January 2023														
13/01/2023	23:00:00	WE28 - Works predominantly consisted of tiling, assembling lifts, and installing services, finishes on Platforms 16-21.	C	36	Chalmers St	53	50	Night	3	56	18	0	0	Construction noise inaudible, Light rail also audible, much louder. Noise levels within predictions.
14/01/2023	8:15:00	WE28 - Works predominantly consisted of tiling, assembling lifts, and installing services, finishes on Platforms 16-21.	C	20	Chalmers St	68	61	Day	7	56	18	0	0	Construction noise in the background. Noise levels within predictions.
15/01/2023	13:45:00	EE: General station fit out works.	C	25	Chalmers St	63	61	Day	2	45	27	0	0	Construction noise inaudible, Light rail also audible, much louder. Noise levels within predictions.

Appendix B – CoA E37/E38 Internal Airborne Noise Levels Monitoring Summary

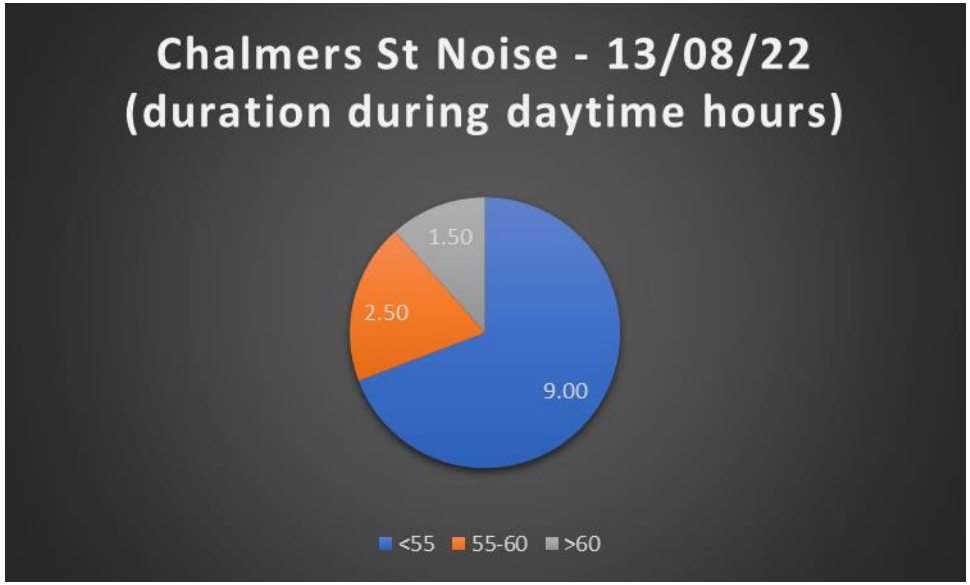

Figure B-1: 13 August 2022 distribution of noise data points (internal airborne noise levels)

Formula	CoA E38 (dB)	Criteria (hours)	Measured (hours)	Compliance with CoA E38
Measured LAeq15mins + 5dB - 20dB	<55	For more than 3.25	9.00	Complies
	55-60	For more than 6.5	2.50	Complies*
	>60	For less than 6.5	1.50	Complies

