

Waterloo Integrated Station Development

Noise and Vibration Annual Monitoring Report

October 2021 to September 2022

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Document and Revision History

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Glossary

Term	Explanation
CEMP	Construction Environmental Management Plan
CNVIS	Construction Noise & Vibration Impact Statement
CNVMP	Construction Noise and Vibration Management Plan
CoA	Condition of Approval
CSSI	Critical State Significant Infrastructure
ICNG	Interim Construction Noise Guideline
ISD	Integrated Station Development
JH	John Holland
MQD	Metro Quarter Development
NML	Noise Management Levels
OOHW	Out of Hours Work
OOHWA	Out of Hours Work Approval
OSD	Over-station Development
PNL	Predicted Noise Level
PPV	Peak Particle Velocity
RBL	Rating Background Level
VDV	Vibration Dose Value

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1. Introduction

1.2 Background

The Sydney Metro City & Southwest is a 30 kilometre metro rail between Chatswood and Bankstown, including; 17 kilometres of new tunnel from Chatswood, under the harbour to Sydenham connecting 7 new underground stations at Crows Nest, Victoria Cross (North Sydney), Barangaroo, Pitt Street, Martin Place, Central and **Waterloo**. Upgrading 13 kilometres of the Bankstown line, including 11 existing stations; Sydenham, Marrickville, Dulwich Hill, Hurlstone Park, Canterbury, Campsie, Belmore, Lakemba, Wiley Park, Punchbowl and Bankstown plus southern service facilities. The Waterloo Integrated Station Development (ISD) forms part of the Sydney Metro City & Southwest Project. The Waterloo ISD comprises of construction of the new station infrastructure to support customer movement and experience. The Waterloo Station works are undertaken by John Holland

The Waterloo ISD is located within Sydney's suburb of Waterloo, as shown in Figure 1, within the Metro Quarter. The Metro Quarter Development (MQD) comprises the land bounded by Botany Road, Raglan Street, Cope Street and Wellington Street, but excluding the Congregational Church located at 103 Botany Road. It is situated approximately 3km from the Sydney CBD and is surrounded by established residential and commercial land uses. The MQD incorporates the Waterloo ISD and the Over-station Development (OSD) however, the OSD component is not subject to the CSSI Project Planning Approval (SSI15_7400) and therefore does not form part of the scope of this report.



Figure 1 Location of the Waterloo ISD

1.3 Purpose

The Waterloo ISD annual noise and vibration monitoring report is a summary of all noise and vibration monitoring conducted over the 12 month period from commencement of Construction on 1st October 2021 to 30 September 2022.

The Construction Noise and Vibration Management Plan (Rev 3) (CNVMP) outlines the details of the monitoring program required by Condition of Approval (CoA) C10 and the frequency of reporting. The Construction Monitoring Program has been endorsed by the Acoustics Advisor and approved by the Secretary in accordance with CoA 13.

CoA C16 requires the results of the monitoring program to be provided to the Secretary for information at the frequency identified in the program. The approved monitoring program states the details of noise and vibration monitoring will be reported to Sydney Metro on an annual basis. The consolidated noise and vibration monitoring report will be submitted for information to the Secretary by Sydney Metro and relevant regulatory agencies and Council by Waterloo ISD.

Details of the compliance requirements are included in Table 1-1.

Table 1-1 Conditions of Approval relating to the Construction Monitoring Program

Condition	Requirement	Reference
C9	<p>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.</p> <ul style="list-style-type: none"> – 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 	<p>Noise and Vibration – refer to the Construction Noise and Vibration Management Plan</p> <p>Blasting – Not applicable</p> <p>Water Quality – Not applicable</p> <p>Groundwater - Not applicable</p>
C16	<p>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</p>	<p>The results of the Construction Noise and Vibration Monitoring Program are discussed in Section 4.</p> <p>In accordance with CoA C16, this report will be submitted to the following agencies for information:</p> <ul style="list-style-type: none"> – Department of Planning Industry and Environment – NSW Environment Protection Authority – City of Sydney Council

The Independent Acoustic Advisor will be provided with the report for endorsement prior to submission by Sydney Metro to the Secretary and submission to the relevant regulatory agencies by Waterloo ISD.

2. Monitoring Program Criteria

2.1 Noise criteria

The three primary noise metrics used to describe construction noise emissions are:

- LA1(1minute) - The typical 'maximum noise level for an event', used in the assessment of potential sleep disturbance during night-time periods. Alternatively, assessment may be conducted using the LAmax or maximum noise level.
- LAeq(15minute) - The "energy average noise level" evaluated over a 15-minute period. This parameter is used to assess the potential construction noise impacts.
- LA90 - The "background noise level" or "Rating Background Level" (RBL) in the absence of construction activities. This parameter represents the average minimum noise level during the daytime, evening and night-time periods respectively. The LAeq(15minute) construction noise management levels are based on the RBLs.
- The subscript "A" indicates that the noise levels are filtered to match normal hearing characteristics (A weighted).

The NSW EPA Interim Construction Noise Guideline (ICNG) requires project specific Noise Management Levels (NMLs) to be established for noise affected receivers. A site-specific Construction Noise and Vibration Impact Statement (CNVIS) has been prepared in accordance with CoA E33 which predicts noise impacts to nearby sensitive receivers. In the event construction noise levels are predicted to be above the NMLs, all feasible and reasonable work practices are investigated to minimise noise emissions.

Having investigated all feasible and reasonable work practices, if construction noise levels are still predicted to exceed the NMLs then the potential noise impacts would be managed as per Section 12 of the CNVMP.

Site specific residential construction NMLs for Waterloo ISD have been nominated in the Sydney Metro Chatswood to Sydenham EIS Technical Paper 2: *Noise and Vibration* (EIS NIA, SLR Consulting Report 610.14718R8 dated 28 April 2016). These NMLs have been reproduced in Table 2-1.

Table 2-1 Residential Construction Noise Management Levels

Receiver Types	LAeq(15minute) Construction NMLs (dBA)			
	Daytime ¹	Daytime OOH ²	Evening ³	Night-time ⁴
Residential ⁵	64	59	52	44

Note 1: The Daytime period includes Monday to Friday 7.00 am to 6.00 pm and Saturdays 8.00 am to 6.00 pm, except for Public Holidays.

Note 2: The Daytime Out of Hours period includes Saturdays 7.00 am to 8.00 am, and Sundays and Public Holidays 7.00 am to 6.00 pm

Note 3: The Evening period includes 6.00 pm to 10.00 pm.

Note 4: The Night-time period includes 10.00 pm to 7.00 am.

Note 5: The EIS NIA determined the NML from noise logging conducted at Monitoring Location B.06 (122 Wellington Street, Waterloo) between 31 August and 14 September 2015. The EIS NIA adopted the NML from B.06 for both Waterloo Noise Catchment Areas (NCAs), NCA29 and NCA31.

The Project specific LAeq(15minute) NMLs for non-residential noise sensitive receivers from the ICNG are provided in Table 2-2.

Table 2-2 Non-Residential Sensitive Receivers Noise Management Levels

Land Use	Area	NML LAeq(15minute) Noise Levels	
		External	Internal
Hotel ¹	Bars and Lounges	70 dBA	50 ^{2,3} (Daytime & Evening)
	Sleeping Areas: - Hotels near major roads	As per Table 6 for residential ⁴	40 ⁴ (Night-time)
Café ¹	Coffee bar	70 dBA ³	50 ^{2,3} (when in use)
Bar/Restaurant ¹	Bars and Lounges / Restaurant	70 dBA ³	50 ^{2,3} (when in use)
Library ¹	Reading Areas	70 dBA	45 ⁵ (when in use)
Recording Studio ¹	Music Recording Studios	70 dBA	25 ⁶ (when in use)
Theatre/ Auditorium ¹	Drama Theatres	70 dBA	30 ⁶ (when in use)
Childcare Centres	Internal Play Area	65 dBA	55 dBA
	Sleeping Area	50 dBA (when in use)	40 dBA (when in use)
Classrooms at schools and other education institutions		55 dBA	45 dBA ⁷ (when in use)
Hospital wards and operating theatres		70 dBA	45 dBA
Places of Worship		70 dBA	45 dBA
Active recreation areas ⁸		65 dBA	-
Passive recreation areas ⁹		60 dBA	-
Community centres		Depends on the intended use of the centre. Refer to the recommended upper internal design sound levels in AS 2107 for specific uses.	
Commercial premises ¹⁰	offices, retail outlets and small commercial premises	70 dBA (when in use)	45 dBA (when in use)
Industrial premises ¹⁰		75 dBA (when in use)	-

Note 1: Design noise levels specified in AS 2107 internal noise levels.

Note 2: Where no external seating has been identified, fixed window glazing and air conditioning is assumed to mitigate high existing ambient noise levels and/or control internal noise break-out. A minimum outside-to-inside attenuation of 20 dB is assumed. The internal ICNG noise goal then corresponds to a façade level of 70 dBA.

Note 3: Where an open frontage or outdoor seating area has been identified, the external noise goal is taken as 60 dBA.

Note 4: Hotels (sleeping areas during the night-time) are assumed to have incorporated acoustic façade design in order to mitigate high existing ambient noise levels (refer to CNVMP Section 9.7) to achieve the internal design noise level of 40 dBA specified in AS 2107. Notwithstanding, the more conservative external NML corresponding to residential receivers (refer to CNVMP Table 6) has been applied to the sleeping areas of hotels.

Note 5: These receivers are typically well insulated from external noise break-in.

Note 6: These receivers are typically well insulated from external noise break-in, with significant acoustic mitigation included in the façade design.

Note 7: Assumed based on external noise levels being 10 dB higher than internal noise levels when windows are open.

Note 8: Characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion.

Note 9: Characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion (eg reading and meditation).

Note 10: Assess at the most affected occupied point on the premises.

2.2 Vibration Criteria

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

- Continuous vibration: machinery, steady road traffic, continuous construction activity such as underground drilling
- Impulsive vibration: infrequent activities that create up to three distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading
- Intermittent vibration: trains, nearby intermittent demolition activity, rock breakers and jack hammers.

Structural vibration in buildings can be detected by the occupants possibly affecting them in various ways including reducing working efficiency and quality of life. Complaint levels from occupants of the buildings subject to vibration depend on the use of the building and the time of day.

Based on the information contained in the CNVIS and EIS, site specific vibration control criteria haven been nominated and are reproduced in Table 2-3.

Table 2-3 Nominated Site Vibration Control Criteria

Building type	Included Buildings	Site Control Criteria ¹	
		Operator warning level	Operator halt level
Reinforced frame structure	All surrounding commercial	20 mm/s PPV	25 mm/s PPV
Unreinforced or light framed structures	All surrounding Residential	5 mm/s PPV	7.5 mm/s PPV
Heritage (structurally sound)	Congregational Church	5 mm/s PPV	7.5 mm/s PPV
Buried Utilities	All	20 mm/s PPV	25 mm/s PPV
Human Response ²	All	0.2 m/s ^{1.75} VDV	0.4 m/s ^{1.75} VDV
Vibration Sensitive Equipment ³	Medical Centre, Hospital	0.013 mm/s PPV	0.018 mm/s PPV

Note 1: An exceedance of the operator warning level does not require activities to cease, but will alert the Project Manager and Foreman to proceed with caution at a reduced force or load.

Note 2: Based on information presented in DECCW's Assessing Vibration: a technical guideline.

Note 3: Based on the Generic Vibration Criteria for Vibration-Sensitive Equipment (SPIE 1991).

3. 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 Project. The program has been executed in accordance with Section 13 of the CNVMP. The Construction Monitoring Program commenced 1 October 2020 at Construction commencement and will continue for the duration of the project.

3.1 Construction Activities

An indicative schedule of work is provided in Table 3-1. Note demolition work has been completed by the Sydney Metro TSE Contractor. No building demolition or blasting works have been identified as part of the Waterloo ISD project.

Table 3-1: Indicative schedule of construction phases for Waterloo ISD

Works	Description	Time
Station Works	<p>The works for the new underground metro station include:</p> <ul style="list-style-type: none"> Detailed excavation and drilling required for sumps, track slab-invert, onsite detention tanks, drainage, services and foundations to support the structural works; Waterproofing of the station box; All primary and secondary structural works including for the entire station box, entrances, all services, utilities, systems, fit out elements, concourses, station platforms, over-track exhaust plenums and vertical transport; Track invert slab including underline crossings, earthing mats and drainage; Plant and equipment rooms; Public and staff toilets; All back of house areas; Architectural fit-out; Low-voltage electrical, fire, hydraulics, lighting and mechanical systems; Building management control system; Provisions for works by Interface Contractors; Provisions for advertising and vending machines; Lifts and escalators; Signage and wayfinding; External façade to the MQD Transfer Level including over street awnings; Landscaping, kerbs and precinct activation works; Bicycle parking facilities; Public art (within the Station Lot); Security measures. 	October 2020 – late 2022
Local Area Works	Resurfacing or reconstruction of affected roads, footpaths, cycle ways or other public amenities, and signage, traffic control signals, street lighting, flood mitigation and traffic and transport management.	October 2020 – late 2022

Works	Description	Time
Utility Service Works	Identification, protection, diversion, reconstruction or repair of affected utility services, new utility service connections and other general provisions.	August 2021 – late 2022
Property Works	Protection and adjustments to affected existing buildings and property.	2022
Retail Works	<p>The works for the base build of the retail spaces in Waterloo Station and the station precinct, but excludes the retail spaces in the MQD Lot, including:</p> <ul style="list-style-type: none"> - Shell of the retail space tenancy units (including storage areas); - Base building services including LV power, cold water supply, chilled water loops (for air conditioning), fire systems, sewage facilities; - Grease traps and ventilation exhausts (where appropriate); - Waste collection facility for the retail areas; - Telephone and data systems; - Glazed shopfront finishes. 	2022
MQD Enabling Works	<p>The works to be performed for the areas of the MQD which are located within the footprint of the station box and below the MQD Transfer Level which are required for the integration of the MQD Works with the Station Works and to enable further construction of the MQD Works without disruption to the operating station. The MQD Enabling Works include:</p> <ul style="list-style-type: none"> - Foundations and structures to support the MQD; and - Egress and any other Building Code of Australia compliance required to support the MQD Works. 	Jan 2022 – late 2022

3.2 Sensitive Receivers

The Waterloo ISD Construction Noise and Vibration Impact Statement (CNVIS) assessed the sensitive receivers potentially affected by construction noise. The receiver locations representing noise and vibration are shown in Figure 2 and Figure 3 .

