Noise and Vibration Monitoring Program

Project Name: M6 Stage 1

Project number:	M6S1
Document number:	M6S1-CGU-NWW-EV-PRG-050000
Revision date:	24/09/2021
Revision:	00

Document approval

Rev	Date	Prepared by	Reviewed by	Recommended	Approved	Remarks
A.01	29/07/2021	[redacted]	[redacted]	[redacted]	[redacted]	Draft issued to TfNSW
Signature:						
A.02	19/08/2021	[redacted]	[redacted]	[redacted]	[redacted]	Issued for consultation
Signature:						
00	24/09/2021	[redacted]	[redacted]	[redacted]	[redacted]	Issued for approval

Table of Contents

Table of Tables

Table of Figures

Table of Appendices

Glossary/ Abbreviations

Term/ Abbreviations	Expanded Text
AA	Acoustic Advisor
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Attenuation	The reduction in the level of sound or vibration.
CEMP	Construction Environmental Management Plan
CNVG	Construction Noise and Vibration Guideline (Roads and Maritime 2016)
CNVIS	Construction Noise and Vibration Impact Statement
CoA	Condition of Approval
CSSI	Critical State Significant Infrastructure
dBA	Decibels using the A-weighted scale measured according to the frequency of the human ear.
DPIE	NSW Department of Planning, Industry and Environment
EIS	Environmental Impact Statement
EMS	Environmental management system
Environmental aspect	Defined by AS/NZS ISO 14001:2015 as an element of an organisation's activities, products or services that can interact with the environment.
Environmental impact	Defined by AS/NZS ISO 14001:2015 as any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's environmental aspects.
EMM	Environmental Management Measure
Environmental objective	Defined by AS/NZS ISO 14001:2015 as an overall environmental goal, consistent with the environmental policy, that an organisation sets itself to achieve.
Environmental target	Defined by AS/NZS ISO 14001:2015 as a detailed performance requirement, applicable to the organisation or parts thereof, that arises from the environmental objectives and that needs to be set and met in order to achieve those objectives.
EPA	NSW Environment Protection Authority
EP&A Act	Environmental Planning and Assessment Act 1979
ER	Environmental Representative
ERG	Environmental Review Group
EWMS	Environmental Work Method Statements
Feasible and reasonable	Consideration of best practice taking into account the benefit of proposed measures and their technological and associated operational application in the NSW and Australian context. Feasible relates to engineering considerations and what is practical to build. Reasonable relates to the application of judgement in arriving at a decision, taking into account mitigation benefits and cost of mitigation versus benefits provided, community views and nature and extent of potential improvements.

Term/ Abbreviations	Expanded Text
ICNG	Interim Construction Noise Guideline (DECC, 2009)
INP	NSW Industrial Noise Policy (EPA 2000)
$L_{Aeq(15min)}$	The A-weighted equivalent continuous (energy average) A-weighted sound pressure level of the construction works under consideration over a 15-minute period and excludes other noise sources such as from industry, road, rail and the community.
$L_{A(max)}$	the A-weighted maximum noise level only from the construction works under consideration, measured using the fast time weighting on a sound level meter.
NCA	Noise catchment areas
NML	Noise Management Level
NVMP	Noise and Vibration Management Sub Plan (this document)
OEH	Office of Environment and Heritage
OOHW	Out-of-hours works
RBL	The Rating Background Level for each period is the medium value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period (day, evening and night)
SWP	Sound Power Level
SSI	State Significant Infrastructure
SPL	Sound Pressure Level
TfNSW	Transport for NSW (formerly Roads and Maritime Services, RMS)
VDV	Vibration Dose Value

1. Introduction

1.1. Context

This Construction Noise and Vibration Monitoring Program (the Program) has been prepared for the Design and Construction of the M6 Stage 1 (the Project). The Program forms Appendix A of the Noise and Vibration Management CEMP Sub-plan (CNVMP) and has been prepared to address the requirements of the Minister's Conditions of Approval (CoA), the Environmental Management Measures (EMMs) listed in the M6 Stage 1 Environmental Impact Statement (EIS) and all applicable legislation.

1.2. Scope

The scope of this Program is to define how the CPB Contractors, Ghella, UGL Engineering (CGU) joint venture intends to monitor potential noise and vibration impacts during construction of the Project. Operational monitoring measures do not fall within the scope of the construction phase and therefore are not included in this Program.

This monitoring Program will apply for the duration of the Project's construction works, unless a longer period is specified by the Secretary of the Department of Planning, Industry and Environment (DPIE).

2. Purpose and objectives

2.1. Purpose

The purpose of the Program is to describe how, where and when CGU will monitor noise and vibration during construction of the Project and supplements the CNVMP, which itself is an Appendix of the Construction Environmental Management Plan (CEMP).

The Program will be implemented to monitor the effectiveness of mitigation measures applied during the construction phase of the Project (refer to Section 9.3 of the CNVMP). Monitoring will be undertaken for modelling verification at sensitive receivers, to assess compliance in response to complaints and for equipment spot checks. For further information refer to Sections 4 and 5.

2.2. Objective

The key objective of this Program is to ensure all CoAs, EMMs, and licence/permit requirements relating to noise and vibration monitoring are described, scheduled, and assigned responsibility as outlined in:

- The Environmental Assessments prepared for the Project;
- Conditions of Approval granted to the project on 18th December 2019;
- RMS specifications G36;
- Environment Protection Licence (EPL); and
- All relevant legislation and other requirements described in Section 3 of the CNVMP.

2.3. Consultation

This Program was prepared in consultation with New South Wales (NSW) Environmental Protection Agency (EPA) in accordance with CoA C13(e). Table 1 outlines the queries raised by stakeholders and the actions CGU undertook to address these matters. Refer to Section 2 of the CEMP for the consultation requirements relating to the CEMP and all sub-plans.

Table 1 Consultation with Stakeholders

Relevant Public Authority	Query	Action
Bayside Council	No queries were raised by Bayside Council in regards to the Noise and Vibration Monitoring Program.	Nil
EPA	The EPA raised a number of issues regarding the level of detail provided in the stand-alone Monitoring Program. The EPA communicated an expectation that the Program must demonstrate that measured noise levels collected in the field, will be assessed against the Noise Management Levels to determine if all reasonable and feasible measures have been implemented to reduce noise levels, as well as Predicted Noise Levels generated through noise modelling. Other matters related to noise monitoring locations, monitoring data collected in the field and monitoring records.	This Monitoring Program was updated in response to EPA comments to provide further clarity of the matters raised. A meeting was held with the EPA on 24/09/2021 to discuss the close out the comments.
NSW Health	Due to current pandemic conditions, NSW Health was unable to provide resources for consultation at this time.	CGU commits to consulting with NSW Health when resources become available.

Community feedback and complaints relating to construction noise and vibration will be managed in accordance with the Communication Strategy and Complaints Management System.