Table B-1: Verification of CoA E37/E38, 13 February 2022

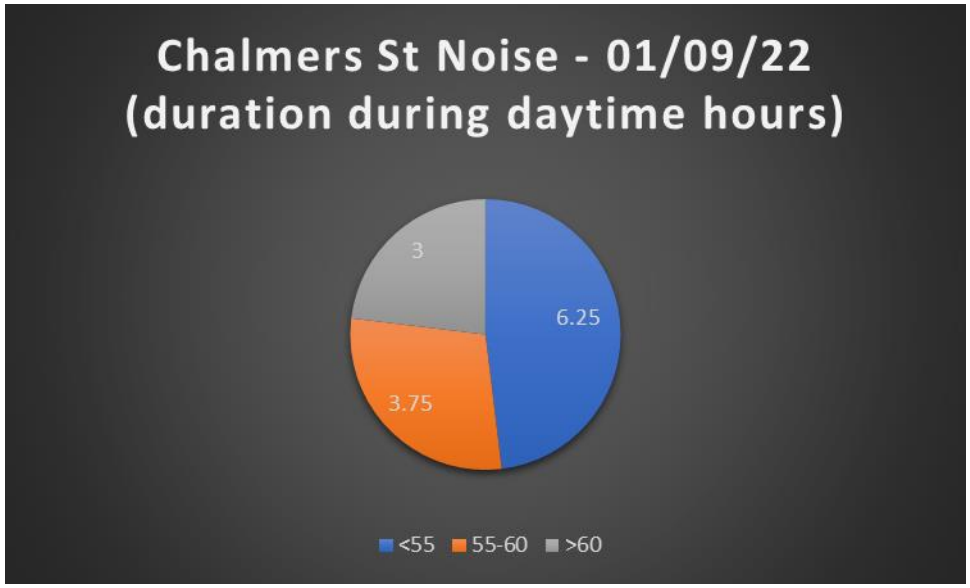

Figure B-2: 1 September 2022 distribution of noise data points (internal airborne noise levels)

Formula	CoA E38 (dB)	Criteria (hours)	Measured (hours)	Compliance with CoA E38
Measured LAeq15mins + 5dB - 20dB	<55	For more than 3.25	6.25	Complies
	55-60	For more than 6.5	3.75	Complies*
	>60	For less than 6.5	3.00	Complies

Table B-2: Verification of CoA E37/E38, 1 September 2022

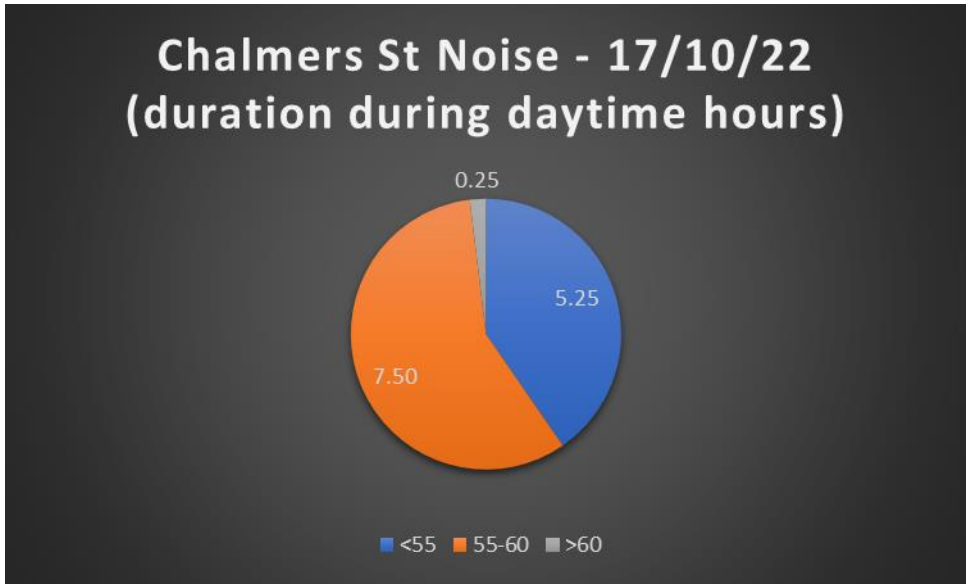

Figure B-3: 17 October 2022 distribution of noise data points (internal airborne noise levels)

Formula	CoA E38 (dB)	Criteria (hours)	Measured (hours)	Compliance with CoA E38
Measured LAeq15mins + 5dB - 20dB	<55	For more than 3.25	5.25	Complies
	55-60	For more than 6.5	7.50	Complies*
	>60	For less than 6.5	0.25	Complies

