# Noise and Vibration Monitoring Program

SMWSTCTP-AFJ-1NL-NV-PLN-000001 Revision 5

Sydney Metro West – Central Tunnelling Package

## DOCUMENT APPROVAL

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| | | | | |
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# GLOSSARY AND ABBREVIATION

| Abbreviation | Description / Definition |
|---|---|
| AFJV | Acciona Ferrovial Joint Venture (the Contractor) |
| AS/NZS | Australia/New Zealand Standards |
| Amendment Report | Sydney Metro West Westmead to The Bays and Sydney CBD Amendment Report Concept and Stage 1 (2020 |
| CEMP | Construction Environmental Management Plan |
| Construction | Includes all work required to construct Stage 1 of the CSSI as described in the documents listed in Condition A1 of Schedule 3, including commissioning trails of equipment and temporary use of any part of the CSSI, but excluding Low Impact Work.<br><br>*Note: As defined in Table 1 of SSI 10038 Infrastructure approval for the Project.* |
| CNVS | Sydney Metro Construction Noise and Vibration Standard Version 4.3 (4/11/2020) (SM-20-00098866) |
| CoA | Minister's Conditions of Approval (as relevant to Sydney Metro West Concept and Stage 1) |
| CTP | Central Tunnelling Package |
| DPE | NSW Department of Planning and Environment |
| EIS | Sydney Metro West Concept and Stage 1 Environmental Impact Statement (April 2020) |
| EMS | Environmental Management System |
| EPA | NSW Environment Protection Authority |
| EP&A Act | *NSW Environmental Planning and Assessment Act 1979* |
| EPL | NSW Environment Protection Licence under the *Protection of the Environment Operations Act 1997*. |
| NVMP | Central Tunnelling Package Noise and Vibration Management Plan (doc number) |
| OCCS | Overarching Community Communication Strategy |
| Planning Secretary | The Planning Secretary of the Department of Planning, Industry and Environment |
| PoEO Act | *NSW Protection of the Environment Operations Act 1997* |
| Project | Sydney Metro West Concept and Stage 1 |
| Relevant Councils | Any or all local government councils as relevant, Inner West Council, Strathfield Council, Burwood Council, City of Canada Bay, Parramatta City Council |
| REMM | Revised Environmental Mitigation Measure |
| Submissions Report | Sydney Metro West Westmead to The Bays and Sydney CBD Submissions Report Concept and Stage 1 (2020) |

# 1. INTRODUCTION

## 1.1 BACKGROUND

Sydney Metro is Australia's biggest public transport program. Services on the North West Metro Line between Rouse Hill and Chatswood started in May 2019. The Sydney Metro network also includes Sydney Metro City & Southwest, Sydney Metro West and Sydney Metro Western Sydney Airport.

Sydney Metro West is a new 24 kilometre metro line between Westmead and the Sydney CBD. This infrastructure investment will double the rail capacity of the Greater Parramatta to Sydney CBD corridor with a travel time target between the two centres of about 20 minutes.

The planning approvals and environmental impact assessment for Sydney Metro West has been split into a number of stages recognising the size of the project. This includes:

- Stage 1 – Concept and all major civil construction works including station excavation and tunnelling between Westmead and The Bays. Planning approval for this stage was granted in March 2021.
- Stage 2 – All major civil construction works including station excavation and tunnelling from The Bays to Sydney CBD
- Stage 3 – Tunnel fit-out, construction of stations, ancillary facilities and station precincts, and operation and maintenance of the Sydney Metro West line

An Environmental Impact Statement (EIS) (Jacobs/Arcadis, 2020) for the Concept and Stage 1 (herein referred to as the Project) assessed the noise and vibration impacts in response to the Secretary Environmental Assessment Requirements issued by the Department of Planning, Industry and Environment. The Project was approved on 11 March 2021 (SSI 10038).

Sydney Metro is delivering the Project via several different packages, including the Central Tunnelling Package (CTP). This Noise and Vibration Monitoring Program (Program) has been prepared to address the Condition of Approval (CoA) C14(a), C15 and C16. In addition, the Program has been developed in accordance with the Project EIS, the Revised Environmental Mitigation Measures (REMMs) and all applicable for the design and construction of the CTP.

## 1.2 SCOPE

This Program outlines how Acciona Ferrovial Joint Venture (AFJV) propose to undertake noise and vibration monitoring during construction of the CTP.

This document should be read in conjunction with the AFJV Noise and Vibration Management Plan.

This Program will be appended to the Noise and Vibration Management Plan (NVMP) which forms part of the Project Construction Environmental Management Plan (CEMP).

## 1.3 OBJECTIVES

This Program is to define, address and implement noise and vibration monitoring requirements and will apply for the duration of construction.

This Program outlines how AFJV will comply with and implement the applicable elements of the following documents, collectively referred to herein as the 'Project requirements' for the CTP:

- The CoA (issued on 11 March 2021 and as modified on 29 July 2021)
- The Project EIS, Submissions Report and Amendment Report
- Sydney Metro Construction Environmental Management Framework (CEMF).

The objectives and targets applicable to the Noise and Vibration Management on the Project are outlined in Section 3.9 of the CEMP and Section 2 of the CNVMP. In addition to these, the following objectives specifically related to the implementation of the monitoring program will be adopted from the CNVS:

- Ongoing noise monitoring during construction at sensitive receivers during critical periods (i.e. times when noise emissions are expected to be at their highest - e.g. piling and hammering) to identify and assist in managing high risk noise events
- Monitoring will be undertaken inform the relevant personnel when the noise or vibration goal has been exceeded so that additional management measures may be implemented
- Regular compliance checks on the noise emissions of all plant and machinery used for the project to:
    - indicate whether noise emissions from plant items were higher than predicted
    - identify defective silencing equipment on the items of plant
    - assist in determining where additional management measures should be implemented.

