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SYDNEY METRO CITY AND SOUTH WEST - LINE-WIDE WORKS

Construction Noise and Vibration Impact Statement - Belmore site compound

22 November 2021

Systems Connect

TK685-03-06F01 CNVIS S2B_P4 Belmore Cmpd (r5)

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1 Introduction

This Construction Noise and Vibration Impact Statement (CNVIS) has been prepared on behalf of Systems Connect in accordance with the Construction Noise and Vibration Management Plan (CNVMP) [SMCSWLWC-SYC-1NL-PM-PLN-000032] [1], for the Design and Construction of the Line-Wide Works (LWW) of the Sydney Metro City & Southwest Project (the Project).

1.1 Relevant requirements and purpose of this CNVIS

As defined in the CNVMP, the works covered by this CNVIS are part of the Portion 4 – Power Supply Works (Southwest Corridor) delivered under Critical State Significant Infrastructure Approval SSI 8256. Condition E27 of CSSI-8256 requires that:

> *Construction Noise and Vibration Impact Statements must be prepared for Construction sites before Construction noise and vibration impacts commence and include specific mitigation measures identified through consultation with affected sensitive receivers. The Statements must augment the Construction Noise and Vibration Management Sub-plan and must be implemented for the duration of Work. The Statements must be informed by a suite of potential management/mitigation options provided in the Construction Noise and Vibration Sub-plan.*

This CNVIS applies to the civil works, site establishment and operational phase of the Belmore site compound. Works will be completed during standard construction hours as well as works outside of standard construction hours where access to the compound is required to support rail possession works. The construction hours of work are defined by the Project Planning Approval conditions as outlined in the CNVMP.

This CNVIS forms part of the CNVMP for the Project.

1.2 Structure of this CNVIS

This CNVIS is structured as follows:

- **Section 2** - Description of construction works and hours
- **Section 3** - Nearest sensitive receivers
- **Section 4** - Construction Noise and Vibration objectives
- **Section 5** - Construction noise assessment
- **Section 6** - Construction vibration impacts
- **Section 7** - Ground-borne noise assessment
- **Section 8 –** Traffic noise assessment
- **Section 9 –** Cumulative impacts.

1.3 Quality assurance

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001. Appendix A contains a glossary of acoustic terms used in this report.

2 Description of construction works and hours

2.1 Summary of works addressed in this CNVIS

2.1.1 Construction activities

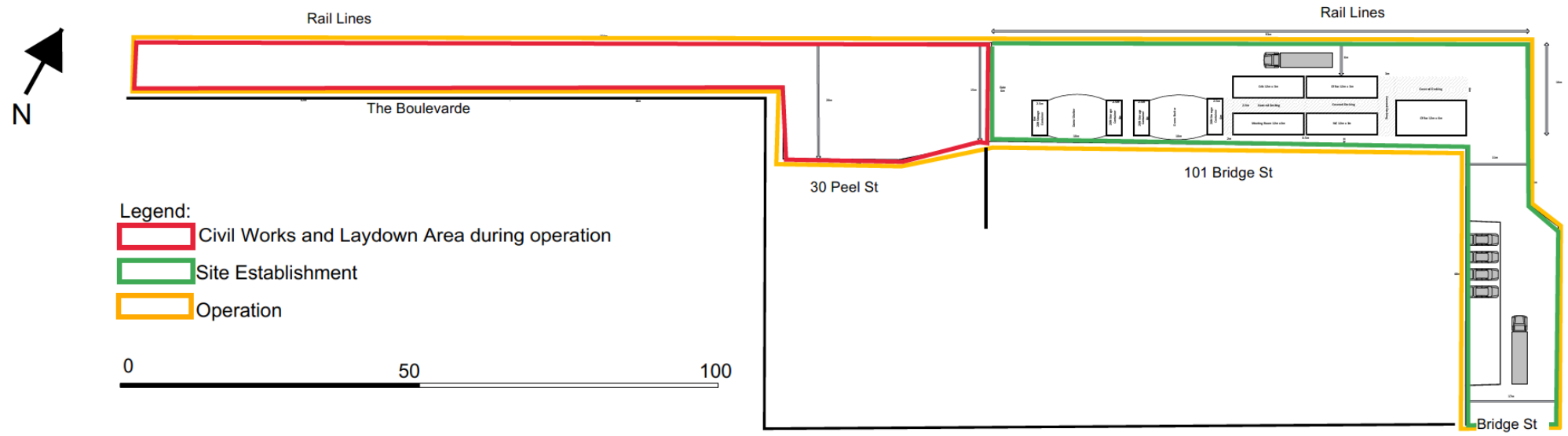
This CNVIS provides an assessment of noise and vibration impacts from activities associated with the civil works, site establishment and operational phases of the Belmore site compound.

The Belmore site compound construction activities will include:

- **Civil works** – Site grading and spoil removal in the western end of the compound
- **Site establishment** – installation of site sheds, utilities connection and minor demolition works
- **Operation** – general worksite, car parking, delivery, storage and out-of-hours (OOH) support works

The proposed works, likely plant and equipment and estimated Project timing is summarised in APPENDIX C and the areas are shown in Figure 2-1 following. Works are planned to occur during standard construction hours.

Figure 2-1: Belmore site compound



2.1.2 Construction traffic

The compound construction works will generate additional traffic movements in the form of:

- Light vehicle movements generated by construction personnel travelling to and from work
- Heavy vehicle movements during the civil works to remove spoil from site
- Heavy vehicle movements generated by delivery vehicles bringing materials, plant and equipment to the worksite

Construction traffic on-site (i.e. within the Project footprint) is included as part of the construction noise assessment of the works activities identified in Sections 5 and APPENDIX C. When construction related traffic moves onto the public road network, a different noise assessment methodology is appropriate as vehicle movements would be regarded as 'additional road traffic' rather than as part of the construction site's activities. Construction traffic noise is addressed in Section 7.

2.1.3 Cumulative construction impacts

All concurrent Sydney Metro construction site works have been considered and addressed in Section 9 of this CNVIS. CSSI-8256 Condition of Approval E26 requires work undertaken for the delivery of the CSSI, including those undertaken by third parties (such as utility relocations) to be coordinated to ensure respite periods are provided. Potentially concurrent construction activities within the vicinity of the Belmore compound have also been considered, as discussed in Section 9.

2.2 Construction hours

The construction hours for the Project are defined in the CSSI-8256 Conditions E19 to E24.

2.2.1 Standard construction hours

The standard construction hours of work are defined by the CSSI-8256 Condition E19. The standard construction hours for the Project are summarised in the Table 2-1 below.

In addition to this, highly noise intensive work that results in an exceedance of the applicable Noise Management Level at the same receiver is limited by CSSI-8256 Condition E24, except where permitted by an Environment Protection License (EPL) as noted in Table 2-1.

Table 2-1: Standard construction hours

Construction Activity	Monday to Friday	Saturday	Sunday/ Public holiday
Standard construction hours	7:00 am to 6:00 pm	8:00 am to 6:00 pm	No work
Highly noise intensive Work	8:00 am to 6:00 pm[1]	8:00 am to 1:00 pm[1]	No work

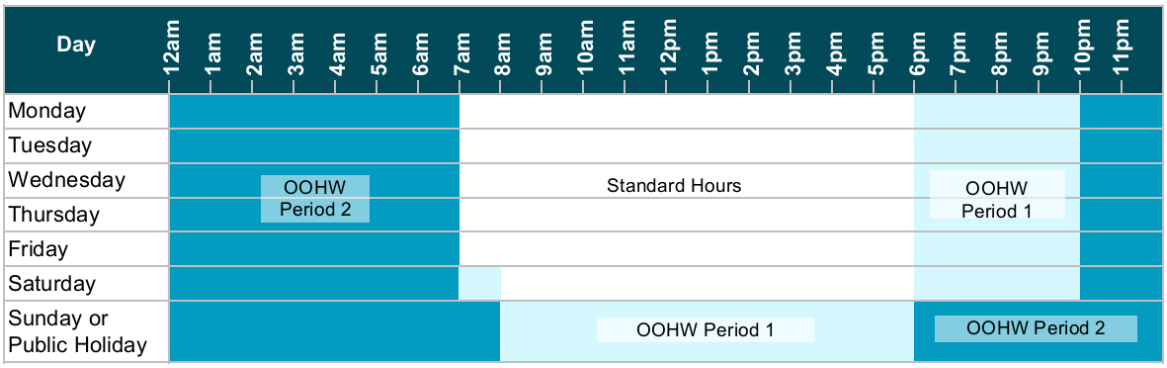
Notes: 1. Works may only be undertaken in continuous blocks not exceeding three (3) hours each with a minimum respite from those activities and Works of not less than one (1) hour between each block. 'Continuous' includes any period during which there is less than a one (1) hour respite between ceasing and recommencing any of the highly noise intensive work.

2.2.2 Out of hours work periods

CSSI-8256 Condition E20 and E23 allow standard construction hours to be varied under specific conditions (where justified), including work permitted under an EPL or under an Out of Hours Work Protocol as required by CSSI-8256 Condition E25. This may, for example include work under a Rail Possession or Road Occupancy License.

The Transport for NSW (TfNSW) Construction Noise and Vibration Strategy (CNVS) [10] provides a hierarchy of Out of Hours (OOH) work periods. The impact of OOH works may be reduced by scheduling work and activities with greater impact during the preferred periods when receivers are likely to be less sensitive to noise and vibration, such as in the day out of hours (OOHD) and evening out of hours (OOHE) periods. Table 2-2 presents the construction work periods as Standard Hours, Out of Hours Work (OOHW) Period 1 and OOHW Period 2.

Table 2-2: Construction hours



Notes

1. Standard construction hours are defined in CSSI-8256 Condition E19 as: Monday to Friday 7:00am to 6:00pm and Saturdays from 8:00am to 6:00pm.
2. Work outside of standard construction hours is defined as Out-of-Hours Work (OOHW) and has been divided by the CNVS into 2 periods of sensitivity.
    - **OOHW Period 1** is the least sensitive OOH period and is defined as Monday to Saturday 6:00pm to 10:00pm (evenings; OOHE), Saturday 7:00am to 8:00am (days; OOHD) and Sunday and public holidays 8:00am to 6:00pm (days; OOHD).
    - **OOHW Period 2** is the most sensitive OOH period and is defined as Monday to Saturday 10:00pm to 7:00am (nights; OOHN) and Sundays and public holidays 6:00pm to 8:00am (nights, OOHN).