Table B-3: Verification of CoA E37/E38, 17 October 2022

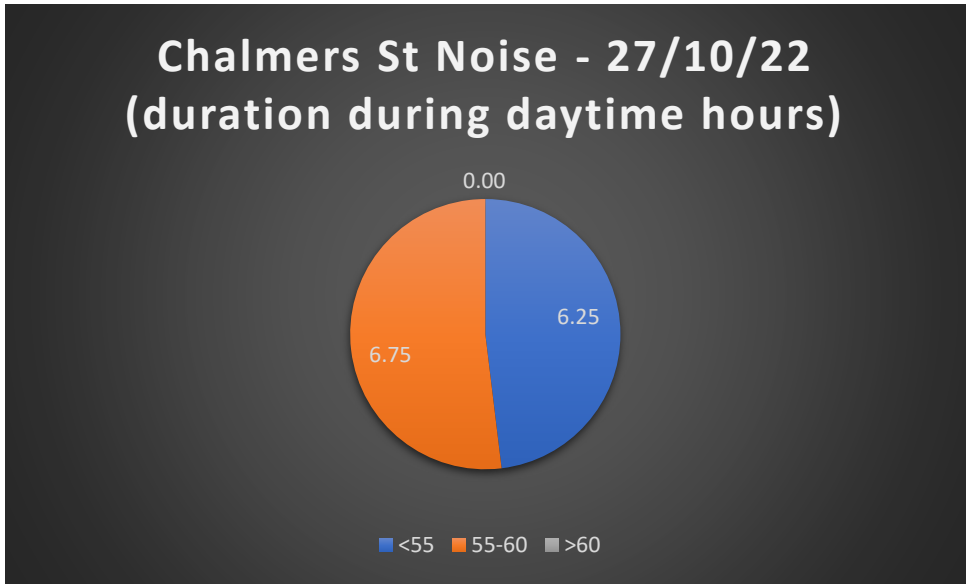

Figure B-4: 27 October 2022 distribution of noise data points (internal airborne noise levels)

Formula	CoA E38 (dB)	Criteria (hours)	Measured (hours)	Compliance with CoA E38
Measured LAeq15mins + 5dB - 20dB	<55	For more than 3.25	6.25	Complies
	55-60	For more than 6.5	6.75	Complies*
	>60	For less than 6.5	0.00	Complies

Table B-4: Verification of CoA E37/E38, 27 October 2022

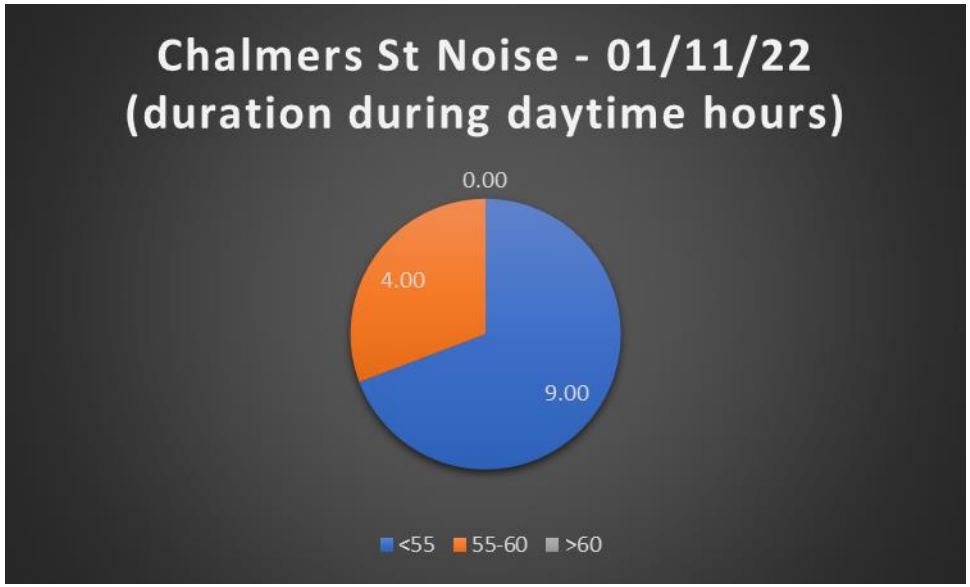

Figure B-5: 1 November 2022 distribution of noise data points (internal airborne noise levels)

Formula	CoA E38 (dB)	Criteria (hours)	Measured (hours)	Compliance with CoA E38
Measured LAeq15mins + 5dB - 20dB	<55	For more than 3.25	9.00	Complies
	55-60	For more than 6.5	4.00	Complies*
	>60	For less than 6.5	0.00	Complies

