

## ENDORSEMENT

### CITY & SOUTHWEST ACOUSTIC ADVISOR

Review of	Construction Noise and Vibration Impact Statement for Line-Wide works Portion 3 Crows Nest Station early access works update	Document reference:	Construction Noise and Vibration Impact Statement Portion 3 – Crows Nest early access works Prepared by Renzo Tonin and Associates for Systems Connect.
Prepared by:	Larry Clark, Alternate Acoustics Advisor		<i>TK685-03-09F01 CNVIS C2S_P3 CST Early Access (r11)</i>
Date of issue:	8 March 2021		<i>Dated 22 February 2021</i>

As approved Alternate Acoustics Advisor for the Sydney Metro City & Southwest project, I have reviewed and provided comment on the updated Construction Noise and Vibration Impact Statement (CNVIS) for Line-Wide works Portion 3 – Crows Nest early access works, as required under A27 (d) of the project approval conditions (SSI 15-7400).

I reviewed and commented on previous versions of the CNVIS. Revision 11 of the CNVIS has been updated since the last endorsed version of the CNVIS (r9) to address EPA Notice of Variation requirements.

I am satisfied that revision 11 of the CNVIS is technically valid, and includes appropriate noise and vibration mitigation and management. On this basis I endorse revision 11 of the CNVIS for Line-Wide works in respect of the Crows Nest early access works.



Larry Clark, City & Southwest Alternate Acoustics Advisor

# SYDNEY METRO CITY AND SOUTH WEST - LINE-WIDE WORKS

## Construction Noise and Vibration Impact Statement Portion 3 - Crows Nest early access works

22 February 2021

Systems Connect

TK685-03-09F01 CNVIS C2S\_P3 CST Early Access (r11)

## Document details

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## Document control

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16.06.2020	Updated	-	3	B. Carlyle	-	T. Gowen
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29.10.2020	Updated to include OOH site sheds removal	-	6	B. Carlyle	-	T. Gowen
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**Important Disclaimer:**

The work presented in this document was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001.

This document is issued subject to review and authorisation by the Team Leader noted by the initials printed in the last column above. If no initials appear, this document shall be considered as preliminary or draft only and no reliance shall be placed upon it other than for information to be verified later.

This document is prepared for the particular requirements of our Client referred to above in the 'Document details' which are based on a specific brief with limitations as agreed to with the Client. It is not intended for and should not be relied upon by a third party and no responsibility is undertaken to any third party without prior consent provided by Renzo Tonin & Associates. The information herein should not be reproduced, presented or reviewed except in full. Prior to passing on to a third party, the Client is to fully inform the third party of the specific brief and limitations associated with the commission.

In preparing this report, we have relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, we have not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

We have derived data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination and re-evaluation of the data, findings, observations and conclusions expressed in this report.

We have prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

The information contained herein is for the purpose of acoustics only. No claims are made and no liability is accepted in respect of design and construction issues falling outside of the specialist field of acoustics engineering including and not limited to structural integrity, fire rating, architectural buildability and fit-for-purpose, waterproofing and the like. Supplementary professional advice should be sought in respect of these issues.

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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 3 – Chatswood to Sydenham LWW delivered under Critical State Significant Infrastructure Approval CSSI 7400. Condition E33 of CSSI-7400 requires that:

*Construction Noise and Vibration Impact Statements must be prepared for each construction site before construction noise and vibration impacts commence and include specific mitigation measures identified through consultation with affected sensitive receivers.*

This CNVIS applies to Crows Nest station early access works package, which includes works to be undertaken on the site surface and within the station box and tunnels. Works will be completed during standard construction hours as well as works outside of standard construction hours. 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 C2S Crows Nest early access site. These activities include:

- Site establishment [completed]
- Materials delivery and handling (including delivery of rail) [delivery of rail completed]
- Track works (including flash butt welding) [flash butt welding completed]
- Crane base construction [completed]
- Demobilisation (removal of acoustic shed and covers)
- Removal of site sheds [completed]
- Trenching – temporary service trench and removal of concrete ramps [temporary services trench cancelled]

The site location is identified on an aerial photograph located in APPENDIX B.

The proposed works, likely plant and equipment and indicative Project timing is presented in APPENDIX C. Site layout drawings and construction staging are also presented in APPENDIX C.

#### 2.1.2 Construction traffic

The Crows Nest early access 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 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

CSSI 7400 Condition of Approval E39 requires Systems Connect to consult with proponents of other construction works in the vicinity of the worksite and take reasonable steps to coordinate works to minimise cumulative impacts of noise and vibration and maximise respite for affected sensitive receivers. Further to this, Condition E40 requires works to be coordinated to provide the required respite periods identified in accordance with the terms of the CSSI 7400 approval.

All concurrent Sydney Metro construction site works have been considered and addressed in Section 9 of this CNVIS. Potentially concurrent construction activities within the vicinity of the Crows Nest site have also been considered, as discussed in Section 9.

## 2.2 Construction hours

The construction hours for the Project are defined by Project Planning Approval (PPA) Conditions E36, E37, E38, E41, E42, E44 and E48. The Environment Protection Licence (EPL 21423) is consistent with these Conditions.

### 2.2.1 Standard construction hours

The standard construction hours of work are defined by the CSSI-7400 Condition E36. The standard construction hours for the Project are summarised in the table below.

**Table 2-1: Standard construction hours**

Construction Activity	Monday to Friday	Saturday	Sunday/ Public holiday
Above ground activities: construction sites and construction traffic	7:00 am to 6:00 pm	8:00 am to 1:00 pm	No work

### 2.2.2 Out of hours work periods

CSSI-7400 Condition E44 and E48 allow standard construction hours to be varied under specific conditions (where justified). Condition E48 allows the following activities to be carried out 24 hours per day, 7 days per week:

- Station and tunnel fit out, and
- Haulage and delivery of spoil and materials.

PPA Condition E44 and Condition E46 allow OOHW where it is permitted or required by an EPL, or the Sydney Metro Out of Hours Work Protocol. Systems Connect will not undertake OOHW until approved by an EPL or through the Out of Hours Work Protocol. Oversize deliveries may need to take place outside of standard construction hours in order to comply with RMS requirements for oversize vehicle movements.

The Transport for NSW (TfNSW) Construction Noise and Vibration Strategy (CNVS) [9] 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**

Day	12am	1am	2am	3am	4am	5am	6am	7am	8am	9am	10am	11am	12pm	1pm	2pm	3pm	4pm	5pm	6pm	7pm	8pm	9pm	10pm	11pm
Monday																								
Tuesday																								
Wednesday																								
Thursday																								
Friday																								
Saturday																								
Sunday or Public Holiday																								

- Standard construction hours are defined in CSSI-7400 Condition E36 as: Monday to Friday 7:00am to 6:00pm and Saturdays from 8:00am to 1:00pm.
- 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 Friday 6:00pm to 10:00pm (evenings), Saturday 7:00am to 8:00am and 1:00pm to 10:00pm (day/ OOHD and evening/ OOHE) and Sunday and public holidays 8:00am to 6:00pm (day/ OOHD)
  - OOHW Period 2** is the most sensitive OOH period and is defined as Monday to Saturday 10:00pm to 7:00am (night/ OOHN) and Sundays and public holidays 6:00pm to 8:00am (evening/ OOHE and night/ OOHN).

### 2.2.3 Justification for OOHW

The track works are an essential component of the Project due to be completed and open to rail traffic in 2024. This completion date has been calculated assuming track work, tunnel systems works and fit out works within the tunnel will be undertaken 24 hours a day, seven days per week. Due to time and space constraints it will not be possible to lift all materials into the station box and tunnel during standard hours, to allow track works to continue 24 hours per day. The process will need to continue during the evening period (6pm to 10 pm) and night period (10 pm and 7am).

OOHW activity on the surface and inside the station box, particularly after 10pm will be managed to minimise impacts on surrounding sensitive receivers. Stationary plant will be located at the bottom of the station box during the night period (10 pm to 7am) to reduce potential noise impact and manage noise from site to within the NMLs.

Allowing track works and tunnel fit out works to occur as OOHW will:

- Ensure key NSW Government program milestones are met.
- Ensure delivery of community and rail commuter user benefits.
- Allow increased project efficiency.

- Reduce the overall duration of the construction phase and in turn reduce the duration of impacts on the surrounding community.

The Project has been identified as Critical State Significant Infrastructure by the NSW Government and will provide an important commuter link connecting the existing Sydney Metro North West with the CBD and South West. There are considerable benefits to the Project, NSW Government and the community from the prompt completion of construction of the Project. For the community particularly, completion of construction works will allow restoration of amenity and, in many respects, an increase in the quality of this amenity.

This, however, will be reviewed once works start and we have a better understanding of the logistics of the work (how efficiently they run and how heavily they are impacted by effects such as supply, traffic impact, etc).

Removal of the site sheds must be completed outside standard construction hours, during the night period (10pm to 7am). The sheds are located adjacent to the Pacific Highway and will require a two lane closure under Road Occupancy Licence (ROL) to complete the removal works safely. Under an expected ROL between 10pm and 5am, two southbound lanes of the Pacific Highway would be closed to allow crane set-up on the Pacific Highway and space for delivery heavy vehicle to be loaded with the site sheds, for removal from site. It is anticipated that the site shed removal works would be completed within two nights.

Any work outside standard construction hours must be undertaken in accordance with an EPL, or 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 – Infrastructure Construction Work Days) Order 2020 commenced on 9 April 2020 and will continue until 25 March 2021. The order permits standard construction hours on this project to be extended as follows:

- Saturday from 1pm to 6pm (no high noise work permitted)
- Sundays from 7am to 6pm (no high noise work permitted)
- Public holidays from 7am 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.

The early access works that are the subject of this CNVIS are permitted 24 hours per day, 7 days per week under CSSI 7400 Condition E48 (see Section 2.2.2), with the exception of:

1. Site establishment works

2. Crane base construction (excluding rock hammering, as this is a high noise impact activity)
3. Acoustic shed demobilisation.

These activities will be carried out during the COVID-19 extended construction 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 site 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, with some modifications to allow for site specific characteristics.

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

#### 3.2 Other sensitive receivers (PPA Condition E34)

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

CSSI-7400 Condition E34 states:

*Noise generating works in the vicinity of potentially-affected, religious, educational, community institutions and noise and vibration-sensitive businesses and critical working areas (such as theatres, laboratories and operating theatres) must not be timetabled within sensitive periods, unless other reasonable arrangements to the affected institutions are made at no cost to the affected institution or as otherwise approved by the Secretary.*

Sydney Metro and Systems Connect have undertaken consultation with identified sensitive receivers to determine sensitive periods. This has been taken into consideration in finalising respite strategies for high noise impacts.

#### 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 A.2 of the CNVMP. Table 3.1 identifies the heritage-listed structures close to work areas.

**Table 3.1: Assessment heritage receivers**

Name	Address/Location	Significance
St Leonards Centre	28 - 34 Clarke Street	Local
Higgins Buildings	366 - 376 Pacific Highway	Local



## 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)[10], CSSI-7400 Conditions, in accordance with the Sydney Metro City & Southwest Construction Noise and Vibration Strategy (SMCSNVS) [8] and as set out in the CNVMP.

For the Crows Nest site, external NMLs are derived from the Interim Construction Noise Guideline (ICNG)[3], as identified in Section 5.1.1 of the CNVMP[1] and summarised in Table 4-1 below. Internal NMLs are also applicable at residential receiver locations during the 7 am to 8 pm period through CSSI-7400 Conditions E37 and E38; and 8 pm to 7 am period per E41 and E42, as summarised in Table 4-1 below.