3. Noise and vibration monitoring

3.1. Relevant standards and guidelines

The main guidelines, specifications and policy documents relevant to this noise and vibration monitoring Program include:

- NSW Interim Construction Noise Guideline, Department of Environment and Climate Change 2009;
- NSW Industrial Noise Policy, Environment Protection Authority 2000;
- NSW Noise Policy for Industry, Environment Protection Authority 2017;
- NSW Assessing Vibration – a technical guideline (AVTG), Department of Environment and Conservation 2006;
- Roads and Maritime Construction Noise and Vibration Guideline (Roads and Maritime 2016);
- Australian Standard 1055 Acoustics – Description and Measurement of Environmental Noise;
- Australian Standard AS 2187.2 Explosives - Storage and use - Part 2 Use of explosives;
- Australian Standard AS2436-2010 Guide to noise and vibration control on construction, demolition and maintenance sites Australian Standard 2659.1 – 1998 Guide to the use of sound measuring equipment – portable sound level meters;
- Australian Standard 2659.1 – 1998 Guide to the use of sound measuring equipment – portable sound level meters;
- Australian Standard 2775 Mechanical Mounting of Accelerometers;
- British Standard BS 6472-2008, ‘Evaluation of human exposure to vibration in buildings (1-80Hz);
- British Standard 7385: Part 2-1993 'Evaluation and measurement of vibration in buildings';
- German Standard DIN4150-3:2016 Vibration in buildings – Part 3: Effects on structures;
- International Standard IEC 61672.1 Electroacoustic – Sound Level Meters – Specifications;
- International Standard IEC 60942 'Electroacoustics - Sound calibrators;
- ISO 3744 Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Engineering methods for an essentially free field over a reflecting plane;
- ISO 3746 Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Survey method using an enveloping measurement surface over a reflecting plane;
- ISO 6393 Earth-moving machinery - Determination of sound power level - Stationary test conditions;
- ISO 6395 Earth-moving machinery - Determination of sound power level - Dynamic test conditions; and
- NATA General Accreditation Guidance - General Equipment - Calibration and Checks, General Equipment Table 2018.

3.2. Existing environment (baseline monitoring)

As part of the EIS process, baseline noise monitoring was conducted within the following three noise monitoring periods:

- June 2015 (as part of the New M5 Motorway project);
- November/December 2017; and
- February 2018.

The monitoring locations were representative of receivers that would likely be most affected by the construction and operation of the Project. The EIS noted that key noise sources in the study area include transport infrastructure, including the M5 East Motorway, the arterial road network, Sydney Airport and freight and passenger railway lines.

For further information regarding baseline noise monitoring refer to Section 4.2 of the CNVMP and Section 3 of the EIS Appendix G Noise and Vibration Technical Report.

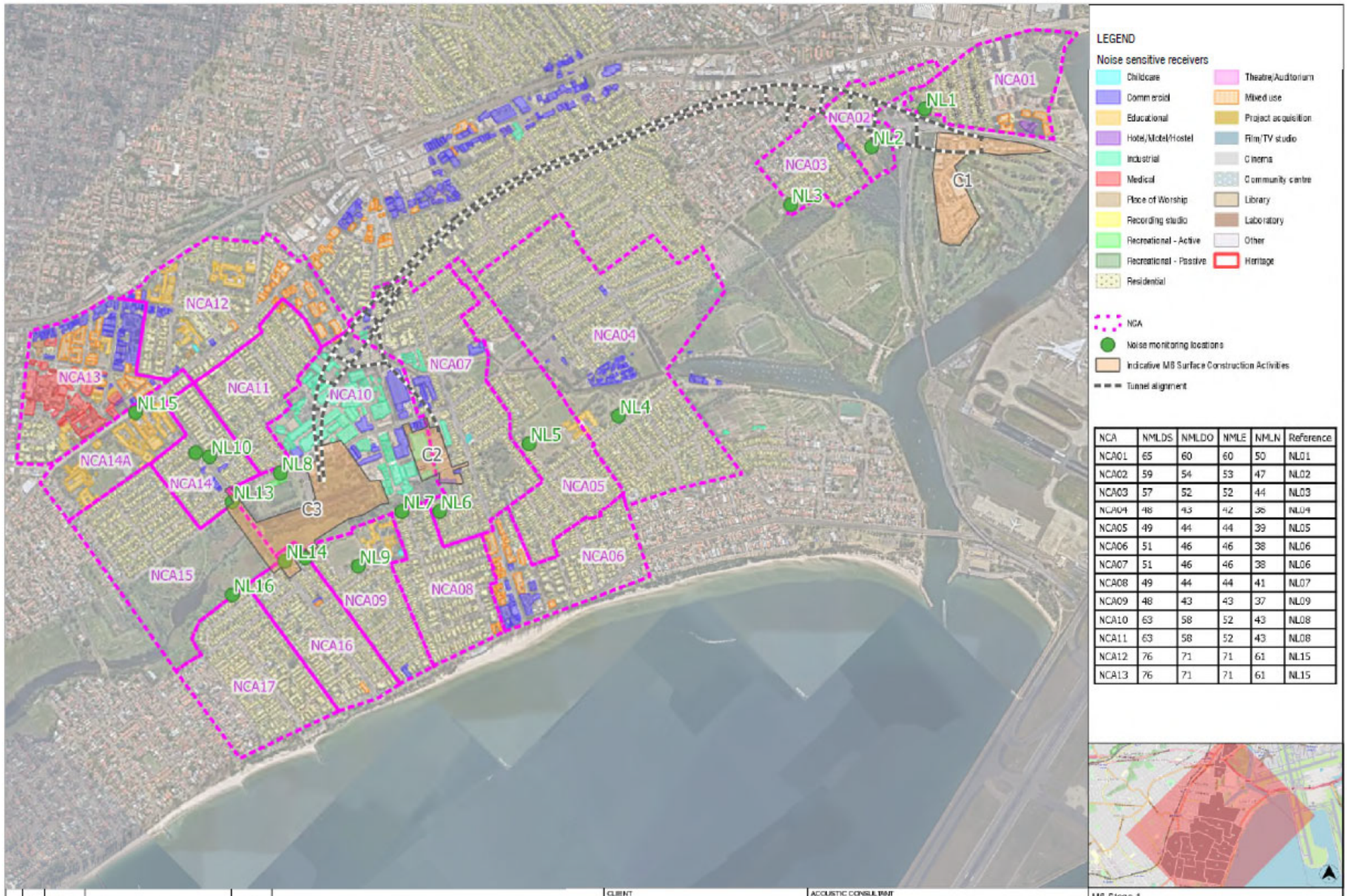
A review was undertaken on the data from June 2015 (as part of the M8 Motorway project) as the data is more than 5 years old. The data is considered representative of the existing acoustic environment in Arncliffe. Furthermore, monitoring during COVID 19 restrictions in Sydney may result in non-typical background noise levels. No additional baseline monitoring is anticipated, however, if required, it will be undertaken in accordance with the relevant guidance and the CNVMP will be updated as necessary and issued to DPIE for approval.

3.3. Sensitive receptors

A land use survey in areas where works could impact on sensitive receivers is included in Appendix B of the CNVMP. The land use survey identified the existing land use and development within and around the Project contains a mix of residential, educational, commercial, industrial and open space uses.

To facilitate the assessment of noise impacts from the Project, receivers along the Project alignment have been divided into Noise Catchment Areas (NCAs). NCAs group individual sensitive receivers by common traits such as existing noise environment and location in relation to the Project. An overview of the NCA's featured in Figure 1 below.