2.2.3 Justification for OOHW

Construction activities at the Belmore site compound will be undertaken during standard construction hours, as described above. However, access to the compound during OOH periods may sometimes be required to support HV cabling works during rail possessions. Access to the compound during OOH periods would be sporadic and of short duration, for the following:

- As part of a response to an incident
- In an event of a plant breakdown
- To pick up additional materials and tools if needed due to unexpected conditions on the worksite

- To access to office for to pick up documentation, printing etc.

Any work outside standard construction hours must be undertaken in accordance with the Out of Hours Works Protocol and the CNVMP [1].

2.2.4 COVID-19 extended construction hours

The Environmental Planning and Assessment (COVID-19 Development – Construction Work Days) Order 2020 is now in place and will continue to apply until 31 March 2022, subject to any more changes by the NSW Government.. The order permits standard construction hours on this project to be extended as follows:

- Sundays from 8am to 6pm (no high noise work permitted)
- Public holidays from 8am to 6pm (no high noise work permitted).

High noise work means activities such as rock breaking, rock hammering, sheet piling, pile driving or similar noisy activities, unless an existing consent or approval already allows these works to occur on any of the extended days. At this stage works within the compound are not planned during these extended hours, so impacts from the extended construction hours have not been assessed in this CNVIS. Should works be scheduled during the extended hours period the CNVIS will be updated or an addendum prepared to assess the extended hours.

Appropriate noise management levels for the extended hours period (i.e. Sundays/ Public Holidays 8am to 6pm) are as outlined for the Day (D/ D(O)) period in Section ~~4.1.1~~.

3 Nearest sensitive receivers

3.1 Residential receivers

To assess and manage construction noise and vibration impacts, the residential areas surrounding the works have been divided into Noise Catchment Areas (NCAs) based on each area's similar acoustic environment prior to the start of construction work. The NCAs are based on those established in the EIS for the Project [2], with some modifications to allow for site specific characteristics.

All relevant NCAs and residential sensitive receivers near the worksite are identified on an aerial photograph located in APPENDIX B.

3.2 Other sensitive receivers (PPA Condition E28)

Additional to residential receivers above, other noise and vibration sensitive receivers such as passive recreation areas and places of worship surrounding the construction area have been identified and are summarised and identified on an aerial photograph located in APPENDIX B.

CSSI-8256 Condition E28 states:

> *Noise generating Work in the vicinity of potentially-affected, religious, or educational institutions resulting noise levels above the noise management levels must not be timetabled within sensitive periods, unless other reasonable arrangements with the affected institutions are made at no cost to the affected institution or as otherwise approved by the Planning Secretary.*

Systems Connect would undertake consultation with identified sensitive receivers to determine sensitive periods prior to construction works commencing on site. Feedback from the consultation would be taken into consideration in finalising respite strategies for high noise impacts. Sydney Metro and Systems Connect are working with sensitive receivers to further assess and determine other reasonable arrangements to be implemented.

3.3 Commercial and industrial premises

All commercial and industrial premises near the worksite have been considered in this assessment.

3.4 Heritage receivers

Heritage receivers have been identified in the Land Use Survey in Annexure B of the CNVMP. There no heritage listed buildings near to Belmore site compound that would be potentially impacted by construction vibration.

4 Construction Noise and Vibration objectives

4.1 Noise goals

4.1.1 Noise management levels (NMLs)

Construction noise management levels (NMLs) have been determined using the Construction Environmental Management Framework (CEMF), CSSI-8256 Conditions, in accordance with the Sydney Metro City & Southwest Construction Noise and Vibration Strategy (SMCSNVS) [9] and as set out in the CNVMP.

External NMLs are derived from the Interim Construction Noise Guideline (ICNG) [4] , as identified in Section 5.1.2 of the CNVMP[1]. Airborne NMLs are determined using the ICNG. For residential receivers these are based on the background noise levels derived from long-term noise logging conducted by SLR on behalf of Transport for NSW (TfNSW) to quantify ambient noise levels for the Environmental Impact Statement (EIS) [2]. This has been incorporated into the CNVMP.

The NMLs for 'other' sensitive receivers are from the ICNG, as reported in Table 10 of the CNVMP. These are applicable when the other sensitive receiver is in use.

Airborne NMLs are summarised and presented in APPENDIX B.

Receivers are considered 'noise affected' where construction noise levels are greater than the NMLs identified in APPENDIX B. The noise affected level represents the point above which there may be some community reaction to noise. Where predicted and/or measured construction noise levels are above the NMLs, all feasible and reasonable work practices will be applied to meet the NMLs.

Where construction activities are tonal or impulsive in nature and are described in the ICNG as being particularly annoying, 5 dB(A) must be added to the activity noise. Activities that are defined in the ICNG as particularly annoying include but are not limited to the use of 'beeper' style reversing or movement alarms; power saws; vibratory rolling; jack hammering, rock hammering or rock breaking; impact piling.

During standard construction hours, a highly affected noise objective of $L_{Aeq(15min)}$ 75 dB(A) applies in relation to airborne noise at all residential receivers.

4.1.2 Sleep disturbance

Consistent with Section 5.1.3 of the CNVMP [1], an initial screening level of $L_{Amax} \leq L_{A90(15min)} + 15$ dB(A) is used. In situations where this results in an external screening level of less than 55 dB(A), a minimum screening level of 55 dB(A) is set. Note that this is equivalent to a maximum internal noise level of 45 dB(A) with windows open.

Where noise events are found to be above the screening level, further analysis is made to identify:

- the likely number of events above 45 dB(A) (internal) that might occur during the night assessment period
- whether events are above an 'awakening reaction' level of 55 dB(A) L_{Amax} (internal) that equates to NML of L_{Amax} 65 dB(A) (assuming open windows).

The ICNG recommends that where construction works are planned to extend over more than two consecutive nights, maximum noise levels and the extent and frequency of maximum noise level events above the RBL should be considered.

During construction works at night, attended noise monitoring will be undertaken at representative residences most impacted by the works during night-time periods (see Section 5). The noise monitoring will follow the procedures outlined in APPENDIX E of the CNVMP [1], which includes measurement of L_{Amax} noise metrics. If maximum noise levels are found to be above the sleep NML of 45 dB(A), the responsible noise source(s) will be identified and further analysis undertaken to quantify the extent and frequency of events above the NML. Additional feasible and reasonable mitigation measures may need to be considered to reduce potential impacts.

4.1.3 Construction related road traffic noise objectives

On the roads immediately adjacent to construction sites, the community may associate heavy vehicle movements with the Belmore site compound works. Construction traffic movements on public roads will aim to limit any increase in existing road traffic noise levels to no more than 2 dB(A). All feasible and reasonable noise mitigation and management measures will be implemented.

4.2 Construction vibration goals

As reported in Section 5.4 and 5.5 of the CNVMP [1], construction vibration goals have been determined using:

- for human exposure, the acceptable vibration values set out in the Environmental Noise Management Assessing Vibration: A Technical Guideline (Department of Environment and Conservation, 2006) [5]
- for structural damage, the vibration limits set out in the
    - British Standard BS 7385-2:1993 Evaluation and measurement for vibration in buildings. Guide to damage levels from ground-borne vibration [6] and
    - German Standard DIN 4150-3: Structural Vibration - effects of vibration on structures [7].

4.2.1 Disturbance to building occupants (human annoyance)

For disturbance to human occupants of buildings, we refer to '*Assessing Vibration; a technical guideline*' [5]. This document provides criteria which are based on the British Standard BS 6472-1992, *'Evaluation of human exposure to vibration in buildings (1-80Hz)'* [8].

Intermittent vibration is assessed using vibration dose values (VDVs). For the assessment of potential vibration at the nearest vibration sensitive receivers preferred and maximum VDV goals for the day period (7:00am to 10:00pm) are presented in Table 4-1.

Table 4-1: Construction vibration disturbance goals

Location	Assessment period[1]	Vibration Dose Value (VDV), m/s$^{1.75}$	
		Preferred values	Maximum values
Critical areas[2]	Day or Night	0.10	0.20
Residences	Day	0.20	0.40
	Night	0.13	0.26
Offices, schools, educational institutions and places of worship	Day or Night	0.40	0.80
Workshops	Day or Night	0.80	1.60

Notes

1. Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am
2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas. Source: BS 6472-1992

4.2.2 Structural damage to buildings

A conservative vibration damage screening level per receiver type, assuming vibration predominantly has a frequency of 20 Hz, is given below:

- Reinforced or framed structures (Group 1): 25.0 mm/s
- Unreinforced or light framed structures (Group 2): 7.5 mm/s

At locations where the predicted and/or measured vibration levels are greater than shown above (peak component particle velocity), a more detailed analysis of the building structure, vibration source, dominant frequencies and dynamic characteristics of the structure would be required to determine the applicable safe vibration level.

It is noted that vibration levels required to cause minor cosmetic damage are typically 10 x higher than levels that will cause disturbance to building occupants. Many building occupants assume that building damage is occurring when they feel vibration or observe rattling of loose objects, however the level of vibration at which people perceive vibration or at which loose objects may rattle is far lower than vibration levels that can cause damage to structures.

4.2.3 Utilities and other vibration sensitive structures

Where utilities or other vibration sensitive structures are identified, relevant vibration criteria will be established for each item per Section 5.5.4 of the CNVMP [1], and any corresponding management or mitigation measures determined.

5 Construction noise assessment

5.1 Noise prediction methodology

Modelling and assessment of airborne noise impacts from activities associated with the construction works were determined by modelling the noise sources, receiver locations, topographical features, and possible noise mitigation measures using a Cadna-A computer noise model developed for this project. The model calculates the contribution of each noise source at identified sensitive receiver locations and allows for the prediction of the total noise from a site for the various stages of the construction works.