**Table 4-1: Application of NMLs at CS2 Crows Nest (CSSI 7400 Conditions of Approval)**

Time Period	Area	Receiver Type	Condition	Noise management level <sup>3, 5</sup>
<b>ICNG</b>				
Day <sup>1</sup>	All	All	CNVS <sup>3</sup> Section 5.3	ICNG (see Table B1 in APPENDIX B)
Day <sup>1</sup> OOHV Period 1	All	All	CNVS <sup>3</sup> Section 5.3	ICNG (see Table B1 in APPENDIX B)
Evening <sup>1</sup> OOHV Period 1	All	All	CNVS <sup>3</sup> Section 5.3	ICNG (see Table B1 in APPENDIX B)
Night <sup>1</sup> OOHV Period 2	All	All	CNVS <sup>3</sup> Section 5.3	ICNG (see Table B1 in APPENDIX B)
<b>CSSI-7400</b>				
Day <sup>1</sup> (D/ D(O)) Evening <sup>1</sup> 6pm to 8pm (E1)	Identified precincts (inc Crows Nest)	All	CSSI-7400 E38	Noise levels are required to be less than $L_{Aeq(15\text{ minute})}$ 60 dB(A) for at least 6.5 hours between 7am and 8pm, of which at least 3.25 hours must be below $L_{Aeq(15\text{ minute})}$ 55 dB(A). Noise equal to or above $L_{Aeq(15\text{ minute})}$ 60dB(A) is allowed for the remaining 6.5 hours between 7am and 8pm. <sup>4</sup>
Evening <sup>1</sup> 8pm to 10pm (E2) Night <sup>1</sup> 10pm to 7am (N)	Residential zones <sup>2</sup>	Residential	CSSI-7400 E42	$L_{Aeq(15\text{ minute})}$ 45 dB(A) (internal)
All	All	All	CSSI-7400 E43	$L_{Aeq(8\text{ hour})}$ 85 dB(A) (external) near the CCSI

- Day refers to 7am to 6pm Monday to Friday and 8am to 6pm Saturday, Sunday and Public Holidays; Evening refers to Monday to Sunday 6:00pm to 10:00pm; Night refers to Monday to Friday 10:00pm to 7:00am and Saturdays, Sundays and public holidays 10:00pm to 8:00am.
- These are identified by the applicable Local Environmental Plan land zoning of the receiver.
- Sydney Metro City & South West Construction Noise and Vibration Strategy (Sydney Metro 2016)
- Criteria as described in SSI 7400 Condition E38
- A 5 dB penalty shall be applied if rock breaking or any other annoying activity likely to result in ground-borne noise or a perceptible level of vibration is planned

#### 4.1.2 Sensitive receiver NMLs and respite for high noise impact works (CSSI-7400 Conditions E37 and E38)

Day-time works need to be assessed against the requirements of CSSI-7400 Conditions E37 and E38. Consultation will be undertaken with receivers predicted to experience internal noise levels greater than  $L_{Aeq(15\text{minute})}$  60 dB(A), between 7am and 8pm, to determine appropriate hours of respite in accordance with CSSI-7400 Conditions E37 and E38. Receivers have been identified using the following process:

- An NML equivalent to an internal noise level of  $L_{Aeq(15\text{minute})}$  60 dB(A) was established for all identified receivers:
  - For residential receivers, the equivalent external NML is based on a 10 dB(A) minimum (conservative) difference between external and internal noise levels (assuming windows open)
  - For non-residential receivers with light weight glazing, the equivalent external NML is based on a 20 dB(A) minimum (conservative) difference between external and internal noise levels (assuming windows closed)
  - For non-residential receivers with heavy glazing, the equivalent external NML is based on a 25 dB(A) minimum (conservative) difference between external and internal noise levels (assuming windows closed)
  - Where additional information is available (e.g. if residential or non-residential properties have been acoustically treated), alternative outdoor to indoor noise difference will be determined to establish the equivalent external noise threshold
- Receivers where noise is predicted to be above the equivalent external NML are identified in APPENDIX F as requiring consultation.

The adopted difference between external and internal noise levels is identified in APPENDIX F.

#### 4.1.3 Residential receiver NMLs – 8pm to 7am (CSSI-7400 Conditions E41 and E42)

CSSI-7400 Conditions E41 and E42 require that residential receivers within non-residential zones or residential zones (respectively) are not above the internal noise levels identified in Table 4-1. In accordance with CSSI-7400 Conditions E41 and E42, if construction works are particularly annoying (as described in *ICNG NMLs* above) or include ground-borne noise or a perceptible level of vibration at the affected receiver, a 5 dB(A) penalty should be added to the predicted construction noise level.

Where the above internal noise levels cannot be achieved, additional mitigation in accordance with the *Sydney Metro City and South West Noise and Vibration Strategy (SMCSNVS)* [8] is to be offered.

Addendum A of the SMCSNVS notes that the applicable Local Environmental Plan land zoning of the receiver be used to identify if residential receivers are located within residential or non-residential zones. An extract from the North Sydney Local Environmental Plan 2013 land zoning map LZN\_001 and Lane Cove Local Environmental Plan 2009 land zoning map LZN\_004 is provided in Figure 4.1 and Figure 4.2 respectively. Red and pink areas (R2, R3 and R4) indicate residential zones. The zoning map indicates

that the nearest residential receivers to the Crows Nest site are in mixed use areas (zone B4 in Figure 4.1).

Figure 4.1: Extract from the North Sydney Local Environmental Plan 2013 land zoning map LZN\_001

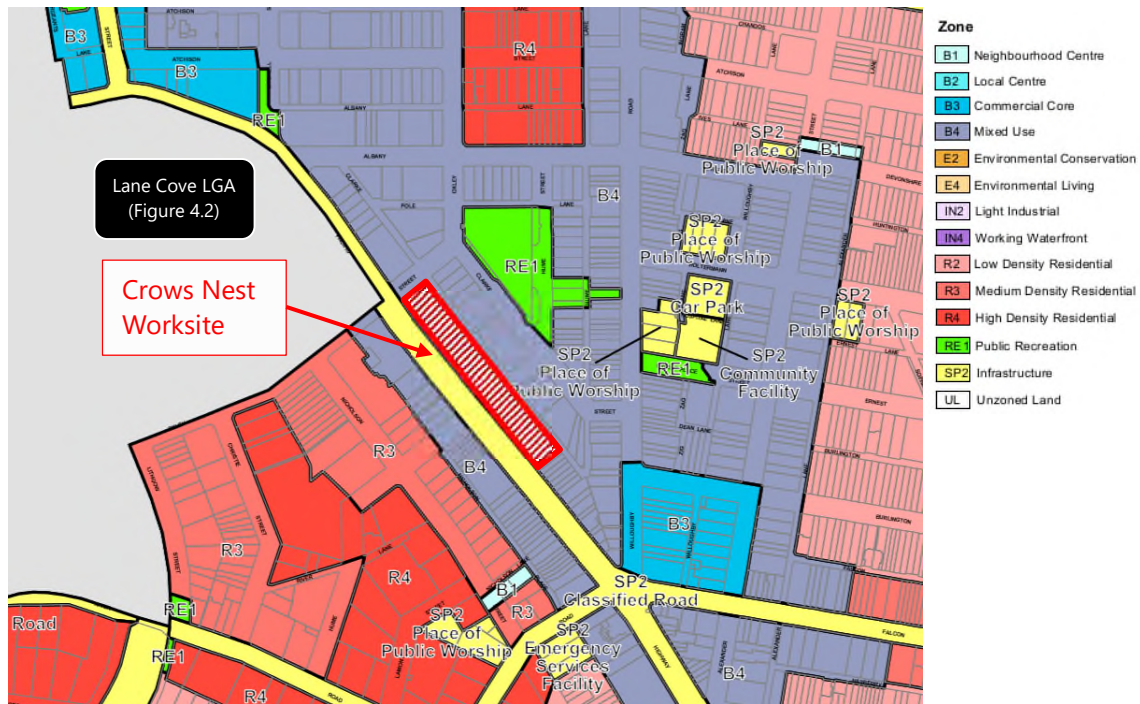
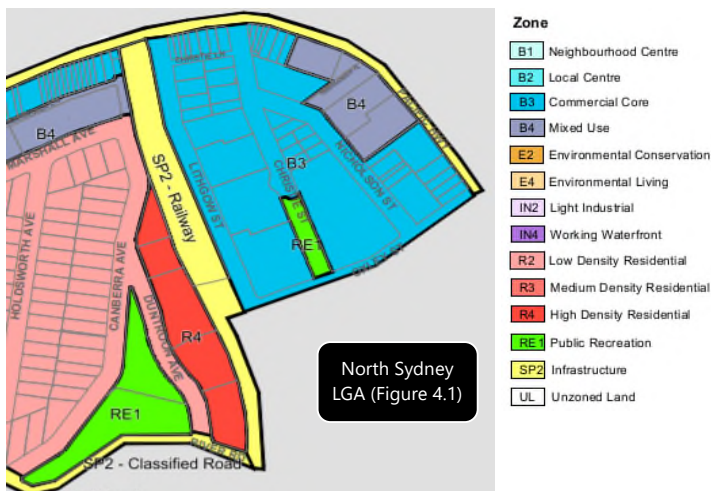


Figure 4.2: Extract from Lane Cove Local Environmental Plan 2008 land zoning map LZN\_004



For this assessment, all residential receivers are conservatively assumed to be in residential zones, with a corresponding internal noise threshold level of  $L_{Aeq(15\text{minute})}$  45 dB(A) between 8pm and 7am. Based on a minimum (conservative) external to internal noise difference of 10 dB(A) (assuming windows open), an equivalent external noise threshold of  $L_{Aeq(15\text{minute})}$  55 dB(A) is applicable between 8pm and 7am for all receivers except for those that are receiving at-property treatments from TfNSW due to the operation of the rail corridor. In this case, a conservative external noise threshold of  $L_{Aeq(15\text{minute})}$  65 dB(A) is

considered. Where these external equivalent levels are above the external noise threshold, additional mitigation may be required in accordance with the SMCSNVS.

The assessment presented in Section 5.2 has assessed all receivers against the approach outlined in the SMCSNVS [8] and the CNVMP [1] which achieves the requirements of PPA Conditions E41 and E42, and is consistent with the ICNG [3] and the EIS [2].

#### 4.1.4 Sleep disturbance

Consistent with Section 5.1.3 of the CNVMP [1], an initial screening level of  $L_{Amax} \leq L_{A90(15min)} + 15 \text{ dB(A)}$  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.

#### 4.1.5 National Standard for exposure to noise

In accordance with PPA Condition E43, Systems Connect worksites will be managed to ensure that noise generated by construction will not be above the National Standard for exposure to noise in the occupational environment of an eight-hour equivalent continuous A-weighted sound pressure level of  $L_{Aeq,8h}$ , of 85 dB(A) for any employee working at a location near a Systems Connect worksite.

#### 4.1.6 Construction related road traffic noise objectives

On the roads immediately adjacent to construction sites, the community may associate heavy vehicle movements with the Crows Nest site. 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) [4]
- 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 [5] and
  - German Standard DIN 4150-3: Structural Vibration - effects of vibration on structures [6].

### 4.2.1 Disturbance to building occupants (human annoyance)

For disturbance to human occupants of buildings, we refer to 'Assessing Vibration; a technical guideline' [4]. This document provides criteria which are based on the British Standard BS 6472-1992, 'Evaluation of human exposure to vibration in buildings (1-80Hz)' [7].

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 4-2.

**Table 4-2: Construction vibration disturbance goals**

Location	Assessment period <sup>1</sup>	Vibration Dose Value (VDV), m/s <sup>1.75</sup>	
		Preferred values	Maximum values
Critical areas <sup>2</sup>	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 is given below:

- Reinforced or framed structures (Line 1): 25.0 mm/s
- Unreinforced or light framed structures (Line 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 Heritage

Section 4.2.3 of the CNVMP [1] outlines the approach to manage potential vibration impacts on heritage items, where identified. The actions to be taken shall be to:

- 1) Identify heritage items where the 2.5 mm/s peak component particle velocity objective may be exceeded during specific construction activities
- 2) Structural engineering report to be undertaken on identified heritage items, to confirm structural integrity of the building and confirm if item is 'structurally sound'
- 3) If item confirmed as 'structurally sound', the screening criteria in Section 4.2.2 shall be adopted, or
- 4) If item confirmed as 'structurally unsound', the more conservative cosmetic damage objectives of 2.5 mm/s peak component particle velocity would be adopted.

#### 4.2.4 Sensitive scientific and medical equipment

Proposed works will take place in proximity to Crows Nest Day Surgery (22 Clarke Street), which is used for dental and eye surgery. Operating hours are 7am to 5pm, Monday to Friday, and operations are generally confirmed three days in advance.

A draft property assessment commissioned by Transport for NSW adopted a screening criterion of 0.025 mm/s (VC-B criterion from ASHRAE) for eye surgery procedures and 0.1 mm/s for other surgery procedures.

Consultation with the surgery where construction activities are predicted to generate vibration levels that exceed the screening criteria when operating theatres are in use.

#### **4.2.5 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 and the likely timing of each activity/aspect.
- 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. A staging diagram for the works is presented in APPENDIX C.



### 5.1.1 Detailed design outcomes

During the site design process, Renzo Tonin & Associates played a key role in assisting Systems Connect to determine the noise mitigation measures required to reduce the site's noise impact, incorporating existing mitigation measures from previous stages of the project. The key noise mitigation measures that have been included in the noise modelling results presented in this CNVIS are the following:

- Acoustic shed for deliveries;
- A full acoustic cover over the station box, with all penetrations sealed, including those around the ventilation fans. Track Works (including flash butt welding) and Crane Base Construction to occur under the cover. Trenching and ramp removal to occur without the cover in place;
- 2.1 metre high noise barriers around the site;
- Attenuated pumps, compressors, ventilation fans and other plant/equipment.
- Shed doors must be closed at all times, except the minimum time necessary to allow vehicles to enter or exit.
- Heavy vehicle movements restricted to 4 per hour during E2 and night.
- Demolition saw not to operate during E2 and night.
- Only one grinder to operate at any one time during E2 and night.

The above listed mitigation measures, include but are not limited to, all the existing measures that have previously been implemented for the TSE works which will remain on site and will not be altered from the existing configuration. The exception is that the full acoustic cover over the station box and shed which will be removed towards the end of the early access works as noted in Table C1 in APPENDIX C.

### 5.1.2 Construction activities

Table 5-1 presents a summary of the construction activities and aspects that are proposed to take place during the works. Note, the Track Works will be undertaken within the tunnel and are not expected to contribute to the Rail Welding works and Crane Base Construction occurring within the station box.

There may be a period of 1 month where the Track Works will occur whilst the acoustic cover and acoustic shed is being dismantled. During this period, noise impacts are not expected as the Track works will be occurring well within the tunnel. Works will be managed to ensure no noise impact. Furthermore, given the acoustic shed will be the last thing to be removed, surface deliveries are unlikely to occur without the acoustic shed in place. In the event deliveries occur without the shed, noise levels will be approximately 10-15 dB(A) higher than that predicted for Delivery (D) scenario and will be restricted to Daytime and E1 period only.