# 2. ENVIRONMENTAL REQUIREMENTS

## 2.1 RELEVANT LEGISLATION AND GUIDELINES

Legislation relevant to this Program includes:

- *Protection of the Environment Operations Act 1997* (POEO Act)

The guidelines, specifications and policy documents relevant to this Program include:

- Sydney Metro Construction Noise and Vibration Standard (CNVS) 2020 v4.3
- Sydney Metro Construction Environmental Management Framework (CEMF) 2020 v4.1
- 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 Noise Policy for Industry, Environment Protection Authority 2017
- NSW Assessing Vibration – a technical guideline (AVTG), Department of Environment and Conservation 2006
- Australian Standard 1055:2018 Acoustics – Description and Measurement of Environmental Noise
- Australian Standard AS/NZS 2107:2016 Acoustics - Recommended design sound levels and reverberation times for building interiors
- Australian Standard AS2436-2010 Guide to noise and vibration control on construction, demolition and maintenance sites
- Australian Standard 2659.1 – 1988 Guide to the use of sound measuring equipment – portable sound level meters[1]
- Australian Standard 2775-2004 Mechanical Mounting of Accelerometers
- Australian Standard 2834-1995 Computer Accommodation, Chapter 2.9 Vibration
- Australian Standard IEC 61672.1 Electroacoustic – Sound Level Meters – Specifications
- British Standard 7385:1993 Evaluation and measurement of vibration in buildings – Part 2 Guide to damage from ground-borne vibration German Standard DIN4150-3:2016 Vibration in buildings – Part 3: Effects on structures
- ISO 3744:2010 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 3746:2010 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.

## 2.2 CONDITIONS OF APPROVAL

CoA relevant to the preparation of this Program are identified in Table 1. A cross reference is also included to indicate where the requirement is addressed in this Program or other documents.

[1] AS 2659.1 – 1988 was withdrawn and not replaced in 2017, however is still widely used as a guidance document

TABLE 1: COMPLIANCE TABLE - REQUIREMENTS FOR PREPARATION OF CNVMP

| Ref | Requirement | Document reference |
|---|---|---|
| C14 | The following Construction Monitoring Programs must be prepared in consultation with the relevant government agencies identified for each to compare actual performance of constructionof Stage 1 of the CSSI against the performance predicted in the documents listed in Condition A1 of this schedule or in the CEMP:<br>(a) Noise and vibration – EPA, SOPA (in respect of Sydney Olympic Park), Place Management NSW (in respect of The Bays) and Relevant Council(s) | This Program |
| C15 | Each Construction Monitoring Program must provide: | |
| | (a) details of baseline data available including the period of baseline monitoring | Section 4 |
| | (b) details of baseline data to be obtained and when | Section 4 |
| | (c) details of all monitoring of the project to be undertaken | Section 5 & Section 6 |
| | (d) the parameters of the project to be monitored | Section 5 & Section 6 |
| | (e) the frequency of monitoring to be undertaken | Section 5 & Section 6 |
| | (f) the location of monitoring | Appendix A |
| | (g) the reporting of monitoring results and analysis results against relevant criteria | Section10<br>Section 4 NVMP |
| | (h) details of methods that will be used to analyse the monitoring data | Section 8 |
| | (i) procedures to identify and implement additional mitigation measures where the results of the monitoring indicated unacceptable project impacts; | Section 9 |
| | (j) a consideration of SMART principles; and | Section 9 |
| | (k) any consultation to be undertaken in relation to the monitoring programs; and | Section 3.1 |
| | (l) any specific requirements as required by Conditions C16 to C17 of this schedule. | Noted |
| C16 | The Noise and Vibration Construction Monitoring Program and Blasting Construction Monitoring Program must include: | Note, blasting not currently proposed |
| | (a) noise and vibration monitoring determined in consultation with the AA to confirm the best- achievable construction noise and vibration levels with consideration of all reasonable and feasible mitigation and management measures that will be implemented; | Section 5 & Section 6 |
| | (b) for the purposes of (a), noise monitoring must be undertaken during the day, evening and night-time periods and within the first month of work as well as throughout the construction period and cover the range of activities being undertaken at the sites; and | Section 5 & Section 6 |

| Ref | Requirement | Document reference |
|---|---|---|
| | (c) a process to undertake real time noise and vibration monitoring. The results of the monitoringmust be readily available to the construction team, the Proponent, ER and AA. The Planning Secretary and EPA must be provided with access to the results on request. | Section 5 & Section 6 |

## 2.3 ENVIRONMENTAL PROTECTION LICENCE

An Environmental Protection Licence (EPL) has been obtained for the Project (EPL 21610). Noise monitoring requirements from the EPL have been incorporated into this Monitoring Program.

## 2.4 CONSTRUCTION ENVIRONMENTAL MANAGEMENT FRAMEWORK

The CEMF requirements relevant to the preparation of this Program are identified in Table 2. A cross reference is also included to indicate where the requirement is addressed, in this Program or other documents. The CEMF requires this document be prepared consistently with the CNVS, as such this a cross reference demonstrating compliance with the CNVS is also included in Table 2.