In accordance with CoA E33, ongoing consultation with sensitive receivers is undertaken as the project progresses based on the scenarios identified in the CNVIS. The scenarios are reviewed and refined with the input of construction detail to determine the potential impact and appropriate mitigation. 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.



Figure 2 Noise Sensitive Receivers

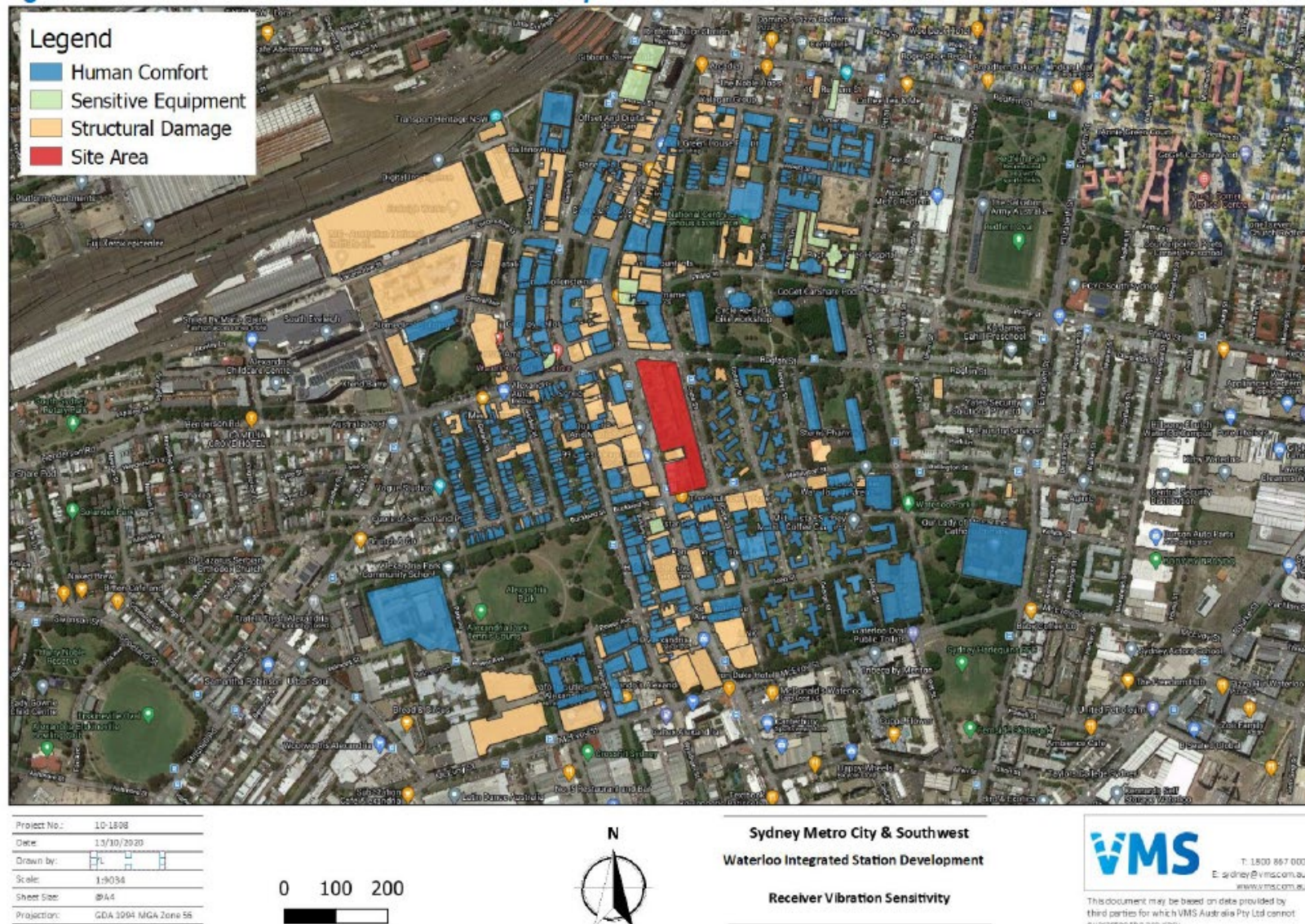


Figure 3 Vibration Sensitive Receivers

3.3 Monitoring

3.3.1 Attended noise monitoring

Noise monitoring has been undertaken by a suitably qualified person in accordance with the CNVMP. Attended measurements were undertaken from the commencement of each stage of construction in order to confirm that the noise and vibration levels in the adjacent community are consistent with the predictions in the CNVIS. Attended noise measurements would be repeated to ensure ongoing compliance.

The following key locations were identified in the CNVMP:

- Waterloo Congregational Church (noise and vibration)
- 104 Cope Street (noise)
- 219 Cope Street (noise)

Additional locations were monitored for noise impacts as the activities changed during the reporting period, this included noise monitoring outside 122-136 Wellington Street.

3.3.2 Unattended noise monitoring

Real time (unattended) noise or vibration monitoring will be undertaken to satisfy Project Planning Approval Condition C11. Real time monitoring will be deployed to manage impacts from 'high risk' activities, where the CNVIS predictions identify there is a high risk of annoyance from construction. The real-time noise monitors will be installed prior to commencement of the high risk activity. The monitor will be installed by an appropriately trained person in the measurement and assessment of construction noise and vibration, who is familiar with the requirements of the relevant standards and procedures. The real-time monitoring data will be available to Waterloo ISD, Sydney Metro, ER, AA, DPIE and EPA via a web based portal. Note no "high risk" activities were identified or conducted during the reporting period.

3.3.3 Noise monitoring parameters

Noise monitoring will be recorded over 15 minute sample intervals. Every 15 minutes, the data is to be processed statistically and stored in memory. The minimum noise metrics to be stored in memory and reported are the following A-weighted noise levels: L90, Leq and Lmax.

3.3.4 Vibration monitoring

Vibration monitoring was completed at the Congregational Church which is located adjacent to the construction site. A continuous vibration monitor has been installed inside the church which records vibration. The monitor has been set up to provide an alert via SMS at trigger levels corresponding to "Warning Level" and "Halt Level".

In response to vibration complaints additional monitoring may be undertaken to investigate and assess the extent and source of vibration exceedances and to apply mitigation measures preventing the complaint from reoccurring.

3.3.5 Vibration monitoring parameters

Vibration measurements will be undertaken in accordance with the procedures documented in the *OEH's Assessing Vibration - a technical guideline (2006)*, *AS 2107.2 2006 Explosives – Storage and Use* and *DIN 4150:Part 3-1999 Structural Vibration - Effects of Vibration on Structures*.

Vibration monitoring will be recorded over a minimum 15 minute sample interval. For every sample, the data is to be processed statistically and stored in memory. The minimum vibration metrics to be stored in memory and reported are the following vibration levels: *Vibration Dose Value VDV*, *RMS*, *Peak Particle Velocity (PPV)* and *Frequency (Hz)*.

If ongoing/continuous vibration monitoring is required, peak vibration levels are recorded and trigger an audible/visual alarm and/or SMS Alert corresponding to both “Operator Warning Level” and “Operator Halt Level” set according to nominated site vibration criteria levels presented in Table 2-3.

4. Results

The noise and vibration monitoring program includes details of the frequency of monitoring required to manage and control impacts associated with the construction activities. Refer to Section 13 Table 22 of the CNVMP.

Attended noise measurements will be undertaken within a period of 14 days from the commencement of each stage of construction in order to confirm that the noise and vibration levels in the adjacent community are consistent with the predictions in the CNVIS. Attended noise measurements would be repeated at a minimum interval of every month in order to ensure ongoing compliance.

The following are representative monitoring locations:

- Waterloo Congregational Church (noise and vibration)
- 104 Cope Street (noise)
- 219 Cope Street (noise)

Note, alternate monitoring locations were selected based on the location of work relative to sensitive receivers, e.g. 122 - 136 Wellington Street, Waterloo.

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.

The CNVMP requires real time noise monitoring to be deployed to manage impacts from 'high risk' activities, where the CNVIS predictions identify there is a high risk of annoyance from construction. During the reporting period, 'high risk' activities have not been identified.

4.1 Summary of activities

A summary of activities, including out of hours works, is provided in Table 4-1. The monitoring schedule is detailed in Table 4-2.

Table 4-1 Activities by Month

Month	Activity	Approved out of hours activities
October 2021	<ul style="list-style-type: none"> - Site sheds, stair access - Precast installation - Concrete pour B2 slab - Blockwork level B5 - Reinforce perimeter wall works 	<ul style="list-style-type: none"> - Oversized deliveries - Concrete pour and finishing works - Crane usage for lifting within the station box (use of crane to install/move items safely and minimise number of workers within the lifting area) - Utility investigative works
November 2021	<ul style="list-style-type: none"> - B2 slab works - Wall pours - Blockwork level B5 - Deliveries - Steel fixing, formwork placement 	<ul style="list-style-type: none"> - Oversized deliveries (including unloading) - Concrete finishing works

Month	Activity	Approved out of hours activities
	- Services installation within the site	
December 2021	<ul style="list-style-type: none"> - Formwork, reo/steel fixing - Precast installation on B2, B1 - Perimeter wall works progressing and pouring of B2 and B1 walls - Cranage of materials - Deliveries - Services installation within the site 	<ul style="list-style-type: none"> - Oversized deliveries (including unloading) - Concrete set-up (early start)/Concrete finishing works due to large size of pours for walls and base slab - Prefabricated steel formwork placement within the station box (use of crane to install safely) - Ausgrid Outage Cope St LV/HV works
January 2022	<ul style="list-style-type: none"> - Formwork, reo/steel fixing - Perimeter wall and B1 slab pour - Fit out of services within level B3-B5 - Wall pours - Pre cast installation - Cranage of materials - Deliveries - Services installation within the site - Cable tray and duct work 	<ul style="list-style-type: none"> - Oversized deliveries (including unloading) - Concrete set-up (early start)/Concrete finishing works due to large size of pours for walls and base slab - Prefabricated steel formwork placement within the station box (use of crane to install safely) - Site setup and road closure of Cope St
February 2022	<ul style="list-style-type: none"> - Formwork, reo/steel fixing - Perimeter wall and B1 slab pour - Cranage of materials - Tower crane install - Deliveries - Relocation of HV/LV - B2-B5 fit out of services 	<ul style="list-style-type: none"> - Oversized deliveries (including unloading) - Concrete set-up (early start)/Concrete finishing works due to large size of pours for walls and base slab - Prefabricated steel formwork placement within the station box (use of crane to install safely) - Site setup and road closure of Cope St
March 2022	<ul style="list-style-type: none"> - Formwork, reo/steel fixing - Stripping of formwork - Wall pours - Installation of precast columns - Station fit out and blockwork - Cranage of materials - Deliveries 	<ul style="list-style-type: none"> - Oversized deliveries (including unloading)/Installation of precast elements - Concrete set-up (early start)/Concrete finishing works due to large size of pours for walls and base slab - Crane usage for lifting within the station box (use of crane to install/move items safely and minimise number of workers within the lifting area) - Utility works including potholing, investigative works and cable pulling
April 2022	<ul style="list-style-type: none"> - Formwork, reo/steel fixing - Stripping of formwork - Wall pours - Cranage of materials, using tower cranes and mobile/fixed cranes on surface - Deliveries - Pre-cast planks and beam installation - Over track exhaust (OTE) installation 	<ul style="list-style-type: none"> - Oversized deliveries (including unloading)/Installation of precast elements - Concrete set-up (early start)/Concrete finishing works due to large size of pours for walls and base slab - Crane usage for lifting within the station box (use of crane to install/move items safely and minimise number of workers within the lifting area)