The trenching activities (duration 2 weeks - cancelled) and ramp removal (duration 1 week) will occur when the cover has almost completely been removed. The predictions assume there is no cover during trenching and ramp removal.

**Table 5-1: Summary of construction activities**

Activity	Aspect	Assessment reference	Work period	Duration
Site establishment (surface works)	Site already Established - Maintain site / enviro controls and hoardings	SE	Day & E1 (E2 & Night - light vehicles only)	August 2020 to September 2020 [completed]
Deliveries (surface works)	Deliver FBW Plant and equipment, track materials Deliver Rail	D	Day, E1, E2 & Night	August 2020 to November 2020
Rail Welding (track level works)	Flash butt Welding	W	Day, E1, E2 & Night	September 2020 to November 2020 [completed]
Crane Base Construction (track level works)	Crane Base Construction	CB	Day & E1	September 2020 to November 2020
Demobilisation (surface and track level works)	Remove acoustic shed and covers (to commence following the completion of FBW and Crane Base Construction)	DEM	Day & E1	November 2020 to January 2021
Removal of site sheds	Remove site sheds (3 sheds at the northern end)	R_North	Night	Two nights, November 2020
	Remove site sheds (4 sheds at the southern end)	R_South		
Trench at the bottom of the station box for temporary tunnel services and removal of concrete ramps	Excavation with Saw and spoil removal of trench	TER (SAW)	Day & E1	Trenching [cancelled]: 5-10 days December 2020 Ramp removal: 5 days January 2021
	Excavation with 20t rockhammer and spoil removal of trench	TER (H20)		
	Excavation with 13t rockhammer and spoil removal of trench	TER (H13)		
	Backfill of trench	TB		
Track Works (tunnel activities between Crows Nest and Victoria) and some surface deliveries	Surface deliveries Rail distribution Tunnel track activities Material handling and distribution Tunnel support systems Cross passage fit-out	n/a – except for surface deliveries all work located in tunnel	Day, E1, E2 & Night	September 2020 to December 2020

## 5.2 Predicted noise levels

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

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.

## 5.2.1 ICNG NMLs

### 5.2.1.1 ICNG Standard construction hours

Table 5-2 presents the predicted worst-case construction noise levels for each of the construction stages identified in Table 5-1 at the most affected receiver in each NCA. The results are presented in terms of level above the ICNG standard daytime NMLs.

For **Standard Hours** construction noise impacts are presented as follows:

- Below NML
- < 10dB(A) above NML - construction noise clearly audible
- ◆ > 10dB(A) above NML - construction noise moderately intrusive
- > 75dB(A) - highly noise affected (for residential receivers)

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

NCA	Construction scenario (see Table 5-1)													
	SE	D	W_H	D+ W_H	CB_H	DEM	TER_H (SAW)	TER_H (H20)	TER_H (H13)	W_L	D+ W_L	CB_L	TER_L	TB
CN_01	●	●	●	●	●	□	□	□	□	●	●	●	●	●
CN_02	○	●	●	○	●	○	●	●	●	●	●	●	●	○
CN_03	●	●	●	●	●	●	○	○	●	●	●	●	●	●
CN_04	●	●	●	●	●	○	●	●	●	●	●	●	●	●
CN_05	●	●	●	●	●	●	●	●	●	●	●	●	●	○
OSR	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆

Notes: OSR: this includes all commercial, industrial and other sensitive receivers

During the standard daytime period, works are typically below or within 10 dB(A) of the ICNG NMLs for assessed residential receivers. The exceptions are:

- One receiver in NCA CN\_01 (22 Clarke Street, Crows Nest) during Demobilisation
- Two receivers in NCA CN\_01 (22 Clarke Street, Crows Nest and 545 Pacific Highway, St Leonards) during trenching excavation [cancelled] and removal of concrete ramps when using a saw or a Rockhammer (13t or 20t) at the nearest end of the station box.

The exceedance is a worst case scenario when works are occurring at the at the closest end of the station box to the receiver and would not occur for the full extent of works.

Noise levels at nearby other (mainly commercial) sensitive receivers are predicted to be less than 20dB(A) above the NMLs during all assessed activities. The Demobilisation, trenching excavation [cancelled] and removal of concrete ramps are predicted to cause the greatest impact to the closest other sensitive receivers (6-8 Clarke Street, Crows Nest; 10-12 Clarke Street, Crows Nest; 20 Clarke Street, Crows Nest; 28-34 Clarke Street, Crows Nest; 38 Oxley Street, St Leonards) .

All reasonable and feasible noise mitigation measures have been incorporated into the site design, as outlined in Section 5.1.1. Further mitigation measures that would be adopted, where practicable, are identified in Section 5.3. Further, it is necessary to apply Planning Approval Conditions E37 and E38 in order to manage impacts (see Section 5.2.2).

### 5.2.1.2 ICNG OOHW

Table 5.3 presents the predicted worst-case construction noise levels for each of the construction stages identified in Table 5-1 at the most affected receiver in each NCA. The results are presented in terms of level above the ICNG NMLs for the OOHW period.

- Below 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 Period 1 and 2**

NCA	Construction scenario (see Table 5-1)									
	Evening				Night					
	SE	D	W_L	D+ W_L	SE	D	W_L	D+ W_L	R_North	R_South
CN_01	●	●	●	●	●	◆	◆	◆	■	○
CN_02	●	◆	○	◆	●	◆	◆	◆	●	●
CN_03	●	●	●	●	●	◆	◆	◆	◆	■
CN_04	●	●	●	●	●	◆	◆	◆	■	□
CN_05	-	●	●	●	-	●	●	●	●	●
OSR	○	■	◆	■	○	■	◆	■	◆	○

Notes: Evening (E1/E2): Evening period from 6pm to 10pm

Night-time (N) period from 10pm to 7am Sunday to Thursday and 10pm to 8am Fridays, Saturdays and Public Holidays.

During the OOHW evening, predicted noise levels are generally less than 5dB above the ICNG NMLS for all residential receivers. The exceptions are two residential receivers in NCA CN\_02 (39 and 43 Hume

Street, Crows Nest) during Deliveries (and Deliveries plus Welding (low impact) as a result of the deliveries).

During the OOHW night-time period, noise levels are predicted to be between 5 to 15dB(A) above the ICNG NMLs at the most affected residential receivers for most of the activities required to be completed during the night period. During the removal of site sheds, which due to road occupancy requirements must be completed at night, the impacts are predicted to be higher at the closest receivers to the works. There are two receivers where predicted noise levels are more than 25 dB(A) above the NML (368 and 370 Pacific Highway, Crows Nest).

Noise levels at nearby other sensitive (mainly commercial) receivers are generally predicted to be between 5 to 15dB(A) above the ICNG NMLs (or marginally higher) during the assessed evening activities. It is noted that these receivers are unlikely to be occupied outside standard construction hours.

As the ICNG NMLs have not been achieved for all proposed activities on the site, all reasonable and feasible noise mitigation and management measures would be implemented. These mitigation and management measures are discussed in Section 5.1.1 and 5.3 of this report. Further, it is necessary to apply Planning Approval Conditions E41 and E42 in order to manage impacts (see Section 5.2.3).

## 5.2.2 CSSI-7400 Conditions E37 and E38

The following sections present the predicted worst-case construction noise levels for each of the construction stages identified in Table 5-1 at the most affected residential receiver in each NCA and other sensitive receivers (OSR). The results are compared with the internal NMLs in CSSI-7400 Conditions E37 and E38. Where the measured or predicted noise levels are above the equivalent external NML, consultation will be undertaken with affected receivers to determine appropriate hours of respite in accordance with PPA Conditions E37 and E38.

The impacts presented are as follows:

- ◆ Noise levels predicted to be below internal NMLs in PPA Conditions E37 and E38
- Noise levels predicted to be above internal NMLs in PPA Conditions E37 and E38.

**Table 5-4: Summary of construction noise impacts – CSSI-7400 Conditions E37/ E38**

NCA	Construction scenario (see Table 5-1)													
	SE	D	W_H	D+ W_H	CB_H	DEM	TER_H (SAW)	TER_H (H20)	TER_H (H13)	W_L	D+ W_L	CB_L	TER_L	TB
CN_01	◆	◆	◆	◆	◆	◆	□	□	◆	◆	◆	◆	◆	◆
CN_02	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
CN_03	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
CN_04	◆	◆	◆	◆	◆	□	◆	◆	◆	◆	◆	◆	◆	◆
CN_05	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
OSR	◆	◆	◆	◆	◆	◆	□	◆	◆	◆	◆	◆	◆	◆

NCA	Construction scenario (see Table 5-1)												
	SE	D	W_H	D+ W_H	CB_H	DEM	TER_H (SAW)	TER_H (H20)	TER_H (H13)	W_L	D+ W_L	CB_L	TER_L TB

Notes:

Day: 7am to 6pm Monday to Saturday and 8am to 6pm Sunday and Public Holidays

E1: Evening period from 6pm to 8pm.

OSR: this includes all commercial, industrial and other sensitive receivers.

H: includes construction with high noise impact plant (demolition saw, rock hammer and anchor drill)

L: includes construction without high noise impact plant (demolition saw, rock hammer and anchor drill)

Based on the results presented in Table 5-4 above, noise levels are predicted to be below the NMLs in PPA Conditions E37/E38 during the 7 am to 8 pm day/evening period at all locations. The exceptions are:

- One receiver in NCA CN\_04 (368 Pacific Highway, Crows Nest) during Demobilisation
- One receiver in NCA CN\_01 (22 Clarke Street, Crows Nest) during trenching excavation [cancelled] and removal of concrete ramps when using a saw or a 20t Rockhammer at the nearest end of the station box
- Two Other Sensitive Receivers (20 Clarke Street, Crows Nest and 10-12 Clarke Street, Crows Nest) during Trenching Excavation [cancelled] when using a saw

All receivers with predicted internal  $L_{Aeq(15\text{minute})}$  noise levels greater than 60 dB(A) (see APPENDIX F) will be consulted to determine appropriate hours of respite in accordance with CSSI-7400 Conditions E37 and E38. Additional mitigation measures will be implemented in accordance with the documented procedure in Addendum A of the SMCSNVS.

The respite hours will be 7-8am, 10-11am, 12.30-1.30pm and 4.30-6pm unless consultation determines that other hours are more appropriate

For more detailed predictions, see APPENDIX D. For more detailed additional noise measures, refer to Section 5.3.

### 5.2.3 PPA Conditions E41/42

Table 5-5 summarises the predicted noise impacts for each construction stage in each NCA compared with the internal NMLs in CSSI-7400 Conditions E41 and E42. Where predicted levels are above the E41/42 NMLs at residential receivers, additional mitigation measures will be implemented in accordance with the documented procedure in Addendum A of the SMCSNVS.

The impacts presented are as follow:

- ◆ Noise levels predicted to be below internal NMLs in PPA Conditions E41 and E42;
- Noise levels predicted to be above internal NMLs in PPA Conditions E41 and E42.

**Table 5-5: Noise level summary for PPA Conditions E41/42 (residential only)**

NCA	Construction scenario (see Table 5-1)									
	E2				N					
	SE	D	W_L	D+ W_L	SE	D	W_L	D+ W_L	R_North	R_South
CN_01	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
CN_02	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
CN_03	◆	◆	◆	◆	◆	◆	◆	◆	◆	□
CN_04	◆	◆	◆	◆	◆	◆	◆	◆	□	□
CN_05	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆

Notes:

E2: Late evening period from 8pm to 10pm.

N: Night-time period from 10pm to 7am.

The results in Table 5-5 indicate that construction noise is predicted to comply with the internal noise threshold of PPA Conditions E41/E42 at the nearest residential receivers within all NCAs. The exceptions are during the night period when removal of the site sheds occurs:

- Northern site shed removal -
  - One receiver in NCA CN\_04 (402-420 Pacific Highway)
- Southern site shed removal -
  - Three receivers in NCA CN\_03 (463 Pacific Highway, 469A Pacific Highway and 471A Pacific Highway); and
  - Seven receivers in NCA CN\_04 (332 Pacific Highway, 334 Pacific Highway, 336 Pacific Highway, 348 Pacific Highway, 368 Pacific Highway, 370 Pacific Highway and 374 Pacific Highway).

The works will take two nights to complete, with each shed lift taking approximately 30 minutes. Receivers will only exceed the NML for one night, with most receivers being impacted during the southern site shed removal works.

The works cannot be undertaken safely without an ROL in place. Physical noise mitigation measures such as temporary noise screens have been considered, but are not feasible or reasonable as there is limited space in the road occupancy corridor to install them, and both the receivers and the noise generating works will typically be above the height of temporary noise screens. Impacts will be managed to reduce noise impacts by adopting the site noise control measures referenced in Table 5-6, where practicable. In accordance with the CNVMP, the additional mitigation measures outlined in Section 5.3.3 will be offered to sensitive receivers that qualify.

Based on the assessment conducted for this CNVIS, sawing works at the base of the station box for the track works would exceed the internal noise levels and has therefore been excluded during the evening and night-time periods. Onsite measurements should be conducted to validate the noise levels presented in APPENDIX C for the sawing activity. If measured noise levels at the most affected residences are found to comply with the PPA Conditions E41/E42, sawing could be undertaken.