The noise prediction models take into account:

- Location of noise sources and sensitive receiver locations.
- Height of sources and receivers referenced to one metre digital ground contours for the site area and surrounding area.
- Sound Power Levels (L_w) of plant and equipment likely to be used during the various construction activities (see Table C1 in APPENDIX C). Table C1 also identifies the plant and equipment that will operate during each assessment period.
- Separation distances between sources and receivers.
- Ground type between sources and receivers.
- Attenuation from barriers (natural and purpose built).

Key details regarding the construction site layout, the likely plant and equipment (including truck movements), and hours of operation were informed by the Design and Construction Teams. This information is presented in APPENDIX C and formed the basis for all modelling assumptions used in this assessment.

5.2 Construction activities

The assessment considered combinations of work activities at key project stages, which are summarised in Table 5-1. The early civil works would require use of high noise generating plant and equipment such as saw and rock breakers for demolition of site structures. For this activity, the works have been subdivided into the following two categories:

- High impact activities, which will include rock hammers and saws;
- Typical activities, which will exclude high impact sources (e.g. no rock hammer, concrete saw etc).

This information is provided in detail in APPENDIX C.

Table 5-1: Summary of construction activities

Activity (details in APPENDIX C Table C1)	Duration	Assessment reference
Civil works, utilities, delivery and Installation of site sheds	June-2020 to August-2020	S01H (high activity) S01T (typical activity)
Operation	May 2020 to June 2022	S02
Operation - OOH support works	December 2021 to June 2022	S03

5.3 Predicted noise levels

Noise emissions were determined by modelling the noise sources during each stage identified in Table 5-1, receiver locations, and construction activities. Details of the plant and adopted sound power levels are presented in APPENDIX C.

Predicted L_{Aeq} noise levels from the worksite are assessed against the NMLs and summarised in Section 5.3.1 with colour coding to denote the highest level of exceedance of the NML. Detailed results for each receiver are given in APPENDIX D.

For the civil construction works (S01H and S01T), the noise predictions presented in this CNVIS represent a realistic worst-case scenario when construction occurs at work locations close to residences and other sensitive receivers. At each receiver, noise levels will vary during the construction period based on the position of equipment within the worksite, the distance to the receiver, the construction activities being undertaken and the noise levels of particular plant items and equipment. Actual noise levels will often be less than the predicted levels presented in this CNVIS.

During the site operation phase (S02), noise predictions presented in this CNVIS represent typical operations based on the site layout.

5.3.1 Standard construction hours

Table 5-2 presents the predicted construction noise levels for each of the construction stages identified in Table 5-1 at the most affected residential receiver in each NCA. The results are presented in terms of level above the NML. For **Standard Hours**, construction noise impacts are presented as follows:

●	Complies with NML
○	< 10dB(A) above NML - construction noise clearly audible
◆	> 10dB(A) above NML - construction noise moderately intrusive
□	> 75dB(A) - highly noise affected

Table 5-2: Summary of construction noise impacts at nearby receivers – standard hours

NCA	Level of compliance with NML		
	S01H	S01T	S02
S2B_07	□	□	◆

NCA	Level of compliance with NML		
	S01H	S01T	S02
S2B_08	☐	◆	◔
OSR	◔	◔	●

Notes
Standard hours (7am to 6pm Monday to Friday and 8am to 6pm Saturday)
OSR: this includes all commercial, industrial and other sensitive receivers defined in Section 3.2 and APPENDIX B.

During the civil and site establishment phase, residences near the works in NCAs S2B_07 and S2B_08 are predicted to experience noise levels above the day-time NMLs. Residences adjacent to the works in NCA S2B_07 and S2B_08 are predicted to be highly noise affected during with early phase civil and site establishment works. Use of rollers and graders during the civil works along with rock breakers and saws would have the most noise impact, which would be for a duration of approximately six days.

During the operational phase, residences near the works in NCAs S2B_07 and S2B_08 are predicted to experience noise levels above the day-time NMLs. Construction noise is predicted to be moderately intrusive at nearby residences in NCA S2B_07. Impacts would be greatest when the works in the workshop area result in use of hand tools (including power tools).

Proposed measures to minimise construction noise levels are outlined in Section 5.4. For more detailed predictions, refer to APPENDIX D. For more detailed additional noise management measures, refer to APPENDIX E.

5.3.2 Out of hours work

Access to the Belmore site compound during OOH periods is required to support HV cabling works during rail possessions. Table 5-3 presents the predicted construction noise levels for the proposed OOH support works identified in Table 5-1 and APPENDIX C at the most affected residential receiver in each NCA. The results are presented in terms of level above the NML. For **OOHW periods**, construction noise impacts are presented as follows:

●	Complies with NML
◔	< 5dB(A) above NML - construction noise noticeable
◆	5 to 15dB(A) above NML – construction noise clearly audible
■	> 15 to 25dB(A) above NML - construction noise moderately intrusive
☐	> 25dB(A) above NML – construction noise highly intrusive

Table 5-3 Summary of construction noise impacts at nearby receivers – OOHW periods

NCA	Level of compliance with NML		
	S03 Day OOHW Period 1	S03 Evening OOHW Period 1	S03 Night OOHW Period 2
S2B_07	◔	◔	◆
S2B_08	●	●	◔
OSR	●	●	●

NCA	Level of compliance with NML		
	S03 Day OOHW Period 1	S03 Evening OOHW Period 1	S03 Night OOHW Period 2

Notes Standard hours (7am to 6pm Monday to Friday and 8am to 6pm Saturday)
OSR: this includes all commercial, industrial and other sensitive receivers defined in Section 3.2 and APPENDIX B.

Should the HV Cabling Team require access to the Belmore compound to support their OOHW works during the Day and Evening OOHW Period 1, there is one residential receiver (30 Peel Street, Belmore) in NCA S2B_07 that is predicted to experience construction noise levels that are noticeable. Other nearby residential receivers in NCAs S2B_07 and S2B_08 are predicted to comply with the corresponding NMLs.

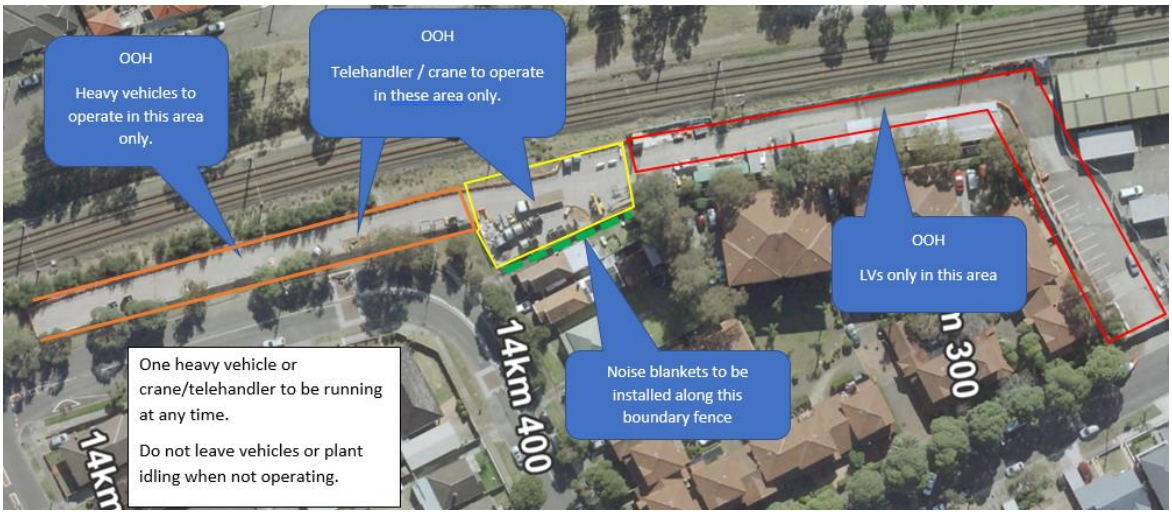
If the HV Cabling Team require access to the Belmore compound to support their OOHW works during the OOHW Period 2, there is one residential receiver (30 Peel Street, Belmore) in NCA S2B_07 that is predicted to experience construction noise levels that are clearly audible. Up to ten residential receivers in NCAs S2B_07 and up to four residential receivers in S2B_08 may experience construction noise levels that are noticeable (i.e. within 5 dB of the NML). It is noted that this OOHW activity would occur occasionally during rail possession works, as noted in Section 2.2.3.

Other sensitive receivers within the proximity of the compound are predicted to comply with the corresponding NMLs.

Given that 30 Peel Street is directly adjacent to the Belmore compound site, noise mitigation measures to reduce the potential OOH noise impacts shall be implemented. The specific site noise mitigation measures include the following:

- Non-concurrent operation, with only one item to be operating at any time;
- Plant and vehicles are not to be left idling;
- Temporary noise screens shall be installed along the boundary between the compound; and 30 Peel Street, Belmore; and
- Plant and vehicles to be restricted to the areas shown below.

Figure 5-1: Belmore site compound OOH noise mitigation measures



Additional measures to minimise construction noise levels are outlined in Section 5.4. For more detailed predictions, refer to APPENDIX D. For more detailed additional noise management measures, refer to APPENDIX E.

5.3.3 Sleep disturbance

Accessing the Belmore compound during the night period may produce instantaneous noise events with the potential to cause sleep disturbance. Toolbox talks will be used to advise all personnel of the need to follow quiet work practices during OOHW periods, including limiting the need for car door closing and warning personnel of the need to respect the residential receivers surrounding the compound. No high noise impact activities are required for the proposed OOH works.

Due to the nature of the low noise works, it is likely that maximum noise levels will be below the sleep disturbance NML of 65 dB(A) $L_{A,max}$ during the OOHW Period 2 works.

5.4 Noise mitigation and management

5.4.1 Consultation with affected receivers

CSSI-8256 Condition E28 requires consultation with affected community, religious or educational institutions where construction noise is found to exceed the NMLs to assist in managing works outside sensitive periods. Systems Connect will continue consultation with potentially affected landholders (taking into consideration consultation outcomes undertaken by Sydney Metro to date) regarding specific mitigation measures applicable to the works at the Belmore compound:

- Ongoing direct contact with residents and businesses on streets surrounding the site via doorknocks, phone and email.
- Bi-annual newsletters distributed to businesses and residents within 500m of the site.