Month	Activity	Approved out of hours activities
		<ul style="list-style-type: none"> - Utility works including potholing, investigative works and cable pulling
May 2022	<ul style="list-style-type: none"> - Formwork, reo/steel fixing - Stripping of formwork - Wall pours - Mezzanine floor slab pour - Cranage of materials, using tower cranes and mobile/fixed cranes on surface - Deliveries - Pre-cast stairs, platform, beam and plank deliveries - Over track exhaust (OTE) installation 	<ul style="list-style-type: none"> - Oversized deliveries (including unloading)/Installation of precast elements - Concrete set-up (early start)/Concrete finishing works due to large size of pours for walls and base slab - Crane usage for lifting within the station box (use of crane to install/move items safely and minimise number of workers within the lifting area) - Utilities conduit install, cable pulling, pole footings
June 2022	<ul style="list-style-type: none"> - Precast installation - Wall pours - B3, B4, B5 fit out - B1 blockwork - Cranage of materials, using tower cranes and mobile/fixed cranes on surface - Deliveries - Pre-cast beam and plank deliveries - Over track exhaust (OTE) installation 	<ul style="list-style-type: none"> - Oversized deliveries (including unloading)/Installation of precast elements - Concrete set-up (early start)/Concrete finishing works due to large size of pours for walls and base slab - Crane usage for lifting within the station box (use of crane to install/move items safely and minimise number of workers within the lifting area) - Utilities cable pulling and cutover works
July 2022	<ul style="list-style-type: none"> - Formwork, reo/steel fixing - Stripping of formwork - Blockwork installing and fill occurring on across B3 and surface level. - Cranage of materials, using tower cranes and mobile/fixed cranes on surface - Deliveries - Capping beam removal - Earthing pit works on Cope St 	<ul style="list-style-type: none"> - Fit out works and service installation across B5 and beginning B3 South and concourse level. - Crane usage for lifting within the station box (use of crane to install/move items safely and minimise number of workers within the lifting area) - Ausgrid outage and utility works (external to Site) - Electrical cable pulling in station
August 2022	<ul style="list-style-type: none"> - Formwork, reo/steel fixing above B3 - Stripping of formwork - Cranage of materials, using tower cranes and mobile/fixed cranes on surface - Deliveries - Utility work (external to the site) - Eastern capping beam removal (Cope St side) removed using wire saw 	<ul style="list-style-type: none"> - Concrete Pour of southern structure - Concrete set-up (early start)/Concrete finishing works due to large size of pours for walls and base slab - Crane usage for lifting within the station box (use of crane to install/move items safely and minimise number of workers within the lifting area)
September 2022	<ul style="list-style-type: none"> - Formwork, reo/steel fixing Level 2 North - Stripping of formwork - Cable install - Cranage of materials, using tower cranes and mobile/fixed cranes on surface - Deliveries 	<ul style="list-style-type: none"> - Oversized deliveries (including unloading)/Installation of precast elements - Concrete set-up (early start)/Concrete finishing works due to large size of pours for Level 2 North - Crane usage for lifting within the station box (use of crane to install/move items

Month	Activity	Approved out of hours activities
	<ul style="list-style-type: none"> - Pre-cast beam and plank deliveries - Block work, fire spray - Earthing pit works - Utility works on Cope and Wellington Streets 	<ul style="list-style-type: none"> - safely and minimise number of workers within the lifting area - Utility work (external to the site) - Internal station work, eg. Fire spray, block work, duct work etc

Table 4-2 Noise and Vibration Monitoring Schedule

Aspect	Monitoring Frequency		
	Continuous	Monthly (attended)	Other
Noise	In response to complaint / start of high-risk activity	X	Start of new works or OOHW or in response to a complaint
Vibration	X		If working within minimum working distances or in response to a complaint

4.2 Noise results

4.2.1 Attended noise monitoring

Noise monitoring was conducted to verify construction noise levels with Predicted Noise Level (PNL) outlined in the CNVIS and applicable OOHWA. During the reporting period a total of 101 events were conducted. Of these events, 53 monitored works during standard hours and 48 monitored out of hours works.

The construction noise level (LAeq 15min) was observed to be greater than the PNL for 31 events in total, with 17 of these events occurring out of hours. Generally, where the PNL was less than the actual noise during the monitoring event it was determined to be due to external factors such as traffic noise rather than specific construction activities.

A summary of noise monitoring results for the reporting period is outlined in **Table 4-3**.

4.2.2 Unattended real time noise monitoring

Unattended real time noise monitoring is only required at Waterloo ISD to manage impacts from 'high risk' activities, where the CNVIS predication identifies there is a high risk of annoyance from construction.

During the reporting period no high risk activities were identified and therefore no real time noise monitoring was undertaken.

4.2.2 Plant and equipment monitoring

Plant and equipment monitoring is required to be completed in accordance with CNVMP. **Table 4-4** includes monitoring for the Concrete Agitator, 400T Diesel Crane, 130T Diesel Crane, Vacuum Truck, Telehandler, 150T Crane, 8T Excavator, 450T Crane (with noise blankets) and wire saw. The monitoring was generally consistent with the sound pressure levels in the CNVMP. Obtaining the noise data is constrained due to the high number of activities also occurring at the same time in the same location.

Table 4-3: Noise monitoring results

Monitoring Month	Standard or OOHW	Construction Activity	Date	Time	Construction location	Monitoring location	RBL (dBA)	PNL (dBA)	LAeq (15 min) (dBA)	Exceedance of PNL		Exceedance due to construction activities	Construction activities	Comments/ observations during monitoring
Oct-21	Day Works	Activity 6 Station Box Works	08/10/2021	3:36:00 PM	Main site - Monthly Monitoring	104 Cope Street, Waterloo NSW 2017	54	55	77.2	Yes	22.2	No	Dominant Traffic on Raglan Street and FerryCarrig Excavation works	
Oct-21	Day Works	Activity 6 Station Box Works	08/10/2021	4:00:00 PM	Main site - Monthly Monitoring	219 Cope St, Waterloo NSW 2017	54	49	62.2	Yes	13.2	No	Minimal traffic on Cope Street and Minimal Noise from Caravan Generators	
Oct-21	Day Works	Activity 6 Station Box Works	08/10/2021	2:50:00 PM	Main site - Monthly Monitoring	Waterloo Congregational Church	54	58	69.2	Yes	11.2	No	Dominant traffic on Botany Road, Motorcyclists at 80dB	
Oct-21	OOHWA #19	S2a - Service Relocation (Raglan St)/Activity 5	11/10/2021	9:24:00 PM	Raglan St (footpath)	129 Raglan Street, Waterloo	47	80	73.2	No	-6.8	N/A	Works dominant noise source. Plant was switched off when not in use.	
Oct-21	OOHWA #19	Ferrycarrig Caravans - Cope Street	11/10/2021	9:40:00 PM	Cope St (Ferrycarig MAF)	213 Cope Street, Waterloo NSW 2017, Australia	47	52	56.2	Yes	4.2	No	Background noise (cicadas and pedestrians) and Traffic were the dominant noise source from Cope St and reason for elevated levels. When other noises aren't present the caravan generator was below NML. Freedom Day - large number of drunk pedestrians	
Oct-21	OOHWA #19	S2a - Service Relocation (Raglan St)/Activity 5	11/10/2021	10:00:00 PM	Raglan St (footpath)	129 Raglan Street, Waterloo	39	70	67.8	No	-2.2	N/A	Works around 64db throughout. Convenient store closing shop very loud and possible cause of La max. Traffic and pedestrians periodically throughout.	
Oct-21	OOHWA #19	Ferrycarrig Caravans - Cope Street	11/10/2021	10:17:00 PM	Cope St (Ferrycarig MAF)	213 Cope Street, Waterloo NSW 2017, Australia	39	44	55.5	Yes	11.5	No	Faint hum. Pedestrian and traffic dominant noise. Hand tools from station box audible. Background noise dominant and source of exceedance.	
Oct-21	OOHWA #19	S2a - Service Relocation (Botany Rd)/Activity 5	12/10/2021	9:25:00 PM	108 Botany Road Alexandria NSW 2015	76-84 Botany Road Alexandria NSW 2015	47	85	69.1	No	-16	N/A	Traffic dominant noise source. Works audible but below traffic. Traffic near constant. Hammering hitting 63db.	
Oct-21	OOHWA #19	S2a - Service Relocation (Botany Rd)/Activity 5	12/10/2021	9:45:00 PM	108 Botany Road Alexandria NSW 2015	130 Botany Road Alexandria NSW 2015	47	80	67.5	No	-13	N/A	Traffic dominant noise source. Works audible but below traffic. Traffic frequent throughout monitoring.	
Oct-21	OOHWA #19	S2a - Service Relocation (Botany Rd)/Activity 5	12/10/2021	10:00:00 PM	108 Botany Road Alexandria NSW 2015	76-84 Botany Road Alexandria NSW 2015	39	75	68.4	No	-6.6	N/A	Traffic dominant noise source. Works audible but below traffic. Traffic frequent	
Oct-21	OOHWA #19	S2a - Service Relocation (Botany Rd)/Activity 5	12/10/2021	10:30:00 PM	108 Botany Road Alexandria NSW 2015	130 Botany Road Alexandria NSW 2015	39	70	67.5	No	-2.5	N/A	Traffic dominant noise source. Works audible but below traffic. Traffic frequent throughout monitoring.	
Nov-21	OOHWA #20	S2a - Service Relocation (Wellington St)/Activity 5	02/11/2021	9:45:00 PM	123 Botany Rd, Waterloo NSW 2017	122-136 Wellington St Waterloo	47	85	67.2	No	-18	No	FerryCarrig utility works- vacuum truck in use and hand tools. Switched off vac truck when not in use. Meeting close together to discuss works rather than shouting - good behaviour. Frequent traffic on botany and steel works audible from station box.	
Nov-21	OOHWA #20	S2a - Service Relocation (Wellington St)/Activity 5	02/11/2021	10:00:00 PM	123 Botany Rd, Waterloo NSW 2017	122-136 Wellington St Waterloo	39	75	68.9	No	-6.1	No	FerryCarrig utility works- vacuum truck in use and hand tools. Switched off vac truck when not in use. Meeting close together to discuss works rather than shouting - good behaviour. Frequent traffic on botany road	
Nov-21	Day Works	Activity 6 Station Box Works	15/11/2021	3:10:00 PM	Main site - Monthly Monitoring	104 Cope Street, Waterloo NSW 2017	54	49	71.1	N/A		N/A	Concrete Pump in use on South side of station box, Steel works, dropping/placing of steel on ground detected during monitoring	Boral trucks on Cope St, Pedestrians, and bus present on Cope St

Monitoring Month	Standard or OOHW	Construction Activity	Date	Time	Construction location	Monitoring location	RBL (dBA)	PNL (dBA)	LAeq (15 min) (dBA)	Exceedance of PNL		Exceedance due to construction activities	Construction activities	Comments/ observations during monitoring
Nov-21	Day Works	Activity 6 Station Box Works	15/11/2021	2:50:00 PM	Main site - Monthly Monitoring	219 Cope St, Waterloo NSW 2017	54	49	73.9	N/A		N/A	Cranes carrying reo over hoarding, concrete pump in use on South side of station box	Pedestrians walking on Cope St, Delivery trucks on Cope St, reversal beepers from delivery truck, cars on Cope St
Nov-21	Day Works	Activity 6 Station Box Works	15/11/2021	2:35:00 PM	Main site - Monthly Monitoring	122-136 Wellington St, Waterloo NSW 2017	54	49	69	N/A		N/A	Concrete pump in use on south side of station box, FerryCarrig Services on Wellington/Cope St corner (No noise noticed at the time of monitoring)	Pedestrians walking on sidewalk (Wellington Street)
Nov-21	Day Works	Activity 6 Station Box Works	15/11/2021	3:30:00 PM	Main site - Monthly Monitoring	Waterloo Congregational Church	54	58	77.3	N/A		N/A	Cranes in use	Car traffic on Botany Road (Dominant Noise)
Nov-21	LWW-OOHW-140 (SMCSWLWC-SYC-SWL-EM-PMT-009561) REV 01	Systems Connect Concreting Works	12/11/2021	8:55:00 PM	Concreting activities located within the tunnel.	130 Wellington St, Waterloo	50	60	58	No	-2	No	Note that the concrete pump works located within the tunnel were not audible at this monitoring location.	
Nov-21	LWW-OOHW-140 (SMCSWLWC-SYC-SWL-EM-PMT-009561) REV 01	Systems Connect Concreting Works	12/11/2021	9:17:00 PM	Concreting activities located within the tunnel.	213 Cope Street, Waterloo	50	60	58	No	-2	No	Note that the concrete pump works located within the tunnel were not audible at this monitoring location.	
Nov-21	LWW-OOHW-140 (SMCSWLWC-SYC-SWL-EM-PMT-009561) REV 01	Systems Connect Concreting Works	12/11/2021	9:42:00 PM	Concreting activities located within the tunnel.	72 Botany Road, Alexandria	50	60	67	Yes	7	No	Note that this measurement was heavily affected by road traffic. Note that the concrete pump works located within the tunnel were not audible at this monitoring location.	
Nov-21	LWW-OOHW-140 (SMCSWLWC-SYC-SWL-EM-PMT-009561) REV 01	Systems Connect Concreting Works	12/11/2021	10:03:00 PM	Concreting activities located within the tunnel.	130 Wellington Street, Waterloo	45	60	59	No	-1	No	Note that the concrete pump works located within the tunnel were not audible at this monitoring location.	
Nov-21	LWW-OOHW-140 (SMCSWLWC-SYC-SWL-EM-PMT-009561) REV 01	Systems Connect Concreting Works	12/11/2021	10:03:00 PM	Concreting activities located within the tunnel.	213 Cope Street, Waterloo	45	60	60	No	0	No	Note that the concrete pump works located within the tunnel were not audible at this monitoring location.	
Nov-21	LWW-OOHW-140 (SMCSWLWC-SYC-SWL-EM-PMT-009561) REV 01	Systems Connect Concreting Works	12/11/2021	10:43:00 PM	Concreting activities located within the tunnel.	72 Botany Road, Alexandria	45	60	68	Yes	8	No	Note that this measurement was heavily affected by road traffic. Note that the concrete pump works located within the tunnel were not audible at this monitoring location.	
Nov-21	OOHWA - Ausgrid Spotter Wellington St	S2a - Service Relocation (Wellington St)	19/11/2021	9:45:00 PM	Wellington/Cope Intersection	123 Wellington St	47	65	58.9	No	-6.1	No	NDD & hand tools in use	Works below PNL. Works dominant noise source.
Nov-21	OOHWA - Ausgrid Spotter Wellington St	S2a - Service Relocation (Wellington St)	19/11/2021	10:00:00 PM	Wellington/Cope Intersection	123 Wellington St	39	65	59	No	-6	No	Works below PNL. Works dominant noise source.	Traffic on Wellington Street (noise measured: 63-68 db)
Nov-21	Raglan Minor Ancillary Facility	Generator	24/11/2021	9:45:00 PM	Raglan Street	149 Cope Street	47	50	54	Yes	4	No	Works inaudible. Traffic/background noise dominant	
Nov-21	Raglan Minor Ancillary Facility	Generator	24/11/2021	10:00:00 PM	Raglan Street	149 Cope Street	39	50	54.6	Yes	4.6	No	Works inaudible. Traffic/background noise dominant	