Proposed measures for managing potential noise impacts are provided in Section 5.3. For more detailed predictions, see APPENDIX D.

Based upon results presented in Section 5.2, additional noise mitigation is not required other than for the removal of site sheds during the night. For more detailed additional noise measures, refer to APPENDIX E.

#### 5.2.4 Sleep disturbance

Maximum noise levels associated with on-site heavy vehicle movements may potentially cause sleep disturbance at nearby residential receivers. Some heavy vehicle movements are required at night time, to:

- deliver rail required to support track works [completed];
- transport the site sheds removed from the site over two nights [completed].

Heavy vehicles and metal-on-metal bangs from rail unloading and site shed lifts may cause  $L_{max}$  noise levels greater than the sleep disturbance screening criterion. Noise emission from rail unloading are predicted to be lower than those associated with site shed lifts and heavy vehicle movements entering and exiting the site, as rail unloading will only occur within the acoustic shed.

Heavy vehicles and unloading associated with rail deliveries are expected to be infrequent and will only occur 4 times per night-time shift. Heavy vehicles and site shed lifts will only occur for two nights. The nearest residences on the Pacific Highway and Clarke Street are already exposed to frequent maximum noise events from heavy vehicle traffic on the Pacific Highway, as shown in the noise logger graphs provided in the EIS.

These activities will be managed by instructing truck drivers to minimise unnecessary acceleration, avoid vigorous slamming of truck doors, installing air brake silencers and broadband reversing alarms on heavy vehicles, unloading material only within the acoustic shed and minimising heavy vehicle movements where practicable.

The potential of loose items or plant/equipment that could generate metal-on-metal bangs will be identified and managed accordingly. For rail unloading, the utilisation of a special lifting attachment 'clamp' (which rigidly holds 7 rails at a time) will be adopted to minimise the duration of unloading and limit the extent of bangs and clangs (the clamp does not contain lifting chains that come in contact with each other or the rails). For site shed lifts, where practical the use of slings rather than chains will be utilised.

In addition, toolbox talks will be used to advise all personnel of the need to follow quiet work practices during OOHW periods and of the need to respect the residential receivers surrounding the work site. Other management measures are outlined in Section 5.3 to aid in providing additional noise reduction benefits where noise is above the criterion.



## 5.3 Noise mitigation and management

### 5.3.1 Consultation with affected receivers (CSSI-7400 Condition E33)

CSSI-7400 Condition E33 requires consultation with affected receivers to assist in determining site-specific mitigation measures to be included in this CNVIS.

Systems Connect will continue consultation with potentially affected stakeholders including business and residential receivers regarding specific mitigation measures applicable to the construction works at the Crows Nest Station site. Consultation is undertaken to understand stakeholders' noise and vibration expectations and preferences for timing of high impact noise respite. This is consistent with the requirements in CSSI-7400 Conditions E34 and E38.

Systems Connect will continue to consult with potentially affected sensitive receivers, both prior to and following commencement of construction. Consultation is informing and will continue to inform the identification of specific mitigation measures for the Crows Nest site. These measures may include minimising high noise impact works during night time hours; limiting night time works in individual locations to no more than two consecutive nights; scheduling high noise impact works around sensitive periods where feasible and reasonable; offers of movie or dinner vouchers; alternative accommodation offers.

### 5.3.2 Site noise control measures

In addition to the noise mitigation measures identified during detailed design (see Section 5.1.1), the following Table 5-6 presents additional noise control measures recommended to reduce and manage potential noise impacts. Table C1 in APPENDIX C notes specific management measures for the key construction stages to reduce noise impacts.

**Table 5-6: Site noise control measures**

Control type	Control measure	Typical use
At-source control measures	Limit equipment in use	Only the equipment necessary during each stage of the works 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.
	Truck movements	Where practicable, avoid the use of park air brakes at night. Set up relevant traffic management measures to minimise the use of air brakes when leaving site. Air brake silencers are to be correctly installed and fully operational for any heavy vehicles (as per CNVMP). Minimise unnecessary acceleration on site and avoid vigorous slamming of truck doors.

Control type	Control measure	Typical use
	Limit clangs and bangs at night	Identify potential of loose items or plant/equipment that could generate metal-on-metal bangs and managed accordingly.
	Non-tonal reversing alarms	Alternative reverse alarms, such as 'quackers' will be installed on all vehicles & mobile plant regularly used on site and on all vehicles & mobile plant required for OOHV.
Path mitigation measures	Temporary noise screens	Where practicable, temporary noise screens (e.g. Flexshield, Echo-barrier, or similar) should be used to provide additional noise reduction during works. Temporary noise screens can provide 5 to 10 dB noise reduction, where they can break line of sight.
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: <ul style="list-style-type: none"> <li>• location of nearest sensitive receivers</li> <li>• relevant project specific and standard noise and vibration mitigation measures;</li> <li>• permitted hours of work;</li> <li>• OOHV Procedure and Form</li> <li>• construction employee parking areas.</li> </ul>
	Community consultation	Inform community of construction activity and potential impacts.
	Respite periods	Noise levels are required to be less than $L_{Aeq(15 \text{ minute})}$ 60 dB(A) for at least 6.5 hours between 7am and 8pm, of which at least 3.25 hours must be below $L_{Aeq(15 \text{ minute})}$ 55 dB(A). Noise equal to or above $L_{Aeq(15 \text{ minute})}$ 60 dB(A) is allowed for the remaining 6.5 hours between 7am and 8pm.
	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 5.3.4.

### 5.3.3 Additional noise mitigation measures

Table 5-7 below should be used to advise the appropriate additional noise mitigation during construction, based on the CNVS [9] and the CNVMP [1].

Table 5-7: Additional airborne noise mitigation measures

When is the work being undertaken?	Predicted $L_{Aeq,15min}$ noise level above		Identify additional management measures to be implemented	
	Background (RBL)	Noise Management Level (NML)		
<b>Standard Hours</b> M-F 7am to 6pm Sat 8am to 1pm	0 to 10 dB(A)	-	-	-
	> 10 to 20 dB(A)	≤ 10 dB(A)	-	-
	> 20 to 30 dB(A)	> 10 to 20 dB(A)	LB, M	[MM2]
	> 30 dB(A)	> 20 dB(A)	LB, M	[MM2]
<b>OOHW Period 1</b> M-F 6pm to 10pm Sat 1pm to 10pm Sun/ PH 8am to 10pm	0 to 10 dB(A)	≤ 5 dB(A)	-	-
	> 10 to 20 dB(A)	> 5 to 15 dB(A)	LB	[MM1]
	> 20 to 30 dB(A)	> 15 to 25 dB(A)	LB, M	[MM2]
	> 30 dB(A)	> 25 dB(A)	LB, M, IB, PC, RO, SN	[MM3]
<b>OOHW Period 2</b> M-F 10pm to 7am Sat 10pm to 8am Sun/ PH 6pm to 8am	0 to 10 dB(A)	≤ 5 dB(A)	-	-
	> 10 to 20 dB(A)	> 5 to 15 dB(A)	LB, M	[MM2]
	> 20 to 30 dB(A)	> 15 to 25 dB(A)	LB, M, IB, PC, RO, SN	[MM4]
	> 30 dB(A)	> 25 dB(A)	LB, M, IB, PC, RO, SN, AA	[MM5]

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  
 M = Monitoring  
 IB = Individual briefings  
 SN = Specific notifications  
 PC = Phone calls and emails  
 RO = Project specific respite offer  
 AA = Alternative accommodation

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

Prior to starting work, residential receivers around the site, identified in APPENDIX E, will be notified to advise that noise from the works may at times be audible. Note that 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 5.3.5).

During the 8pm to 7am evening/night period, additional noise mitigation measures (i.e. respite offers, relocation or at-property treatments), determined in accordance with the SMCSNVS, will be considered at affected residential receivers where internal noise levels are predicted to be above the  $L_{Aeq(15minute)}$  45 dB(A) threshold between 8pm and 7am.

### 5.3.4 Attended noise monitoring

Real time noise monitoring in accordance with CSSI-7400 Condition C11 is not proposed to be undertaken for the Crows Nest site. Attended noise monitoring will be undertaken as required by this CNVIS. 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.

Attended noise monitoring will be undertaken during works at one of the representative residential receivers identified in the table below. Nominated attended measurement locations have been selected with the best opportunity to validate the predicted noise levels.

**Table 5-8: Nominated verification monitoring locations**

NCA	Nominated receiver address	Monitoring location at 1 m from
CN_01	22 Clarke Street	South-western façade facing Clarke Lane
CN_02	39 Hume Street	Western façade
CN_03	473 Pacific Highway	North-eastern façade
CN_03	471A Pacific Highway	South-western façade facing Pacific HWY
CN_04	374 Pacific Highway	North-eastern façade
CN_04	400 Pacific Highway	North-eastern façade
OSR	20 Clarke Street	South-western façade facing Clarke Lane
	10-12 Clarke Street	South-western façade facing Clarke Lane

**Notes:**

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.

Noise monitoring will be undertaken to determine if the construction noise levels are higher than the external equivalent NML specified in CSSI-7400 Conditions E37/38 and E41/E42. If verification monitoring shows that the external noise levels are consistently above the predicted (or required) noise levels (i.e. 2 or more consecutive verification monitoring events/ occasions that find the works to be the primary contributor noise above the E37/E38 and E41/E42 NML) presented in Section 5.2, investigation will be undertaken to understand the cause of the exceedance and additional mitigation and management measures will be implemented in accordance with Sydney Metro City and South West Noise and Vibration Strategy.

### 5.3.5 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 ([linewideMetro@transport.nsw.gov.au](mailto:linewideMetro@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 and equipment include:

- Excavator w/rock hammer (30t) for crane pads
- Excavator w/rock hammer (13-20t) for trenching/ removal of concrete ramps
- Drill rig for crane pads
- Demolition saw for crane pads and trenching

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 are presented in Table 6-1 and Table 6.2. Site specific minimum working distances for vibration intensive plant items must be measured on site where plant and equipment are likely to operate close to or within the minimum working distances for cosmetic damage (Table 6-1).

Unlike noise, vibration cannot be readily predicted. There are many variables from site to site, such as soil type and conditions, sub surface rock, building types and foundations, and actual plant on site.

The data relied upon in this assessment (tabulated below) is taken from a database of vibration levels measured at various sites or obtained from other sources (such as BS5228-2:2009). They are not specific to this project 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.

**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) <sup>1</sup>	Unreinforced or light framed structures (e.g. residential buildings) <sup>1</sup>	Sensitive structures (e.g. heritage structures) <sup>2</sup>
Excavator with rock hammer (30t)	5	10	15
Excavator with rock hammer (13-20t)	5	10	10
Drill rig	5	5	15
Demolition saw	5	5	5

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.

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

Plant item	Minimum working distances, m				
	Critical areas <sup>1,4</sup>	Residences Day <sup>2</sup>	Night <sup>2</sup>	Offices <sup>3,4</sup>	Workshops <sup>4</sup>
Excavator with rock hammer (30t)	30	25	-	20	10
Excavator with rock hammer (13-20t)	30	20	-	15	10
Drill rig	25	15	-	10	10
Demolition saw	15	10	-	5	5

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.

## 6.2 Vibration assessment

### 6.2.1 Structural damage

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

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

Works	Plant item	Number of buildings	
		Screening criteria for non-heritage structures	Screening criteria for heritage structures
Crane pads	Excavator with rock hammer (30t)	0	0
	Drill rig	0	0
	Demolition saw	0	0
Trenching and ramp removal	Excavator with rock hammer (13-20t)	0	0
	Demolition saw	0	0

The excavator with 30t hammer and drill rig will be used in the centre of the station boxes to install the tower crane pads. The crane pads have a horizontal distance of approximately 20 metres from the nearest receivers and are 15-20 metres lower in elevation.

The 13t and 20t excavators will be used to construct the trench that runs along the length of the station box and transverse trenches/pits located at either end of the station box. They would also be used to remove the concrete ramps at either end of the station box (maximum of 1 hammer at each end, 2 in total). The main trench and has a horizontal distance of approximately 18 metres from the nearest receivers. The northern and southern transverse trenches/pits respectively have a horizontal distance of approximately 15 metres and 4 metres from the nearest receivers. The trenches/pits are 15-20 metres lower in elevation from the nearest receivers. The location of the crane pads and trenches are shown in APPENDIX C.

There are no buildings within the minimum working distances established for cosmetic damage during use of the equipment.

### 6.2.2 Human annoyance

The assessing vibration guideline [4] 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.

Properties where vibration levels may be above the vibration disturbance goals in Table 4-2 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**

Works	Plant item	Critical areas <sup>1,4</sup>	Residences <sup>5</sup>		Offices <sup>3,4</sup>	Workshops <sup>4</sup>
			Day <sup>2</sup>	Night <sup>2</sup>		
Crane pads	Excavator with rock hammer (30t)	1	0	-	0	0
	Drill rig	0	0	-	0	0
	Demolition saw	0	0	-	0	0
Trenching and ramp removal	Excavator with rock hammer (13-20t)	2	0	-	0	0
	Demolition saw	0	0	-	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.

During sawing and drilling there are no receivers that are within the minimum working distances for human annoyance.