TABLE 2: CEMF REQUIREMENTS

| **CEMF** | | |
|---|---|---|
| Req. | Condition requirements | Document Reference |
| 3.14a) | Issue specific environmental monitoring will be undertaken as required or as additionally required by any approval, permit or licence conditions. | This document |
| 3.14b) | The results of any monitoring undertaken as a requirement of a licence or permit that is required to be published will be published on the Principal Contractor's, or a project specific, website within 14 days of obtaining the results. | Section 10 |
| 3.16a) | Principal Contractors will maintain appropriate records of the following:<br>i. Site inspections, audits, monitoring, reviews or remedial actions;<br>ii. Documentation as required by performance conditions, approvals, licences and legislation;<br>iii. Modifications to site environmental documentation (eg CEMP, sub-plans and procedures); and<br>iv. Other records as required by this Construction Environmental Management Framework. | Section 10 |
| 3.16b) | Records must be accessible onsite for the duration of works. | Section 10 |
| 3.16c) | Additionally records will be retained by the Principal Contractor for a period of no less than 7 years. Records will be made available in a timely manner to Sydney Metro (or their representative) upon request. | Section 10 |
| 8.2c) | Noise and vibration monitoring would be undertaken for construction as specified in the CNVS. | This document |

| | | |
|---|---|---|
| **CEMF** | | |
| 8.2d) | The following compliance records would be kept by Principal Contractors:<br>i. Records of noise and vibration monitoring results against appropriate NMLs and vibration criteria; and<br>ii. Records of community enquiries and complaints, and the Contractor's response. | Section 10 |
| **CNVS** | | |
| 6.1 | Sound power level comparison against values in Section 4.3 of CNVS | Section 5.1.4 |
| 6.2 | Noise monitoring where noise goals predicted to be exceeded | Section 5.1.1 |
| 6.3 | Vibration monitoring where exceedance of cosmetic damage criteria expected, or where human response exceedance is expected and where concerns raised. | Section 6 |

## 2.5 REVISED ENVIRONMENTAL MITIGATION MEASURES

There is only one REMM which applies specifically to noise and/or vibration monitoring; REMM NV16 describes the following requirement:

> *Where vibration levels are predicted to exceed the screening criteria, a more detailed assessment of the structure (in consultation with a structural engineer) and vibration monitoring would be carried out to ensure vibration levels remain below appropriate limits for that structure.*
>
> *For heritage items, the more detailed assessment would specifically consider the heritage values of the structure in consultation with a heritage specialist to ensure sensitive heritage fabric is adequately monitored and managed.*

This has been addressed in Section 6.4 , and also in the Heritage Management Plan which forms part of the CEMP. The Heritage Management Plan list items/locations of heritage value which will also be reflected in the Environmental Control Maps and identified in the Project DNVIS.

# 3. DOCUMENT CONSULTATION AND APPROVAL

## 3.1 DOCUMENT CONSULTATION

This monitoring plan builds on the consultation that had been undertaken by the EIS, and Response to Submissions managed by the project proponent, Sydney Metro.

In accordance with CoA C14(a), this Program will be provided to the following government agencies for review and comment.

- EPA
- SOPA (in respect of Sydney Olympic Park),
- Place Management NSW (in respect of The Bays); and
- Inner West Council
- City of Canada Bay
- Strathfield City Council
- Burwood Council
- City of Paramatta Council.

Details of issues raised by a government agency during consultation will be included as Appendix F of the NVMP, including copies of all correspondence from those agencies, as required under CoA A6.

Ongoing consultation with stakeholders may be undertaken as required during project delivery.

## 3.2 DOCUMENT APPROVAL

In accordance with CoA C18 this Monitoring Program will be submitted to the Planning Secretary for approval, following ER and AA endorsement.

# 4. BASELINE MONITORING DATA

Baseline noise levels were established as part of the EIS through background noise monitoring between March and July 2019 at representative locations, with results summarised for each Noise Catchment Area (NCA) in Table 3.

Noise levels in the project area generally display a typical diurnal trend with lower levels during the night-time than the daytime and evening periods (with some exceptions). This is characteristic of urban and suburban areas, where the ambient noise environment is primarily influenced by road traffic.

The baseline information was used to establish the Rating Background Level (RBL), which represents the average minimum background sound level for each measurement period, averaged over the measurement days.

Baseline data from the EIS has been reviewed and is representative of ambient noise in the project area. No further baseline monitoring is proposed prior to commencement of construction of the CTP.

TABLE 3: BACKGROUND NOISE MONITORING RESULTS

| Noise Catchment Area (NCA) | Noise level (dBA) | | |
|---|---|---|---|
| | Day RBL | Evening RBL | Night RBL2 |
| NCA-8 | 48 | 48 | 46 |
| NCA-9 | 48 | 46 | 41 |
| NCA-10 | 47 | 47 | 44 |
| NCA-11 | 51 | 47 | 39 |
| NCA-12 | 43 | 43 (47)[3] | 42 |
| NCA-13 | 48 | 48 | 44 |
| NCA-14 | 42 | 41 | 33 |
| NCA-15 | 43 | 43 (44)[3] | 38 |
| NCA-16 | 36 | 36 (39)[3] | 33 |
| NCA-17 | 43 | 43 (45)[3] | 37 |
| NCA-18 | 48 | 45 | 37 |
| NCA-19 | 43 | 43 | 35 |
| NCA-20 | 51 | 51 | 45 |
| NCA-21 | 48 | 47 | 39 |

Notes:

1. The RBL values have been extracted from the EIS; refer to Table 4 in the EIS Technical Paper 2.
2. Daytime is 7:00am to 6:00pm, evening is 6:00pm to 10:00pm and night-time is 10:00pm to 7:00am.
3. During the EIS noise assessment, the monitoring level was found to be higher than the daytime. In this situation, the NPfI requires that the evening level be reduced to match the daytime.