Monitoring Month	Standard or OOHW	Construction Activity	Date	Time	Construction location	Monitoring location	RBL (dBA)	PNL (dBA)	LAeq (15 min) (dBA)	Exceedance of PNL		Exceedance due to construction activities	Construction activities	Comments/ observations during monitoring
Nov-21	Raglan Minor Ancillary Facility	Generator	24/11/2021	10:15:00 PM	Raglan Street	179 Cope Street	39	50	57	Yes	7	No	Works very faintly audible - faint hum. Traffic/background noise dominant noise source.	
Nov-21	OOHWA #20	S2a - Service Relocation (Wellington St)/Activity 5	23/11/2021	10:45:00 PM	62-72 Botany Road	62-72 Botany Road	39	75	78.3	Yes	3.3	No	Vacuum Truck in use with large quantities of traffic on Botany Road. Construction noise consistent at approximately 75dB with traffic noise diluting the sample with constant cars passing elevating levels.	
Nov-21	Raglan Minor Ancillary Facility	Generator	24/11/2021	3:30:00 PM	Raglan Minor Ancillary Facility	Raglan Minor Ancillary Facility	54	65	61.7	No	-3.3	No	Sound Power Level Verification at 7m. Model sound power level is +4dB above the monitored value. Night time PNL is hence 46dB and +2dB above NML.	
Dec-21	Day Works	Vaccum truck	06/12/2021	1:00:00 PM	Cope Street (Southern End)	170-174 Cope Street Waterloo NSW 2017	54	85	68.5	No	-17	N/A	Sound power level of vacuum truck taken onsite. Monitoring done 7m away from vehicle operating.	
Dec-21	Day Works	S7 - Core Walls and Precast Beam	14/12/2021	11:25:00 AM	Main site - Monthly Monitoring	104 Cope Street, Waterloo NSW 2017	54	61	68.9	Yes	7.9	No	Occasional scabbling audible, cranes in use, deliveries on going via botany road entrance and Wellington St gate, utilities ongoing	Traffic dominant. Large volumes passing through intersection. Pedestrians frequent passing monitoring location. Traffic dominant & source of exceedance. Some works slightly audible. General construction works occurring within Project site.
Dec-21	Day Works	S7 - Core Walls and Precast Beam	14/12/2021	11:45:00 AM	Main site - Monthly Monitoring	219 Cope St, Waterloo NSW 2017	54	88	73.1	No	-15	N/A	Utilities works, general carnage, formwork in the box. Utility works and general construction works occurring external to and within project site, respectively. Works below PNL.	Some public vehicles passing on Cope St. Mostly works audible.
Dec-21	Day Works	S2a - Service Relocation (Cope St)	14/12/2021	12:20:00 PM	Main site - Monthly Monitoring	Waterloo Congregational Church	54	71	70.1	No	-0.9	N/A	General crange, formwork, concrete pours	Traffic from botany road dominant and frequent. Traffic dominant and reason for elevated levels. Works from site not audible. General works occurring within Project site.
Jan-22	Day Works	S7 - Core Walls and Precast Beam	14/01/2022	9:43:00 AM	Main site - Monthly Monitoring	104 Cope Street, Waterloo NSW 2017	54	62	69.3	Yes	7.3	No	FerryCarrig undertaking service relocation works at the cope Raglan intersection. General construction works occurring within project site. Including FRP, OTE install, beam install & crane removal prep.	Traffic and pedestrians constantly present at monitoring location and source of elevated noise levels. Works not audible. Exceedance due to surround traffic/passing vehicles.
Jan-22	Day Works	S7 - Core Walls and Precast Beam	14/01/2022	10:00:00 AM	Main site - Monthly Monitoring	219 Cope St, Waterloo NSW 2017	54	65	59.1	No	-5.9	N/A	FerryCarrig undertaking service relocation works at the cope Raglan intersection. General construction works occurring within project site. Including FRP, OTE install, beam install & crane removal prep.	General traffic & pedestrians passing noise monitoring location.
Jan-22	Day Works	S7 - Core Walls and Precast Beam	14/01/2022	10:25:00 AM	Main site - Monthly Monitoring	Waterloo Congregational Church	54	71	71.5	No	0.5	No	FerryCarrig undertaking service relocation works at the cope Raglan intersection. General construction works occurring within project site. Including FRP, OTE install, beam install & crane removal prep.	Car traffic on Botany Road (Dominant Noise). Exceedance of PNL due to traffic on Botany Road.
Jan-22	OOHWA #22 - Cope/Raglan Outage Works	S2a - Service Relocation (Cope St)	22/01/2022	6:11:00 PM	149 Cope St Waterloo NSW 2017 Australia	149 Cope St Waterloo NSW 2017 Australia	45	68.5	63.4	No	-5.1	N/A	Works finishing earlier than expected. Backfilling trench for hot mixing. Bogie delivered backfill during monitoring. Predominantly hand tools during monitoring and excavator in use. Plant switched off when not in use. Noise blankets overlapping.	Apartment ventilation/exhaust background noise.
Jan-22	OOHWA #22 - Cope/Raglan Outage Works	S2a - Service Relocation (Cope St)	22/01/2022	11:15:00 PM	149 Cope St Waterloo NSW 2017 Australia	149 Cope St Waterloo NSW 2017 Australia	39	80	65.2	No	-15	N/A	Day maker running. Demobilising worksite prior to asphalt delivery - Using excavator to load bogie.	Botany road traffic audible. Occasional cars passing on raglan.
Jan-22	OOHWA #25	S2a - Service Relocation (Botany Rd)/Activity 5	24/01/2022	9:10:00 PM	62 Botany Road Waterloo NSW 2017 Australia	62 Botany Road Waterloo NSW 2017 Australia	45	63	73.1	Yes	10.1	No	Jackhammering and vac truck during monitoring.	Vehicle noise higher than works and dominated monitoring period over jackhammering and vac truck use, police chase passed during monitoring. Exceedance of PNL due to traffic on Botany Road.
Feb-22	Day Works	S7 - Core Walls and Precast Beam	18/02/2022	9:00:00 AM	Main site - Monthly Monitoring	104 Cope Street, Waterloo NSW 2017	54	62	71.7	Yes	9.7	No	Utilities works, general carnage, formwork in the box	General traffic & pedestrians passing noise monitoring location.

Monitoring Month	Standard or OOHW	Construction Activity	Date	Time	Construction location	Monitoring location	RBL (dBA)	PNL (dBA)	LAeq (15 min) (dBA)	Exceedance of PNL		Exceedance due to construction activities	Construction activities	Comments/ observations during monitoring
Feb-22	Day Works	S7 - Core Walls and Precast Beam	18/02/2022	10:00:00 AM	Main site - Monthly Monitoring	219 Cope St, Waterloo NSW 2017	54	65	64.3	Yes	-0.7	No	Utilities works, general carnage, formwork in the box	General traffic & pedestrians passing noise monitoring location.
Feb-22	Day Works	S7 - Core Walls and Precast Beam	18/02/2022	10:30:00 AM	Main site - Monthly Monitoring	Waterloo Congregational Church	54	71	74.5	Yes	3.5	No	Utilities works, general carnage, formwork in the box	Car traffic on Botany Road (Dominant Noise)
Mar-22	Day Works	S6 - Precast Placement	15/03/2022	9:00:00 AM	Main site - Monthly Monitoring	104 Cope Street, Waterloo NSW 2017	54	65	72.1	Yes	7.1	No	Utilities works, general carnage, formwork in the box, craneage works on Cope St	General traffic & pedestrians passing noise monitoring location.
Mar-22	Day Works	S6 - Precast Placement	15/03/2022	10:00:00 AM	Main site - Monthly Monitoring	219 Cope St, Waterloo NSW 2017	54	71	65.7	No	-5.3	No	Utilities works, general carnage, formwork in the box, craneage works on Cope St	General traffic & pedestrians passing noise monitoring location.
Mar-22	Day Works	S6 - Precast Placement	15/03/2022	10:30:00 AM	Main site - Monthly Monitoring	Waterloo Congregational Church	54	70	75.7	Yes	5.7	No	Utilities works, general carnage, formwork in the box, craneage works on Cope St	Car traffic on Botany Road (Dominant Noise)
Mar-22	Day Works	S13a - Cope St Closure Crane Crane Operations	18/03/2022	1:38:00 PM	Cope St South Compound	122-136 Wellington St Waterloo	54	64	61.7	No	-2.3	N/A	1 min - Stationary 2 min - 61.9dB winch operating 3 min - 60dB suspended load 4 min - 60.3dB winch operating 5 min - 57dB suspended load 6 min - 56.7dB suspended load 7 min - 60.4dB winch operating 8 min - 60.2dB winch operating 9 min - 58.3dB suspended load 10 min - 58.1dB suspended load 11 min - 60.5dB winch operating 12 min - 56.3dB suspended load 13 min - 60.7dB winch operating 14 min - 55.8dB suspended load 15 min - 60.1dB winch operating	Traffic passing monitoring location during monitoring event. Cars and motorcycles ranging from 65-78dB.
Mar-22	Day Works	S13a - Cope St Closure Crane Crane Operations	18/03/2022	1:54:00 PM	Cope St South Compound	219 Cope St Waterloo	54	73	64.2	No	-8.8	N/A	1 min - 66.6dB winch operating 2 min - 61.2dB suspended load 3 min - 61.1dB suspended load 4 min - 62.2dB winch operating 5 min - 60.4dB suspended load 6 min - 61.4dB suspended load 7 min - 60.5dB suspended load 8 min - 67.5dB winch operating 9 min - 67.7dB winch operating 10 min - 67.3dB winch operating 11 min - 68dB winch operating 12 min - 61.2dB suspended load 13 min - 60.8dB suspended load 14 min - 64.4dB winch operating 15 min - 60.7dB suspended load	78dB max due to car passing on Wellington St.
Mar-22	OOHW permit # 21	S13a - Cope St Closure Crane Crane Operations	25/03/2022	3:00:00 AM	Cope St South Compound	122-136 Wellington St Waterloo	39	64	59.5	No	-4.5	N/A	0min - 59.4 moving winch 1 min - 60.6 moving winch 2min - 61.5 moving winch 3min - moving winch 61.8 4 min - 54.6 holding load 5min - holding load 55.9 6min - 56.3 holding load 7min - 57.6 holding load 8min - 57.8 moving winch 9min - 61.0 moving winch 10min - 65.9 moving 11 min - 63.9 moving 12 min - 57.5 holding 13 min - 69.2 car passing & 62.5 moving 14 min - 63.4 moving	Traffic on Botany Rd audible. Cars passed monitoring location.
Mar-22	OOHW permit # 21	S13a - Cope St Closure Crane Crane Operations	25/03/2022	3:15:00 AM	Cope St South Compound	219 Cope St Waterloo	39	73	68.8	No	-4.2	N/A	0min - 71.2 moving 1min - 70.6 moving 2mins - 76.0 moving 3mins - 74.1 moving 4mins - 74.8 moving 5min - 74.9 moving 6min - 68.1 moving	N/A