Rock hammers will not be used at night. During crane pad rock hammering, **1 critical area** (22 Clarke Street) is within the minimum working distances for human annoyance. During trenching [cancelled] rock hammering, **2 critical areas** (22 Clarke Street and 20 Clarke Street) are within the minimum working distances for human annoyance. Properties are shown in APPENDIX H. It is noted that for the concrete ramp removal, no properties are within the minimum working distances for human annoyance.

The above assessment is based on vibration-generating equipment operating at the closest location to a receiver. When vibration-generating equipment operates further from the closest point, vibration

levels will reduce along with the probability of adverse comment. Due to the limited time the above plant will be operating close to each receiver (trenching will progress at a rate of approximately 40 metres per day), the risk of annoyance is low. It is therefore recommended that attended vibration measurement is carried out in the event of complaint from the nearest receiver to confirm that vibration is within the acceptable range for human annoyance.

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, and/or critical areas, appropriate additional mitigation measures will be considered (see Section 6.3.2).

### 6.2.3 Sensitive scientific and medical equipment

At the Crows Nest Day Surgery (22 Clarke Street), Crows Nest Cosmetic and Vein Clinic (10-12 Clarke Street), Sydney Vasectomy (10-12 Clarke Street) and SomnoMed (20 Clark Street), vibration levels are predicted to be above the criteria nominated in Section 4.2.4. Consultation with each surgery is needed, to make sure that construction activities do not generate unacceptably high noise or vibration levels when operating theatres are in use.

Due to the proximity of sensitive equipment within 22 Clark Street, vibration monitoring is recommended (see Section 6.3.3). If measurement results indicate vibration levels above the objectives for human annoyance and/or critical areas (i.e. sensitive equipment) at these locations, vibration control and management measures will be provided to reduce vibration impact (see Section 6.3.1).

## 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).

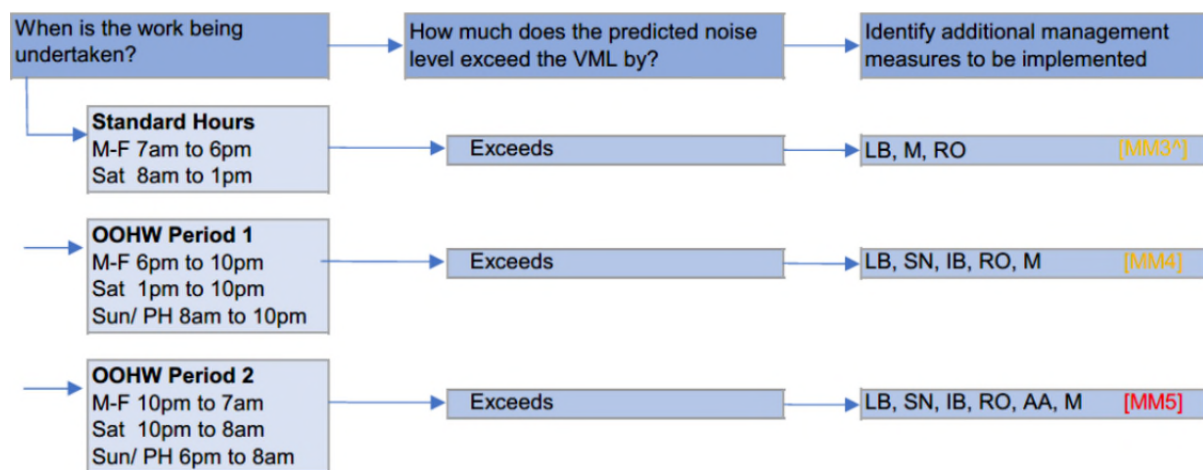


Control type	Control measure	Typical use
	Community consultation	Implement community consultation measures – inform community of construction activity & potential impacts – inform community that the level of vibration at which people perceive it, or at which loose objects may rattle, is far lower than 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 drill rigs can, where practicable, be operated with the pneumatic 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 6.3.4). 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 minimum working distances 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 at representative locations are still above relevant vibration objectives for human annoyance, the appropriate additional vibration mitigations measures, based on the CNVS [9] and the CNVMP [1].

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  
 ^MM3 slightly modified to include respite offer (RO) in place of specific notification (SN)  
 LB = Letter box drops      SN = Specific notifications      RO = Project specific respite offer  
 M = Monitoring of predicted noise levels      (personalised letter, phone call, email, individual briefing)      AA = Alternative accommodation

### 6.3.3 Vibration monitoring

As a minimum, it is recommended that attended monitoring is undertaken at the locations identified in Table 6-7, when vibration significant plant items operate close to or within the minimum working distances. Attended vibration monitoring is to be undertaken to determine and verify site specific minimum working distances for human annoyance and scientific equipment. If monitoring indicates vibration levels above the objectives for human annoyance and/or critical areas (i.e. sensitive equipment), vibration control and management measures will be provided to reduce vibration impact (see Section 6.3.1)

Real-time vibration monitoring in accordance with PPA Condition C11 is not proposed for this site. Additional monitoring may also be required in response to vibration complaints.

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

Plant	Work areas	Address	Vibration objectives to check			
			Heritage structures	Unreinforced or light framed structures	Human annoyance <sup>1</sup>	Sensitive equipment <sup>2</sup>
Excavator with rock hammer (30t)	Crane pad	Crows Nest Day Surgery (22 Clarke Street)	-	-	√	√ <sup>3</sup>
		Crows Nest Cosmetic and Vein Clinic (10-12 Clarke Street),	-	-	-	√ <sup>1,3</sup>
		Sydney Vasectomy (10-12 Clarke Street)	-	-	-	√ <sup>1,3</sup>
		20 Clarke Street (SomnoMed)	-	-	-	√ <sup>1,3</sup>
Excavator with rock hammer (13-20t)	Trenching [cancelled]	Crows Nest Day Surgery (22 Clarke Street)	-	-	√	√ <sup>3</sup>
		Crows Nest Cosmetic and Vein Clinic (10-12 Clarke Street),	-	-		√ <sup>1,3</sup>
		Sydney Vasectomy (10-12 Clarke Street)	-	-		√ <sup>1,3</sup>
		20 Clarke Street (SomnoMed)	-	-	√	√ <sup>1,3</sup>

Notes: 1: In the event of complaint related to vibration.

2: Should vibration sensitive equipment be found

3: Monitoring on private property is subject to owner consent and where relevant, occupier consent.

### 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 (linewideMetro@transport.nsw.gov.au).

## 7 Ground-borne noise assessment

### 7.1 Ground-borne noise prediction methodology

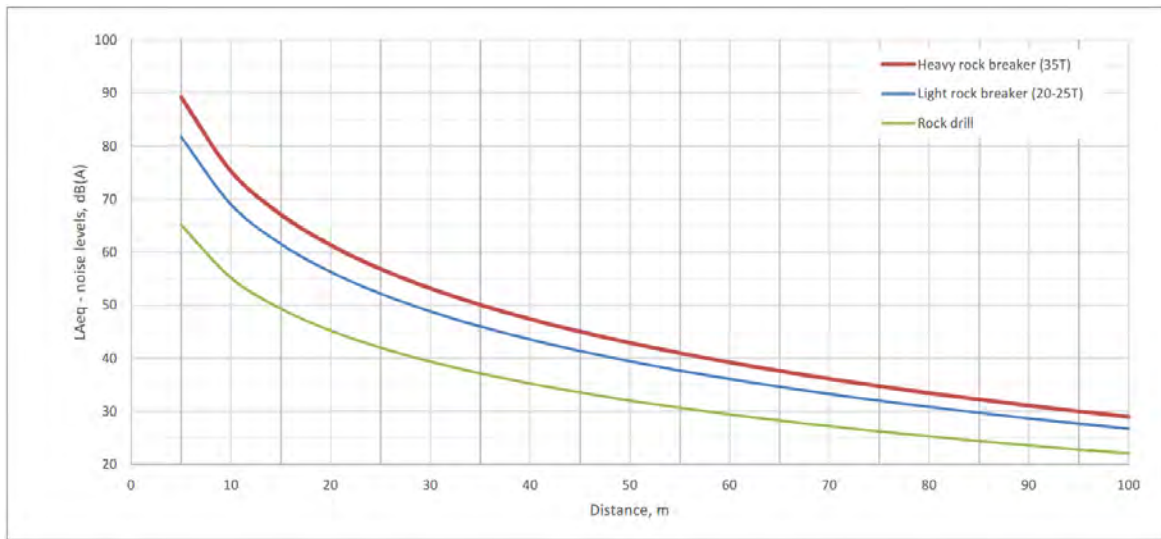
Ground-borne noise (GBN) levels at receivers around the Crows Nest Station site were predicted based on the travel distance (shortest path through the ground) from the dominant vibration generating item to each receiver. The following GBN significant activities were considered:

1. 30t rock hammer breaking out the crane pad areas during the 7am to 8pm day/evening period
2. Drilling machine drilling rock anchors in the crane pad areas during the 7am to 8pm day/evening period.
3. 20t rock hammer breaking out the trenches/ ramps during the 7am to 8pm day/evening period (one rock hammer at either end of station box)
4. 13t rock hammer breaking out the trenches/ ramps during the 7am to 8pm day/evening period (one rock hammer at either end of station box)

The model included the following features:

- GBN predictions for rock hammer excavation include 5dB penalty.
- GBN predictions include a 3 dB(A) engineering safety factor.
- Travel distance was calculated from the distance from the crane pads and the trenches to the edge of the station box plus the distance from the edge of the station box to the receiver building. This is the shortest path through the ground. Assumed location of emitting plant was:
  - o station box ground level (RL 71) for crane pad area and anchors.

Based on the GBN levels versus distance prediction curves for each plant item, ground-borne noise levels are calculated at each building location. The algorithms used in the modelling (see Figure 7.3) have been developed from measurement data obtained from various Sydney projects, including the Cross City Tunnel (CCT), Lane Cove Tunnel (LCT), Epping to Chatswood Rail Link (ECRL), North West Rail Link (NWRL) and M4 East.

**Figure 7.3: Indicative ground-borne noise levels**

## 7.2 Predicted ground-borne noise levels

GBN levels were determined by modelling the noise source, excavation location and receiver locations, based on the information presented in Section 7.1. Predictions are representative of a typical worst-case scenario where construction activities are undertaken at the closest possible location to nearby receivers. They represent the typical maximum ground-borne noise levels that receivers may experience for a limited amount of time and will reduce as equipment moves further away.

Assessment was undertaken for the following activities:

- Crane base construction with 30t rock hammer (7am to 8pm under cover)
- Crane base construction with rock drill (7am to 8pm under cover)
- Trench construction/ramp removal with 20t rock hammer (7am to 8pm)
- Trench construction/ramp removal with 13t rock hammer (7am to 8pm)

For the day and evening, PPA Conditions E37 and E38 require consultation with affected receivers, if predicted ground-borne noise levels are above 60 dB(A). Drilling and rock hammering works are not anticipated during the evening 2 and night periods.

Ground-borne noise maps are provided in APPENDIX G where internal GBN levels are predicted to be above 60 dB(A).

### 7.2.1 Crane base construction with 30t rock hammer (7am to 8pm under cover)

The estimated number of properties affected by GBN from crane base construction with rock hammer is summarised in Table 7.1.

**Table 7.1: Number of potentially GBN affected buildings during crane base construction with rock hammer**

Receiver type	Number of GBN affected buildings <sup>1</sup>			
	36-40 dB(A)	41-45 dB(A)	46-60 dB(A)	>60 dB(A)
Residential <sup>2</sup>	30	8	10	0
Non-residential	10	15	10	1

Notes: 1. Predicted noise levels include a 5 dB(A) penalty.

2. Predicted noise levels at residential buildings are at the most-affected residential floor of the building.

The predicted GBN levels in the table identifies buildings that may be affected by GBN from crane base excavation with rock hammer. Maximum GBN levels are predicted to be:

- above 35 dB(A) and less than 45 dB(A) at up to 63 buildings
- above 45 dB(A) and less than 60 dB(A) at up to 20 buildings
- above 60 dB(A) at up to 1 building.

For receivers where the predicted internal GBN levels are above 60 dB(A) between 7 am and 8 pm, consultation is required to provide respite in accordance with approval conditions E37 and E38. APPENDIX G.1 shows the receivers where GBN is predicted to be above 60 dB(A) and APPENDIX F nominates the receivers which require consultation.

Rock hammering will be operating for a maximum 4 shifts per crane base. Rock hammering is not proposed to occur between 8pm and 7am, and respite will be provided.

There is no feasible and reasonable alternative to hydraulic (rock) hammering for breaking out of the crane pad areas. The two crane bases will be 6.5m by 6.5m and a depth of 1.5m will need to be excavated. The sandstone at the base of the station box is expected to be very hard. Due to the size, depth and hardness a rock hammer is required.

The crane bases will be supported by rock anchors (installed using the drill rig), approximately 10m in depth. This means that the bases are smaller than what would generally be required to support the tower cranes. This measure will minimise the rock hammering required to build the crane bases.

### 7.2.2 Crane base construction with rock drill (7am to 8pm under cover)

The estimated number of properties affected by GBN from crane base construction with rock drill is summarised in Table 7.2.