# 5. NOISE MONITORING

## 5.1 AIRBORNE NOISE MONITORING

### 5.1.1 ATTENDED AIRBORNE NOISE MONITORING

Attended monitoring of construction noise levels will be undertaken as follows:

- At the commencement of activities (i.e. within the first month) for each location a Detailed Noise and Vibration Impact Statement (DNVIS) has been prepared, to confirm that actual noise and vibration levels are consistent with noise and vibration predictions and 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
- Where appropriate in response to a noise related complaint(s) (determined on a case-by-case basis) and in accordance with EPL Condition M7.5
- To consider the actual equipment in use and confirm proposed physical mitigation measures (such as noise shielding and enclosures) are being implemented in accordance with the DNVIS
- To confirm operating sound power level per section 6.1 of the CNVS
- As otherwise required by the DNVIS

- For approved out-of-hours works (see Section 5.3 of this document)
- As required by the EPL Condition M4
- Following the implementation of mitigation measures or noise attenuation due to exceedance of predicted noise levels
- Ongoing spot checks for noise intensive plant and equipment will be undertaken throughout construction to ensure compliance with the maximum noise level goals for construction equipment
- During daytime, evening and night-time periods to verify predicted noise levels during the different work periods.
- Close out monitoring program for attended noise monitoring can be found in as Appendix C of the Noise and Vibration Management Plan

### 5.1.2 UNATTENDED AIRBORNE NOISE MONITORING

#### 5.1.2.1 UNATTENDED REAL TIME MONITORING

Unattended (real time) airborne noise monitoring will also be completed with noise loggers deployed to obtain noise results over longer periods to satisfy CoA C16(c).

To satisfy CoA C16, real time unattended noise monitoring is proposed commence prior to the commencement of construction, for a minimum period of six consecutive months. At this time, the results and validity of the real time unattended monitoring program will be reviewed in consultation with the SM, AA and ER, and any appropriate changes will be made at this time.

Real time monitoring results will be available via a portal to the Environment Manager and relevant personnel of the construction management team. Access to the data set will be provided to Sydney Metro, the ER and AA, which may include a process of annotating irregular results to identify anomalies or corruption in the dataset. Additionally, this data will be provided to the Planning Secretary and EPA upon request.

Close out monitoring program for unattended real time monitoring can be found in as Appendix C of the Noise and Vibration Management Plan

#### 5.1.2.2 UNATTENDED MONITORING (NOT REAL TIME)

Monitoring will be undertaken for a minimum of 24 hours prior to the activity commencing (to obtain background vibration levels) and will continue for a minimum of 48 hours of the activity commencing and should this not include the peak vibration generating activity, until the completion of the peak vibration generating activity. Close out monitoring program for unattended not real time monitoring can be found in as Appendix C of the Noise and Vibration Management Plan

#### 5.1.2.3 UNATTENDED MONITORING LOCATIONS

Where possible, monitoring will be undertaken at the most affected noise sensitive receiver's location in proximity to the CTP construction activities. Noise monitoring locations will consider factors including:

- The location of previous monitoring sites
- The proximity of the receiver to a Project worksite
- Availability of power and security

- The sensitivity of the receiver to noise
- Background noise levels
- The expected duration of the impact.

Some locations may be the boundary of construction sites while others may be within the property of sensitive receivers, where access is granted. Indicative monitoring locations are illustrated in Appendix A, however these will be revised on completion of the relevant DNIVS for that location.

In accordance with the ICNG the duration and amount of noise monitoring will depend on the scale of the construction activities and extent of expected noise impacts. Noise monitoring will cover a representative period of the construction activity.

During unattended monitoring, noise loggers will record audio (triggered by noisy events) to allow for the identification of construction noise contribution and the presence of any extraneous noise, if privacy concerns can be overcome.

### 5.1.3 METHODOLOGY

Environmental noise monitoring (excluding spot checks of plant and equipment) will be recorded over 15-minute sample intervals, excluding periods of extraneous noise, until a representative sample has been obtained.

A representative sample will be determined by the operator, who will be competent, suitability trained and experienced in undertaking noise measurements.

All environmental noise monitoring will be undertaken with a fast time constant (i.e. 125 milliseconds), and A-weighted frequency weighting. The minimum range of noise metrics to be stored in the memory for later retrieval include the following A-weighted noise levels: LA90, LAeq, LA10, LA (max).

All outdoor noise measurements will be undertaken with a windscreen over the microphone and measurements of noise will be disregarded when it is raining and/or the wind speed is greater than 5 m/s (18 km/h).

Where possible, noise monitoring is to be carried out at least 3.5 m from any reflective surface other than the ground and the preferred microphone/measurement height is 1.2-1.5 m above the ground while using a tripod.

Where high background noise levels obscure construction noise contribution during attended noise measurements, operators will either:

- Measure closer to the source and calculate back to the required position
- Measure with the source noise off and then on (where possible) and calculate the difference
- Use the ‘pause and back-erase feature on the sound level meter to try to exclude as much of the extraneous noise as possible.