Monitoring Month	Standard or OOHW	Construction Activity	Date	Time	Construction location	Monitoring location	RBL (dBA)	PNL (dBA)	LAeq (15 min) (dBA)	Exceedance of PNL		Exceedance due to construction activities	Construction activities	Comments/ observations during monitoring
													7min - 62.4 holding 8min - 63.3 holding 9min - 62.3 holding 10min - 62.7 holding 11min - 63.8 moving boom 12min - 63.2 holding 13min - 61.3 holding 14min - 60.8 holding	
Mar-22	OOHW permit # 21	S13a - Cope St Closure Crane	29/03/2022	1:05:00 AM	Cope St South Compound	219 Cope St Waterloo	39	64	65.7	Yes	1.7	No		
Mar-22	OOHW permit # 21	S13a - Cope St Closure Crane	29/03/2022	1:30:00 AM	Cope St South Compound	128 Cope St Waterloo	39	64	63.7	No	-0.3	N/A		
Apr-22	OOHW permit # 28	Ausgrid Outage #2	12/04/2022	9:10:00 PM	Cope St/Raglan St	62 Botany Road Waterloo NSW 2017 Australia	47	85	71.6	No	-13	N/A	Electric saw in use. Very quiet. Below 70db. Traffic on botany road constant at approximately 70db. Traffic dominant. Approx 15mins of work only and tree cutting ceased.	Traffic dominant noise source on Botany Rd
Apr-22	OOHW permit # 28	Ausgrid Outage #2	13/04/2022	9:20:00 PM	Cope St/Raglan St	213 Cope St Waterloo	39	75	61.5	No	-14	N/A	Joint bay works, pole and overhead line removal occurring. Generators also in use.	
Apr-22	OOHW permit # 28	Ausgrid Outage #2	13/04/2022	11:25:00 PM	Cope St/Raglan St	213 Cope St Waterloo	47	75	62.9	No	-12	N/A	Joint bay works, pole and overhead line removal occurring. Generators also in use.	Traffic consistent on Botany Road General traffic & pedestrians passing noise monitoring location. General traffic & pedestrians passing noise monitoring location. Car traffic on Botany Road (Dominant Noise) General traffic & pedestrians passing noise monitoring location. General traffic & pedestrians passing noise monitoring location. Car traffic on Botany Road (Dominant Noise) General traffic & pedestrians passing noise monitoring location. General traffic & pedestrians passing noise monitoring location.
Apr-22	Day Works	S6 - Precast Placement	28/04/2022	9:00:00 AM	Main site - Monthly Monitoring	104 Cope Street, Waterloo NSW 2017	54	65	64.8	No	-0.2	N/A	Saw cutting completed at 7.30mins of monitoring. Hand excavation from 7.30-9.30 mins Generator 9.30-10.10 Hand tools for conduct install 10.10 main noise is traffic from 10.10.	
Apr-22	Day Works	S6 - Precast Placement	28/04/2022	9:20:00 AM	Main site - Monthly Monitoring	219 Cope St, Waterloo NSW 2017	54	71	66.6	No	-4.4	N/A	Utilities works, general carnage, formwork in the box, crange works on Cope St	
Apr-22	Day Works	S6 - Precast Placement	28/04/2022	9:40:00 AM	Main site - Monthly Monitoring	Waterloo Congregational Church	54	70	68.8	No	-1.2	N/A	Utilities works, general carnage, formwork in the box, crange works on Cope St	
May-22	Day Works	S8 - Construction of Levels 1 & 2	03/05/2022	9:00:00 AM	Main site - Monthly Monitoring	104 Cope Street, Waterloo NSW 2017	54	70	61	No	-9	N/A	Utilities works, general carnage, formwork in the box, crange works on Cope St	
May-22	Day Works	S8 - Construction of Levels 1 & 2	03/05/2022	9:20:00 AM	Main site - Monthly Monitoring	219 Cope St, Waterloo NSW 2017	54	69	67.6	No	-1.4	N/A	Utilities works, general carnage, formwork in the box, crange works on Cope St, scaffolding install, column & beam precast works for level 1 & 2	
May-22	Day Works	S8 - Construction of Levels 1 & 2	03/05/2022	9:40:00 AM	Main site - Monthly Monitoring	Waterloo Congregational Church	54	70	70.8	Yes	0.8	No	Utilities works, general carnage, formwork in the box, crange works on Cope St, scaffolding install, column & beam precast works for level 1 & 2	
Jun-22	Day Works	S8 - Construction of Levels 1 & 2	23/06/2022	9:00:00 AM	Main site - Monthly Monitoring	104 Cope Street, Waterloo NSW 2017	54	70	60	No	-10	N/A	Utilities works, general carnage, formwork in the box, crange works on Cope St, scaffolding install, column & beam precast works for level 1 & 2	
Jun-22	Day Works	S8 - Construction of Levels 1 & 2	23/06/2022	9:20:00 AM	Main site - Monthly Monitoring	219 Cope St, Waterloo NSW 2017	54	69	65.2	No	-3.8	N/A	Utilities works, general carnage, formwork in the box, crange works on Cope St	
Jun-22	Day Works	S8 - Construction of Levels 1 & 2	23/06/2022	9:40:00 AM	Main site - Monthly Monitoring	Waterloo Congregational Church	54	70	72.1	Yes	2.1	No	Utilities works, general carnage, formwork in the box, crange works on Cope St	
Jun-22	OOHW permit # 33	S8 - Construction of Levels 1 & 2	29/06/2022	21:10PM	Main site - Level 1 & 2 Wellington St	124 Wellington St, Waterloo NSW 2017, Australia	47	63	59.5	No	-3.5	N/A	Utilities works, general carnage, formwork in the box, crange works on Cope St	Car traffic on Botany Road (Dominant Noise)
Jun-22	OOHW permit # 33	S8 - Construction of Levels 1 & 2	29/06/2022	21:35PM	Main site - Level 1 & 2 Wellington St	124 Wellington St, Waterloo NSW 2017, Australia	47	63	61.2	No	-1.8	N/A	No activities occurring at Level 1 & 2 (meal break) Monitoring representative of background	Noise monitored related to traffic noise on Wellington St/Botany Road and pedestrians passing by. Dog barking, overhead aeroplanes audible during monitoring event
Jun-22	OOHW permit # 33	S8 - Construction of Levels 1 & 2 S12 General Crane operations	30/06/2022	19:45PM	Main site - Level 1 & 2 Wellington St	124 Wellington St, Waterloo NSW 2017, Australia	47	63	64.3	Yes	1.3	No	Activities occurring at level 1 & 2 included: - scaffold install - Level 1 - prep work for formwork/steel fixing on Level 2	loud car at 3 mins intermittent traffic noise on Wellington St traffic noise on Botany Rd audible
Jun-22	OOHW permit # 36	Utility Works	27/06/2022	21:45PM	Wellington/Botany/Buckland Intersection	136 Wellington St, Waterloo NSW 2017, Australia	47	65	63.4	No	-1.6	No	Activities occurring at level 1 & 2 included: - scaffold install - Level 1 - prep work for formwork/steel fixing on Level 2 - crane in use on Cope St	intermittent traffic noise on Wellington St traffic noise on Botany Rd audible

Monitoring Month	Standard or OOHW	Construction Activity	Date	Time	Construction location	Monitoring location	RBL (dBA)	PNL (dBA)	LAeq (15 min) (dBA)	Exceedance of PNL		Exceedance due to construction activities	Construction activities	Comments/ observations during monitoring
Jun-22	OOHW permit # 36	Utility Works	27/06/2022	22:00PM	Wellington/Botany/Buckland Intersection	132 Botany Rd, Waterloo NSW 2017, Australia	39	55	69.4	Yes	14.4	No	Works inaudible. Traffic from botany Rd dominant.	
Jul-22	Day Works	S8 - Construction of Levels 1 & 2	25/07/2022	15:45PM	Main site - Level 1 & 2 Wellington St	136 Wellington St, Waterloo NSW 2017, Australia	54	75	62.3	No	-13	No	Works inaudible. Traffic from botany Rd dominant.	
Jul-22	OOHW permit # 38	Level 1 & 2 Concrete Pours	29/07/2022	05:30AM	Main Site - Level 2 Wellington St	123 Wellington St	39	68	73.1	Yes	5.1	No	Utilities works, general carnage, formwork in the box, cranage works on Cope St	General traffic & pedestrians passing noise monitoring location.
Jul-22	OOHW permit # 38	Level 2 Concrete Pours	29/07/2022	05:47AM	Main Site - Level 2 Wellington St	136 Wellington St, Waterloo NSW 2017, Australia	39	63	76.1	Yes	13.1	No	Concrete trucks pulling in and out of Cope Street and main site. Pumping concrete to Level 2	Passing traffic on Wellington Street most audible, especially delivery trucks going through roundabout ranging from 65-80dB. 84.1dB max reading when truck drove past roundabout. 97.3dB recorded when truck beeped horn. Truck noise most audible when trucks driving along road outside of site, not considered to be construction related.
Jul-22	OOHW permit # 38	Level 2 Concrete Pours	29/07/2022	06:05AM	Main Site - Level 2 Wellington St	132 Botany Rd, Alexandria NSW 2015, Australia	39	58	71.1	Yes	13.1	No	Concrete trucks pulling in and out of Cope Street and main site. Pumping concrete to Level 2	Bus and truck traffic on Botany Rd most audible. 84.3dB recorded when large truck drove past monitoring location on Botany Road.
Aug-22	Day Work	S8 - Construction of Levels 1 & 2	16/08/2022	12:25:00 PM	Main Site - Level 1 & 2 Wellington St	122-136 Wellington St, Waterloo NSW 2017, Australia	54	75	64.9	No	-10	N/A	Activities occurring at level 1 & 2 included: - scaffold install - Level 1 - prep work for formwork/steel fixing on Level 2 - crane in use on Cope St	Intermittent traffic noise on Wellington St, garbage truck passing was loudest noise audible traffic noise on Botany Rd audible
Aug-22	Day Work	S8 - Construction of Levels 1 & 2	16/08/2022	12:50:00 PM	Main Site - Level 1 & 2 Wellington St and North structure	213 Cope Street, Waterloo	54	75	59.2	No	-16	N/A	Activities occurring at level 1 & 2 included: - scaffold install - Level 1 - prep work for formwork/steel fixing on Level 2 - crane in use on Cope St - no wire saw in use	Intermittent pedestrian traffic
Aug-22	Day Work	Activity 6	18/08/2022	12:30:00 PM	Main Site Station Box B2 South	122-136 Wellington St	54	75	63.2	No	-12	N/A	Jackhammering B2 South, Scaffolding works Level 1 & , general crane operations on Cope St	Pedestrian and bike traffic on footpath, frequent car traffic on Wellington St and Botany Rd.
Aug-22	OOHW permit # 42	Utility Works	24/08/2022	9:45:00 PM	Wellington St/ Botany Rd intersection	122-136 Wellington St	47	68	62.3	No	-5.7	N/A	Station work fit out, EWP in use, Wellington St watermain works	Pedestrian and bike traffic on footpath, frequent car traffic on Wellington St and Botany Rd.
Aug-22	OOHW permit # 42	Utility Works	24/08/2022	10:10:00 PM	Wellington St/ Botany Rd intersection	122-136 Wellington St	39	68	63.8	No	-4.2	N/A	Crane works on Cope St, Wellington St watermain works, hammering5 mins to break asphalt	Pedestrian and bike traffic on footpath, frequent car traffic on Wellington St and Botany Rd.
Aug-22	OOHW permit # 42	Utility Works	24/08/2022	10:27:00 PM	Wellington St/ Botany Rd intersection	Cope/wellington St 80m from works	39	68	64.2	No	-3.8	N/A	General station work, cranage, fit out more audible than Wellington St works	Pedestrian and bike traffic on footpath, frequent car traffic on Wellington St
Aug-22	OOHW permit # 42	Utility Works	24/08/2022	10:45:00 PM	Wellington St/ Botany Rd intersection	Waterloo Congregational church Botany Rd (80m from works)	39	68	66.2	No	-1.8	N/A	Wellington St watermain works vac truck	Traffic on Botany Rd most audible. Wellington St works inaudible
Sep-22	Day Work	S8 - Construction of Levels 1 & 2 S12 General Crane operations	20/09/2022	9:53:00 AM	Main site - Monthly Monitoring	219 Cope St, Waterloo NSW 2017	54	69	69	No	0	N/A	Activities occurring at level 1 & 2 South Structure included: - scaffold install - Level 1 - prep work for formwork/steel fixing on Level 2 - crane in use on Cope St	Traffic on Wellington St audible with intermittent pedestrians
Sep-22	Day Work	S8 - Construction of Levels 1 & 2 S12 General Crane operations	20/09/2022	10:10:00 AM	Main site - Monthly Monitoring	209 Cope St, Waterloo NSW 2017, Australia	54	69	58.3	No	-11	N/A	Activities occurring at level 1 & 2 South structure included: - scaffold install - Level 1 - prep work for formwork/steel fixing on Level 2 - crane in use on Cope St - Jack hammering western side of capping beam (5 mins towards end of recording). Not very audible, raglan St traffic more audible	Traffic on Raglan St most audible, with intermittent pedestrians
Sep-22	Day Work	S8 - Construction of Levels 1 & 2 S12 General Crane operations	20/09/2022	10:35:00 AM	Main site - Monthly Monitoring	122-136 Wellington St, Waterloo	54	63	63.7	Yes	0.7	No	Activities occurring at level 1 & 2 South Structure included: - scaffold install - Level 1 - prep work for formwork/steel fixing on Level 2 - crane in use on Cope St	Traffic on Wellington St most audible with intermittent pedestrians

Monitoring Month	Standard or OOHW	Construction Activity	Date	Time	Construction location	Monitoring location	RBL (dBA)	PNL (dBA)	LAeq (15 min) (dBA)	Exceedance of PNL		Exceedance due to construction activities	Construction activities	Comments/ observations during monitoring
Sep-22	OOHW permit # 38	Level 1 & 2 Concrete Pours	27/09/2022	5:30:00 AM	Main Site Level 2 North Structure	62-82 Botany Rd, Alexandria	39	58	73.1	Yes	15.1	No	Concrete trucks pulling in and out of Botany Rd Gate B1 & B2, Concrete pumping works on northern structure for Level 2 Pour 1	Traffic on Botany Rd most audible, passing buses, cars and trucks not related to site activities
Sep-22	OOHW permit # 38	Level 2 Concrete Pours	27/09/2022	5:50:00 AM	Main Site Level 2 North Structure	125-131 Raglan St, Waterloo	39	58	69.4	Yes	11.4	No	Concrete trucks pulling in and out of Botany Rd Gate B1 & B2, Concrete pumping works on northern structure for Level 2 Pour 1	Traffic on raglan st most audible, with passing motorbike causing peak noise. Pedestrian traffic and noise from convenience store audible
Sep-22	OOHW permit # 38	Level 2 Concrete Pours	27/09/2022	6:08:00 AM	Main Site Level 2 North Structure	104 Raglan St, Waterloo NSW 2017, Australia	39	68	65.4	No	-2.6	N/A	Concrete trucks pulling in and out of Botany Rd Gate B1 & B2, Concrete pumping works on northern structure for Level 2 Pour 1	Minor traffic on raglan st audible with intermittent pedestrians passing by

Table 4-4: Plant and equipment monitoring results (as per Section 13.5 of the CNVMP)