Table B-5: Verification of CoA E37/E38, 1 November 2022

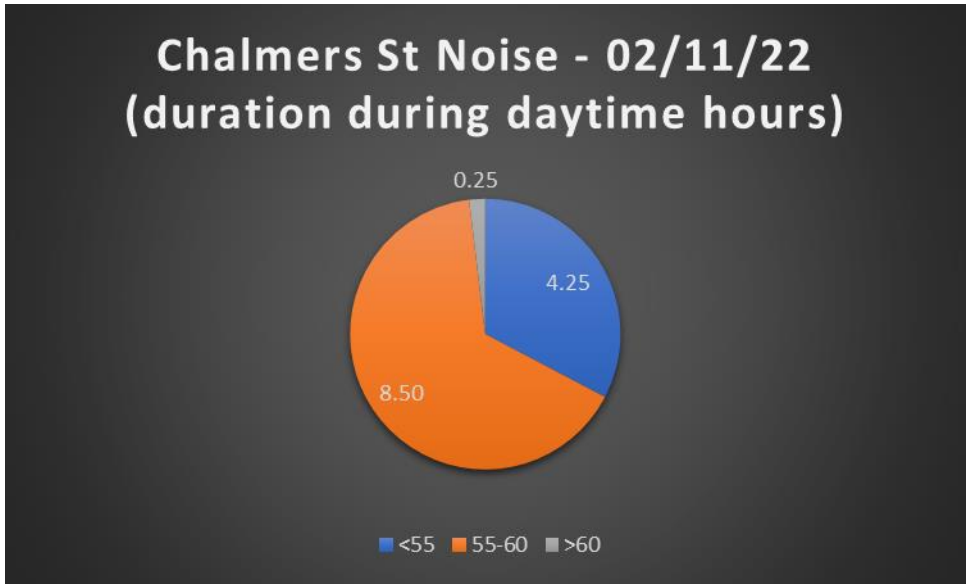

Figure B-6: 2 November 2022 distribution of noise data points (internal airborne noise levels)

Formula	CoA E38 (dB)	Criteria (hours)	Measured (hours)	Compliance with CoA E38
Measured LAeq15mins + 5dB - 20dB	<55	For more than 3.25	4.25	Complies
	55-60	For more than 6.5	8.50	Complies*
	>60	For less than 6.5	0.25	Complies

Table B-6: Verification of CoA E37/E38, 2 November 2022

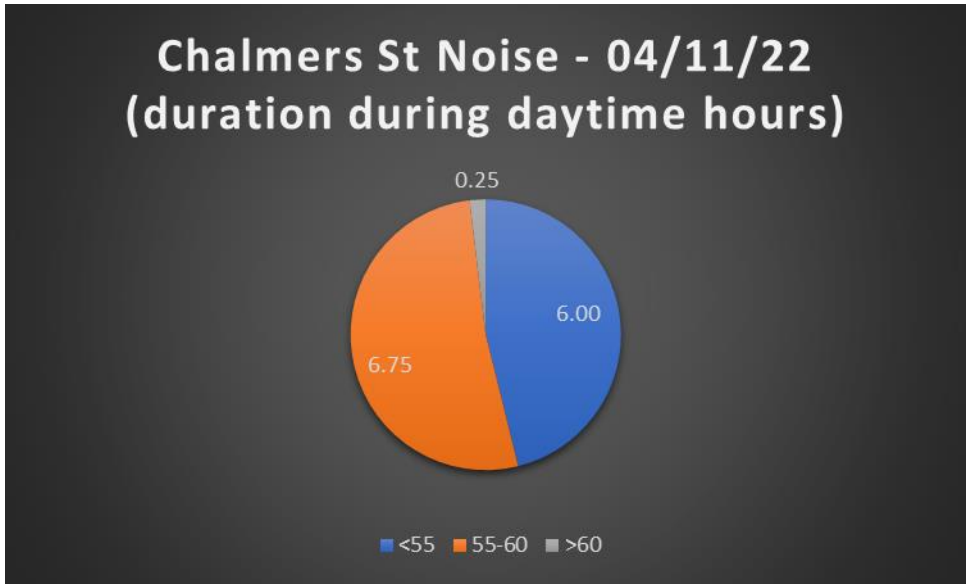

Figure B-7: 4 November 2022 distribution of noise data points (internal airborne noise levels)

Formula	CoA E38 (dB)	Criteria (hours)	Measured (hours)	Compliance with CoA E38
Measured LAeq15mins + 5dB - 20dB	<55	For more than 3.25	6.00	Complies
	55-60	For more than 6.5	6.75	Complies*
	>60	For less than 6.5	0.25	Complies