The NCAs and Land Use Survey are described and presented in more detail in Section 4.1 and nine detailed maps are featured in Appendix B of the CNVMP.



NCA	NMLDS	NMLDO	NMLE	NMLN	Reference
NCA01	65	60	60	50	NL01
NCA02	59	54	53	47	NL02
NCA03	57	52	52	44	NL03
NCA04	48	43	42	36	NL04
NCA05	49	44	44	39	NL05
NCA06	51	46	46	38	NL06
NCA07	51	46	46	38	NL06
NCA08	49	44	44	41	NL07
NCA09	48	43	43	37	NL09
NCA10	63	58	52	43	NL08
NCA11	63	58	52	43	NL08
NCA12	76	71	71	61	NL15
NCA13	76	71	71	61	NL15

REV	BY	DATE	DESCRIPTION	APPROVER
r1	SS	19/08/21	Add Tunnel Alignment	MT
r0	MS	29/07/21	Prepare figures	TG

Figure 1 Noise Catchment Areas for Project

3.4. Noise monitoring

3.4.1. Overview

This Program describes monitoring of noise impacts during construction of the Project. Note that details related to monitoring to be undertaken during Stage 2 Construction activities have been greyed out. These sections will be triggered when consultation on the Noise and Vibration CEMP Sub-plan for Construction begins.

For further information on the staging of the Project, refer to:

- CEMP for Preliminary construction including commencement activities:
  - Section 1.1;
  - Section 3.2.1; and
  - Appendix A2 Aspects and Impacts Register.
- Staging Report.

3.4.2. Monitoring locations during Stage 1 Preliminary Construction

Attended noise monitoring will be carried out during Stage 1 Preliminary Construction in accordance with Table 5.6, Section 5.3.4 of the CNVIA for Preliminary Construction including commencement activities. This document is found in Appendix F of the Noise and Vibration CEMP Sub-plan for Preliminary Construction including commencement activities. An extract of nominated monitoring locations are identified in Table 2 below.

Table 2 Nominated attended noise monitoring locations

Worksite	NCA	Nominated receiver address
C1	NCA01	26 Marsh Street, Wolli Creek 2205
C1	NCA02	6 Eve Street, Arncliffe
C2	NCA07	396 West Botany Street, Rockdale 2216
C2	NCA07	203 Bay Street, Rockdale 2216
C2	NCA07	3 England Street Street, Brighton Le Sands 2216
C2/C3	NCA08	2 Kings Road, Brighton-Le-Sands 2216
C3 (MOC3)	NCA11	79 French Street, Kogarah 2217
C3	NCA09	Brighton Le Sands Public School, 35 Crawford Rd, Brighton-Le-Sands 2216
C3	NCA09	1 Sybill Lane, Brighton Le Sands 2216

3.4.3. Monitoring locations during Stage 2 Construction

The monitoring locations will take into consideration the nature of construction activities being undertaken by the Project. Some activities will occur withing static work sites, like those at C1, C2 and C3. Other construction activities will move progressively over time along roads and other

transport corridors, as in the case for C4, C5 and C6. Therefore, this Program will be tailored to reflect the nature of both static and transient construction works of the Project.

Fixed station (real time) noise monitoring

To provide real time noise monitoring data to assess and confirm whether noise emission from site is within the predicted noise levels identified in the Construction Noise and Vibration Impact Statements (CNVIS), long-term, unattended noise monitoring will occur at fixed locations at construction compounds C1, C2 and C3. A fourth semi-mobile monitoring station will be allocated for construction compounds C4, C5 and C6. This station will be moved along the roads and transport alignment as works progress.

The location of the real-time noise monitoring equipment will be subject to the final work site layouts and availability of mains power and will be selected in consultation with the Acoustic Advisor (AA). Indicative locations of all monitoring stations are found in Appendix A and coordinates are featured in Table 3.

Table 3: Indicative coordinates of fixed real-time noise monitoring stations

Fixed station monitoring location ID	Easting	Northing
Fixed Monitor C1	329552	6243384
Fixed Monitor C2	328799	6240957
Fixed Monitor C3	328786	6240196
Semi-mobile Monitor C4 – C6	To be deployed along road and ATC alignment	

Activities based airborne noise monitoring

Attended noise monitoring locations may vary throughout the life of the Project. Locations would be determined on a case-by-case basis in a CNVIS, via the Project's noise and vibration management tool (Gatewave, see CNVMP Section 7.3) or in response to complaints. The identification of monitoring locations in the CNVIS or via Gatewave will consider the following:

- Most affected noise sensitive receiver location in proximity to the assessed activities,
- Location of previous monitoring sites,
- Proximity of the receiver to a Project worksite,
- Sensitivity of the receiver to noise,
- Background noise levels, and
- Safety of personnel undertaking the measurements,
- Expected duration of the impact.

Noise monitoring should, where practicable, be in positions with unobstructed views of general site activities, whilst shielded as much as possible from non-construction site noise (e.g. road traffic, rail noise and other surrounding noise). In accordance with Australian Standard AS1055, outdoor noise monitoring is to be undertaken at least 3.5m from any reflecting structure other than the ground. The preferred measurement height is 1.2-1.5m above the ground. Where the noise monitors are placed within 3.5 metres of building facades, walls or cliffs, then a reflection correction of up to -2.5dB(A) shall be applied to remove the effect of increased noise due to sound reflections from such structures.

Measurements inside buildings should be at least 1m from the walls or other major reflecting surfaces, 1.2 m to 1.5m above the floor, and about 1.5m from windows.

Plant/ equipment noise checks

Plant/ equipment noise checks are required for noise intensive plant and equipment to ensure compliance with the noise levels for construction equipment assumed in the CNVIS (see Appendix C, Table C1 of the relevant CNVIS) or the levels established in Table F.1 of the CNVG. Spot checks would be carried out as required on a case-by-case basis, such as in response to a plant/equipment specific noise related complaint and during noise and vibration assessment validation monitoring when it is possible to isolate the noise from one piece of plant or equipment.

Ongoing spot checks for noise intensive plant and equipment should typically be carried out at a distance of 7 metres from the plant. The measurements should be undertaken at least 3.5m from any reflecting structure other than the ground. The preferred measurement height is 1.2-1.5m above the ground. Where the noise monitors are placed within 3.5 metres of building facades, walls or cliffs, then a reflection correction of up to -2.5dB(A) shall be applied to remove the effect of increased noise due to sound reflections from such structures.

Further guidance for noise monitoring of specific plant items can be obtained from ISO 3744, ISO 3746, ISO 6393 and ISO 6395, referenced in Section 3.1.

Ground-borne noise monitoring

Ground-borne noise monitoring locations would be determined on a case-by-case basis in a CNVIS, via the Project's noise and vibration management tool (Gatewave, see CNVMP Section 7.3) or in response to complaints. The monitoring will be undertaken in the most affected habitable room of the sensitive receiver building and will be conducted in conjunction with vibration measurements whenever practicable. The room selected for noise monitoring should be well shielded from airborne noise intrusions, such as road traffic noise to allow the ground-borne noise to dominate over non-construction generated airborne noise.