Standard or OOHW	Construction Activity	Date	Time	Construction location	Monitoring location	Maximum allowable construction plant sound levels - dBA		1-min SPL recorded	Exceedance of SPL at 7m		Construction activities	Comments/ observations during monitoring
						Sound Power Level	Sound Pressure Level (SPL) at 7m					
Standard	Concrete Agitator	14/12/2021	12:40:00 PM	Main Site – Concrete Agitator	7m away from plant	105	80	69	No	-11	Concrete agitator operating and pouring into concrete pump. Pumping into station box. Works below PNL. Traffic source of max value.	PNL of 80 dB sound pressure level at 7 meters taken from CNVIS
Standard	400T Diesel Crane	21/12/2021	12:00:00 PM	Main Site - 400T Crane	7m away from plant	110	85	76.6	No	-8.4	400T Crane in use. Sound pressure level taken at 7m away from crane. Crane was under load lifting materials into the station box.	1-min sound pressure level measurement taken Sound Pressure Level below predicted
Standard	450T Crane	03/05/2022	10:10:00 AM	Main Site - 450T Crane	7m away from plant	110	85	65.8	No	-19.2	450T Crane in use. Sound pressure level taken at 7m away from crane. Crane was under load lifting materials.	1-min sound pressure level measurement taken Sound Pressure Level below predicted
Standard	130T Diesel Crane	21/12/2021	12:10:00 PM	Main Site - 130T Crane	7m away from plant	110	85	64.1	No	-20.9	130T Crane in use. Sound pressure level taken at 7m away from crane. Crane was under load lifting materials into the station box.	1-min sound pressure level measurement taken Sound Pressure Level below predicted
Standard	8T Excavator (Bucket)	28/04/2022	10:00:00 AM	Main Site – 8T Excavator	7m away from plant	100	75	66.1	No	-8.9	8T Excavator with bucket. Sound pressure level taken from 7m away from excavator. Excavator was excavating trench	1-min sound pressure level measurement taken Sound Pressure Level below predicted
Standard	Vacuum Truck	14/01/2022	9:41:00 AM	Main Site- Vacuum Truck	7m away from plant	110	85	79.2	No	-5.8	Vacuum Truck in use. Sound pressure level taken at 7m away from vacuum truck. Plant was under load whilst sucking up material from within trench.	1-min sound pressure level measurement taken Sound Pressure Level below predicted
Standard	Telehandler	15/03/2022	9:30:00 AM	Main Site – Telehandler	7m away from plant	96	71	64.5	No	-6.5	Telehandler in use. Sound pressure level taken at 7m away from telehandler whilst in use	1-min sound pressure level measurement taken Sound Pressure Level below predicted
Standard	Wire Saw*	27/07/2022	4:00:00PM	Main Site – Wire Saw	7m away from plant			79			Wire Saw in use. Sound pressure level taken at 7m away from wire saw whilst in use	1-min sound pressure level measurement taken Sound Pressure Level below predicted

*- No values for sound power level and sound pressure level included in table for wire saw as this piece of equipment was not included in the CNVIS.

4.3 Vibration results

Continuous vibration monitoring was conducted to verify construction vibration levels were not exceeding the nominated structural damage site vibration control criteria outlined in the CNVIS. During the reporting period vibration monitoring was conducted continuously at the Waterloo Congregational Church using Texcel Geophone (VM), serial number 7361.

A total of two alerts were received, notifying that an event had occurred, however, both events were due actions unrelated to construction. A summary of the peak monitoring results are provided in **Table 4-5** and the trigger events are outlined below:

- In November 2021, an exceedance of the operator warning level was reported. This was due to steel mesh being removed from the window and placed against the vibration monitor resulting in the trigger value. The mesh was then removed so as not to cause any more vibration events.
- In September 2022, an exceedance of the operator warning level was reported. The event was not a result of construction activities rather a failure in the adhesive tape used to secure the monitor to the structure. The monitor peeled away from the tape causing the monitor to fall to the ground which caused the spikes/exceedances.

Table 4-5: Continuous vibration monitoring results summary at Waterloo Congregational Church

	Highest recorded vibration (PPV)					Compliance CNVIS				
Monitoring month	Date & time of Event	vSum (mm/s)	X Peak (mm/s)	Y Peak (mm/s)	Z Peak (mm/s)	Operator warning (mm/s)	Operator halt (mm/s)	No. of Events above halt warning	Events above trigger as a result of construction	Comments
October 2021	06/10/2021 13:31	2.04	1.22	1.9	0.6	5	7.5	0	N/A	
November 2021	26/10/2021 12:39	7.46	2.01	1.76	7.15	5	7.5	0	No	Within the church annex a steel mesh was removed from the window and placed against the vibration monitor resulting in the trigger value. The mesh has been moved away from the monitor to not cause any more vibration events.
December 2021	29/11/2021 21:40	2.02	2.01	0.59	0.41	5	7.5	0	N/A	
January 2022	14/11/2021 10:40	0.2	0.2	0.1	0.1	5	7.5	0	N/A	
January 2022	24/01/2022 20:30	2.24	N/A	N/A	N/A	5	7.5	0	N/A	Monitoring at Redfern Surf Club- Jackhammering and saw cutting adjacent to building. Peak VSUM occurred during Jackhammering next to building and monitoring location.
February 2022	21/02/2022 10:22	0.78	0.76	0.14	0.14	5	7.5	0	N/A	
February 2022	17/02/2022 21:00	0.22	N/A	N/A	N/A	5	7.5	0	N/A	Monitoring at 62-82 Botany Road - 5T excavator with hammer and hand held jackhammer vibration monitoring adjacent to building
March 2022	15/03/2022 10:30	0.2	0.1	0.1	0.1	5	7.5	0	N/A	
April 2022	17/04/2022 17:50	2.07	1.82	1.65	0.33	5	7.5	0	N/A	
May 2022	18/05/2022 9:35	1.06	0.98	0.22	0.41	5	7.5	0	N/A	
June 2022	31/05/2022 21:38	2.69	2.63	0.5	0.43	5	7.5	0	N/A	
July 2022	28/06/2022 11:19	1.19	1.17	0.31	0.65	5	7.5	0	N/A	
August 2022	28/07/2022 15:53	1.98	0.22	0.95	1.95	5	7.5	0	N/A	
September 2022	22/09/2022 14:59	54.55	51.09	28.42	23.26	5	7.5	14	No	Adhesive tape used as a base for the vibration monitor to protect the wall/paint work of the attached building failed. The monitor peeled away from the tape causing the monitor to fall to the ground which caused the spikes/exceedances. The monitor was then left aside until the environmental representative came to turn off the monitor and reattach the monitor to the wall. New tape and glue have been used

5. Community Consultation

5.1 Management measures

Each month a project update which outlines the upcoming construction works was distributed to residents and businesses in the local area. Regular doorknocks and briefings and specific notifications were provided by the Waterloo Community Team to inform the stakeholders of proposed works and likely impacts.

Over the course of out of hours work that has been undertaken, the directly impacted community were provided with an offer for moulded ear plugs. This has been ongoing with a total of 47 receivers accepting the offer of ear moulds to date. In addition to the ear moulds, alternate accommodation was offered to residents when identified by the noise modelling to trigger this management measure such as where high noise impacting construction activities were required to continue throughout the night period, for example, utility works requiring a road opening licence.

Respite offers also provided when triggered by the noise modelling.

5.2 Complaints summary

During the reporting period, a total of 65 complaints were received from the community. A breakdown of the complaints is provided in Table 5-1.

- 51 complaints related to noise and vibration.
 - o 18 complaints relating to noise and vibration during standard hours
 - o 33 complaints related to noise and vibration during out of hours work
- 14 complaints were unrelated to the project.

All complaints were managed and reported to Sydney Metro as required by the Community Communication Strategy.

Table 5-1 Complaints breakdown

Month	Noise	Vibration	Monthly Total
October 2021	– 3#	– 0	– 3
November 2021	– 5#	– 0	– 5
December 2021	– 2#	– 0	– 2
January 2022	– 1#	– 0	– 1
February 2022	– 4*	– 1	– 5
March 2022	– 4*	– 0	– 4
April 2022	– 4*	– 0	– 4
May 2022	– 1#, 8*	– 0	– 9
June 2022	– 2*	– 0	– 2
July 2022	– 2#, 3*	– 0	– 5

Month	Noise	Vibration	Monthly Total
August 2022	– 1#, 5*	– 0	– 6
September 2022	– 2#, 3*	– 0	– 5
Total	– 50	– 1	– 51

*Refers to OOHW complaint, # refers to standard hours

6. Conclusion

The requirements for the noise and vibration monitoring program are outlined in the CNVMP Section 13. The program identified criteria, methodology and monitoring parameters. The program was endorsed by the Acoustic Advisor and approved in accordance with the Project Planning Condition C13.

A CNVIS has been prepared for the project and outlines the predicted noise and vibration impacts as a result of construction works. Attended noise monitoring has been completed in accordance with the noise monitoring program to review actual noise levels with predicted noise. This data is used to determine if the noise management measures implemented are effective at minimising the impacts of construction on the surrounding community. The attended monitoring determined the exceedance of the PNL was generally due to external factors such as traffic on the surrounding streets rather than related to construction activities.

Plant and equipment monitoring was completed during the reporting period, refer to Table 4-4 for details.

A continuous vibration monitor has been installed in the Waterloo Congregational Church to measure any vibration impacts and to confirm compliance with the CNVIS. During the reporting period, one event triggered a “operator warning” alarm. This was due to steel mesh being removed from the window and placed against the vibration monitor resulting in the trigger value. The mesh was then removed so as not to cause any more vibration events. Furthermore, one exceedance of the structural criteria was observed during the reporting period. The event was not a result of construction activities rather a failure in the adhesive tape used to secure the monitor to the structure. The monitor peeled away from the tape causing the monitor to fall to the ground which resulted in the reported spikes/exceedances.

During the reporting period a total of 51 complaints were received that were related to construction activities. To manage the noise impacts during out of hours work, a respite offer for moulded ear plugs was commenced in May 2021 which continued to be rolled out by the Waterloo Community Team during the year. This offer assisted in reducing the noise impact on receivers and contributed to managing the number of complaints received. Additionally, over the progress of out of hours work 3 receivers have been fitted with blackout blinds and 5 receivers have been provided with earbuds or noise cancelling headphones to help reduce the impact of noise.

Further mitigation measures offered as a result of out of hours work included, respite offers (e.g. vouchers) and alternative accommodation when triggered through the noise modelling process.

Appendix A – Calibration Certificates

ETM CALIBRATION CERTIFICATE

#736120220725

DATE: 25/07/2022
SERIAL NUMBER: 7361

SERVICE NOTES:

As part of this Calibration service, the monitor, sensors and accessories were tested, and found to be functioning correctly.

CERTIFIED QUANTITIES:

Monitor electronics passed all calibration tests to within $\pm 2.0\%$.

Sensor	Sensitivity	Frequency	Tolerance
Geophone	27 mV/mm/s	63 Hz	± 1.2 mV/mm/s


GENERAL:

- (1) Instrument calibration measurements were performed with a Calibrated Multimeter.
- (2) Sensor calibration measurements were performed with a National Instruments 500 kS/s Multifunction DAQ Model USB-6343(BNC).
- (3) Geophone sensitivity was determined by comparing the output from the geophones under test with that of a reference accelerometer.
- (4) Microphone sensitivity was determined by comparing the output from the microphone under test with that of a reference microphone.

CALIBRATION INSTRUMENTS USED:

	Type	Serial	Calibrated
(1) Multimeter	Tonghui TH1941	71104376	August 2021
(2) NI Multifunction I/O	USB-6343(BNC)	1F664FD	January 2021
(3) Vibration Reference Horizontal	PCB 333B50	44878	August 2021
(4) Vibration Reference Vertical	PCB 333B50	44877	August 2021

All instrument calibrations NATA Certified or traceable to the Australian Government National Measurement Institute.

Tests Performed by: 
(Calibration Station)

Date: 25/07/2022

Warranty on Calibration Services

Warranty

Our services come with guarantees that cannot be excluded under the Australian Consumer Law. You are entitled to a replacement or refund for a major failure and for compensation for any other reasonably foreseeable loss or damage. You are entitled to have the services provided again (without charge) if they are not of an acceptable quality and the failure does not amount to a major failure.

The benefits provided to the Customer by this Warranty are in addition to the other rights and remedies of the Customer under the Australian Consumer Law.

Exclusions

Any warranty that Texcel Pty Ltd is required to provide at law for its calibration services does not cover damage or defect resulting from:

- Abnormal Use by the customer including damage to the monitor, microphones, geophones, modem or any other external accessory resulting from Abnormal Use;
- unauthorised modifications, repairs or servicing of the Goods;
- internal corrosion due to condensation or water ingress into the Goods;
- the failure of any component of the monitor that was not replaced or serviced during the Calibration Service and is no longer covered under the original purchase warranty ; and
- the failure of any accessory product, such as the modem or microphone, that was not manufactured by Texcel.

Please note:

1. **Warning:** User-generated data which has been saved to this monitor may be lost as a result of the work performed during the calibration service or any other repair or maintenance. Customers are encouraged to save their data before the work is performed. Texcel will not be responsible for any data that is lost as a result of the works.
2. **Abnormal Use** includes use of the Goods in a manner for which they were not designed or a failure by the owner to ensure that the Goods are appropriately serviced, maintained and cared for.
3. **Goods** mean the Texcel monitoring system and attachments.