For spot checks of noise intensive plant and equipment, duration of monitoring will depend on the source of noise being monitored. Sources of continuous noise (such as generators), measurements will be monitored over one-to-two-minute intervals. For dynamic plant, such as front-end loaders, spot checks will capture a representative activity, such as one truck-and-dog load cycle.

### 5.1.4 PLANT NOISE AUDITING

Plant or equipment operating on the Project shall have an operating sound power level (SWL) which is no higher than the corresponding SWL presented in Table 13 of the CNVS unless otherwise justified. In line with CNVS Section 4, noise generating items of plant that have a predicted SWL of 105dB(A) or over, operating at the site surface outside the acoustic sheds would have noise audits conducted upon arrival at the Project site and at 6-month intervals thereafter. The purpose of these audits is to verify individual items of plant and equipment fall within the nominated SWL’s.

For all measurements, the plant or equipment under test would be measured while operating under typical operating conditions. If this is not practical, it may be appropriate to conduct a stationary test at high idle.

Monitoring will be undertaken in line with applicable standards described in the CNVS including:

- AS2012–1990 Acoustics – Measurement of Airborne Noise Emitted by Earthmoving Machinery and Agricultural Tractors – Stationary Test Condition Part 1: Determination of Compliance with Limits for Exterior Noise
- International Standard ISO 9614-2 1996 Acoustics – Determination of sound power levels of noise sources using sound intensity - Part 2: Measurement by scanning
- Australian Standard AS2012–1977 Method for Measurement of Airborne Noise from Agricultural Tractors and Earthmoving Machinery.

In the case of an exceedance in SWL the item of plant would either be replaced, or the advice of sought to provide suitable mitigation measures, which may include:

- Completing appropriate maintenance
- Implementing additional or upgrading existing muffling devices
- Building enclosures around items of stationary plant (e.g. pumps or generators).

A register of measured sound power levels for each item of plant would be kept for reference where future noise audits are conducted. The register would be reviewed annually in conjunction with this strategy and corresponding revisions made to the Sound Power Levels presented in Section 4.3 of the CNVS to represent contemporary plant noise emission levels.

## 5.2 GROUNDBORNE NOISE MONITORING

### 5.2.5 FREQUENCY AND LOCATION OF GROUND BORNE NOISE MONITORING

The need for ground-borne noise monitoring would be determined by a DNVIS, which would identify at which residences the NML may be exceeded and where impacts are likely. The offer of monitoring within the residence may form part of the response to complaints and in accordance with EPL Condition M7.5.

Where monitoring is not triggered by complaint, monitoring would be completed at representative receivers where tunnelling is predicted to exceed the NML and where access is granted. Frequency of GBN monitoring would be dependent on access to affected residences; however, in this way, regular verification of predicted GBN can be completed.

Most ground-borne monitoring will be unattended since monitoring is usually completed within a private residence and typically at night. In these cases, noise loggers may be left in place over night and picked up at a mutually agreed time with the resident.

Attended monitoring of ground-borne construction noise levels may be undertaken, where appropriate, in response to noise-related complaint (determined on a case-by-case basis), where access for unattended monitoring is not granted and the resident would prefer to be present.

Close out monitoring program for ground-born noise and vibration monitoring can be found in as Appendix C of the Noise and Vibration Management Plan.

### 5.2.6 GROUND BORNE NOISE MONITORING METHODOLOGY

Monitoring will be undertaken in the most affected habitable room of the residence or other sensitive building and will be conducted in conjunction with vibration measurements whenever practicable.

Ground-borne noise monitoring will be recorded over 15-minute sample intervals, where every 15 minutes the data is to be processed statistically and stored in memory. The minimum range of noise metrics to be stored in the memory for later retrieval include the following A-weighted noise levels: LA90, LAeq, LA1 and LA (max).

Measurements taken inside buildings should be at least one metre from walls or other reflective surface, and about 1.5 metres from windows, where such instrument siting is possible.

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, AFJV will endeavour to monitor at the next most suitable available room or location, noting this in the monitoring form.

Noise loggers will record audio to allow for identification of the construction noise contribution and the presence of any extraneous noise provided privacy concerns can be overcome. Where the resident or receiver will not allow the noise logger to record audio, attended noise monitoring will be offered where appropriate.

Measurements will be carried out by an appropriately trained and competent person in the measurement and assessment of construction noise and vibration.

## 5.3 OUT OF HOURS WORK

Where out-of-hours works (OOHW) are undertaken, noise monitoring including a visual inspection of the activities may be undertaken as identified by the OOHW Permit, including to:

1. Ensure noise mitigation measures specified in the approved application are appropriately implemented
2. Verify assumptions and model outcomes of the OOHW works (i.e. predicted noise levels)
3. Any necessary additional measures are identified and implemented where reasonable and feasible.

Where OOHW monitoring is required, this will be conducted as soon as practicable (e.g. preferably first night) during the approved works and would involve attended monitoring as described in Section 5.1.1.

Personnel carrying out monitoring will consider the actual vs proposed equipment in use and confirm proposed physical mitigation measures (such as noise shielding and enclosures) are being implemented in accordance with the OOHW Permit.

Monitoring results will be compared with predicted levels to establish the accuracy of predicted noise and inform future predictions. Where the need for additional controls is identified, these will be implemented as soon as possible as actions undertaken in response to monitoring results.