There may be instances where the resident does not allow access to monitor in the most suitable habitable room. In these instances, CGU will endeavour to monitor at the next most suitable available room or location, noting this in the monitoring form.

3.4.4. Monitoring frequency and method

All environmental noise monitoring equipment used must be at least Type 2 instruments as described in AS IEC 61672.1 'Electroacoustic - Sound Level Meters - Specifications'. Noise measurement will be taken with the following meter settings:

- Time Constant: Fast (i.e. 125 milliseconds)
- Frequency Weightings: A-weighting
- The minimum range of noise metrics to be recorded are the following A-weighted noise levels:
  - For attended noise monitoring outlined in Section 3.4.2, L_{90}, L_{eq}, and L_{max}
  - For noise monitoring outlined in Section 3.4.3, L_{90}, L_{eq}, L_{10}, L_1 and L_{max}.

Meteorological conditions such as wind velocity, wind direction and rainfall shall also be either monitored on site or recorded from the nearest weather station to the project site, during the noise monitoring period. Measurements of noise should be disregarded when rain or wind affects the measured noise levels as described in the AS 1055.

Monitoring frequency and methods are outlined in Table 4.

Table 4: Monitoring frequency and method

Type of noise monitoring	Timing/ Frequency	Duration
Stage 1 Preliminary Construction monitoring	▪ At the first opportunity within the first month of Stage 1 preliminary construction activities, as well as throughout the construction period to: ▸ ensure the range of activities being undertaken at the site are measured (see CNVMP Section 9.3.1), ▸ confirm that actual noise levels are consistent with predicted noise impacts and that the management measures that have been implemented are appropriate, ▪ Where a change in methodology, plant or equipment is anticipated to result in a significant increase in construction noise impact than what has been assessed, ▪ In response to a noise related complaint(s) (determined on a case-by-case basis) and in accordance with EPL Conditions, ▪ As directed by an authorised officer of the EPA, ▪ As otherwise required by the CNVIS and/or CNVIA (refer to CNVMP Section 7.2 for information regarding CNVIS). Specific monitoring requirements will be identified in the relevant CNVIS as they are location and task specific, ▪ As required by the Out of Hours Works (OOHW) Protocol (refer Section 4.3) or EPL (refer Section 4.5), ▪ Following the implementation of mitigation measures or noise attenuation as a result of exceedance of predicted noise levels (see Section 4.3)	15-minute
Fixed station monitoring[11]	Continuous	15-minute
Activities based airborne noise monitoring	▪ At the first opportunity within the first month of starting construction activities as well as throughout the construction period to: ▸ ensure the range of activities being undertaken at the site are measured (see CNVMP Section 9.3.1), ▸ confirm that actual noise levels are consistent with predicted noise impacts and that the management measures that have been implemented are appropriate, ▪ Where a change in methodology, plant or equipment is anticipated to result in a significant increase in construction noise impact than what has been assessed, ▪ In response to a noise related complaint(s) (determined on a case-by-case basis) and in accordance with EPL Conditions, ▪ As directed by an authorised officer of the EPA, ▪ As otherwise required by the CNVIS (refer to CNVMP Section 7.2 for information regarding CNVIS). Specific monitoring requirements will be identified in the relevant CNVIS as they are location and task specific, ▪ As required by the Out of Hours Works (OOHW) Protocol (refer Section 4.3) or EPL (refer Section 4.5),	15-minute

Type of noise monitoring	Timing/ Frequency	Duration
	▪ Following the implementation of mitigation measures or noise attenuation as a result of exceedance of predicted noise levels (see Section 4.3)	
Plant/ Equipment checks	▪ At the first opportunity within the first month of starting construction activities as well as throughout the construction period. ▪ Spot checks would be carried out as required on a case-by-case basis, such as in response to a specific noise related complaint and during noise verification monitoring when it is possible to isolate the noise from one piece of plant or equipment.	Static/ constant plant[2]: 1 to 2-minute Dynamic plant[3]: capture a representative activity, such as one truck-and-trailer load cycle
Ground-borne noise monitoring	▪ At the first opportunity following commencement of works if ground-borne noise impacts identified, ▪ Where appropriate in response to ground-borne noise related complaint(s) (determined on a case-by- case basis) and in accordance with the EPL, and ▪ As otherwise required by a CNVIS, OOHW Protocol or EPL.	15-minute

NOTES: 1. Fixed noise monitoring stations will be located at C1, C2 and C3. A semi-mobile monitoring station will be deployed for C4, C5 and C6 as required. This will take place during Stage 2 Construction activities.
2. Constant noise source (e.g. generator, fan)
3. Variable or inconstant noise source (e.g. front-end loader in spoil bin)
Text greyed out will trigger upon Stage 2 construction activities.

3.4.5. Noise goals

The noise monitoring results will be assessed against the noise management levels (NMLs) outlined in Section 5 of the CNVMP. Where, after all reasonable and feasible mitigation measures have been implemented, measured noise levels are above the NMLs, they will be compared to the predicted noise levels in the relevant CNVIS.

If exceedance of the NML is identified, a review of site-specific mitigation measures will be undertaken to confirm that all reasonable and feasible mitigation and management measures have been implemented and confirm if there are any opportunities to further reduce noise levels on site.

If, after all reasonable and feasible mitigation measures have been implemented, an exceedance of the predicted noise levels is identified, a management response will be triggered. Details on this management response is detailed in Section 4.3.

3.5. Vibration monitoring

3.5.1. Overview

This Program describes monitoring of vibration impacts during construction of the Project. Note that details related to monitoring to be undertaken during Stage 2 Construction activities has been greyed out. These sections will be triggered when the Planning Secretary issues the approval of the Noise and Vibration CEMP Sub-plan.

Where human comfort is a concern, vibration monitoring will meet the requirements of the EPA's Assessing Vibration – a technical guideline. Where property damage is a concern, vibration monitoring will meet the requirements of BS7385-2:1993 and DIN 4150-3:2016.

3.5.2. Monitoring locations during Stage 1 Preliminary Construction

Vibration monitoring will be carried out during Stage 1 Preliminary Construction in accordance with Table 6.7, Section 6.3.5 of the CNVIA for Preliminary construction including commencement activities. This document is found in Appendix F of the Noise and Vibration CEMP Sub-plan for Preliminary construction including commencement activities. An extract of nominated monitoring locations are identified in Table 5 below.