To: Tristan Rodrigues	Technician: Calibration Station
John Holland	Ref: 11240
	Date: 25/07/2022

Service Report 7361

Item	Description
1.	Calibrated monitor and sensors
2.	Supplied new software
3.	Upgraded firmware
Recommendations	1. Do NOT Leave the Monitor on charge all the time 2. Top-up charge the night before monitoring and/or every 3 months 3. Check configuration prior to monitoring



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Sound Level Meter

IEC 61672-3:2013

Calibration Certificate

Calibration Number C22475

Client Details	Waterloo Integrated Station Development John Holland JV 84-88 Botany Road Waterloo NSW 2016
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Equipment Tested/ Model Number :	Rion NL-42EX
Instrument Serial Number :	00409019
Microphone Serial Number :	185664
Pre-amplifier Serial Number :	90464

Pre-Test Atmospheric Conditions	Post-Test Atmospheric Conditions
Ambient Temperature : 20.6°C	Ambient Temperature : 22.4°C
Relative Humidity : 43.2%	Relative Humidity : 39.7%
Barometric Pressure : 101.74kPa	Barometric Pressure : 101.72kPa

Calibration Technician : Lucky Jaiswal	Secondary Check: Shaheen Boaz
Calibration Date : 15 Jul 2022	Report Issue Date : 15 Jul 2022

Approved Signatory :

Juan Agüero

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
12: Acoustical Sig. tests of a frequency weighting	Pass	17: Level linearity incl. the level range control	N/A
13: Electrical Sig. tests of frequency weightings	Pass	18: Toneburst response	Pass
14: Frequency and time weightings at 1 kHz	Pass	19: C Weighted Peak Sound Level	Pass
15: Long Term Stability	Pass	20: Overload Indication	Pass
16: Level linearity on the reference level range	Pass	21: High Level Stability	Pass

The sound level meter submitted for testing has successfully completed the class 2 periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed.

However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2013 because evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2013 and because the periodic tests of IEC 61672-3:2013 cover only a limited subset of the specifications in IEC 61672-1:2013.

Uncertainties of Measurement -			
Acoustic Tests		Environmental Conditions	
125Hz	±0.13dB	Temperature	±0.1°C
1kHz	±0.13dB	Relative Humidity	±1.9%
8kHz	±0.14dB	Barometric Pressure	±0.014kPa
Electrical Tests	±0.13dB		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.



This calibration certificate is to be read in conjunction with the calibration test report.

Acoustic Research Labs Pty Ltd is NATA Accredited Laboratory Number 14172.
Accredited for compliance with ISO/IEC 17025 - Calibration.

The results of the tests, calibrations and/or measurements included in this document are traceable to SI units.


NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration and inspection reports.



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Sound Level Meter
IEC 61672-3:2013
Calibration Certificate
Calibration Number C20372

Client Details	John Holland Pty Ltd Level 3, 65 Pirrama Road Pyrmont NSW 2009
Equipment Tested/ Model Number :	Rion NL-42EX
Instrument Serial Number :	00409019
Microphone Serial Number :	185664
Pre-amplifier Serial Number :	90464
Pre-Test Atmospheric Conditions	Post-Test Atmospheric Conditions
Ambient Temperature : 20.8°C	Ambient Temperature : 23.8°C
Relative Humidity : 45.3%	Relative Humidity : 42%
Barometric Pressure : 101.97kPa	Barometric Pressure : 101.85kPa
Calibration Technician : Jeff Yu	Secondary Check: Max Moore
Calibration Date : 7 Jul 2020	Report Issue Date : 8 Jul 2020
Approved Signatory :	
	
Juan Aguero	

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
12: Acoustical Sig. tests of a frequency weighting	Pass	17: Level linearity incl. the level range control	Pass
13: Electrical Sig. tests of frequency weightings	Pass	18: Toneburst response	Pass
14: Frequency and time weightings at 1 kHz	Pass	19: C Weighted Peak Sound Level	Pass
15: Long Term Stability	Pass	20: Overload Indication	Pass
16: Level linearity on the reference level range	Pass	21: High Level Stability	Pass

The sound level meter submitted for testing has successfully completed the class 2 periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed.

However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2013 because evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2013 and because the periodic tests of IEC 61672-3:2013 cover only a limited subset of the specifications in IEC 61672-1:2013.

Least Uncertainties of Measurement -			
Acoustic Tests		Environmental Conditions	
	125Hz	Temperature	±0.2°C
	1kHz	Relative Humidity	±2.4%
	8kHz	Barometric Pressure	±0.015kPa
Electrical Tests	±0.10dB		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.



This calibration certificate is to be read in conjunction with the calibration test report.

Acoustic Research Labs Pty Ltd is NATA Accredited Laboratory Number 14172.
Accredited for compliance with ISO/IEC 17025 - calibration.

The results of the tests, calibrations and/or measurements included in this document are traceable to SI units.

NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration and inspection reports.



3-20-41 Higashimotomachi Kokubunji Tokyo 185-8533
Phone:042(359)7888, Facsimile:042(359)7442

Certificate of Calibration

Name : Sound Level Meter, Class 2
Model : NL-42 **S/No.** : 00409019
Date of Calibration : May, 20, 2020

We hereby certify that the above product was tested and calibrated according to the prescribed Rion procedures, and that it fulfills specification requirements.

The measuring equipment and reference devices used for testing and calibrating this unit are managed under the Rion traceability system and are traceable according to official Japanese standards and official standards of countries belonging to the International Committee of Weights and Measures.

RION CO., LTD.



Manager, Quality Control Department



Supplied Accessories

< 1 / 1 >

Model	NL-42	Product Name	Sound Level Meter, Class 2
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Ensure all the items below are in the package.
If there is a missing part, please contact your supplier.

Type	Description	Quantity	Note
NL-42	Main unit	1	
NL-42-025	Storage case	1	
WS-10	Windscreen	1	
NL-42-033	Windscreen fall prevention rubber	1	attached to the main unit
VM-63-017	Hand strap	1	
LR6	Size AA alkaline batteries	4	
	CD-ROM (Instruction manual, Serial Interface manual, Technical notes, Program option manual)	1	
	Description for IEC 61672-1	1	
	SD memory card (512 MByte)	1	only when NX-42EX is pre-installed
	Inspection certificate	1	This sheet
	Document for China RoHS	1	only to China

Inspection Certificate

INSPECTOR

We hereby certify that this product has been tested and calibrated at our factory according to RION specifications and that the product satisfies all relevant requirements.

RION CO., LTD.
3-20-41 Higashimotomachi, Kokubunji,
Tokyo 185-8533,
Japan

Sound and Vibration Measuring Instrument Section Product information and software downloads can be found on our web-site:

<https://rion-sv.com/>

Please check it out.

N°C11030302



Sound Level Meter IEC 61672-3:2013 Calibration Test Report

Calibration Number **C22475**

Client Details	Waterloo Integrated Station Development John Holland JV 84-88 Botany Road Waterloo NSW 2016
Equipment Tested/ Model Number :	Rion NL-42EX
Instrument Serial Number :	00409019
Microphone Serial Number :	185664
Pre-amplifier Serial Number :	90464
Pre-Test Atmospheric Conditions	Post-Test Atmospheric Conditions
Ambient Temperature : 20.6°C	Ambient Temperature : 22.4°C
Relative Humidity : 43.2%	Relative Humidity : 39.7%
Barometric Pressure : 101.74kPa	Barometric Pressure : 101.72kPa
Calibration Technician : Lucky Jaiswal	Secondary Check: Shaheen Boaz
Calibration Date : 15 Jul 2022	Report Issue Date : 15 Jul 2022

Approved Signatory :

Juan Agüero

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
12: Acoustical Sig. tests of a frequency weighting	Pass	17: Level linearity incl. the level range control	N/A
13: Electrical Sig. tests of frequency weightings	Pass	18: Toneburst response	Pass
14: Frequency and time weightings at 1 kHz	Pass	19: C Weighted Peak Sound Level	Pass
15: Long Term Stability	Pass	20: Overload Indication	Pass
16: Level linearity on the reference level range	Pass	21: High Level Stability	Pass

The sound level meter submitted for testing has successfully completed the class 2 periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed.

However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2013 because evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2013 and because the periodic tests of IEC 61672-3:2013 cover only a limited subset of the specifications in IEC 61672-1:2013.

Uncertainties of Measurement -			
Acoustic Tests		Environmental Conditions	
125Hz	±0.13dB	Temperature	±0.1°C
1kHz	±0.13dB	Relative Humidity	±1.9%
8kHz	±0.14dB	Barometric Pressure	±0.014 kPa
Electrical Tests	±0.13dB		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.



This report applies only to the item tested and shall only be reproduced in full, unless approved in writing by Acoustic Research Labs.

Acoustic Research Labs Pty Ltd is NATA Accredited Laboratory Number 14172.
Accredited for compliance with ISO/IEC 17025 - Calibration.

The results of the tests, calibrations and/or measurements included in this document are traceable to SI units.

NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration and inspection reports.

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1. OVERVIEW

This report presents the calibration test results of a Rion NL-42EX Sound Level Meter, and associated equipment. Calibration is carried out in accordance with *IEC 61672-3:2013, Electroacoustics - Sound Level Meters - Part 3: Periodic Tests*.

Relevant clauses from this standard have been used for periodic testing in conjunction with Acoustic Research Labs internal test methods described in Section 2 of the calibration work instruction manual.

1.1 UNCERTAINTIES

For each test performed, the associated measurement uncertainties are derived at the 95% confidence level and are given with a coverage factor of 2.

The uncertainty applies at the time of measurement only, and takes no account of any drift or other effects that may apply afterwards. When estimating uncertainty at any later time, other relevant information should also be considered, including, where possible, the history of the performance of the instrument and the manufacturer's specifications.

1.2 DOCUMENT CONVENTIONS

Test results which highlight non-conformances relative to the standard, and the sound level meter type specified by the manufacturer have been marked with an **F** in the respective tests.

Any tests that are not required, due to sound level meter configuration, are marked N/A.

2. GENERAL

2.1 ENVIRONMENTAL CONDITIONS DURING TEST

No corrections have been applied to any results obtained to compensate for the environmental conditions.

2.2 CALIBRATION TESTS

Where applicable the following tests were performed in accordance with the requirements of *IEC 61672-3:2013*. These clauses are used to define the periodic testing of Sound Level Meters.

Clause 10	Indication at the Calibration Check Frequency
Clause 11	Self Generated Noise
Clause 12	Acoustical Signal Tests of Frequency Weighting
Clause 13	Electrical Signal Tests of Frequency Weightings
Clause 14	Frequency and Time Weightings at 1kHz
Clause 15	Long Term Stability
Clause 16	Level Linearity on the Reference Level Range
Clause 17	Level Linearity including the level range control
Clause 18	Toneburst Response
Clause 19	Peak C Sound Level
Clause 20	Overload Indication
Clause 21	High Level Stability

2.3 TEST EQUIPMENT USED

All test equipment used during periodic testing are calibrated every 12months by an accredited laboratory, traceable to SI units.

The performance of all equipment during these calibrations and the effects of instrument stability are used to determine the measurement uncertainty of each reported result.

2.3.1 Multi-function Acoustic Calibrator

A Bruel & Kjaer 4226 Multi-function calibrator (S/N - 2985012) was used for frequency response testing of the entire instrument (including microphone). This instrument was used as a reference calibrator and for frequency response verification.

2.3.2 Microphone Electrical Equivalent Circuit

Calibration of most instrument parameters is carried out using electrical signals fed to the unit via a two-port electrical equivalent circuit of the microphone.

A 19pF capacitance dummy microphone was used during testing.

2.3.3 Adjustable Attenuator

A means for varying the attenuation of electrical signals via the dummy microphone was provided by a JFW Industries dual rotary attenuator (S/N - 792819 2132). The attenuator is switchable in 1dB steps between 0dB and 60dB.

2.3.4 Arbitrary Function Generator

A Hewlett Packard 33120A (S/N - US36047448) was used to generate the required electrical signals.

2.3.5 Environmental Monitoring

A MHB-382SD (S/N – AH.88227) was used for measuring environmental conditions during device calibration. It is capable of providing temperature, relative humidity and pressure measurements.

3. CALIBRATION TEST RESULTS

3.1 INDICATION AT THE CALIBRATION CHECK FREQUENCY

The indication of the sound level meter at the calibration check frequency was checked by application of an acoustic signal at the reference sound pressure level and frequency.

Stated reference conditions as found in manual are

Reference Level : 94.0 dB

Reference Frequency : 1000.0 Hz

Indications before and after adjustments were recorded and are shown in Table 1 (all measurements in dB) -

Table 1 - Check Frequency Calibration Results

Frequency Weighting	Initial Response	B&K 4226 Corrected	FreeField Corrected	Final Corrected Response
A	93.90	94.10	94.00	94.02
C	93.90	94.10	94.00	94.02
Z	93.90	94.10	94.00	94.02

Free field adjustment data as provided by the manufacturer. Windscreen correction factors applied.

3.2 SELF GENERATED NOISE

3.2.1 Microphone Installed

Self generated noise was measured with the microphone installed on the sound level meter, in the configuration submitted for periodic testing. The sound level meter was set to the most-sensitive level range and with frequency weighting A selected.

Ten (10) time weighted observations were made over a period of 60 seconds.

Random Readings dB(A)

14.60	14.70	14.70	14.60	14.60
14.60	14.60	14.70	14.60	14.60

Acoustic Noise Floor : 14.6 dB(A)

3.2.2 Electrical Input Signal Device

With the microphone replaced by the electrical input signal device and terminated as specified, the sound level meter was set to the most-sensitive level range and with frequency weightings Z, C and A selected as provided.

Ten (10) time weighted observations were made over a period of 60 seconds.

Random Readings dB(A)

7.80	7.80	7.80	7.80	7.80
7.80	7.80	7.80	7.80	7.80

Random Readings dB(C)

8.40	8.40	8.40	8.40	8.70
8.60	8.40	8.60	8.60	8.60

Random Readings dB(Z)

13.1	13.0	13.1	13.4	13.2
13.4	13.1	13.0	13.4	13.3

Electric Noise Floor :

dB(A)	dB(C)	dB(Z)
7.8	8.5	13.2

3.3 ACOUSTICAL SIGNAL TESTS OF A FREQUENCY WEIGHTING

The sound level meter was set to measure frequency weighting C with a FAST response. The test was carried out using a multi-function acoustic calibrator set to pressure mode.