# 6. VIBRATION MONITORING

## 6.1 ATTENDED VIBRATION MONITORING

Attended vibration monitoring is to be undertaken as follows:

- At the commencement of operation for each plant or activity on site for which:
  - Has the potential to generate significant vibration levels
  - Screening criteria is likely to be exceeded
  - As determined by a vibration assessment
- At the commencement of vibration generating activities that have the potential to impact on heritage items to confirm/identify the minimum working distances to prevent cosmetic damage
- Where vibration sensitive locations are determined to fall within the 'minimum working distances' established for each item of plant, to refine the indicative minimum working distances
- Where appropriate in response to a vibration related complaint(s) (determined on a case-by-case basis)
- As otherwise required by the DNVIS or EPL Condition M4.

Vibration monitoring will be undertaken in accordance with the relevant vibration measurement requirements in the reference standards and documents in Section 1.4. Monitoring results will be assessed against relevant standards as follows:

- Where human comfort is a concern, Tables 2.2 and 2.4 of the EPA's Assessing Vibration – a technical guideline
- Where property damage is a concern, British Standard 7385, as presented in the NVMP
- For heritage structures, BS7385-2:1993 does not provide numerical vibration levels to prevent structural damage; refer to Section 6.4 of this Monitoring Program.

Vibration monitoring shall be undertaken in accordance with the vibration measurement requirements stipulated in the reference standards and documents listed above, including the following aspects of mounting the device.

- 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 bees wax or a magnetic mounting plate onto a steel washer, plate or bracket which shall be either fastened or glued to the surface of interest
- Where a suitable mounting surface is unavailable, then a metal stake of at least 300mm in length shall be driven into solid ground adjacent to the building of interest and the vibration sensor or transducer shall be mounted on that.

For each monitoring event, the following information shall be recorded:

- Date and time of measurements

- Name of person undertaking the measurements
- Type and model number of instruments
- Sample times, measurement time intervals and time of day
- Map of area showing measurement location, source location and sensitive receivers
- Measurement location details and number of measurements at each location
- Operation and load conditions of the plant under investigation.

Monitoring will be undertaken using tri-axial geophones or accelerometers, which measure vibration as velocity and/or acceleration in three axes.

Close out monitoring program for attended vibration monitoring can be found in as Appendix C of the Noise and Vibration Management Plan.

## 6.2 UNATTENDED VIBRATION MONITORING

Where monitoring is planned to extend over a longer period than practicable for attended monitoring, such as when works will remain within the safe minimum working distance to prevent cosmetic damage, the monitoring instrumentation will be fitted with the ability to warn plant operators via flashing light, SMS, or email that vibration is approaching levels and where there is potential for cosmetic damage to buildings and structures.

Where unattended vibration monitors are left in place on a private property, they will be picked up at a mutually agreed time with the resident.

Vibration data will be processed statistically and stored in memory. The minimum range of vibration metrics to be stored in memory for later retrieval is the following:

- Root-Mean-Square acceleration (RMS), or
- Vector-sum peak-particle velocity (PPV).

All short term attended vibration monitoring will be recorded over a representative sampling interval where the worst-case vibration levels can be captured. Where unattended vibration monitoring is proposed, monitoring will be undertaken continuously whilst the vibrating plant is operational to capture the worst-case vibration levels within the pre-determined 'minimum working distance' from the potentially affected building.

Typical 'minimum working distances' for construction equipment are presented in the NVMP.

Ideally, vibration would be measured directly on a structure. Where access is not available, vibration will, at times, be monitored in proximity to the equipment and measured levels extrapolated to the nearest structure based on the following equation for geometric damping (conservatively ignoring material damping).

$$PPV_2 = PPV_1 \left(\frac{R_1}{R_2}\right)^n$$

Where:

PPV – Peak Particle Velocity at the source (PPV1) and Receiver (PPV2)

R – distance from source of reference level (R1) and distance from source of receiver (R2)

n – ground factor assumed as 1 for body waves

Close out monitoring program for unattended vibration monitoring can be found in as Appendix C of the Noise and Vibration Management Plan.

## 6.3 REAL-TIME UNATTENDED VIBRATION MONITORING

To satisfy CoA C16(c) real-time unattended vibration monitoring will be established continuously monitor PPV resulting from construction activities. The monitors will be installed following approval of this monitoring program and prior to commencement of vibration intensive works in a potentially affected area.

Real-time noise monitors will be installed as close to sensitive receivers as possible, in consideration of:

- Potential locations of vibration-intensive activities
- Power availability and
- Security
- Access
- Outcomes of the DNVIS.

Some locations may be the boundary of ancillary sites, similar to noise monitoring locations, while others will be within the property of sensitive receivers, where access is granted. Indicative real-time vibration monitoring locations are illustrated in Attachment A and these will be updated once further information is available.

The monitors will be installed by a person appropriately trained in the measurement and assessment of construction vibration, who is familiar with establishment of real-time monitoring equipment.

Unattended (real time) vibration monitoring will also be completed to satisfy CoA C16(c). Monitoring results will be available via a portal to the Environment Manager and relevant personnel of the construction management team. Following an initial screening review, to identify any anomalies or corruption in the dataset, results of the monitoring will be made readily available to the Sydney Metro, the ER and AA and will be provided to the Planning Secretary and EPA upon request.

For each monitoring event, the following information shall be recorded:

- Date and time of measurements
- Type and model number of instruments
- Sample times, measurement time intervals and time of day
- Map of area showing measurement location, source location and sensitive receivers
- Measurement location details and number of measurements at each location.