Table 5 Nominated vibration monitoring locations

Worksite Plant item Address	Worksite Plant item Address	Worksite Plant item Address	Vibration objectives			
			Reinforced or unreinforced structures	Heritage structures	Cosmetic damage	Human annoyance
C1	Jackhammer Plate compactor 35T excavator with rock hammer attachment Smooth drum roller (13t) – High vibration	43 Innesdale Road, Wolli Creek 2205	✓	-	-	✓
C2	Jackhammer Plate compactor 35T excavator with rock hammer attachment Smooth drum roller (13t) – High vibration	10/380 West Botany Street, Rockdale 2216	✓	-	✓	✓
		396 West Botany Street, Rockdale 2216	✓	-	✓	✓
		406-408 West Botany Street, Rockdale 2216	✓	-	✓	✓
		205 Bay Street, Rockdale 2216	✓	-	✓	✓
		211 Bay Street, Rockdale 2216	✓	-	✓	✓
C3 (MOC3)	Jackhammer Plate compactor 35T excavator with rock hammer attachment Smooth drum	443 West Botany Street, Rockdale 22162	✓	-	✓	✓
		443 West Botany Street,	-	-	✓	✓

Worksite Plant item Address	Worksite Plant item Address	Worksite Plant item Address	Vibration objectives			
			Reinforced or unreinforced structures	Heritage structures	Cosmetic damage	Human annoyance
	roller (13t) – High vibration	Rockdale 22162				
C3	Jackhammer Plate compactor 35T excavator with rock hammer attachment Smooth drum roller (13t) – High vibration	466 West Botany Street, Rockdale 2216	✓	-	-	✓

3.5.3. Monitoring locations during Stage 2 Construction

The monitoring locations will take into consideration the nature of construction activities being undertaken by the Project. Some activities will occur within static work sites, like those at C1, C2 and C3. Other construction activities will move progressively over time along roads and other transport corridors, as in the case for C4, C5 and C6. Therefore, this Program will be tailored to reflect the nature of both static and transient construction works of the Project.

Fixed station (real time) vibration monitoring

To provide real time vibration monitoring data to assess vibration generated by construction activities, long-term, unattended vibration monitoring will occur at fixed locations, where identified in the relevant CNVIS.

The Project will utilise the facilities established for the construction of the M8 Motorway at construction compound C1. Real-time vibration monitoring is not necessary at this site as there are limited vibration intensive works required.

A semi-mobile monitoring station will be allocated for construction compounds C4, C5 and C6. This station will be moved along the roads and transport alignment as works progress.

The final timing, duration and location of the real-time vibration monitoring equipment will be subject to the construction program, availability of mains power, safety requirements and consultation with the Acoustic Advisor (AA). Indicative locations of all monitoring stations are found in Appendix A and coordinates are featured in Table 6.

Table 6: Indicative coordinates of fixed real-time vibration monitoring stations

Fixed station monitoring location ID	Easting	Northing
Fixed Monitor C2	To be confirmed	
Fixed Monitor C3	To be confirmed	
Semi-mobile Monitor C4 – C6	To be deployed along road and ATC alignment	

Building damage vibration monitoring

Attended or unattended vibration monitoring locations may vary throughout the life of the Project. Locations would be determined on a case-by-case basis in a CNVIS, via the Project's predictive noise and vibration management tool (Gatewave, see CNVMP Section 7.3) or in response to complaints. The identification of a suitable vibration monitoring location will consider the following:

- vibration monitoring equipment shall be placed outside at the footings or foundations of the building of interest closest to the vibrating plant;
- the surface should be solid and rigid to best represent the vibration entering the structure of the building under investigation;
- the vibration sensor or transducer shall not be mounted on loose tiles, loose gravel or other resilient surfaces;
- the vibration sensor or transducer shall be directly mounted to the vibrating surface using either adhesive, double sided tape or a magnetic mounting plate onto a steel washer, plate or bracket which shall be either fastened or glued to the surface of interest; and
- where a suitable mounting surface is unavailable, then a metal ground spike shall be driven into solid ground adjacent to the building of interest, and the vibration sensor or transducer shall be mounted on that.

Plant/ equipment vibration monitoring

Attended vibration monitoring to confirm the site specific minimum working distances for vibration intensive plant/ equipment would be determined on a case-by-case basis in a CNVIS, via the Project's noise and vibration management tool (Gatewave, see CNVMP Section 7.3). Items to consider in the identification of a suitable vibration monitoring location are noted above.

Human exposure vibration monitoring

Attended vibration monitoring to confirm human exposure to vibration would be determined on a case-by-case basis in a CNVIS, via the Project's noise and vibration management tool (Gatewave, see CNVMP Section 7.3) or in response to complaints. The monitoring will be undertaken in the most affected habitable room of the sensitive receiver building and will be conducted in conjunction with ground-borne noise measurements where applicable. The room selected for vibration monitoring should be well shielded from extraneous vibration intrusions, such as heavy vehicle road traffic, condenser units or pumps.

There may be instances where the resident does not allow access to monitor in the most suitable habitable room. In these instances, CGU will endeavour to monitor at the next most suitable available room or location, noting this in the monitoring form.

3.5.4. Monitoring frequency and method

The minimum range of vibration metrics to be recorded is the following:

- Root-Mean-Square acceleration (RMS);
- Peak Particle Velocity (PPV) or
- Vibration Dose Values (VDVs) (for human exposure to vibration).

Monitoring frequency and methods are outlined in Table 7.

Table 7: Monitoring frequency and method

Type of noise monitoring	Timing/ Frequency	Duration
Fixed station monitoring[11]	Continuous	15-minute
Building damage vibration monitoring	▪ at the commencement of vibration generating activities that have the potential to impact on heritage items and the vibration sensitive locations are found to fall within the site specific or recommended minimum working distances established for vibration intensive plant	Representative sample of vibration being generated
Plant/ Equipment checks	▪ at the commencement of vibration intensive activities on site that have been identified in a CNVIS (refer to CNVMP Section 7.2 for information regarding CNVIS) or in the noise and vibration management tool (Gatewave) as likely to exceed the vibration screening criteria	Representative sample of vibration being generated
Human exposure vibration monitoring	▪ At the first opportunity following commencement of works, concurrent with ground-borne noise monitoring where applicable, ▪ Where appropriate in response to vibration related complaint(s) (determined on a case-by- case basis) and in accordance with the EPL, and ▪ As otherwise required by a CNVIS, OOHW Protocol or EPL.	15-minute or Representative sample of vibration being generated (as required)

NOTES: 1. Fixed monitoring stations at C2 and C3. A semi-mobile "fixed" monitoring station will be deployed along the Permanent Power Supply and C4, C5 and C6 as required. This will take place during Stage 2 Construction activities.
Text greyed out will trigger upon Stage 2 construction activities.

3.5.5. Vibration management

The vibration monitoring results will be compared to the vibration goals outlined in Section 5.5 of the CNVMP, as required.

If an exceedance is identified, a management response will be triggered. Details on this management response is detailed in Section 4.3.

Building damage vibration monitoring

Vibration monitoring would be undertaken as outlined in Figure 2. Vibration monitoring results will be assessed and reported against the British Standard 7385 and German Standard DIN 4150, as presented in the CNVMP (Section 5.5.2). The approach that will be adopted for the Project to assess and manage potential vibration impact, including on heritage structures is outlined in Section 5.5.4 of the CNVMP.