Three (3) readings were made at each test frequency. The average of the readings was then corrected to the multi-function acoustic calibrator.

Table 2 - Frequency Weighting C Response

Freq Hz	Reading 1	Reading 2	Reading 3	U95
125	94.3	94.3	94.3	0.13
1 000	94.0	94.0	94.0	0.13
8 000	87.8	87.8	87.8	0.14

Actual Freq Hz	B&K 4226 Corrections	Corrected Response dB(C)		Uexp
		Actual	re 1kHz	
125.90	-0.06	94.24	0.32	0.13
1005.10	-0.08	93.92	0.00	0.13
7915.10	0.00	87.80	-6.12	0.14

Adjustments were then applied to correct for free field and sound level meter body effects with data supplied by the manufacturer as per Table 3. Windscreen correction factors applied.

Table 3 - Correction Data

Actual Freq Hz	FreeField Corrections	U95	BodyEffects Corrections	U95	Windscreen Corrections	U95
125.90	0.00	0.25	0.00	0.25	0.000	0.200
1005.10	0.10	0.25	0.00	0.25	-0.100	0.200
7915.10	3.20	0.35	0.30	0.35	0.000	0.300

Finally, the corrected responses are normalised to the response at 1kHz and compared to the tolerances stated in Table 2 of IEC 61672.1-2013.

Table 4 - Acoustic C Response

Actual Freq (Hz)	Corrected Response dB(C)		Expected Response dB(C)		Deviation	P/F	Uexp
	Actual	re 1kHz	re 1kHz	Tolerance			
125.90	94.24	0.32	-0.2	±1.5	0.52	P	0.43
1005.10	93.92	0.00	0.0	±1.0	0.00	P	0.43
7915.10	91.30	-2.62	-3.0	±5.0	0.38	P	0.60

3.4 ELECTRICAL SIGNAL TESTS OF FREQUENCY WEIGHTINGS

Frequency weighting responses for Z, C and A were determined relative to the response at 1kHz using steady sinusoidal electrical input signals.

On the reference level range, and for each frequency weighting under test, the level of a 1kHz input signal was adjusted to yield 93dB. At test frequencies other than 1kHz, the input signal level was adjusted to compensate for the design goal attenuations as specified in Table 2 of IEC 61672.1-2013.

Table 5 - Measured Electrical Frequency Response

Freq Hz	A Weighting (dB)	C Weighting (dB)	Z Weighting (dB)	U95
63	92.9	93.0	92.9	0.13
125	92.8	93.0	93.0	0.11
250	92.9	93.0	93.0	0.10
500	92.9	93.0	93.0	0.10
1 000	93.0	93.0	93.0	0.10
2 000	93.0	93.0	93.0	0.10
4 000	93.0	93.0	93.0	0.10
8 000	93.0	93.0	93.0	0.10
15 850	N/A	N/A	N/A	0.14

Adjustments were then applied to correct for a uniform free field response and sound level meter body effects with data supplied by the manufacturer as per Table 6. Windscreen correction factors applied.

Table 6 - Correction Data

Freq Hz	Ufreq	U95	Body Effects	U95	WS Effects	U95
63	0.000	0.250	0.000	0.250	0.000	0.200
125	0.000	0.250	0.000	0.250	0.000	0.200
250	0.000	0.250	0.000	0.250	0.000	0.200
500	0.000	0.250	-0.100	0.250	-0.100	0.200
1 000	0.000	0.250	0.000	0.250	-0.100	0.200
2 000	0.200	0.250	0.000	0.250	-0.300	0.200
4 000	0.400	0.250	0.300	0.250	-0.300	0.200
8 000	-0.500	0.350	0.300	0.350	0.000	0.300
15 850	0.000	0.000	0.400	0.350	0.700	0.300

Finally, the corrected responses were referenced to the response at 1kHz and compared to the tolerances stated in Table 2 of IEC 61672.1-2013.

Table 7 - A Weighted Electrical Response

Freq Hz	Response		Tolerance (dB)	P/F	Uexp
	Corrected	re 1kHz			
63	92.90	0.00	+1.0 / -2	P	0.43
125	92.80	-0.10	±1.5	P	0.42
250	92.90	0.00	±1.5	P	0.42
500	92.70	-0.20	±1.5	P	0.42
1 000	92.90	0.00	±1.0	P	0.42
2 000	92.90	0.00	±2.0	P	0.42
4 000	93.40	0.50	±3.0	P	0.42
8 000	92.80	-0.10	±5.0	P	0.59
15 850	N/A	N/A	+5.0 / -∞	N/A	0.49

Table 8 - C Weighted Electrical Response

Freq Hz	Response		Tolerance (dB)	P/F	Uexp
	Corrected	re 1kHz			
63	93.00	0.10	+1.0 / -2	P	0.43
125	93.00	0.10	±1.5	P	0.42
250	93.00	0.10	±1.5	P	0.42
500	92.80	-0.10	±1.5	P	0.42
1 000	92.90	0.00	±1.0	P	0.42
2 000	92.90	0.00	±2.0	P	0.42
4 000	93.40	0.50	±3.0	P	0.42
8 000	92.80	-0.10	±5.0	P	0.59
15 850	N/A	N/A	+5.0 / -∞	N/A	0.49

Table 9 - Z Weighted Electrical Response

Freq Hz	Response		Tolerance (dB)	P/F	Uexp
	Corrected	re 1kHz			
63	92.90	0.00	+1.0 / -2	P	0.43
125	93.00	0.10	±1.5	P	0.42
250	93.00	0.10	±1.5	P	0.42
500	92.80	-0.10	±1.5	P	0.42
1 000	92.90	0.00	±1.0	P	0.42
2 000	92.90	0.00	±2.0	P	0.42
4 000	93.40	0.50	±3.0	P	0.42
8 000	92.80	-0.10	±5.0	P	0.59
15 850	N/A	N/A	+5.0 / -∞	N/A	0.49

3.5 FREQUENCY AND TIME WEIGHTINGS AT 1KHZ

A steady sinusoidal electrical input signal of 1kHz at the reference sound pressure level was applied to the reference level range.

The deviations of the indicated level of C and Z frequency weightings were recorded, along with the deviations of the indication of A weighted time averaged, and SLOW weighted response.

Table 10 - Frequency and Time Weighting Results

Frequency Weighting	Time Weighting	Response (dB)	Deviation (dB)	P/F	Tolerance (dB)	U95
A	Fast	94.0	0.0	P	±0.2	0.10
	Leq	94.0	0.0	P	±0.2	0.10
	Slow	94.0	0.0	P	±0.2	0.10
C	Fast	94.0	0.0	P	±0.2	0.10
Z	Fast	94.0	0.0	P	±0.2	0.10

3.6 LONG-TERM STABILITY

Long-term stability was tested by comparing a steady sinusoidal electrical signal applied at the start, and at the end of testing. The applied signal level was set to the reference level and frequency and was maintained constant. The difference between the indicated levels was recorded.

Table 11 - Frequency and Time Weighting Results

Signal Level (mV)	Initial Response (dB)	Final Response (dB)	Deviation (dB)	P/F	Tolerance (dB)	U95
68.4	94	94.0	0.0	P	±0.3	0.10

3.7 LEVEL LINEARITY ON THE REFERENCE LEVEL RANGE

Level linearity was tested with a steady sinusoidal electrical signal at a frequency of 8kHz, with the meter set to display frequency weighted A, FAST response.

The starting point for level linearity testing was set to 94.0dB as stated in the instruction manual.

Level linearity was measured in 5dB steps of increasing input signal level from the starting point up to within 5dB of the stated upper limit, then at 1dB steps up to (but not including) the first indication of overload.

Table 12 - Level Linearity - Increasing

Ideal (dB)	Response (dB)	Deviation (dB)	Tolerance (dB)	P/F	U95
94.0	94.0	0.0	±1.1	P	0.1
99.0	99.0	0.0	±1.1	P	0.1
104.0	104.0	0.0	±1.1	P	0.1
109.0	109.0	0.0	±1.1	P	0.1
114.0	114.0	0.0	±1.1	P	0.1
119.0	119.0	0.0	±1.1	P	0.1
124.0	124.0	0.0	±1.1	P	0.1
129.0	129.0	0.0	±1.1	P	0.1
131.0	131.0	0.0	±1.1	P	0.1
132.0	132.0	0.0	±1.1	P	0.1
133.0	133.0	0.0	±1.1	P	0.1
134.0	134.0	0.0	±1.1	P	0.1
135.0	135.0	0.0	±1.1	P	0.1
136.0	136.0	0.0	±1.1	P	0.1
137.0	137.0	0.0	±1.1	P	0.1

Overload indication at 138.0dB.

Level linearity test was the continued in 5dB steps of decreasing input signal level from the starting point up to within 5dB of the stated lower limit, then at 1dB steps up to (but not including) the first indication of under range.

Table 13 - Level Linearity - Decreasing

Ideal (dB)	Response (dB)	Deviation (dB)	Tolerance (dB)	P/F	U95
94.0	94.0	0.0	±1.1	P	0.1
89.0	89.0	0.0	±1.1	P	0.1
84.0	84.0	0.0	±1.1	P	0.1
79.0	79.0	0.0	±1.1	P	0.1
74.0	74.0	0.0	±1.1	P	0.1
69.0	69.0	0.0	±1.1	P	0.1
64.0	64.0	0.0	±1.1	P	0.1
59.0	59.0	0.0	±1.1	P	0.1
54.0	54.0	0.0	±1.1	P	0.1
49.0	49.0	0.0	±1.1	P	0.1
44.0	44.0	0.0	±1.1	P	0.1
39.0	39.0	0.0	±1.1	P	0.1
34.0	34.0	0.0	±1.1	P	0.1
30.0	29.9	-0.1	±1.1	P	0.1
29.0	28.9	-0.1	±1.1	P	0.1
28.0	27.9	-0.1	±1.1	P	0.1
27.0	26.8	-0.2	±1.1	P	0.1
26.0	25.8	-0.2	±1.1	P	0.1
25.0	24.7	-0.3	±1.1	P	0.1

Under range indication at 24.0dB.

3.8 TONEBURST RESPONSE

The response of the sound level meter to short-duration signals was tested on the reference range with 4kHz tone bursts.

The tone bursts were generated from a steady sinusoidal signal at a level of 135.0dB.

Table 14 - FAST Weighted Response

Burst Length	Response dB(A)	Deviation (dB)	Tolerance (dB)	P/F	U95
200ms	134.0	0.0	±1.0	P	0.1
2ms	117.0	0.0	+1.0 / -2.5	P	0.1
0.25ms	107.9	-0.1	+1.5 / -5	P	0.1

Table 15 - SLOW Weighted Response

Burst Length	Response dB(A)	Deviation (dB)	Tolerance (dB)	P/F	U95
200ms	127.6	0.0	±1.0	P	0.1
2ms	108.0	0.0	+1.0 / -5	P	0.1

Table 16 - Sound Exposure Level Response

Burst Length	Response dB(A)	Deviation (dB)	Tolerance (dB)	P/F	U95
200ms	128.1	0.1	±1.0	P	0.1
2ms	108.5	0.5	+1.0 / -2.5	P	0.1
0.25ms	98.9	-0.1	+1.5 / -5	P	0.1

3.9 PEAK C RESPONSE

Indication of Peak C sound level was tested on the least sensitive level range. Test signals used were -

- A single complete cycle of an 8kHz sinusoid, starting and stopping at zero crossings
- Positive and negative half cycles of a 500Hz sinusoid, starting and stopping at zero crossings.

The level of the steady 8kHz sinusoid was adjusted to display 133.0dB(C).

Table 17 - Single Cycle Response

Response Peak C	Deviation (dB)	Tolerance (dB)	P/F	U95	Overload Peak C
136.4	0.0	±3.0	P	0.22	N

Table 18 - Half Cycle Response

Signal Orientation	Response Peak C	Deviation (dB)	Tolerance (dB)	P/F	U95
Positive	134.4	-1.0	±2.0	P	0.1
Negative	134.4	-1.0	±2.0	P	0.1

No overload was noted during Peak C testing.

3.10 OVERLOAD INDICATION

The overload indication was tested on the least sensitive level range, with the sound level meter set to display frequency weighted A, time averaged values.

Positive and negative half cycle sinusoidal electrical signals at 4kHz were used. The test began at an indicated time averaged level of 137.0dB(A).

Using the positive half cycle signal, the signal level was increased in steps of 0.5dB up to, but not including, the first indication of overload. The level of the input signal was then increased in steps of 0.1dB until the first indication of overload. These steps were repeated using the negative half cycle signal.

Table 19 - Overload Indication

Signal Orientation	Overload Response	Difference	Tolerance	P/F	Uncertainty
Positive	136.6	0.0	±1.5	P	0.1
Negative	136.6				

Overload indication was verified.

Overload latch indication was verified.

3.11 HIGH LEVEL STABILITY

High level stability was tested by measuring the response of the meter to high signal levels. The result was evaluated as the difference between the A-Weighted indicated levels in response to a steady 1kHz signal applied over 5 minutes.

Table 20 - FAST Weighted Response

Time Weighting	Initial Response (dB)	Final Response (dB)	Deviation (dB)	Tolerance (dB)	P/F	U95
Fast	137.0	137.0	0.0	±0.3	P	0.10
Slow	N/A	N/A	N/A	±0.3	N/A	0.10
Leq	137.0	137.0	0.0	±0.3	P	0.10