## 6.4 HERITAGE STRUCTURES

Heritage buildings and structures should not be assumed to be more sensitive to vibration unless they are found to be structurally unsound. In accordance with CoA D49 a conservative vibration damage screening level of 2.5 mm/s will be adopted for heritage structures and other sensitive structures of great intrinsic value where they are found to be structurally unsound. Otherwise, the standard 7.5mm/s criteria will apply (as discussed in Section 6.4 of the NVMP). In accordance with CoA D46, AFJV will conduct vibration monitoring during vibration generating activities that have the potential to impact on heritage items that have been identified as structurally unsound, and where preliminary vibration contours indicate that the vibration damage screening level of 2.5 mm/s is likely to be exceeded.

In line with CoA D47, AFJV will seek the advice of the Project's heritage and noise and vibration specialists on methods and locations for installing equipment upon heritage-listed structures.

All heritage items, including heritage structures are included in the Environmental Control Maps (ECMs) for the Project and will be identified in the DNVIS, with the relevant vibration triggers appointed to that location/structure so that potential exceedances can be clearly identified and addressed prior to works commencing.

### 6.5 OUT OF HOURS WORK

Where out-of-hours works (OOHW) are undertaken, visual and vibration monitoring may be undertaken as identified by the OOHW Permit, including to:

1. Ensure vibration mitigation measures specified in the approved application are appropriately implemented
2. Verify assumptions and model outcomes of the OOHW works (i.e. predicted vibration levels)
3. Any necessary additional measures are identified and implemented where reasonable and feasible.

Where OOHW monitoring is required, this will be conducted as soon as practicable (e.g. preferably first night) during the approved works and would involve attended monitoring as described in Section 6.1.

Personnel carrying out monitoring will consider the actual vs proposed equipment in use and confirm proposed physical mitigation measures (such as noise shielding and enclosures) are being implemented in accordance with the OOHW Permit.

Monitoring results will be compared with predicted levels to establish the accuracy of predicted vibration and inform future predictions. Where the need for additional controls is identified, these will be implemented as soon as possible as actions undertaken in response to monitoring results.

## 7. MONITORING RECORDS

For each monitoring event, the following information shall be recorded:

- Date and time of measurements
- Name of person undertaking the measurements
- Type and model number of instruments
- Sample times, measurement time intervals and time of day
- Map of area showing measurement location, source location and sensitive receivers
- Measurement location details and number of measurements at each location
- Operation and load conditions of the plant under investigation
- Measured noise parameters including LA90, LAeq, LA10, LA (max)
- Estimated contribution of the Project's activities vs. noise from extraneous and environmental sources (e.g. traffic, aircraft, trains, dogs barking, insects)
- Where possible, describe the frequency of noise events noticeably above the LAeq level, i.e. transient or impulsive events at or around the LAMax value for the monitoring period, either numerically (e.g. up to 5 events in the monitoring period) or subjectively (frequent/single event).

# 8. CALIBRATION, QUALITY ASSURANCE AND COMPETENCY

All monitoring will be undertaken by competent personnel, suitability trained and experienced in undertaking noise and vibration measurements. Specific targeted training will be developed by the Environmental Manager to ensure that environmental monitoring officers are appropriately trained. Refer to the CEMP for full details on environmental training.

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

Noise monitoring would be completed using at minimum Class 2 instruments, as per Australian Standard IEC 61672.1.

# 9. CONTINUAL IMPROVEMENT AND CORRECTIVE ACTION

Monitored noise and vibration levels will be analysed against the noise and vibration objectives and predictions made in the relevant DNVIS or using the Project's predictive tools. Results will be utilised to confirm model predictions and confirm vibration minimum working distances (i.e. 'site law').

Where monitored construction levels are found to be above noise or vibration management levels and predicted levels, the following actions will be undertaken:

- Assess the noise/vibration generating sources and activities to identify a potential source of the exceedance
- Confirm the monitored levels are not being impacted by other noise or vibration sources
- Confirm if the exceedance is due to an uncharacteristically noisy or vibration-intensive piece of equipment
- Confirm that the modelling reflects the actual activity being undertaken
- Implement other feasible and reasonable measures which may include reducing plant type or size, modifying time of works, changing operational settings (such as turning off the vibratory function of the machine), utilising alternative construction methodology or a combination of these
- Ensure that the learnings from the above are fed back into the noise modelling assessment process for fine-tuning
- Continue work where impacts can be reduced
- Where noise cannot be reduced for this activity, re-assess the extent of impacts based on new information (e.g. revised equipment sound power level) and implement appropriate mitigation and management measures
- Communicate lessons learnt to relevant personnel
- AFJV will review the activity and where possible, modify the work or activity to prevent any recurrence. Lessons learnt will be communicated to relevant personnel in toolbox talks.

This process follows SMART principles in that the actions are specific and measurable, the outcomes are achievable and realistic, and all steps are time-focussed.

Where monitored construction levels are found to be below predicted noise or vibration levels, there may be an opportunity to highlight a technique or item of equipment that can be used in other situations to reduce noise impacts or amend the noise predictions for improved accuracy. In this situation:

- Assess the noise/vibration generating sources and activities to identify potentially lower noise levels than anticipated
- Confirm if the reduced level is due to equipment sound power or operating variables
- Where sound power is lower, include data in register of plant noise levels for future reference (See Section 5.1.4)
- Where operation is less intense, or other mitigation has been applied to reduce levels, make a note in the register of plant noise levels for future reference and identification of any trends.