- Monthly notification distributed to businesses and residents within 100m of the site and include updates on recent works and works coming up.
- Community information session on site with environment, engineers, community on an as-needed basis.
- Specific consultation with businesses impacted by our works (adjacent to work areas).
- Invitation to all property owners within 500m to register for weekly email updates included in the bi-annual newsletter.
- Systems Connect would ensure that all consultation is undertaken following the process described Section 6.3 of the Community Communications Strategy (CCS-LW) Rev01 to ensure culturally and linguistically diverse (CALD) communities are informed where aspects of the Project may cause an impact.

5.4.2 Site noise control measures

The following standard noise control measures are recommended to reduce potential noise impacts:

Table 5-4: Site noise control measures

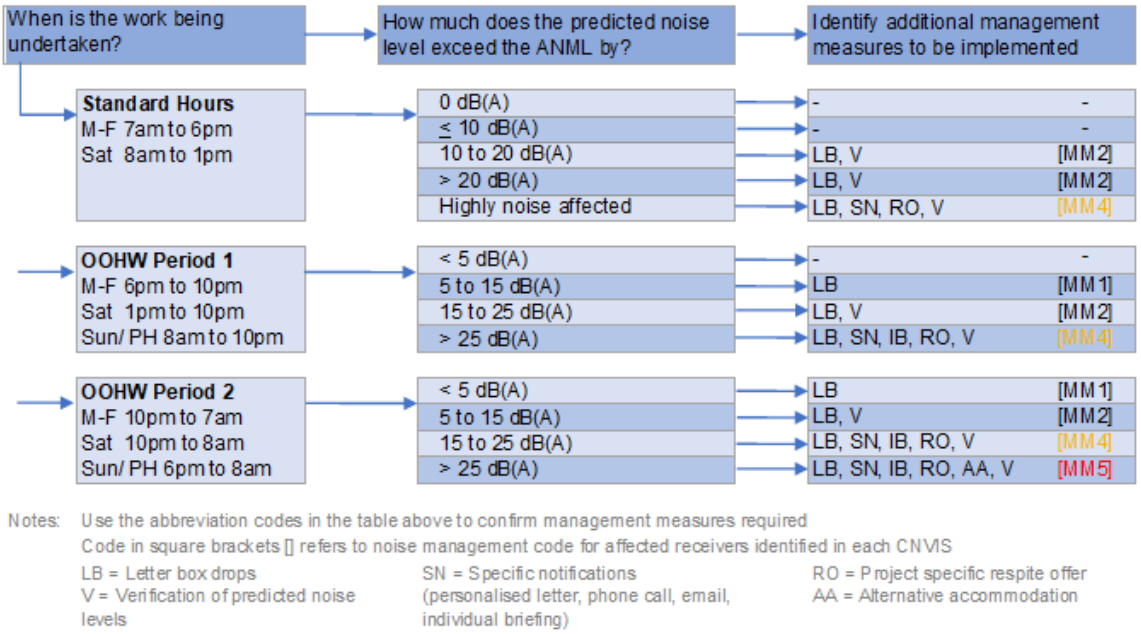
Control type	Control measure	Typical use
At-source control measures	Noise control kits	Plant that is brought to site for regular use should meet the sound power limits identified in Table C1. Where plant are above limits then the plant may require installation of 'noise control kits' to comply with the noise limits in Table C1. Such 'noise control kits' comprise: high performance 'residential-grade' exhaust mufflers, additional engine cowling / enclosure lined inside with sound absorbent industrial-grade foam, and air intake and discharge silencers / louvres. The need to fit 'noise control kits' onto the identified plant, will be confirmed once each plant item is tested prior to its regular use on site.
	Limit equipment in use	Only the equipment necessary will be used.
	Timing of equipment in use	Where practicable, activities and plant will be limited as outlined in Table C1 (APPENDIX C).
	Limit activity duration	Any equipment not in use for extended periods shall be switched off. For example, heavy vehicles should switch engines off when not in use.
	Use and siting of plant	Avoid/ limit simultaneous operation of noisy plant and equipment within discernible range of a sensitive receiver. Direct noise-emitting plant away from sensitive receivers where practicable. Locate fixed location plant items as far from sensitive receivers as practicable.
	Equipment selection	Use quieter and less noise/ vibration emitting construction methods where feasible and reasonable.
	Temporary noise screens	Where practicable, out of hours works should utilise temporary noise screens (e.g. Echo-barrier, or similar) to provide noise screening during noisier works, such as concrete pours etc that are required to be completed during more sensitive time periods. Temporary noise screens can provide 5 to 10 dB noise reduction, where they can break line of site.

Control type	Control measure	Typical use
	Truck movements	Set up relevant traffic management measures to minimise the use of air brakes when leaving the site. Air brake silencers are to be correctly installed and fully operational for any heavy vehicles (as per CNVMP). Minimise unnecessary acceleration on site.
	Non-tonal reversing alarms	Alternative reverse and movement alarms, such as 'quackers' will be installed on all plant and equipment, where practicable.
Noise management measures	Site inductions & Toolbox Talks	All employees, contractors and subcontractors will receive a Project induction. The environmental component may be covered in toolboxes and should include: • location of nearest sensitive receivers • relevant project specific and standard noise and vibration mitigation measures; • permitted hours of work; • construction employee parking areas.
	Community consultation	Inform community of construction activity and potential impacts.
	Respite periods	High noise impact activities are carried out in continuous blocks of up to 3 hours. Respite from high noise impact activities will be provided between each block for at least 1 hour. No high noise impact activities will be carried out during this 1 hour respite period.
	Work scheduling around sensitive areas	Where feasible and reasonable, construction would be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels would be scheduled during less sensitive time periods. When working adjacent to schools, medical facilities and childcare centres, scheduling noisy activities around HSC exam times, child care sleep times and other identified sensitive times should be considered, where feasible and reasonable. When working adjacent to churches and places of worship noisy activities should be scheduled outside services, where feasible and reasonable.
	Behavioural practices	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors.
	Noise monitoring	Noise monitoring is to be carried out as detailed in Section 5.4.4.

5.4.3 Additional noise mitigation measures

Table 5-5 below should be used to advise the appropriate additional noise mitigation during construction, based on the CNVS [10] and the CNVMP [1].

Table 5-5: Additional airborne noise mitigation measures



APPENDIX E presents a summary of the additional noise mitigation measures applicable for construction activities where, after application of all reasonable and feasible mitigation options, predicted construction noise levels still exceed the NMLs.

Prior to the commencement of the site establishment works, residential receivers around the site, in particular those identified in APPENDIX E will be notified to advise that noise from the works may at times be audible. All potentially impacted receivers will be kept informed of the nature of works to be carried out, the expected noise levels and duration, as well as be given the project enquiries and complaints 1800 numbers (see Section 5.4.5).

5.4.4 Attended noise monitoring

Attended noise monitoring will be undertaken during works at one of the representative residential receivers identified in the table below in the NCAs most impacted by the works (i.e. a minimum of one location for each NCA). Nominated attended measurement locations have been selected with the best opportunity to validate the predicted noise levels. Noise monitoring is subject to obtaining the property owner/occupier's consent to access the property (where required). If consent to access property is denied, monitoring will be done on public land on the property boundary, provided it is safe to do so.

Table 5-6: Nominated verification monitoring locations

NCA	Nominated receiver address	Monitoring location
NCA_S2B_07	30 Peel Street, Belmore	Northern boundary of property
NCA_S2B_07	101-105 Bridge Road, Belmore	Northern or eastern boundary of property
NCA_S2B_08	1 The Boulevarde, Belmore	Northern boundary of property
NCA_S2B_08	34 Moreton Street, Lakemba	Northern boundary of property

NCA	Nominated receiver address	Monitoring location
OSR	348 Burwood Road, Belmore	Western boundary of property

Notes

1. Monitoring on private property is subject to owner consent and where relevant, occupier consent. If consent to access property is denied, monitoring will be done on public land on the property boundary, provided it is safe to do so.

If verification monitoring shows that the external noise levels are consistently above the predicted levels, investigation will be undertaken to understand the cause of the exceedance. Periodic assessment of plant noise levels will be undertaken in accordance with Section 9.2.3 and Table 20 of the CNVMP to confirm the plant noise levels are within the APPENDIX C Table C1.

All noise monitoring will follow the procedures outlined in Appendix D of the CNVMP.

5.4.5 Complaints Handling

Noise complaints received and responded to will be managed in accordance with the CNVMP and the Community Consultation Strategy.

Transport for NSW operate a 24-hour construction complaints line (1800 171 386).

Enquiries/ complaints may also be received through the Sydney Metro project email (linewide@transport.nsw.gov.au).

6 Construction vibration impacts

6.1 Minimum working distances for vibration intensive plant

From the plant and equipment listed in APPENDIX C, the dominant vibration generating plant include:

- Roller (12t)
- Excavator with rock breaker attachment (30t)

Potential vibration generated to receivers is dependent on separation distances, the intervening soil and rock strata, dominant frequencies of vibration, and the receiver structure. The recommended minimum working distances for vibration intensive plant presented in Table 6-1 and

Table 6-2 are taken from a database of vibration levels measured at various sites or obtained from other sources (e.g. BS5228-2:2009). They are not specific to these works as final vibration levels are dependent on many factors including the actual plant used, its operation and the intervening geology between the activity and the receiver.

Site specific minimum working distances for vibration significant plant items must be measured on site where plant and equipment is likely to operate close to or within the recommended minimum working distances for cosmetic damage (Table 6-1).