**Table 7.2: Number of potentially GBN affected buildings during crane base construction with rock drill**

Receiver type	Number of GBN affected buildings			
	36-40 dB(A)	41-45 dB(A)	46-60 dB(A)	>60 dB(A)
Residential <sup>1</sup>	5	1	0	0
Non-residential	3	3	0	0

Notes: 1. Predicted noise levels at residential buildings are at the most-affected residential floor of the building.

The predicted GBN levels in the table above identify buildings that may be affected by GBN from crane base construction with rock drill. Rock drilling is proposed to occur between 7am and 8pm. It is predicted to result in maximum GBN levels:

- above 35 dB(A) at up to 12 buildings

No buildings are predicted to receive GBN from rock drilling above 45 dB(A).

### 7.2.3 Trench construction/ramp removal with 20t rock hammer (7am to 8pm)

The estimated number of properties affected by GBN from trench construction with a 20t rock hammer is summarised in Table 7.1.

**Table 7.3: Number of potentially GBN affected buildings during trench construction with 20t rock hammer**

Receiver type	Number of GBN affected buildings <sup>1</sup>			
	36-40 dB(A)	41-45 dB(A)	46-60 dB(A)	>60 dB(A)
Residential <sup>2</sup>	30	7	22	0
Non-residential	12	8	19	1

Notes: 1. Predicted noise levels include a 5 dB(A) penalty.

2. Predicted noise levels at residential buildings are at the most-affected residential floor of the building.

The predicted GBN levels in the table identifies buildings that may be affected by GBN from trench excavation with 20t rock hammer. Maximum GBN levels are predicted to be:

- above 35 dB(A) and less than 45 dB(A) at up to 57 buildings
- above 45 dB(A) and less than 60 dB(A) at up to 41 buildings
- above 60 dB(A) at up to 1 building.

For receivers where the predicted internal GBN levels are above 60 dB(A) between 7 am and 8 pm, consultation is required to provide respite in accordance with approval conditions E37 and E38. APPENDIX G.2 shows the receivers where GBN is predicted to be above 60 dB(A) and APPENDIX F nominates the receivers which require consultation. Predicted GBN levels from the removal of the concrete ramps would be less than 60 dB(A) at all receivers.

Rock hammering will occur for 5-10 days per station box. Rock hammering is not proposed to occur between 8pm and 7am, and respite will be provided.

There is no feasible and reasonable alternative to hydraulic (rock) hammering for breaking out of the trench areas. The trench will be the length of the station box, 1.2 metres wide and a depth of 0.5 metres will need to be excavated. The sandstone at the base of the trench is expected to be very hard. Due to the size and hardness a rock hammer is required.

## 7.2.4 Trench construction/ramp removal with 13t rock hammer (7am to 8pm)

The estimated number of properties affected by GBN from trench construction with a 13t rock hammer is summarised in Table 7.2.

**Table 7.4: Number of potentially GBN affected buildings during trench construction with 13t rock hammer**

Receiver type	Number of GBN affected buildings <sup>1</sup>			
	36-40 dB(A)	41-45 dB(A)	46-60 dB(A)	>60 dB(A)
Residential <sup>1</sup>	7	13	9	0
Non-residential	8	8	12	0

Notes: 1. Predicted noise levels include a 5 dB(A) penalty.

2. Predicted noise levels at residential buildings are at the most-affected residential floor of the building.

The predicted GBN levels in the table above identify buildings that may be affected by GBN from trench construction with a 13t rock hammer. Rock hammering is proposed to occur between 7am and 8pm. It is predicted to result in maximum GBN levels:

- above 35 dB(A) and less than 45 dB(A) at up to 36 buildings
- above 45 dB(A) and less than 60 dB(A) at up to 21 buildings.

No buildings are predicted to receive GBN above 60 dB(A) from trenching [cancelled] or ramp removal with a 13t rock hammer.

## 7.3 Noise mitigation and management

### 7.3.1 Noise control and management measures

The following at-source control and noise management measures are recommended to reduce potential GBN impacts.

**Table 7.5: Noise control and management measures.**

Control Type	Control Measure	Typical Use
	Limit equipment in use	Only the equipment necessary during each stage of the tunnelling will be used.

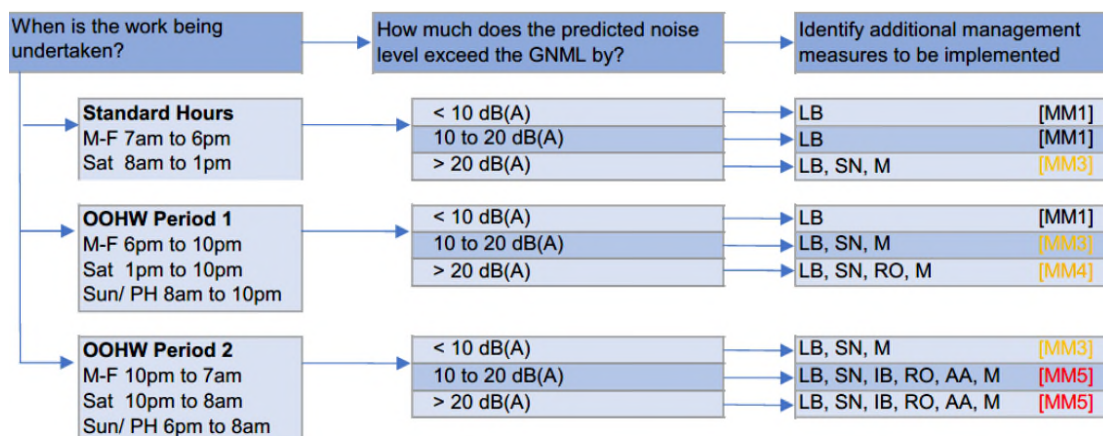
Control Type	Control Measure	Typical Use
At-Source Control Measures	Equipment selection	Use quieter and less noise/ vibration emitting construction methods where feasible and reasonable. Where practicable, use jackhammers in place of rock hammers during day-time.
	Timing of equipment in use / Respite periods	In accordance with PPA Conditions E37 and E38, consultation will be undertaken at affected receivers to determine appropriate hours of respite. These receivers are identified in APPENDIX G.
Noise Management Measures	Site inductions & Toolbox Talks	All employees, contractors and subcontractors are to receive a Project induction. The environmental component may be covered in toolboxes and should include: <ul style="list-style-type: none"> <li>location of nearest sensitive receivers</li> <li>relevant project specific and standard noise and vibration mitigation measures;</li> <li>permissible hours of work;</li> <li>OOHW Procedure and Form.</li> </ul>
	Community consultation	Inform community of construction activity and potential impacts.
	Noise monitoring	Noise monitoring is to be carried out as detailed in Section 5.3.4

### 7.3.2 Additional ground-borne noise mitigation measures

After application of all reasonable and feasible mitigation measures, the  $L_{Aeq(15\text{minute})}$  ground-borne construction noise levels are still predicted to be above the NMLs, additional GBN management measures can be applied to limit the risk of annoyance from construction noise, based on the CNVS [9] and the CNVMP [1]. This supplements the basic requirements in the ICNG.

The steps to be carried out to determine the additional management measures to be implemented are identified in Table 7.6.

**Table 7.6: Additional ground-borne noise 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

M = Monitoring of predicted noise levels

SN = Specific notifications (personalised letter, phone call, email, individual briefing)

RO = Project specific respite offer  
AA = Alternative accommodation



Before starting work, in particular before 24-hour operations, receivers where maximum GBN levels are expected to be above 35 dB(A) (identified in APPENDIX G) will be notified to advise that noise from the works may at times be clearly 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 phone numbers (see Section 7.4).

### 7.3.3 Attended ground-borne noise monitoring

Attended noise monitoring is to be undertaken to validate the GBN model and to verify that GBN resulting from the crane base construction works are in accordance with the levels predicted in this CNVIS and any EPL Condition, subject to obtaining the property owner/occupier's consent to access the property.

Attended noise monitoring will be conducted during the works at representative receivers in the NCAs most affected by the works. Noise measurements will be undertaken internally, ideally in rooms that are the most shielded from existing ambient noise to allow a higher signal to noise ratio to be obtained.

**Table 7.7: Attended noise monitoring - nominated representative locations.**

NCA	Work activity	Nominated Receiver Address	Monitoring Location
OSR	Crane base construction	22 Clarke Street	Crows Nest Day Surgery

## 7.4 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 ([linewideMetro@transport.nsw.gov.au](mailto:linewideMetro@transport.nsw.gov.au)).

## 8 Traffic noise assessment

### 8.1 Traffic sources

All heavy vehicles will access the Crows Nest worksite via the Pacific Highway, which is an arterial road with significant flows. Daytime (7am to 10pm) truck movements will involve up to 14 delivery, truck and dog and concrete trucks per hour travelling on Pacific Highway, Hume Street, Clarke Street and Oxley Street. These number movements are consistent with the TSE works.

For the night-time period, a maximum of 4 heavy vehicle movements per shift is required to deliver rail. These night-time vehicle movements will occur directly from the Pacific Highway onto Hume Street where the trucks will be unloaded in an acoustic shed, then on to Clarke Street, Oxley Street and back to Pacific Highway.

As outlined in Section 4.1.6 (and Section 5.3 of the CNVMP), the noise increase associated with construction traffic movements on public roads aims to limit any increase in existing road traffic noise levels to no more than 2 dB(A). An increase greater than 2 dB(A) may be permitted if construction-related road traffic noise levels are less than the allowable noise levels in the NSW Road Noise Policy (60 dB  $L_{Aeq(15hr)}$  day and 55 dB  $L_{Aeq(9hr)}$  night).

No residential receivers are on the section of Hume Street that will be used by trucks to/from the site (i.e. between Pacific Highway and Clarke Street).

**Table 8.1: Indicative construction traffic volumes (typical worst case scenario)**

Access Road	Assessment period	Existing heavy vehicle movements	Proposed heavy vehicle movements
Clarke Street	Day (1hr)	13	14
	Night (1hr)	7	1 (4 per 9 hour shift)
Oxley Street	Day (15hr)	112	210
	Night (9hr)	16	4
Pacific Highway	Day (15hr)	1625	210
	Night (9hr)	255	4

The highest change in road traffic volumes is expected on Oxley Street and Clarke Street, during the daytime. For assessment purposes, overall noise levels consider road traffic on all nearby roads including the Pacific Highway, which is predicted to be the dominant noise source at the nearest affected residences along Oxley Street.

Predicted construction-related road traffic noise levels are provided in Table 8.2 for the nearest residential receivers exposed to noise from the construction traffic.

**Table 8.2: Construction traffic assessment**

Haul route	Assessment period	RNP Base Criteria, dB(A)	Existing traffic noise level <sup>1</sup> , dB(A)	Predicted construction traffic noise <sup>2</sup> , dB(A)	Total traffic noise, dB(A)	Predicted road traffic noise increase, dB(A)
Truck movements along Clarke Street	Day L <sub>Aeq,1h</sub>	55	62	59	64	1.6
	Night L <sub>Aeq,1h</sub>	50	54	47	55	0.9
Truck movements along Oxley Street	Day L <sub>Aeq,15h</sub>	60	66	56	67	0.4
	Night L <sub>Aeq,9h</sub>	55	60	44	60	0.1

Notes: 1. CORTN calculation using counts in December 2017

2. Moving point source calculations to the most-affected receiver on any of the assessed roads.

The predicted road traffic noise levels indicate a less than 2 dB(A) increase in overall day and night noise on the roads proposed to be used by construction traffic, and so construction traffic noise is predicted to have minimal impact on nearby receivers and complies with the traffic NMLs identified in Section 4.1.6.

Up to four trucks over 9 hours, will access the site during the night time. This number of heavy vehicles is not expected to result in a noticeable increase in the number of maximum noise events at sensitive receivers, compared to existing traffic.

During the site shed removal works, given the works will only occur for two nights and the truck will be restricted to the Pacific Highway, construction traffic noise is predicted to be negligible.

## 8.2 Traffic noise mitigation and management

The Heavy Vehicle Code of Conduct includes several measures, including limiting of compression braking, 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. Currently, we are not aware of any other unrelated construction activities near the site.

If other works are likely to occur simultaneously, cumulative noise and vibration impacts will be reviewed at that point in time. Any necessary changes to mitigation and management measures will then be identified

## 10 Conclusion

Works associated with the C2S Crows Nest early works 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.

Expected construction noise levels have been predicted and presented in Section 5.2 and APPENDIX D. The expected duration of construction activities is outlined in Table C1 of APPENDIX C.

During the day-time/evening period (from 7am to 8pm), the highest noise impacts are predicted to occur during demobilisation, trench excavation and concrete ramp removal. These impacts will be managed by providing respite and using less noise and vibration intensive plant, where practicable.

Construction noise is predicted to comply with Conditions E41 and E42 at all assessed residential receivers, with the exception of the site shed removal works. The shed removal works would be completed over two nights. All reasonable and feasible mitigation measures have been reviewed and would be adopted where practicable. Additional mitigation measures outlined in Section 5.3.3 will be offered to sensitive receivers that qualify (see APPENDIX E).

Noise mitigation and management measures have been presented in Section 5.3 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. Suitable management measures have been presented in Sections 6.3.

Ground-borne noise (GBN) impacts have been presented in Section 7. Nearest receivers will be GBN affected during excavation of the crane pad and trenches. Suitable management measures have been presented in Sections 7.3.