Table B-7: Verification of CoA E37/E38, 4 November 2022

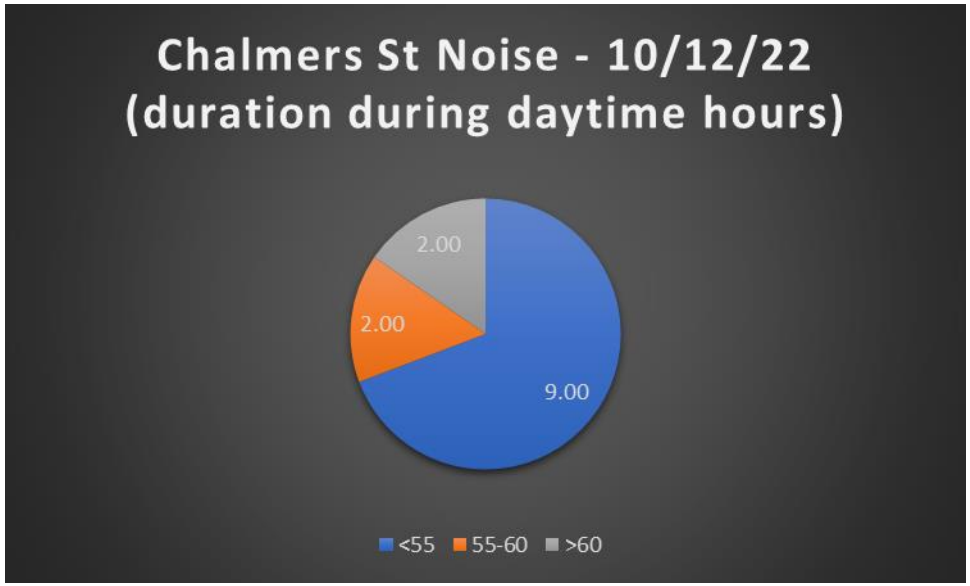

Figure B-8: 10 December 2022 distribution of noise data points (internal airborne noise levels)

Formula	CoA E38 (dB)	Criteria (hours)	Measured (hours)	Compliance with CoA E38
Measured LAeq15mins + 5dB - 20dB	<55	For more than 3.25	9.00	Complies
	55-60	For more than 6.5	2.00	Complies*
	>60	For less than 6.5	2.00	Complies

Table B-8: Verification of CoA E37/E38, 10 December 2022

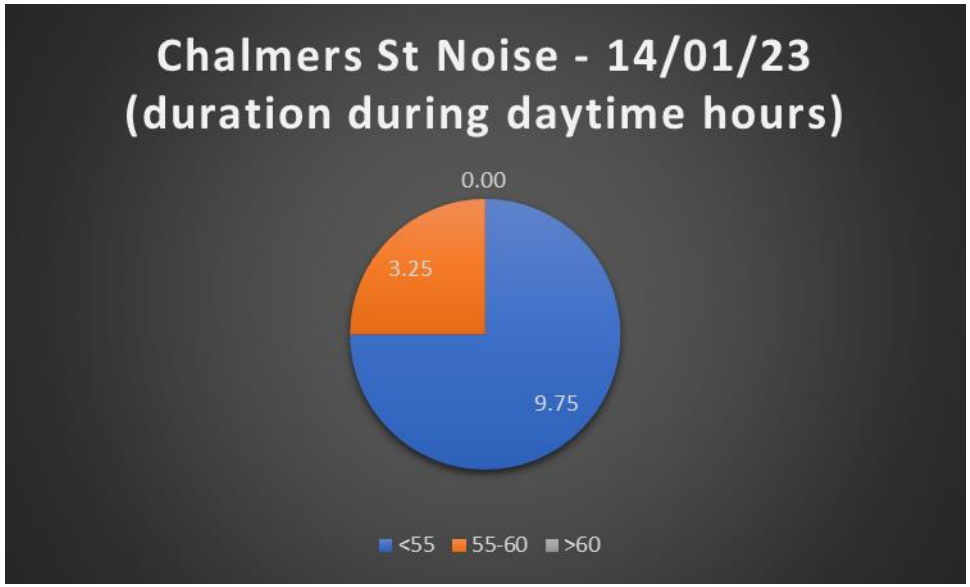

Figure B-9: 14 January 2023 distribution of noise data points (internal airborne noise levels)