Table 6-1: Minimum working distances (m) for cosmetic damage (continuous vibration)

Plant item	Minimum working distance (m)		
	Reinforced or framed structures (e.g. commercial buildings)[1]	Unreinforced or light framed structures (e.g. residential buildings)[1]	Sensitive structures (e.g. heritage structures)[2]
Roller (12t)	5	5	15
Excavator with rock breaker (30t)	5	5	10

Notes

1. Initial screening test criteria reduced by 50% due to potential dynamic magnification in accordance with BS7385.
2. In accordance with Section 5.8.1 of CNVMP, a site inspection should determine whether a heritage structure is structurally unsound.
3. Minimum working distances are in 5m increments only to account for the intrinsic uncertainty of this screening method. Jackhammers and direction drills are likely to have minimum working distances smaller than 5 m (e.g. 1m in accordance with TfNSW CNS).

Table 6-2: Minimum working distances (m) for human annoyance (continuous vibration)

Plant item	Minimum working distances, m				
	Critical areas[1,4]	Residences		Offices[3,4]	Workshops[4]
		Day[2]	Night[2]		
Roller (12t)	105	55	75	30	15
Excavator with rock breaker (30t)[5]	40	25	30	20	15

Plant item	Minimum working distances, m				
	Critical areas[1,4]	Residences		Offices[3,4]	Workshops[4]
		Day[2]	Night[2]		

Notes:

1. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring.
2. Daytime is 7 am to 10 pm; Night-time is 10 pm to 7am.
3. Examples include offices, schools, educational institutions and place of worship.
4. Applicable when in use.
5. Operating for 30% of the time in high vibration mode.

6.2 Vibration assessment

6.2.1 Structural damage

The number of buildings which are close to or within the minimum working distances for cosmetic damage are shown in Table 6-3 and in APPENDIX F.

Table 6-3: Number of buildings within minimum working distances for cosmetic damage

Plant item	Number of buildings[1]	
	Screening criteria for non-heritage structures	Screening criteria for heritage structures[2]
Roller (12t)	1	0
Excavator with rock breaker (30t)	1	0

Notes

1. Site inspection should determine structural conditions of all potentially vibration affected buildings.
2. Potential heritage structures – reference (Land Use Survey in Annexure B of the CNVMP).

There is one non-heritage structure that is located within the minimum working distances established for cosmetic damage during the works. The residence is located at 30 Peel Street, Belmore and is identified in APPENDIX F.

Vibration monitoring is recommended to determine site specific conditions and/or to verify that vibration levels achieve compliance with the structural damage objectives where plant is required to operate within the safe working distance identified in Table 6-1. If the monitoring above identifies that vibration is likely to exceed the structural damage objectives, a different construction method with lower source vibration levels will be considered.

6.2.2 Human annoyance

APPENDIX F and Table 6-4 identifies specific receivers that may be exposed to vibration that may cause adverse comments during construction works. However, due to the limited time the vibration intensive plant will be operating close to these properties, the risk of annoyance is considered low.

Attended vibration measurement should be carried out in the event of complaint from the nearest receiver to confirm that vibration is within the acceptable range for human annoyance (see Section

6.3.3). The assessing vibration guideline [5] notes that inside dwellings, adverse comments often arise when occupants can perceive (feel) vibration, particularly when the vibration arises from a source located outside their home (or outside their control), and assume that the vibration has the potential to damage their building or contents.

However, it is noted that vibration levels required to cause minor cosmetic damage are typically 10 x higher than levels that will cause disturbance to building occupants. Many building occupants assume that building damage is occurring when they feel vibration or observe rattling of loose objects, however the level of vibration at which people perceive vibration or at which loose objects may rattle is far lower than vibration levels that can cause damage to structures.

At properties near the worksite, it is likely that the nearest receivers will be able to feel vibration levels when vibration-generating equipment is being utilised. Properties where vibration levels may be above the vibration disturbance goals in Table 4-1 and there is a probability of adverse comment are shown in Table 6-4.

Table 6-4: Number of buildings within minimum working distances for human annoyance

Plant item	Critical areas[1,4]	Residences[5]		Offices[3,4]	Workshops[4]
		Day[2]	Night[2]		
Roller (12t)	0	25	-	0	0

Notes

1. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring.
2. Daytime is 7 am to 10 pm; Night-time is 10 pm to 7am.
3. Examples include offices, schools, educational institutions and place of worship.
4. Applicable when in use.
5. Hotels and childcare centres are included in the residence category.

From the above table, there are 25 residential properties that may experience vibration which can cause adverse comment when vibration-generating plant is operated nearby (vibratory roller). Properties are further identified in APPENDIX F.

The above assessment is based on vibration-generating equipment operating at the closest location to nearby receivers. When vibration-generating equipment operates further from the closest point, the predicted vibration levels will reduce along with the probability of adverse comment.

Attended vibration measurements are proposed to be carried out proactively and in response to vibration complaints. If measurement results indicate exceedances of the vibration objectives for human annoyance at these locations, vibration control and management measures will be provided to reduce vibration impact (see Section 6.3.1).

After applying all feasible and reasonable vibration mitigation measures, if vibration monitoring still identifies that measured vibration levels are above the relevant vibration criteria for human annoyance, appropriate additional mitigation measures should be considered (see Section 6.3.2).

6.3 Vibration mitigation measures

6.3.1 Vibration control and management measures

In addition to the vibration control measures presented in the CNVMP, the following vibration management measures are provided to minimise vibration impact from construction activities to the nearest affected receivers and to meet the relevant human comfort vibration and structural damage limits identified in Section 4.2.

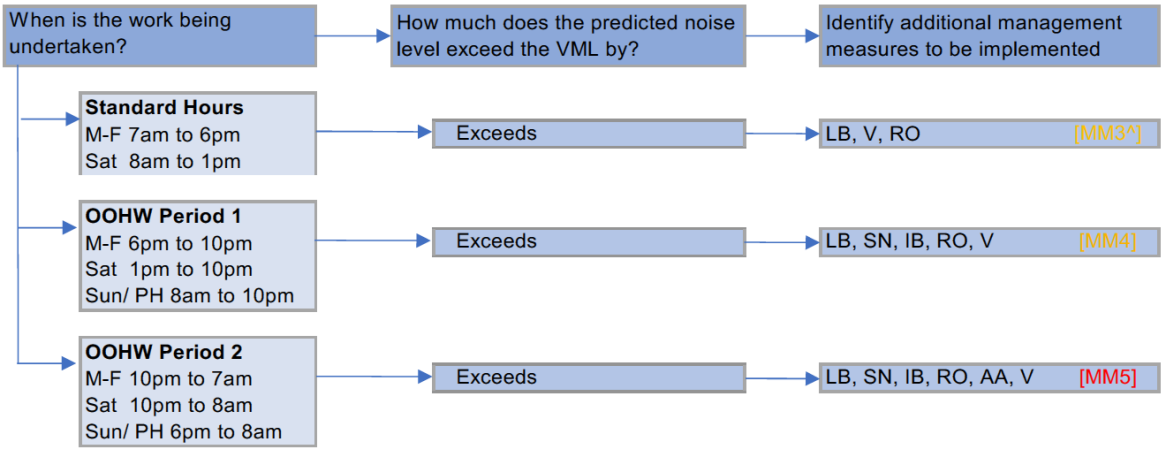
Table 6-5: Site vibration control measures

Control type	Control measure	Typical use
Construction planning	Building condition surveys	Undertake building dilapidation surveys on all buildings located within the buffer zones established for cosmetic damage prior to commencement of activities with the potential to cause property damage (see Section 6.1).
	Community consultation	Implement community consultation measures – inform community of construction activity & potential impacts – inform community that the level of vibration at which people perceive it, or at which loose objects may rattle, is far lower than the level at which minor cosmetic damage is expected to occur
	Equipment selection/ construction method	Use less vibration emitting construction methods where feasible & reasonable, for example vibratory rollers can, where practicable, be operated with the vibratory mode switched off to reduce vibration impact.
	Plan work activities to minimise vibration.	Plan traffic flow, parking & loading/unloading areas to maximise distances between truck routes and sensitive receivers.
Complaints management	Construction Complaints Management System	Complaints will be managed in accordance with the Construction Complaints Management System (see Section 6.2.2). Each complaint shall be investigated and where vibration levels are established as exceeding the set limits, appropriate amelioration measures shall be put in place to mitigate future occurrences. Management measures may include modification of construction methods such as using smaller equipment and establishment of safe buffer zones as mentioned above.

6.3.2 Additional vibration mitigation measures

After applying all feasible and reasonable mitigation measures identified in Table 6-5, if vibration monitoring finds that vibration levels at representative locations are still above relevant vibration objectives for human annoyance, appropriate additional vibration mitigations measures would be implemented, as outlined in Section 8.2 of the CNVMP.

Table 6-6: Additional vibration mitigation measures



Notes: Use the abbreviation codes in the table above to confirm management measures required
Code in square brackets [] refers to noise management code for affected receivers identified in each CNVIS

LB = Letter box drops
V = Verification monitoring
SN = Specific notifications
IB = individual briefing
RO = Project specific respite offer
AA = Alternative accommodation

6.3.3 Vibration monitoring

Attended vibration monitoring is to be undertaken to determine and verify site specific minimum working distances for cosmetic damage and human annoyance. Attended vibration monitoring will be undertaken during works whenever vibration significant plant items are operating close to or within the determined minimum working distances.

As a minimum, it is recommended that attended monitoring is undertaken at the locations in Table 6-7 when vibration significant plant items operate close to or within the minimum working distances. Additional monitoring may also be required in response to vibration complaints.

Real-time vibration monitoring in accordance with PPA Condition C11 is not proposed for this site.

Table 6-7: Attended vibration monitoring - nominated representative locations

Plant	Address	Vibration objectives to check	
		Unreinforced or light framed structures (e.g. residential buildings)	Human annoyance[1]
Roller (12T)	30 Peel Street, Belmore	√	√

Notes: 1. Monitoring required in the event of complaint to vibration

6.3.4 Management of complaints

Vibration complaints received and responded to will be managed in accordance with the CNVMP and the Community Consultation Strategy.

Transport for NSW operate a 24-hour construction complaints line (1800 171 386).

Enquiries/ complaints may also be received through the Sydney Metro project email (linewide@transport.nsw.gov.au).