Construction traffic has been assessed, indicating compliance with construction-related road traffic noise objectives at all residential receiver locations.

## 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 2016 Sydney Metro Chatswood to Sydenham - Technical Paper 2: Noise and Vibration Report Number 610.14718R1 – 28 April 2016
- [3] Department of Environment and Climate Change 2009 NSW Interim Construction Noise Guideline
- [4] Department of Environment Conservation NSW 2006 Assessing Vibration; a technical guideline
- [5] British Standard BS 7385 Part 2 1993, Evaluation and measurement for vibration in buildings. Guide to damage levels from groundborne vibration
- [6] German Standard DIN 4150-3:2016-12 Vibration in buildings – Part 3: Effects on structures
- [7] British Standard BS 6472-2008, Evaluation of human exposure to vibration in buildings (1-80Hz)
- [8] Transport for NSW Sydney Metro City & Southwest Construction Noise Strategy (ref: 610.14213-R3) 08 August 2016
- [9] Transport for NSW Construction Noise and Vibration Strategy (ref: 7TP-ST-157/4.0) May 2018
- [10] Transport for NSW Sydney Metro Construction Environmental Management Framework August 2016
- [11] Department of Environment, Climate Change and Water 2011 NSW Road Noise Policy
- [12] NSW Department of Planning – Development near rail corridors and busy road – interim guideline 2008
- [13] Eric Schreurs, Lex Browns and Deanna Tomerini – Maximum pass-by noise levels from vehicles in real road traffic streams: comparison to modelled levels and measurement protocol issues. Internoise 2011, Osaka Japan, September 4-7

## 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 <sub>Max</sub>	The maximum sound pressure level measured over a given period.
L <sub>Min</sub>	The minimum sound pressure level measured over a given period.

L <sub>1</sub>	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L <sub>10</sub>	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L <sub>90</sub>	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 <sub>eq</sub>	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
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 L <sub>eq</sub> sound levels over any period of time and can be used for predicting noise at various locations.
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**

Table B1: Noise sensitive receivers and construction noise management levels CROWS NEST STATION - EARLY ACCESS WORKS

NCA	Nearest construction work area	Receiver Type	Reference RBL	Existing Noise Levels L <sub>A90(15min)</sub> , dB(A)			Residential NMLs based on ICNG (external), L <sub>Aeq(15min)</sub>				Sleep Dist. L <sub>Amax</sub>		Comments
				RBL Day	RBL Evening	RBL Night	NML DS	NML DO	NML E	NML N	Screening <sup>1</sup>	Max <sup>1</sup>	
Portion 2 & 3	Chatswood to Sydenham (C2S)												
CN_01	Crows Nest Station	Residential south near Pacific Highway, north of site (close to highway)	C2S EIS B.19 for D/E, RTA TG360 for N	59	55	40	69	64	60	45	55	65	RTA additional noise monitoring July 2017
CN_02	Crows Nest Station	Residential northeast of work site (less exposed to traffic)	RTA TG360	48	44	40	58	53	49	45	55	65	RTA additional noise monitoring July 2017
CN_03	Crows Nest Station	Residential and commercial southeast of work site on Pacific Highway and Falcon Street (exposed to traffic)	C2S EIS B.19 for D&E and RTA TH703 for N	59	55	40	69	64	60	45	55	65	RTA additional noise monitoring July 2017
CN_04	Crows Nest Station	Residential south west of site on Pacific Highway (exposed to traffic)	C2S EIS B.19 for D&E and RTA TH703 for N	59	55	40	69	64	60	45	55	65	RTA additional noise monitoring July 2017
CN_05	Crows Nest Station	Residential south west of Pacific Highway, south west of Nicholson Place (less exposed to traffic)	RTA TH511-L01 11 Lamont St, Wollstonecraft	45	45	40	55	50	50	45	55	65	RTA additional noise monitoring July 2017
Other sensitive receivers							Sensitive Receiver NMLs based on ICNG (see comments for details), L <sub>Aeq(15min)</sub>						
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 loss)

DS: standard construction hours from 7 am to 6 pm Monday to Friday and from 8 am to 6 pm Saturday

DO: 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



180 m  
160  
140  
120  
100  
80  
60  
40  
20  
0



**LEGEND**

**Noise sensitive receivers**

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

NCA

Work areas

**SYDNEY METRO - CHATSWOOD TO SYDENHAM**

Crows Nest early access  
Land Use, NCAs



**APPENDIX C**      **Construction details**

## **C.1 Construction timetable/ activities/ management**

Table C1: Construction Timetable/ Activities/ Equipment CROWS NEST STATION - EARLY ACCESS WORKS

Activity/ Work Area	Aspect	Indicative timing/ duration	Modelling ID	Plant/ Equipment (as provided by client)	Day(S) / Day(O) / Evening 1 7am to 8pm Monday to Saturday 8am to 8pm Sunday and Public Holidays		Evening 2 8pm to 10pm	Night 10pm to 7am	Sound Power Level (Lw re: 1pW) in Noise Model, dB(A)			High noise plant (EPL E1)	Vibration intensive plant	Notes
					With noise intensive plant Maximum 6.5 hours a day	Without noise intensive plant Remaining time			L <sub>Aeq</sub>	Penalty	L <sub>Amax</sub>			
CROWS NEST STATION EARLY WORKS														
Site Establishment	Site already Established - Maintain site / enviro controls and hoardings	August 2020 to September 2020		Mobile crane (Franna)	1	1	-	-	99	-	103	-	-	Outside shed and cover
				Hand Tools	2	2	-	-	107	-	111	-	-	Outside shed and cover
				Small Truck	4 per shift	4 per shift	-	-	106	-	111	-	-	Outside shed and cover
				Light vehicles	4 per hour	4 per hour	4 per hour	4 per hour	89	-	100	-	-	Outside shed and cover
Deliveries	Deliver FBW Plant and equipment, track materials	August 2020 to November 2020		Gantry crane (40t)	2	2	-	-	106	-	110	-	-	Inside acoustic shed
				Road truck (deliveries to site)	4 per hour	4 per hour	-	-	106	-	111	-	-	Outside and inside shed
				Franna Crane (20t)	1	1	-	-	99	-	103	-	-	Inside acoustic cover
				Gantry Crane - Electric	1	1	1	1	106	-	110	-	-	Inside acoustic shed
	Deliver Rail - Night	August 2020 to October 2020	Semi Trailer	4 per shift	4 per shift	4 per shift	4 per shift	106	-	111	-	-	Outside/inside shed. During E2 and Night, western shed door to be closed for 10min per 15min period	
			Franna Crane (20t)	1	1	1	1	99	-	103	-	-	Outside and inside shed	
			Traffic control - Light Truck 4.5T	1	1	1	1	103	-	111	-	-	Outside shed and cover. Idling	
			Traffic Control - Ute	2	2	2	2	89	-	100	-	-	Outside shed and cover. Idling	
Rail Welding	Flashbutt Welding	September 2020 to November 2020		Flash butt Welder	1	1	1	1	102	-	105	-	-	Inside acoustic cover
				13t Wheel Loader 950 w/ rail handler	1	1	1	1	103	-	108	-	-	Inside acoustic cover
				5t Telehandler	1	1	1	1	99	-	103	-	-	Inside acoustic cover
				Hand Tools - angle grinder	2	2	1	1	114	-	118	-	-	Inside acoustic cover. During E2 and night, only one grinder to operate at anyone time.
				Demolition saw	1	1	-	-	121	5	129	HN	X	Inside acoustic cover. Plant not to operate during E2 and night
				Rail Grinder	1	1	1	1	114	-	118	-	-	Inside acoustic cover. During E2 and night, only one grinder to operate at anyone time.
Crane Base Construction	Crane Base Construction	September 2020 to November 2020		Excavator w/ Rock Hammer (30t)	1	1	-	-	118	5	123	HN	X	Inside acoustic cover
				Gantry crane - electric	1	1	-	-	106	-	110	-	-	Inside acoustic shed
				Truck and Dog	4 per hour	4 per hour	-	-	106	-	111	-	-	Outside and inside shed
				Concrete Agi	4 per hour	4 per hour	-	-	108	-	111	-	-	Outside and inside shed
				Concrete Pump	1	1	-	-	103	-	107	-	-	Inside acoustic cover
				Concrete vibrator	2	2	-	-	97	-	100	-	-	Inside acoustic cover
				Drill rig - rock anchors	1	1	-	-	114	-	120	HN	X	Inside acoustic cover
Demobilisation	Remove acoustic shed and covers (to commence following the completion of FBW and Crane Base Construction)	November 2020 to January 2021		Excavator (20t) w shears	2	2	-	-	103	-	108	-	-	Located within station box
				Elevated Work Platform	2	2	-	-	95	-	98	-	-	Located within station box
				Hand Tools - H/S Drill, Impact Sockets etc	4	4	-	-	107	-	111	-	-	Located within station box
				300 tonne mobile crane	1	1	-	-	106	-	110	-	-	Located on Hume Street
				60 tonne Mobile Crane	2	2	-	-	104	-	108	-	-	Located on Clarke Lane
				Road truck 12t rigid	1	1	-	-	106	-	111	-	-	Outside and inside shed
				Truck & Dog	4 p.h.	4 p.h.	-	-	106	-	111	-	-	Outside and inside shed
				Traffic control - Light Truck 4.5T	1	1	-	-	103	-	111	-	-	Outside shed and cover. Idling
				Traffic Control - Ute	2	2	-	-	89	-	100	-	-	Outside shed and cover. Idling
Removal of site sheds	Remove site sheds (3 sheds on the northern end and 4 sheds on the southern end)	2 Nights		55 tonne Mobile Crane	-	-	-	1	104	-	108	-	-	Located on southbound lane of Pacific Hwy
				Traffic Control - Ute	-	-	-	2	89	-	100	-	-	Located on southbound lane of Pacific Hwy. Idling
				Elevated Work Platform	-	-	-	1	95	-	98	-	-	Located on southbound lane of Pacific Hwy. For standby only
				Semi Trailer	-	-	-	1	106	-	111	-	-	Located on southbound lane of Pacific Hwy, switched off for majority of time
CROWS NEST STATION WORKS - OUTSIDE ACOUSTIC SHED / COVERS														
Temporary services trench [cancelled] and removal of concrete ramps [scheduled for January]	Excavation/ ramp removal	December 2020/ January 2021 5 to 10 days		Concrete saw	2	2	-	-	121	5	129	HN	X	
				Rock hammer 20t	2	2	-	-	118	5	123	HN	X	A maximum of 2 hammers to operate at anyone time. 1 at each end of station box
				Rock hammer 13t	2	2	-	-	115	5	120	HN	X	A maximum of 2 hammers to operate at anyone time. 1 at each end of station box
				Bob cat / small excavator with bucket (13t)	1	1	-	-	103	-	108	-	-	
				Dump truck	1	1	-	-	106	-	111	-	-	
	Spoil removal - simultaneous with "Excavation"	December 2020 5 to 10 days	Mobile crane <200T	1	1	-	-	104	-	108	-	-		
			Bob cat / small excavator with bucket (13t)	1	1	-	-	103	-	108	-	-		
	Trench backfill	December 2020 5 to 6 days	Dump truck	1	1	-	-	106	-	111	-	-		
			Concrete agi - surface	1	1	-	-	108	-	111	-	-	Concrete delivery via drop pipe - gantry shed likely removed	
				Concrete agi - tunnel	2	2	-	-	108	-	111	-	-	
TRACK WORKS - Tunnel CST to VIC (all activities in tunnels) - deliveries from surface														
Deliveries	Deliveries	September 2020 to December 2020		Concrete Agi	4 per hour	4 per hour	-	-	108	-	111	-	-	Surface
				Road truck (track materials)	4 per hour	4 per hour	-	-	106	-	111	-	-	Surface
Rail distribution	Rail distribution	September 2020 to December 2020		Telehandler	1	1	1	1	99	-	103	-	-	Tunnels
				Rubber tyre Excavator (20t)	1	1	1	1	103	-	108	-	-	Tunnels
				Front end loader	1	1	1	-	110	-	115	-	-	Tunnels
				Rail trolleys	1	1	1	1	89	-	100	-	-	Tunnels
				Hand tools	Various	Various	Various	Various	107	-	111	-	-	Tunnels
Tunnel Track Activities	Track Construction	November 2020 to December 2020		hand held saw	2	2	2	2	114	-	118	-	-	Tunnels
				Hand held tools	Various	Various	Various	Various	114	-	118	-	-	Tunnels
				25t Loader 950 Equ. = Excavator w bucket	1	1	1	1	103	-	108	-	-	Tunnels
				Hi-Ab Truck (Hi-Rail)	4 per hour	4 per hour	4 per hour	2 per hour	98	-	102	-	-	Tunnels
				Light vehicle	8 per hour	8 per hour	8 per hour	8 per hour	89	-	100	-	-	Tunnels
TUNNEL FITOUT WORKS - Tunnel CST to VIC (all activities in tunnels) - deliveries from surface														
Deliveries	Deliveries	September 2020 to December 2020		Concrete Agi	4 per hour	4 per hour	-	-	108	-	111	-	-	Surface
				Road truck (track materials)	4 per hour	4 per hour	-	-	106	-	111	-	-	Surface
Material Handling and Distribution	Material Handling	September 2020 to December 2020		25t Franna Crane	1	1	1	1	99	-	103	-	-	Tunnels
				Telehandler	1	1	1	1	99	-	103	-	-	Tunnels
Tunnel Support Systems (inside tunnels)	Ventilation and dewatering	September 2020 to December 2020		Vent Fan	2	2	2	2	-	-	-	-	-	Tunnels
				Sump Pump	1	1	1	1	97	-	97	-	-	Tunnels
Cross Passage Fitout (inside tunnels)	Base Slab Construction	November 2020 to December 2020		Electric Saw	6	6	6	6	121	5	129	HN	X	Tunnels
				Hand Tools	6	6	6	6	107	-	111	-	-	Tunnels
				Grinder	6	6	6	6	114	-	118	-	-	Tunnels
				25t Franna Crane	2	2	2	2	99	-	103	-	-	Tunnels
				Concrete vibrator	6	6	6	6	97	-	100	-	-	Tunnels
				Hi-Ab Truck	1	1	1	1	98	-	102	-	-	Tunnels
				Light Vehicles	10	10	10	10	89	-	100	-	-	Tunnels

## **C.2 Site layout drawings and construction staging**





Oxley Street

Short rail stockpile

Flash butt welder

Grinding station

Long rail stockpile

Clarke Street

Clarke Lane

Gantry crane  
Franna

Pacific Highway

Hume Street

Acoustic shed / station box

- Telehandler,
- Rubber tyre excavator,
- Front end loader,
- Rail trolleys,

Path of rail delivery  
truck. See TMP for  
more detail.