Formula	CoA E38 (dB)	Criteria (hours)	Measured (hours)	Compliance with CoA E38
Measured LAeq15mins + 5dB - 20dB	<55	For more than 3.25	9.75	Complies
	55-60	For more than 6.5	3.25	Complies*
	>60	For less than 6.5	0.00	Complies

Table B-9: Verification of CoA E37/E38, 14 January 2023

Appendix C – Noise Monitors Calibration Certificates

CERTIFICATE OF CALIBRATION

CERTIFICATE NO: SLM32983

EQUIPMENT TESTED: Sound Level Meter

Manufacturer:	Svantek		
Type No:	Svan-977	**Serial No:**	36834
Mic. Type:	7052E	**Serial No:**	71095
Pre-Amp. Type:	SV12L	**Serial No:**	43613
Filter Type:	1/3 Octave	**Test No:**	F032984

Owner: Laing O'Rourke Australia
Level 4, 100 Arthur Street
North Sydney, NSW 2060

Tests Performed: IEC 61672-3:2013 & IEC 61260-3:2016

Comments: All Test passed for Class 1. (See overleaf for details)

CONDITIONS OF TEST:

Ambient Pressure	1003	hPa ±1 hPa	**Date of Receipt :**	22/06/2022
Temperature	22	°C ±1° C	**Date of Calibration :**	24/06/2022
Relative Humidity	44	% ±5%	**Date of Issue :**	24/06/2022

Acu-Vib Test Procedure: AVP10 (SLM) & AVP06 (Filters)

CHECKED BY: ..... **AUTHORISED SIGNATURE:** .....

Hein Soe

Accredited for compliance with ISO/IEC 17025 - Calibration
Results of the tests, calibration and/or measurements included in this document are traceable to SI units through reference equipment that has been calibrated by the Australian National Measurement Institute or other NATA accredited laboratories demonstrating traceability.

This report applies only to the item identified in the report and may not be reproduced in part.

The uncertainties quoted are calculated in accordance with the methods of the ISO Guide to the Uncertainty of Measurement and quoted at a coverage factor of 2 with a confidence interval of approximately 95%.

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Head Office & Calibration Laboratory
Unit 14, 22 Hudson Ave, Castle Hill NSW 2154
(02) 9680 8133
www.acu-vib.com.au

CERTIFICATE OF CALIBRATION

CERTIFICATE NO: SLM32980

EQUIPMENT TESTED: Sound Level Meter

Manufacturer:	Svantek		
Type No:	Svan-977A	**Serial No:**	59643
Mic. Type:	7052E	**Serial No:**	81291
Pre-Amp. Type:	SV12L	**Serial No:**	64843
Filter Type:	1/1 Octave	**Test No:**	F032982

Owner: Laing O'Rourke Australia
Level 4, 100 Arthur Street
North Sydney, NSW 2060

Tests Performed: IEC 61672-3:2013 & IEC 61260-3:2016

Comments: All Test passed for Class 1. (See overleaf for details)

CONDITIONS OF TEST:

Ambient Pressure	1004	hPa ±1 hPa	**Date of Receipt :**	22/06/2022
Temperature	24	°C ±1° C	**Date of Calibration :**	24/06/2022
Relative Humidity	38	% ±5%	**Date of Issue :**	24/06/2022

Acu-Vib Test Procedure: AVP10 (SLM) & AVP06 (Filters)

CHECKED BY: ..... **AUTHORISED SIGNATURE:** .....

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CERTIFICATE OF CALIBRATION

CERTIFICATE NO: C32981

EQUIPMENT TESTED : Sound Level Calibrator

Manufacturer: Svantek
Type No: SV-33 **Serial No:** 43175
Owner: Laing O'Rourke Australia
Level 4, 100 Arthur Street
North Sydney, NSW 2060
Tests Performed: Measured Output Pressure level, Frequency & Distortion
Comments: See Details overleaf. All Test Passed.