7 Ground-borne noise assessment

Due to the nature of the Belmore site compound works, which are surface works, airborne noise is expected to be much higher than ground-borne noise levels at the nearest sensitive receivers. On this basis, the potential impact of ground-borne noise from construction activities is expected to be negligible.

As such, the risk of annoyance due to ground-borne noise is considered low and has not been addressed further in this CNVIS.

8 Traffic noise assessment

During the civil works, there would be dump trucks arriving and departing site throughout the day, however there would only be two trucks per day for approximately 10 days, and all would be during standard daytime hours only. During the operational phase, delivery trucks may be required once per day when dropping and picking up equipment from the laydown area. Based on the volumes presented in APPENDIX C, the increase in road traffic noise levels is likely be less than 2 dB(A) and so construction traffic will have minimal impact on the roads used to access the site.

Notwithstanding this, the Heavy Vehicle Code of Conduct includes several measures, including limiting of compression braking, minimisation of vehicle idling, which will ensure that noise impacts of heavy vehicle traffic on surrounding streets are minimised.

9 Cumulative impacts

All concurrent Sydney Metro construction works have been considered and addressed in this CNVIS, including works within the South West Corridor which fall under the Systems Connect work scope. Systems Connect are aware of ongoing, potentially concurrent construction activities within the vicinity of the Belmore compound. The works, summarised in Table 9-1, may have the potential to generate cumulative noise impacts on receivers.

These works have been considered but it has been determined that, due to the nature of the other unrelated construction works, no additional physical mitigation measures are deemed reasonable. Nevertheless, in accordance with the CNVMP Systems Connect will endeavour to take all reasonable steps to collaborate with other Projects to minimise cumulative noise and vibration impact where Systems Connect are above management levels and coordinate respite for affected sensitive receivers, whenever practicable.

Table 9-1: Other construction works close to Belmore site compound

Construction company	Project	Timing of activities	Hours of works	Works location	Activity types	General plant types
SWM	Sydney Metro - South West Corridor Station Works	TBC	Standard construction hours, outside construction hours and rail possession works	Stations from Sydenham to Bankstown Stations and corridor works from Sydenham to Bankstown	Station upgrade construction works Stations upgrade and CSR installation works	
Sydney Trains	Sydney Train maintenance works	Based on Sydney Trains trackwork schedule	Based on Sydney Trains trackwork schedule	Any point along the railway corridor. Immediately adjacent to Systems Connect worksite	Rail and signalling maintenance works	Utility relocation, minor earthworks, signal and rail modification.
SC	Sydney Metro - South West Corridor Station Works	Dec-2020 to Feb-2022	Standard construction hours, outside construction hours and rail possession works	Stations and Corridor works from Sydenham to Bankstown.	HV Cabling, 11kV padmount substation installation and Traction substation installation	Cable Stands/Cradle, 6T Winch, 6T Telehandler, Heavy Rigid Crane Truck, EWP (Hi-Rail)

10 Conclusion

Works associated with the Belmore site compound have been identified and described in this report. Potentially affected noise and vibration sensitive receivers and relevant construction noise and vibration objectives have been identified and discussed to allow the assessment of potential construction impacts.

The expected construction noise levels have been predicted and presented in Section 0 and APPENDIX D. The expected duration of construction activities is outlined in Table C1 of APPENDIX C. During standard construction hours, the highest noise impacts are predicted to occur during the civil and site establishment phase, however this would be of short duration. Outside standard construction hours, the nearest residential receivers are likely to experience construction noise levels that are noticeable and clearly audible if access to the Belmore compound is required during rail possession out-of-hours works.

Noise mitigation and management measures have been presented in Section 5.4 to aid in providing additional noise reduction benefits where exceedance of the objective occurs.

Vibration impacts and management measures have been presented in Section 6 to aid in minimising any potential vibration impacts.

The potential impact of ground-borne noise from construction activities is expected to be negligible due to the expectation that airborne noise will be much higher than ground-borne noise levels at the nearest sensitive receivers.

Minimal construction vehicles are proposed as part of the works, and so construction traffic noise on the local road network associated with the works will have minimal impact on receivers in proximity to public roads.

References

[1] Sydney Metro City & Southwest – Line Wide Works Contract Construction Noise and Vibration Management Plan (SMCSWLWC-SYC-1NL-PM-PLN-000032-A-CNVMP-C2B)

[2] SLR Consulting Australia Pty Ltd 2017 Sydney Metro Sydenham to Bankstown - Technical Paper 2: Noise and Vibration Report Number 610.15897-R02 – 28 August 2017

[3] SLR Consulting Australia Pty Ltd 2016 Sydney Metro Chatswood to Sydenham - Technical Paper 2: Noise and Vibration Report Number 610.14718R1 – 28 April 2016

[4] Department of Environment and Climate Change 2009 NSW Interim Construction Noise Guideline

[5] Department of Environment Conservation NSW 2006 Assessing Vibration; a technical guideline

[6] British Standard BS 7385 Part 2 1993, Evaluation and measurement for vibration in buildings. Guide to damage levels from groundborne vibration

[7] German Standard DIN 4150-3:2016-12 Vibration in buildings – Part 3: Effects on structures

[8] British Standard BS 6472-2008, Evaluation of human exposure to vibration in buildings (1-80Hz)

[9] Transport for NSW Sydney Metro City & Southwest Construction Noise Strategy (ref: 610.14213-R3) 08 August 2016

[10] Transport for NSW Construction Noise and Vibration Strategy (ref: 7TP-ST-157/4.0) May 2018

[11] Transport for NSW Sydney Metro Construction Environmental Management Framework August 2016

[12] Department of Environment, Climate Change and Water 2011 NSW Road Noise Policy

[13] NSW Department of Planning – Development near rail corridors and busy road – interim guideline 2008

APPENDIX A Glossary of terminology

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

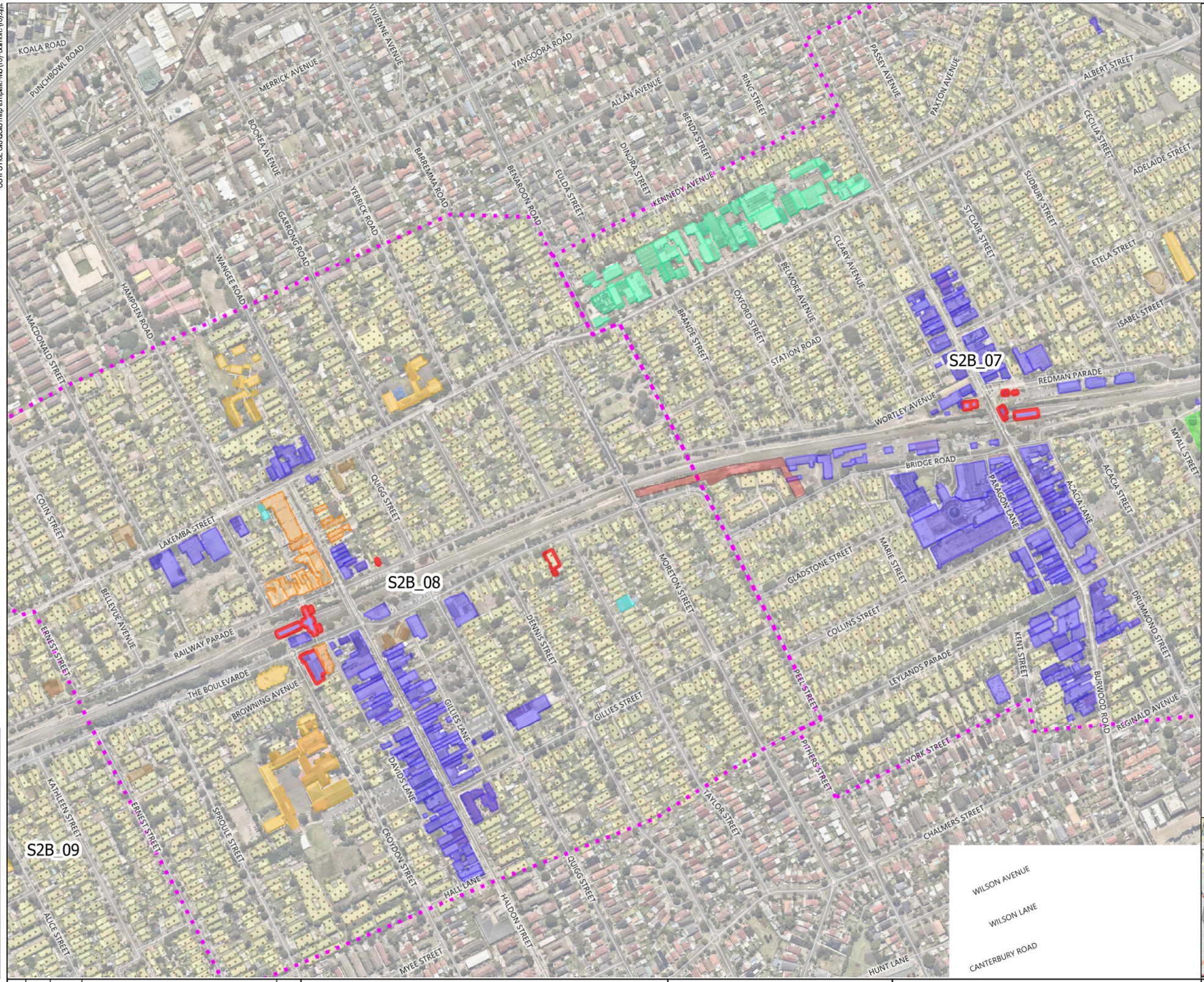
Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
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.
Assessment period	The period in a day over which assessments are made.
Assessment point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of every day sounds: 0dB The faintest sound we can hear 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB CBD mall at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 100dB The sound of a rock band 115dB Limit of sound permitted in industry 120dB Deafening
dB(A)	A-weighted decibels. The A- weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
dB(C)	C-weighted decibels. The C-weighting noise filter simulates the response of the human ear at relatively high levels, where the human ear is nearly equally effective at hearing from mid-low frequency (63Hz) to mid-high frequency (4kHz), but is less effective outside these frequencies.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L_{Max}	The maximum sound pressure level measured over a given period.
L_{Min}	The minimum sound pressure level measured over a given period.