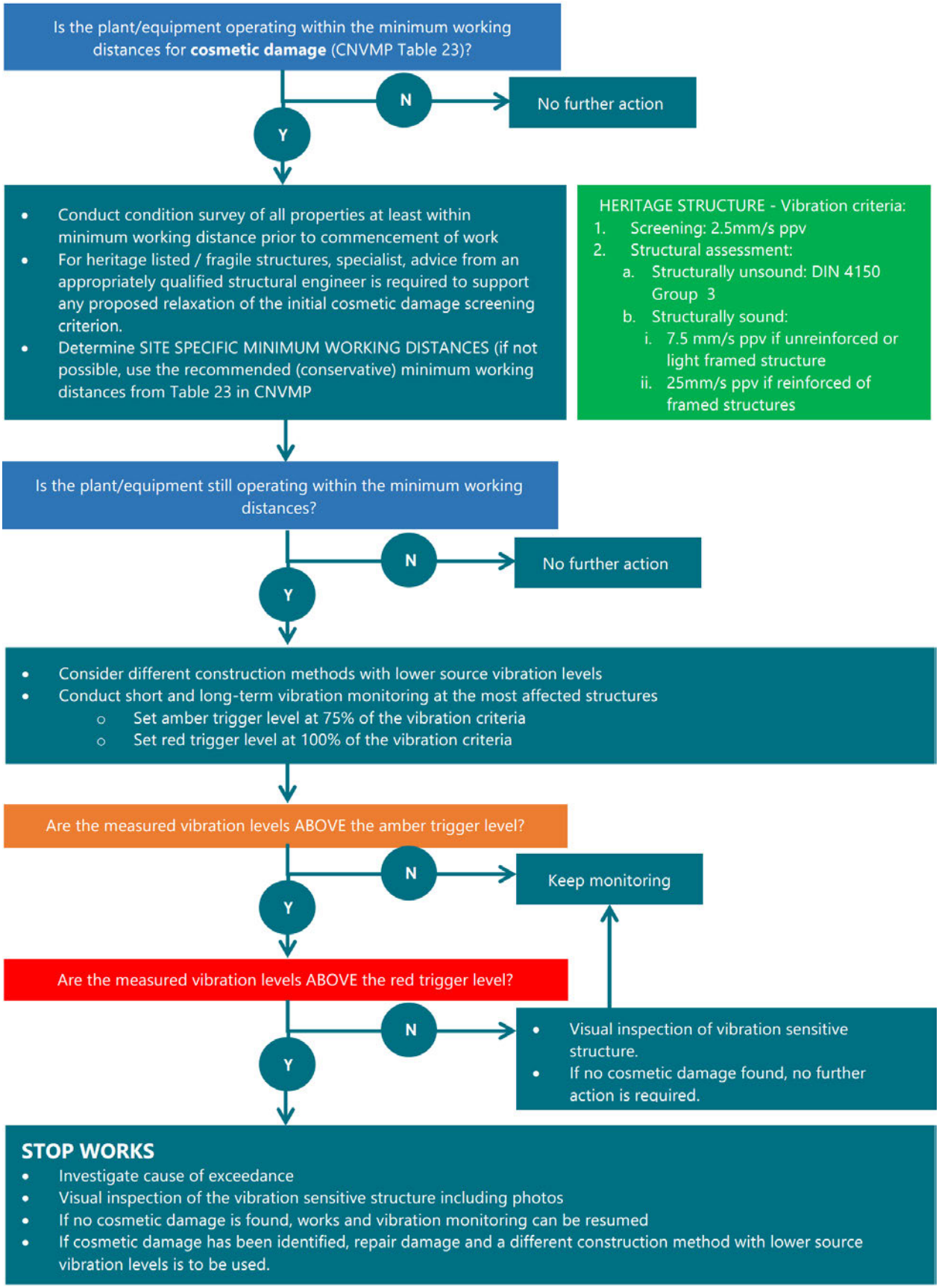


Figure 2: CGU M6 Stage 1 Project vibration monitoring (cosmetic damage to structures) flow chart

Human exposure vibration monitoring

Where human comfort is a concern, vibration monitoring would be undertaken as outlined in Figure 3. Vibration monitoring results would be assessed and reported against the values set out in Tables 2.2 and 2.4 of the EPA's Assessing Vibration – a technical guideline, as presented in the CNVMP (Section 5.5.1).

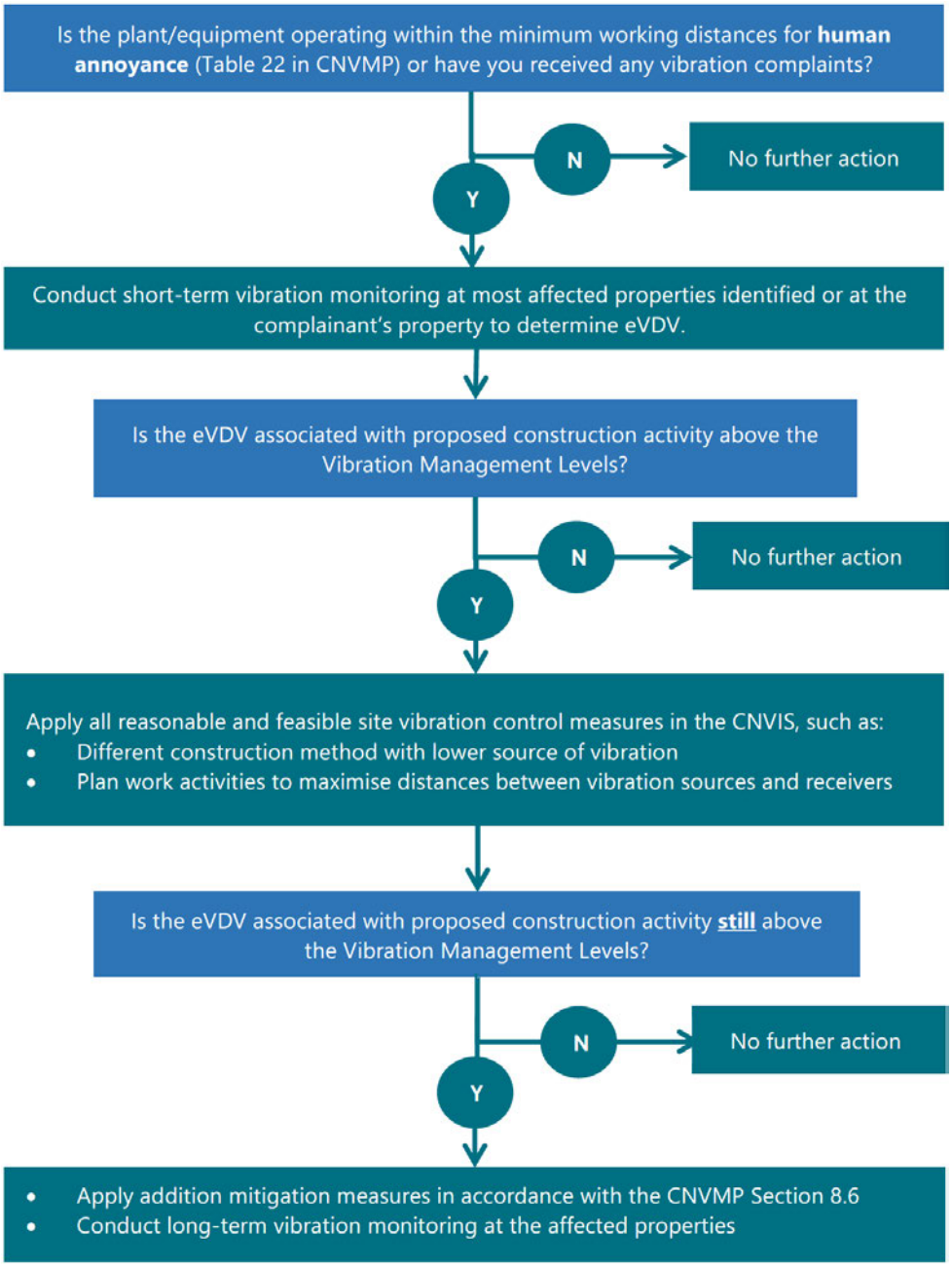


Figure 3: CGU M6 Stage 1 Project vibration monitoring (human exposure) flow chart

3.6. Calibration, quality assurance and documentation

Attended noise monitoring equipment used will be at least Type 2 instruments and calibrated in accordance with manufacturer specifications or relevant Australian Standards. Records of equipment laboratory calibration will be maintained by CGU throughout the delivery of the Project. The calibration of the monitoring equipment will be checked in the field before and after the noise measurement period.