Parameter	Pre-Adj	Adj Y/N	Output: (dB re 20 µPa)	Frequency (Hz)	THD&N (%)
Level:	NA	N	114.04 dB	1000.00 Hz	0.40 %
Uncertainty			±0.11 dB	±0.05%	±0.20 %
Uncertainty (at 95% c.l.) k=2					

CONDITION OF TEST:

Ambient Pressure	1004	hPa ±1 hPa	**Date of Receipt :**	22/06/2022
Temperature	24	°C ±1° C	**Date of Calibration :**	24/06/2022
Relative Humidity	39	% ±5%	**Date of Issue :**	24/06/2022

Acu-Vib Test Procedure: AVP02 (Calibrators)
Test Method: AS IEC 60942 - 2017

CHECKED BY: .....

AUTHORISED SIGNATURE: .....

Hein Soe

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Hexanode Calibration Certificate

Dec 13 2022

Thank you for choosing SiteHive for your realtime environmental management. This calibration certificate is valid for the device noted below.

Noise

The Hexanode sound level meter has been pressure calibrated by SiteHive using a NATA Certified (IEC 60942: Sound calibrators) Sound Level Calibrator, at 2 Foveaux Street, Surry Hills, NSW, 2010.

Serial Number	Calibration Date	Calibration Value
HEX-000189	Nov 22 2022	3.105853

Accuracy:	Complies with precision requirements of IEC 61672 for Class 2
Acoustic overload point:	135 dBSPL
Frequency Range:	20 Hz ~ 12.5 kHz
Frequency Rating:	Z, A and C weighting
Parameters (dB):	Frequency & time weighted integrations, statistical levels, and more
Direction of Arrival:	Device angle & cartesian angle (0°-360°) of dominant noise source

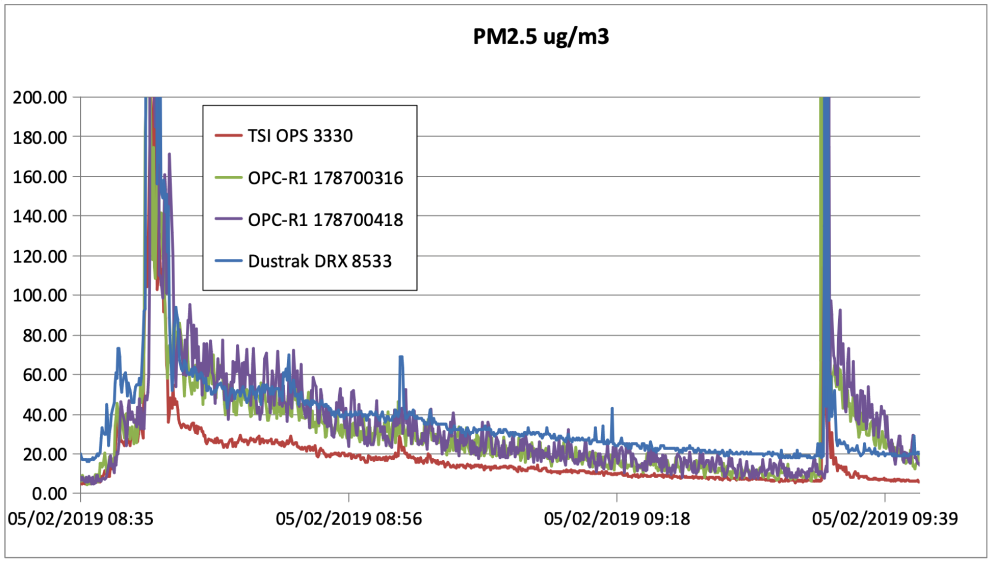
The SiteHive Hexanode uses innovative digital MEMS microphones, and as such cannot achieve full pattern approval in line with international standard IEC 61672, which is written for analogue condenser microphones. However, the SiteHive Hexanode sound level meter has been rigorously tested by the the National Measurement Institute (NMI), the division of the Australian Federal Government Department of Industry, Science, Energy & Resources responsible for providing world-class measurement services to support a fair, safe, healthy and competitive Australia. The National Measurement Institute's (NMI) acoustic, ultrasound and vibration measurement services are the most accurate in Australia, and include providing the certification for NATA (National Association of Testing Authorities) testing facilities, who provide class certification for noise meters. NMI undertook all of the possible tests outlined in IEC 61672-2, with the Hexanode passing all precision requirements within the criteria of a class 2 device.