L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
OOH	Out of Hours (i.e. outside standard construction hours)
OOHW	Out of Hours Work (i.e. works carried out outside standard construction hours)
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sensitive receiver	Includes residences, educational institutions (including preschools, schools, universities, TAFE colleges), health care facilities (including nursing homes, hospitals), religious facilities (including churches), child care centres and passive recreation areas (including outdoor grounds used for teaching).
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

APPENDIX B Nearest sensitive receivers and noise management levels

Plot Date: 21/05/20 - 12:19 Layout: Appendix B r1

GIS File: R:\Ass\2cSyd\Projects\TK6551-TK700\TK685 PK SMCSW Linewide Works (C-PD UGL)\5 Calcs\100 CONSTRUCTION\3-03 S2B\02 Belmore Cmp\03 OUTPUT\02 GIS\GIS map template-MS (r0)-Belmore (r0).qpz



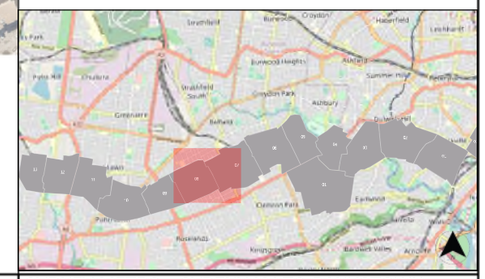
LEGEND

Noise sensitive receivers

- Childcare
- Commercial
- Educational
- Hotel/Motel/Hostel
- Industrial
- Medical
- Place of Worship
- Recording studio
- Recreational - Active
- Recreational - Passive
- Residential
- Theatre/Auditorium
- Mixed use
- Project acquisition
- Film/TV studio
- Cinema
- Community centre
- Library
- Laboratory
- Other
- Heritage

NCA

Belmore site compound



REV	BY	DATE	DESCRIPTION	APPD.
r0	RP	06/04/20		RP
r1	RP	21/05/20	Prepare figures	RP

A3 Original | Co-ordinate System: MGA Zone 56

SCALES

0 150 300 450 m

1:6000

FULL SIZE A3

NOTE: Do not scale from this drawing.

CLIENT

Systems Connect

ACOUSTIC CONSULTANT

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inspired to achieve

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SYDNEY METRO - SYDENHAM TO BANKSTOWN

Belmore site compound
Land Use, NCAs

Status:

Sheet 1 of 1

Drawing No.

Rev. No.

Table B1: Noise sensitive receivers and construction noise management levels **BELMORE SITE COMPOUND**

NCA	Nearest construction work area	Receiver Type	Reference RBL	Existing Noise Levels, dB(A)			Residential NMLs based on ICNG (external)				Sleep Dist. L_{Amax}		Comments
				RBL Day	RBL Evening	RBL Night	NMLDS	NMLDO	NMLE	NMLN	Screening[1]	Max[1]	
Portion 4	**Sydenham to Bankstown (S2B)**												
S2B_07	Rail corridor	Commercial around Belmore Railway Station and residential buildings up and down side of railway line	S2B EIS B.13	41	41	35	51	46	46	40	55	65	
S2B_08	Rail corridor	Commercial around Lakemba Railway Station andresidential buildings up and down side of railway line	S2B EIS B.14	47	47	41	57	52	52	46	56	65	
S2B_09	Rail corridor	Predominantly residential buildings up and down side of railway line with educational buildings	S2B EIS B.16	44	44	36	54	49	49	41	55	65	
Other sensitive receivers													
Studio building (music recording studio)							45	45	45	45			Source: AS2107 'maximum', assuming a conservative façade loss of 20 dB(A)
Studio building (film or television studio)							50	50	50	50			Source: AS2107 'maximum', assuming a conservative façade loss of 20 dB(A)
Cinema space, theatre, auditorium							55	55	55	55			Source: AS2107 'maximum', assuming a conservative façade loss of 20 dB(A)
Hotel (Sleeping areas: Hotels near major roads)							60	60	60	60			Source: AS2107 'maximum', assuming a conservative façade loss of 20 dB(A)
Classrooms at schools and other educational institutions							55	55	55	55			Source: ICNG, assuming a conservative façade loss of 10 dB(A)
Chilcare centre (internal play and sleeping areas)							50	50	50	50			Source: AAAC - guideline for Child Care Centre Acoustic Assessment, assuming a conservative façade loss of 10 dB(A)
Hospital wards and operating theatres							65	65	65	65			Source: ICNG, assuming a conservative façade loss of 20 dB(A)
Places of worship							55	55	55	55			Source: ICNG, assuming a conservative façade loss of 10 dB(A)
Library (reading areas)							65	65	65	65			Source: AS2107 'maximum', assuming a conservative façade loss of 20 dB(A)
Office building (general office areas)							65	65	65	65			Source: AS2107 'maximum', assuming a conservative façade loss of 20 dB(A)
Hotel (bars and lounges)							70	70	70	70			Source: AS2107 'maximum', assuming a conservative façade loss of 20 dB(A)
Community centres – Municipal Buildings							60	60	60	60			Source: AS2107 'maximum', assuming a conservative façade loss of 10 dB(A)
Restaurant, bar (Bars and lounges/ Restaurant)							70	70	70	70			Source: AS2107 'maximum', assuming a conservative façade loss of 20 dB(A)
Railway platform and concourse areas							75	75	75	75			Source: AS2107 'maximum', assuming a conservative façade loss of 20 dB(A)
Café/ Restaurant/ Bar (outdoors)							60	60	60	60			Source: AS2107 'maximum1'
Passive recreation areas (e.g. area used for reading, meditation)							60	60	60	60			Source: ICNG
Active recreation areas (e.g. sports fields)							65	65	65	65			Source: ICNG
Commercial premises (including offices and retail outlets)							70	70	70	70			Source: ICNG
Industrial premises							75	75	75	75			Source: ICNG

Notes: 1 - Levels are estimated assuming an open windows (i.e. 10dBA façade losss)
D(S): standard construction hours from 7 am to 6 pm Monday to Friday and from 8 am to 6 pm Saturday
D(O): out-of-hours day period from 8 am to 6 pm Sunday and Public holidays - OOHW P1
E: evening period from 6 pm to 10 pm Monday to Sunday - OOHW P1
N: night-time period from 10 pm to 7 am Monday to Friday, from 10 pm am to 8 am Saturday, Sunday and Public holidays - OOHW P2

APPENDIX C Construction timetable/ activities/ management

Table C1: Construction Timetable/ Activities/ Equipment

BELMORE SITE COMPOUND

Work acitvity	Details	Indicative timing/ duration	Plant/ Equipment	Plant/ Equipment (as provided by client)	Day	Evening	Night	Sound Power Level (Lw re: 1pW) in Noise Model, dB(A)			Vibration intensive plant	Notes
					7am - 6pm	6pm - 10pm	10pm - 7am	L_{Aeq}	Penalty	L_{Amax}		
Civil works	Spoil removal	June-2020 to July-2020	Grader	Grader	1 for 6 days	-	-	113	-	113	-	
	DGB or capping material 150mm thick		Roller smooth/padfoot (12t)	Roller	1 for 6 days	-	-	109	5	113	X	
	Chip and spray		Dump truck	Dump truck	2 for 10 days	-	-	106	-	111	-	
	Concrete Crash Barriers installation		Delivery truck	Road Truck (Deliveries to site)	5 for 2 day	-	-	106	-	111	-	
	Anti Gawk screen installation		Light vehicles / traffic control utes	Light Vehicle	2	-	-	89	-	100	-	
	Minor Demolition Works		Hand tools	Hand tools	2	-	-	107	-	111	-	
	ATF Fencing Installation		Concrete / road / rail saw	Road Saw	1 for 4 days			121	5	129	X	
	Trenching		Excavator w bucket (25t)	Excavator w bucket (35t)	1 for 4 days	-	-	103	-	108	-	
	Drainage Installation		Excavators with hammers (35-45T)	Excavator w rockhammer (30t)	1 for 4 days	-	-	118	5	123	X	
	Tree Trimming		Compactor / Wacker packer	Vibrating Plate Compactor	1 for 4 days	-	-	108	-	110	X	
			Truck and Dog	Truck and Dog	1 for 4 days	-	-	106	-	111	-	
			Concrete Agi	Agitator truck	1 for 2 days	-	-	108	-	111	-	
			Concrete pump	Concrete Pump	1 for 2 days	-	-	103	-	107	-	
			Hand tools	Electric Saw	1 for 1 day	-	-	107	-	111	-	
			Telehander / Franna crane (20t)	25T Franna	1 for 2 days	-	-	99	-	103	-	
Delivery and Installation of Site Sheds		June-2020 to Aug-2020	Mobile crane (20t-250t)	Mobile Crane 55T	1 for 2 days	-	-	104	-	108	-	
			Delivery truck	Road Truck (Deliveries to site)	6 for 2 days	-	-	106	-	111	-	
			Hand tools	Hand tools	2	-	-	107	-	111	-	
			Light vehicles / traffic control utes	Light Vehicle	2		-	89	-	100	-	
			EWP	EWP (Hi Rail)	1 for 1 day	-	-	95	-	98	-	
Utilities	Power Connection	June-2020 to July 2020	EWP	EWP (Hi Rail)	1 for 2 day	-	-	95	-	98	-	
	Water and Sewer Connection		Light vehicles / traffic control utes	Light Vehicle	2 for 10 day	-	-	89	-	100	-	
			Delivery truck	Road Truck (Deliveries to site)	1 for 4 day	-	-	106	-	111	-	
			Hand tools	Hand tools	2	-	-	107	-	111	-	
Operation		June-2020 to Aug-2022	Light vehicles / traffic control utes	Light Vehicle	20 per day	-	-	89	-	100	-	
			Delivery truck	Waste Management truck	1 per day	-	-	106		110	-	
			Telehander / Franna crane (20t)	Crane Truck	1 per day	-	-	99	-	103	-	
			Hand tools	Hand Tools	2	-	-	107	-	111	-	
			Lifting Platform	6T Telehandler	1 onsite	-	-	95	-	95	-	
OOH support works		December-2021 to June-2022	Delivery truck	Flat-bed truck	-	1	1	106	-	111	-	
			Telehander / Franna crane (20t)	Telehandler or Franna	-	1	1	99	-	103	-	
			Light vehicles / traffic control utes	Light Vehicle	-	1	1	89	-	100	-	

APPENDIX D Detailed predicted noise levels

The impacts presented in the following table are identified by colour coding of the text.