All vibration instruments will be calibrated in accordance with manufacturers specifications or relevant Australian Standards. Records of monitoring equipment calibration will be maintained by CGU throughout the delivery of the Project.

All monitoring records will be retained throughout CGU's delivery of the Project. Monitoring records will record:

- Date and time of measurements;
- Name of person(s) undertaking the measurements;
- Qualifications and/or competency/suitability of the person carrying out the monitoring;
- Weather conditions during measurements;
- Type and model number of monitoring equipment;
- Calibration dates of monitoring equipment;
- Time of day, length of measurement and measurement time intervals;
- Monitoring location details including:
  - a sketched map showing the monitoring location, the location of noise/vibration generating items (construction activities and other environmental noise sources), the location and type of mitigation measures, the location of other acoustically relevant items (e.g. walls/barriers); and
  - photographs clearly identifying the monitoring location;
- Number of measurements at each location;
- Construction activities under investigation, including load conditions of plant; and
- Possible extraneous noise (e.g. road traffic, aircraft, insects) or vibration influences from other sources (e.g. domestic vibrations, other mechanical plant, traffic etc.)
- For noise, the following additional items should be recorded:
  - results of field calibration checks;
  - microphone height;
  - presence (or otherwise) of reflecting surfaces (such as walls), the distance from them in addition to any corrections made for the presence of reflecting surfaces;
  - Measured noise levels including the minimum descriptors required in Section 3.4.4;
  - Estimated noise level from construction activities only;
  - Presence of identified annoying characteristics and if a correction has been made to the measured noise levels;
  - Estimated noise levels from environmental noise sources other than construction; and
  - Mitigation measures in place at the time of the measurement and observations on their potential effectiveness.

4. Compliance management

4.1. Roles, responsibility and training

The CGU Project Team's organisational structure and overall roles and responsibilities are outlined in Section 3.4 of the CEMP. Specific responsibilities for the implementation of environmental controls for construction noise and vibration are detailed in the CNVMP.

All noise and vibration monitoring will be carried out by an appropriately trained and competent person in the measurement and assessment of construction noise and vibration, who is familiar with the requirements of the relevant standards and procedures, detailed in the CNVMP. Training will be undertaken by the Project Noise and Vibration consultant.

All employees, contractors and utility staff working on site will undergo site induction. Further details regarding staff induction and training are outlined in Section 3.6 of the CEMP.

4.2. Monitoring and inspection

This Program details the monitoring requirements for noise and vibration. In accordance with Section 3.4 of the CEMP, CGU Environmental and Sustainability Manager will be responsible for ensuring monitoring activities are undertaken. Additional requirements and responsibilities in relation to inspections are documented in Section 3.9.2 of the CEMP.

4.3. Data analysis and management response

Results obtained as per the construction monitoring Program will be compared against the noise goals listed in Section 3.4.5 and Section 3.5.5. If an exceedance is observed a review will be initiated to determine the significance of the exceedance(s) and possible causes.

The review will assess:

- Activities occurring during the exceedance compared to CNVIS;
- Effectiveness of noise and vibration management and mitigation measures in place (Table 20 of the CNVMP);
- Effectiveness of specific mitigation and management measures identified in the relevant CNVIS; and
- Other aspects that may have influenced the measurement result (e.g. meteorological conditions, extraneous noise/ vibration source).

If the exceedance is determined to be attributable to Project works, the event will be treated as an environmental incident and managed in accordance with the requirements of the CEMP (section 3.8 and Appendix A7). Corrective and preventative actions will be identified and implemented as part of that process.

4.4. Compliance and Auditing

Compliance monitoring and Auditing (both internal and external) will be undertaken to assess the effectiveness of environmental controls, compliance with this Program, CoA, and other relevant approvals, licenses and guidelines. Compliance and auditing requirements are detailed in Section 3.9.3 of the CEMP.

4.5. Reporting

During construction, noise and vibration monitoring data will be collected, tabulated and assessed against the criterion identified in Table 5. A Noise and Vibration Monitoring Report will be submitted to DPIE and EPA within 60 days of the end of the reporting period unless otherwise agreed with DPIE and will be made publicly available.

Reporting requirements associated with the Program for the construction phase of the Project are presented in Table 8.

Table 8: Construction Noise and Vibration Reporting Requirements

Report	Frequency	Content	When	Reporting Authority
Noise and Vibration Monitoring Report	Every 6 months	▪ Data summary tables from monitoring undertaken in reporting period ▪ Exceedances ▪ Management responses to any exceedances which may have occurred during reporting period	Within 60 days of end of reporting period	EPA, DPIE

5. Review and improvement

5.1. Continual improvement

Monitoring data will be reviewed throughout the construction for continual improvement.

Continual improvement of this Program will be achieved by the ongoing evaluation of environmental management performance against environmental policies, objectives and targets and Project performance outcomes of the EIS for the purpose of identifying opportunities for improvement.

The continual improvement process will be undertaken in accordance with Section 3.2 of the CEMP and the intention of this process is to:

- Identify areas of opportunity for improvement of environmental management and performance;
- Determine the cause or causes of non-conformances and deficiencies;
- Develop and implement a Program of corrective and preventative action to address any non-conformances and deficiencies;
- Verify the effectiveness of the corrective and preventative actions;
- Document any changes in procedures resulting from process improvement; and
- Make comparisons with objectives and targets.