Dust

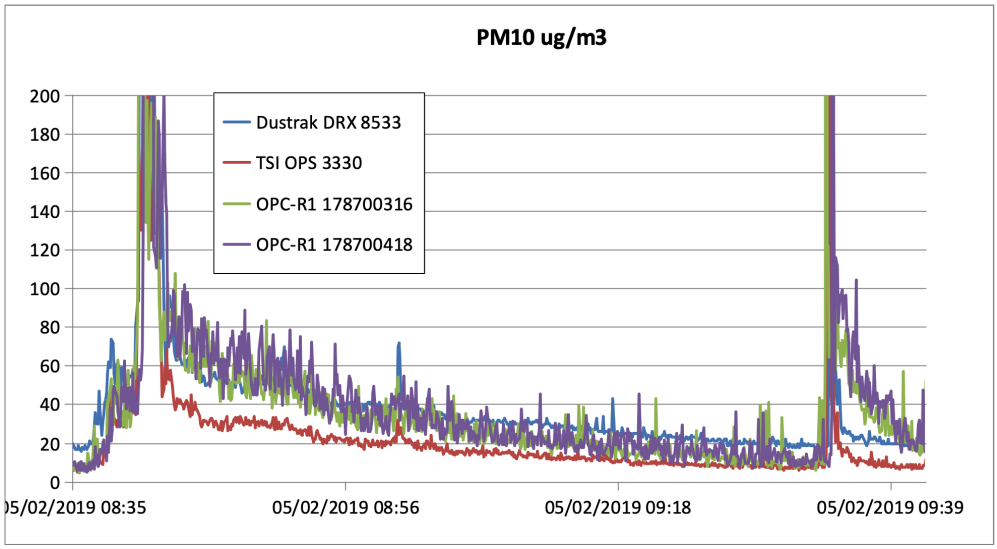
The Hexanode utilises the Alphasense R2 Optical Particle Sensor, to provide real-time dust measurements. Whilst the R2 does not have any gravimetric sampling capabilities, measurements can be adjusted using a K-Factor if one is available. SiteHive software will also provide measurements from the nearest Government air quality station for reference. The full data sheet for the Alphasense R2 is available here.

Particle range	µm spherical equivalent size (based on RI of 1.5)	0.30 to 12.4
Size categorisation	Number of software bins	16
Sampling interval	Histogram period (seconds)	2 to 30
Total flow rate	L/min (typical)	0.24
Max particle count rate	particles/second	10,000
Max coincidence probability	%concentration at 10^6 particles/L	0.7

Prior to deployment, the R2 is tested against TSI Optical Particle Sizer 3330 and DustTrak instruments.



Left: Comparison of PM2.5 monitoring by OPC-R2 sensor and TSI OPS 3330 and DustTrak instruments. All are set at 5s averaging and are sampling the ambient air of a workshop, the raw 3330 data has been used to calculate a PM figure.



Left: Comparison of PM10 monitoring by OPC-R2 sensor and TSI OPS 3330 and DustTrak instruments. All are set at 5s averaging and are sampling the ambient air of a workshop, the raw 3330 data has been used to calculate a PM figure.

APPROVAL
CITY & SOUTHWEST ACOUSTICS ADVISOR

Review of	**Central Station Main Works Construction Noise and Vibration Monitoring Program Report (CSMW)**	**Document reference:**	**Central Station Main Works Construction noise and Vibration Monitoring Program Report August 2022 – January 2023 Prepared by LOR.** *Revision date: 10/5/2023* *Revision: 2*
Prepared by:	Carl Fokkema Alternate Acoustics Advisor		
Date of issue:	30 May 2023		

As approved Alternate Acoustics Advisor for the Sydney Metro City & Southwest project, I have reviewed and provided comment on the Quarterly Construction Noise and Vibration Monitoring Program Report (CNVMPR) for the Central Station Man Works, as required under A27 (d) of the project approval conditions (SSI 15-7400).

I reviewed and commented on previous revision (0 and 1) of the CNVMPR Aug 2022 - Jan 2023. This revision 2 includes minor amendments that required updating or were of an administrative or minor nature and are consistent with the terms of approval and the document approved by the Secretary.

I am satisfied that such amendments are necessary, approve revision 2 of the CNVMPR (dated 10 May 2023), and consider that the document is appropriate for submission to the Secretary for information.

Carl Fokkema, City & Southwest Alternate Acoustics Advisor