For **Standard Hours:**

XX	Complies with NML
XX	< 10dB(A) above NML - construction noise clearly audible
XX	> 10dB(A) above NML - construction noise moderately intrusive
XX	> 75dB(A) - highly noise affected

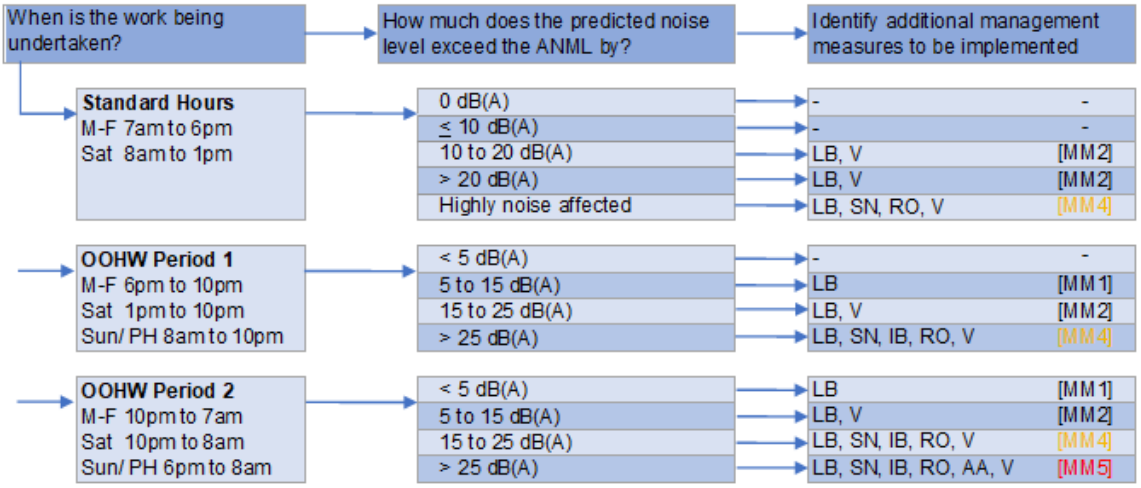
For **OOHW periods:**

XX	Complies with NML
XX	< 5dB(A) above NML - construction noise noticeable
XX	5 to 15dB(A) above NML – construction noise clearly audible
XX	> 15 to 25dB(A) above NML - construction noise moderately intrusive
XX	> 25dB(A) above NML – construction noise highly intrusive

The detailed predicted levels have provided to Systems Connect in a spreadsheet table in order to more adequately mitigate and manage potential noise impacts.

APPENDIX E Additional noise mitigation

The table below is replicated from Table 5-5, and identifies the additional mitigation measures to be applied at construction noise affected receivers.



Notes: Use the abbreviation codes in the table above to confirm management measures required
Code in square brackets [] refers to noise management code for affected receivers identified in each CNVIS
LB = Letter box drops
V = Verification of predicted noise levels
SN = Specific notifications (personalised letter, phone call, email, individual briefing)
RO = Project specific respite offer
AA = Alternative accommodation

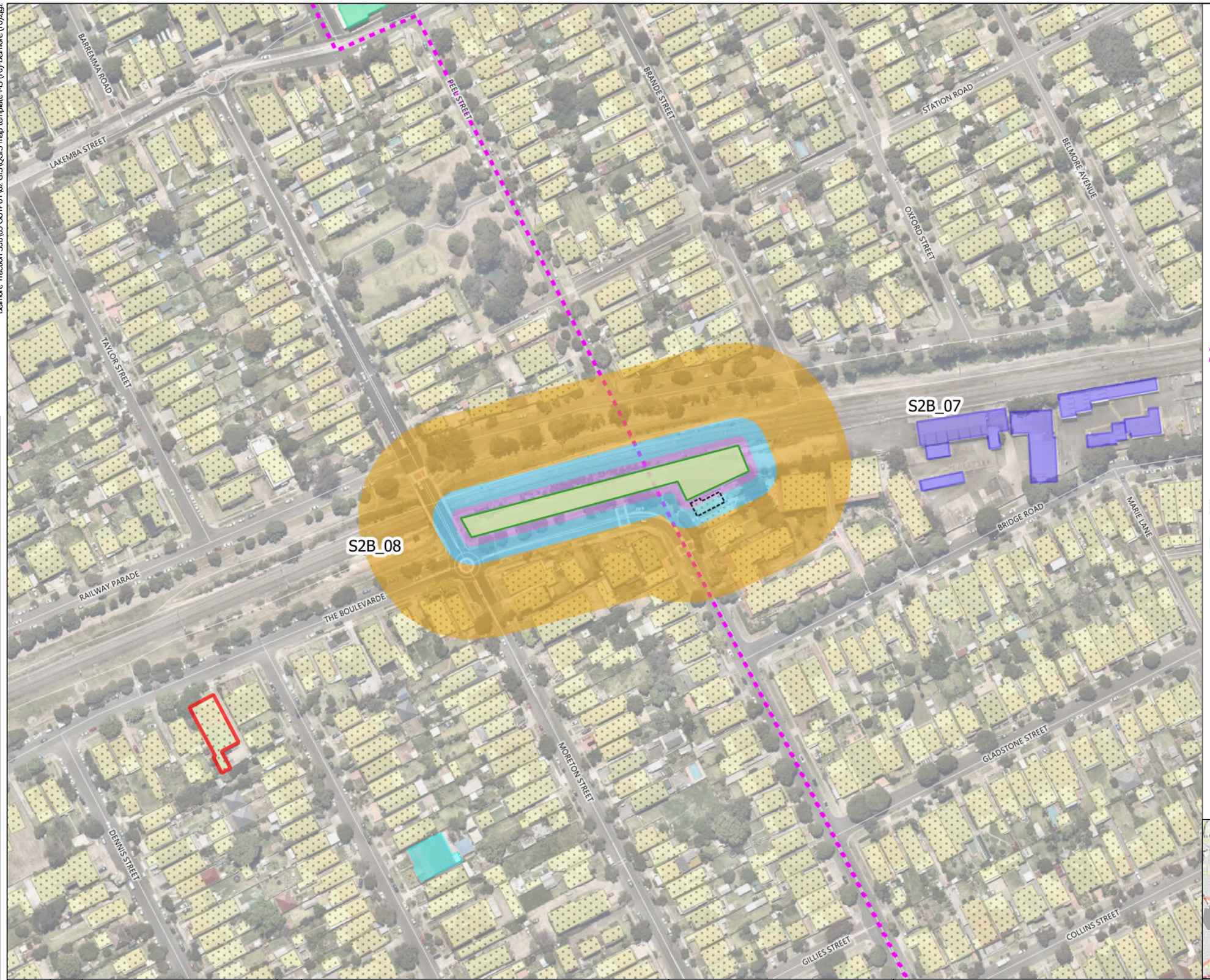
In the following results table, an additional management measure code (MM1, MM2 et al) is given to each receiver if construction noise levels are expected to exceed the Noise Management Level (NML). Each additional management measure code corresponds to a collection of measures identified in the CNVS [10]. The extent of the additional management measures is proportional to the exceedance of the NML and the period in which the exceedance is experienced.

For example, if a receiver experiences construction noise of 10 to 20 dB(A) above the NML during Standard Hours, then the letterbox drop (LB) and verification of predicted noise levels (V) measures are to be adopted for the receiver.

The detailed additional noise and mitigation measures have provided to Systems Connect in a spreadsheet table in order to more adequately mitigate and manage potential noise impacts.

APPENDIX F Minimum working distances

Plot Date: 29/04/20 - 15:33
Layout: TXXXX XX-XX-XX-XX APPB&E-W_O_R_K_A_R_E_A(r5)
GIS File: R:\AecomSydProjects\TK651-TK700\TK695 PK SMCSW Linewide Works (CPB UGL)\5 Calcs\100 CONSTRUCTION\3-03 S2B\02 Belmore Traction Sub\03 OUTPUT\02 GIS\QGIS map template-MS (r0)-Belmore (r0).qgz



300 m
250
200
150
100
50
0

LEGEND

Noise sensitive receive

- Childcare
- Commercial
- Educational
- Hotel/Motel/Hostel
- Industrial
- Medical
- Place of Worship
- Recording studio
- Recreational - Active
- Recreational - Passiv
- Residential
- Theatre/Auditorium
- Mixed use
- Project acquisition
- Film/TV studio
- Cinema
- Community centre
- Library
- Laboratory
- Other
- Heritage

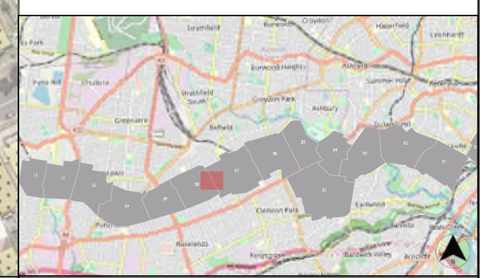
NCA

MWD for cosmetic damage and human annoya

- Unreinforced structures (7.5mm/s ppv)
- Heritage structures (2.5mm/s ppv)
- Human annoyance - Residential (day)

Receivers affected by MWD for cosmetic damage

Work area



REV	BY	DATE	DESCRIPTION	APPD.
r0	RP	29/04/20	Prepare figures	RP

A3 Original
Co-ordinate System: MGA Zone 56

SCALES
0 50 100 150 m
1:2000
FULL SIZE A3
NOTE: Do not scale from this drawing.

CLIENT
Systems Connect

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SYDNEY METRO - SYDENHAM TO

Belmore site compound
MWD for cosmetic damage and human annoyance
Work area: Civil work area

Status:
Sheet 1 of 1
Drawing No.
Rev. No.