# 10. REPORTING OF MONITORING RESULTS

At the completion of monitoring in line with the methods outlined in the above sections, all data will be downloaded by a suitable competent person to be analysed. These results would then be evaluated in comparison to relevant predictions and criteria. The data along with the information recorded about each event (time, weather, type of work etc.) will help to develop a complete picture of the real time noise and/or vibration environment. This would aid in:

- Validating modelling done as part of the project
- Validating any complaints made by the community
- Improving work methods to minimise impacts.

Data from noise and vibration monitoring will be reported in a Construction Monitoring Report in line with CoA C23. The monitoring report as a minimum will include a description of monitoring parameters, frequency, location and analysis in line with the relevant requirements of CoA C15.

The Monitoring Report will then be provided to the AA and ER for review and endorsement from the AA prior to submission to the Secretary of the DPE and relevant regulatory authorities for information.

Reporting requirements associated with the Program for the construction phase of the Project are presented in Table 10-1.

TABLE 10-1 REPORTING REQUIREMENTS AND SCHEDULE

| Schedule (during construction) | Requirements | Submission timeline | Requirement |
|---|---|---|---|
| Noise and Vibration Monitoring Reports (every six months) | AFJV data summary reports presenting tabulated monitoring data collected during the reporting period and highlighting performance criteria exceedances.<br>Applicable management responses will be documented. | The six-monthly monitoring reports will be provided to the relevant authorities within 40 business days of the monitoring period ending. | CNVS S. 6.2<br>CoA C23 |
| Monitoring reports - Within one week / weekly | Where monitoring is conducted externally, the report would be submitted to the construction contractor Environment Manager within one week or at weekly intervals for continuous monitoring.<br>Information from external consultants will be used to inform the six monthly monitoring reports mentioned above. | These reports provided one week after the monitoring event would be used to inform the 6 monthly monitoring reports. . | CNVS S. 6.3 |

In line with CoA B11, a copy of the Construction Monitoring Report will be published on the project website 10 days following submission to DPE.

Separate from the Construction Monitoring Report, additional records relating to noise and vibration training, toolbox talks, monitoring results and audit results will be prepared, maintained, and stored in line with the CEMP. The complaints management and reporting procedure is described in the CEMP.

Monitoring records separate to the Six Monthly Monitoring Report can be requested by the ER and AA throughout the project for information.

Where the Project EPL has additional requirements for monitoring or reporting results, these will be added to the Monitoring Program once available, in accordance with the process for updating documents as described in the CEMP.

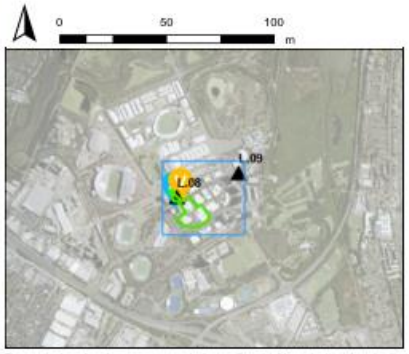
# APPENDIX A INDICATIVE REAL-TIME MONITORING LOCATIONS


Sydney Metro West - CTP

**Indicative monitoring locations - Sydney Olympic Park**

**Legend**

- North Strathfield
- Baseline noise monitoring locations
- Nominal real-time monitoring - noise
- Nominal real-time monitoring - vibration



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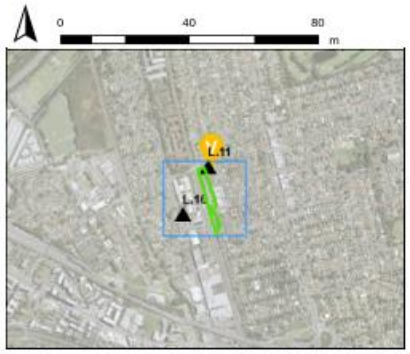
Sydney Metro West - CTP

**Indicative monitoring locations - North Strathfield**

**Legend**

- North Strathfield
- Baseline noise monitoring locations
- Nominal real-time monitoring - noise
- Nominal real-time monitoring - vibration



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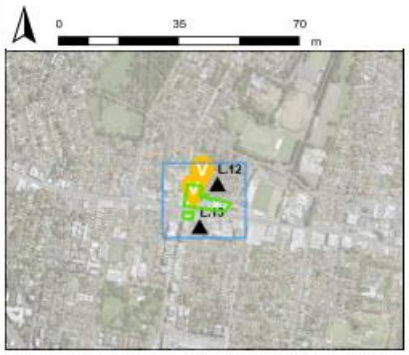
Sydney Metro West - CTP

**Indicative monitoring locations - Burwood North**

**Legend**

- Burwood North
- Baseline noise monitoring locations
- Nominal real-time monitoring - noise
- Nominal real-time monitoring - vibration



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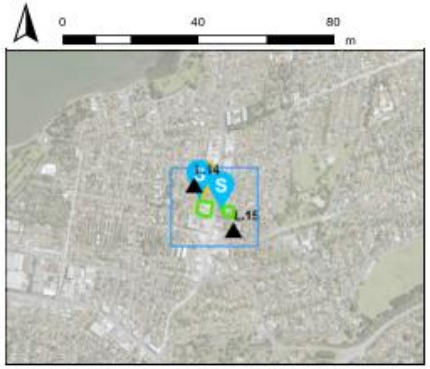
Sydney Metro West - CTP

**Indicative monitoring locations - Five Dock**

**Legend**

- Five Dock
- Baseline noise monitoring locations
- Nominal real-time monitoring - noise
- Nominal real-time monitoring - vibration



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