6. References

- Roads and Maritime QA Specification G36 – Environmental Protection (Management System).
- Roads and Maritime Construction Noise and Vibration Guidelines (CNVG) (Roads and Maritime 2015)
- NSW Interim Construction Noise Guideline (ICNG), Department of Environment and Climate Change 2009
- NSW Road Noise Policy, Dept. of Environment, Climate Change and Water 2011
- NSW Industrial Noise Policy (INP), Environment Protection Authority 2000
- NSW Noise Policy for Industry (NPfI), Environment Protection Authority 2017
- NSW Assessing Vibration – a technical guideline (AVTG), Department of Environment and Conservation 2006
- Sydney Airport Master Plan 2039 and Environment Strategy 2019-2039
- Australian Standard AS/NZS 1055 Acoustics - Description and Measurement of Environmental Noise
- Australian Standard AS/NZS 2012.1 Acoustics - Measurement of airborne noise emitted by earth-moving machinery and agricultural tractors - Stationary test condition - Determination of compliance with limits for exterior noise
- Australian Standard AS/NZS 2107:2016 Acoustics - Recommended design sound levels and reverberation times for building interiors
- Australian Standard AS 2187.2 Explosives - Storage and use - Part 2 Use of explosives
- Australian Standard AS2436-2010 Guide to Noise Control on Construction, Maintenance and Demolition Sites
- Australian Standard 2775 Mechanical Mounting of Accelerometers
- Australian Standard 2834-1995 Computer Accommodation, Chapter 2.9 Vibration
- British Standard BS 6472-2008, ‘Evaluation of human exposure to vibration in buildings (1-80Hz)
- British Standard 7385: Part 2-1993 'Evaluation and measurement of vibration in buildings'
- German Standard DIN4150- 2016 Structural vibration Part 3: Effects of vibration on Structures
- ISO 3746 Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Survey method using an enveloping measurement surface over a reflecting plane

Appendix A Map of Fixed Monitoring Stations

▲ Noise Monitoring Station

N
W E
S

0 50 100 150 200 Metres

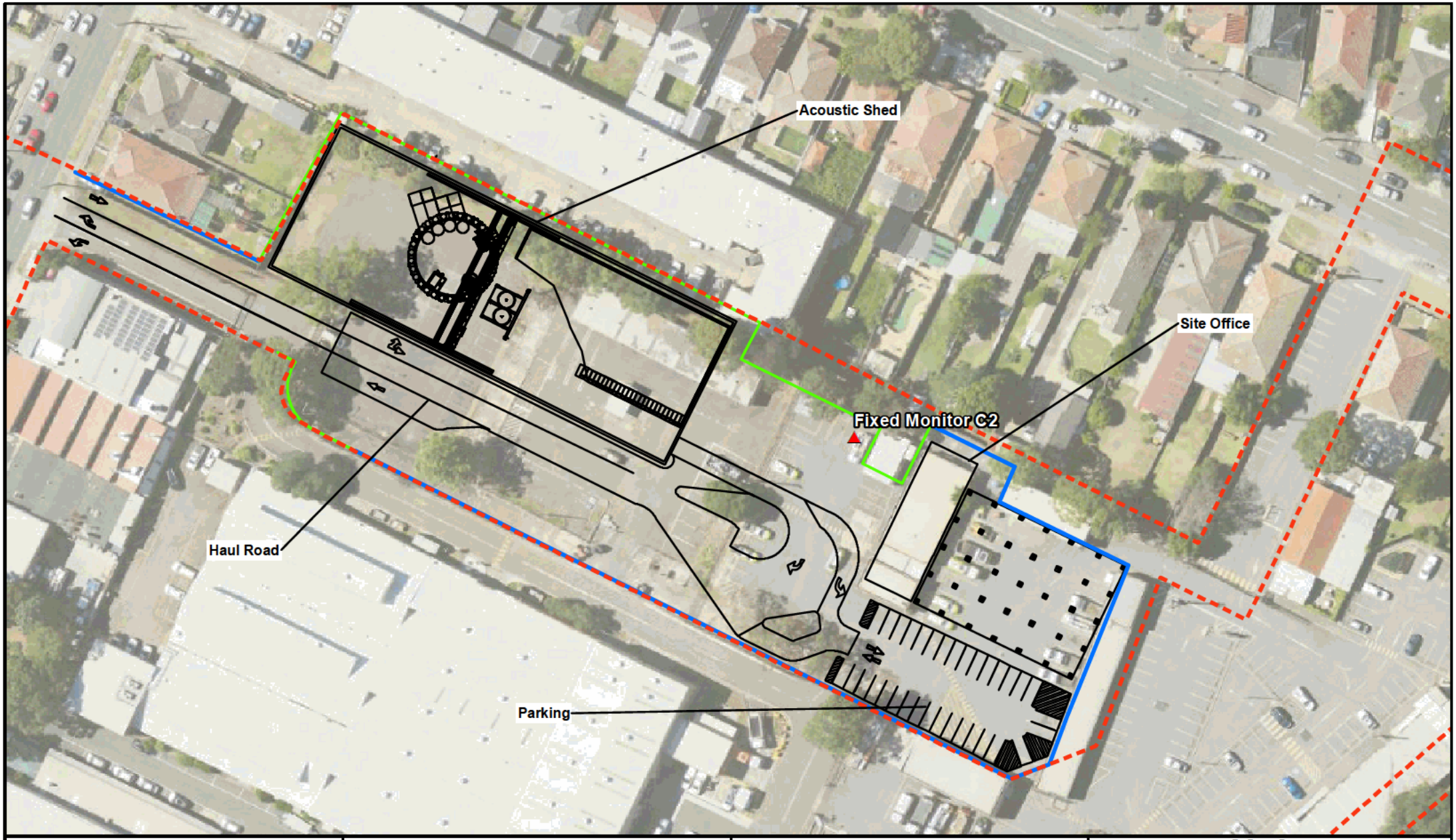
CPB CONTRACTORS | Ghella 5 Generations of Tunnelers | UGL

Original Size	A4	Drawn	GIS
Coordinate System	MGA Zone 56	Designed	MM
Height Datum	AHD	Date Printed	4/082021
Filename	Noise Monitoring - Arncliffe mxd		

Noise Monitoring Station

Arncliffe

Project Number



▲ Noise Monitoring Station

Construction Boundary

N W E S

0 10 20 30 40 50 Metres

CPB CONTRACTORS | Ghella | UGL

Original Size	A4	Drawn	GIS
Coordinate System	MGA Zone 56	Designed	MM
Height Datum	AHD	Date Printed	6/07/2021
Filename	Noise Monitoring - Rockdale Depot.mxd		

Noise Monitoring

Rockdale Depot

Project Number

ATC Boundary

N
W E
S

0 200 400 600 800 Metres

CPB CONTRACTORS | Ghella 5 Generations of Tunnelers | UGL

Original Size	A4	Drawn	GIS
Coordinate System	MGA Zone 56	Designed	MM
Height Datum	AHD	Date Printed	4/08/2021
Filename	Noise Monitoring - ATC.mxd		

Semi Mobile Noise Monitoring Station

Active Transport Corridor

Project Number

Noise Monitoring Station
Construction Boundary
C&C
Open

N
W
E
S

0 20 40 60 80 100 Metres

CPB CONTRACTORS | Ghella | UGL

Original Size	A4	Drawn	GIS
Coordinate System	MGA Zone 56	Designed	MM
Height Datum	AHD	Date Printed	4/08/2021
Filename	Noise Monitoring - Bicentennial Park.mxd		

Noise Monitoring

Bicentennial Park

Project Number

Princes Hwy / Presidents Ave / Local Roads Boundary

N
W E
S

0 100 200 300 Metres

CPB CONTRACTORS | Ghella | UGL

Original Size	A4	Drawn	GIS
Coordinate System	MGA Zone 56	Designed	MM
Height Datum	AHD	Date Printed	04/082021
Filename	Noise Monitoring - Presidents Ave mxd		

Semi Mobile Noise Monitoring Station

Princes Hwy / Presidents Ave / Local Roads

Project Number