Approximate location  
of tower crane bases



Figure C2: Site Layout

Site Shed Removal

CROWS NEST STATION - EARLY ACCESS WORKS

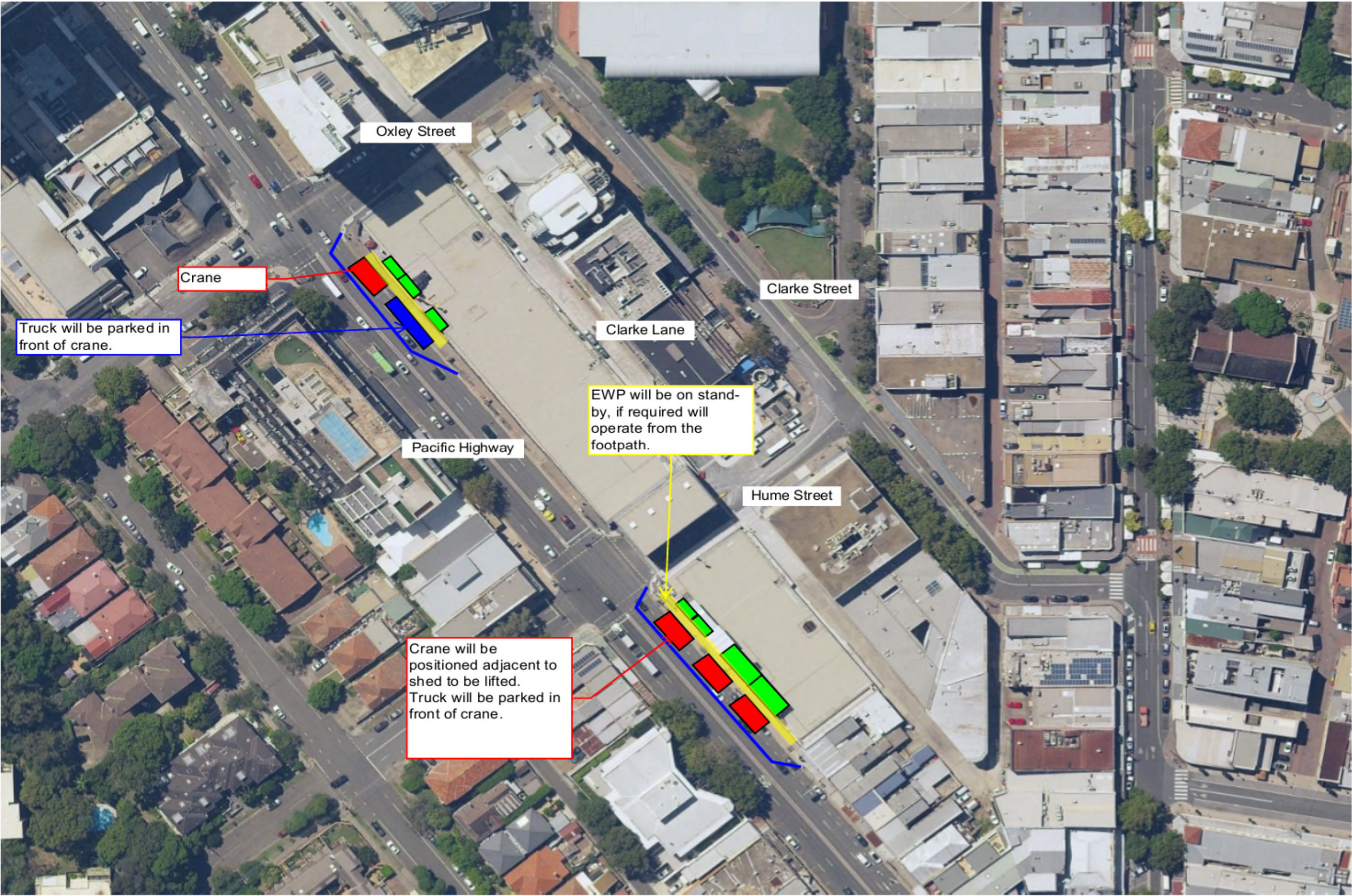




Figure C3: Site Layout

Ramp Removal

CROWS NEST STATION - EARLY ACCESS WORKS



<div><div><div><div><div></div><div>Systems</div><div>Connect</div></div><div><div><div>CPB</div><div>CONTRACTORS</div></div><div><div>UGL</div><div></div></div></div></div></div></div>	
Title	
Description	
<div><div><div></div><div>Sydney Metro City Corridor</div></div><div><div></div><div>Sydney Metro City Alignment</div></div><div><div></div><div>City Stations</div></div></div>	
<div><div><div>NOT USED FOR CONSTRUCTION</div><div>This map is a user generated static output from the New SCLWW GIS tool and is for reference only. Data layers appearing on this map may or may not be accurate, current, or otherwise reliable.</div></div></div>	
Author	Date Printed 12-Nov-2020



## APPENDIX D Detailed predicted noise levels

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

Table D1: Predicted construction noise levels assessed to ICNG NMLs

CROWS NEST STATION - EARLY ACCESS

		Predicted noise levels, dB(A)																																																	
		Day (Standard)														Evening (OOHW)														Night (OOHW)																					
NCA	Address	NML	SE	D	W_H	D+W_H	CB_H	DEM	TER_H (STER_H (I	TER_H (I	W_L	D+W_L	CB_L	R_North	R_South	TER_L	TB	NML	SE	D	W_H	D+W_H	CB_H	DEM	TER_H (STER_H (I	TER_H (I	W_L	D+W_L	CB_L	R_North	R_South	TER_L	TB	NML	SE	D	W_H	D+W_H	CB_H	DEM	TER_H (STER_H (I	TER_H (I	W_L	D+W_L	CB_L	R_North	R_South	TER_L	TB		
CN_01	22 CLARKE STREET CROWS NEST	69	47	56	64	65	80	84	82	79	59	60	57	-	-	65	66	60	41	56	-	-	-	-	80	-	-	-	59	60	-	-	-	-	45	41	56	-	-	-	43	-	-	-	59	60	-	-	-	-	
CN_01	34 OXLEY STREET ST LEONARDS	69	49	46	53	53	55	56	60	59	56	48	50	50	-	-	52	47	60	37	46	-	-	-	56	-	-	-	48	50	-	-	-	-	45	37	46	-	-	-	40	-	-	-	48	50	-	53	37	-	-
CN_01	36 OXLEY STREET ST LEONARDS	69	46	43	54	54	55	56	71	70	67	49	50	47	-	-	55	54	60	35	42	-	-	-	56	-	-	-	49	50	-	-	-	-	45	35	42	-	-	-	38	-	-	-	49	50	-	52	37	-	-
CN_01	545 PACIFIC HIGHWAY ST LEONARDS	69	47	52	59	59	60	61	80	78	75	54	56	55	-	-	61	62	60	39	52	-	-	-	61	-	-	-	54	55	-	-	-	-	45	39	52	-	-	-	44	-	-	-	54	55	-	61	47	-	-
CN_01	563-565 PACIFIC HIGHWAY ST LEONARDS	69	36	46	50	51	51	56	56	54	51	45	48	46	-	-	45	43	60	-	46	-	-	-	56	-	-	-	45	48	-	-	-	-	45	-	46	-	-	-	43	-	-	-	45	48	-	60	44	-	-
CN_02	11 ERNEST STREET CROWS NEST	58	47	40	44	45	45	44	52	51	48	40	42	39	-	-	43	45	49	-	40	-	-	-	43	-	-	-	40	42	-	-	-	-	45	-	40	-	-	-	-	-	-	40	42	-	39	39	-	-	
CN_02	13 ERNEST STREET CROWS NEST	58	46	39	44	45	45	46	51	49	46	39	41	39	-	-	43	46	49	-	39	-	-	-	45	-	-	-	39	41	-	-	-	-	45	-	39	-	-	-	-	-	39	41	-	-	36	-	-		
CN_02	39 HUME STREET CROWS NEST	58	62	57	56	59	57	60	58	56	53	51	57	54	-	-	57	61	49	39	57	-	-	-	60	-	-	-	51	57	-	-	-	-	45	39	57	-	-	-	39	-	-	-	51	57	-	40	42	-	-
CN_02	43 HUME STREET CROWS NEST	58	60	55	55	58	57	56	57	56	53	51	56	53	-	-	57	60	49	37	55	-	-	-	56	-	-	-	50	56	-	-	-	-	45	37	55	-	-	-	37	-	-	-	50	56	-	37	41	-	-
CN_02	45-47 HUME STREET CROWS NEST	58	57	53	53	56	55	53	56	54	51	49	54	51	-	-	52	55	49	34	53	-	-	-	53	-	-	-	48	54	-	-	-	-	45	34	53	-	-	-	34	-	-	-	48	54	-	35	39	-	-
CN_02	51A HUME STREET CROWS NEST	58	53	52	52	54	53	51	55	53	50	47	52	50	-	-	50	54	49	-	52	-	-	-	51	-	-	-	47	52	-	-	-	-	45	-	52	-	-	-	-	-	-	47	52	-	34	36	-	-	
CN_02	35 WILLOUGHBY ROAD CROWS NEST	58	34	-	39	40	41	40	52	50	47	35	36	36	-	-	-	36	38	49	-	-	-	-	40	-	-	-	35	36	-	-	-	-	45	-	-	-	-	-	-	-	-	35	36	-	-	34	-	-	
CN_02	37 WILLOUGHBY ROAD CROWS NEST	58	35	-	39	40	41	40	52	50	47	35	36	36	-	-	-	36	38	49	-	-	-	-	39	-	-	-	35	36	-	-	-	-	45	-	-	-	-	-	-	-	-	35	36	-	-	34	-	-	
CN_02	39A WILLOUGHBY ROAD CROWS NEST	58	44	36	40	41	41	40	52	50	47	36	38	37	-	-	-	35	37	49	-	36	-	-	-	40	-	-	-	36	38	-	-	-	-	45	-	36	-	-	-	-	-	36	38	-	-	34	-	-	
CN_02	41 WILLOUGHBY ROAD CROWS NEST	58	47	36	41	42	43	44	54	52	49	37	39	38	-	-	-	36	38	49	-	36	-	-	-	43	-	-	-	37	39	-	-	-	-	45	-	36	-	-	-	-	-	-	37	39	-	-	35	-	-
CN_02	43 WILLOUGHBY ROAD CROWS NEST	58	45	36	42	42	43	46	54	52	49	37	39	37	-	-	-	37	39	49	-	36	-	-	-	45	-	-	-	37	39	-	-	-	-	45	-	36	-	-	-	-	-	-	37	39	-	-	34	-	-
CN_02	45 WILLOUGHBY ROAD CROWS NEST	58	43	34	40	41	41	46	52	51	48	36	38	36	-	-	-	39	42	49	-	34	-	-	46	-	-	-	36	38	-	-	-	-	45	-	34	-	-	-	-	-	-	36	38	-	-	-	-	-	
CN_02	47A WILLOUGHBY ROAD CROWS NEST	58	49	41	42	44	43	45	52	51	48	38	42	38	-	-	43	46	49	-	41	-	-	-	45	-	-	-	38	42	-	-	-	-	45	-	41	-	-	-	-	-	-	38	42	-	-	35	-	-	
CN_02	71 WILLOUGHBY ROAD CROWS NEST	58	37	35	41	41	42	41	51	50	47	36	38	36	-	-	-	38	39	49	-	35	-	-	-	41	-	-	-	36	38	-	-	-	-	45	-	35	-	-	-	-	-	-	36	38	-	-	-	-	
CN_02	74 WILLOUGHBY ROAD CROWS NEST	58	44	39	44	45	45	44	56	55	52	40	41	39	-	-	42	43	49	-	39	-	-	-	44	-	-	-	39	41	-	-	-	-	45	-	39	-	-	-	-	-	-	39	41	-	-	-	-		
CN_02	75 WILLOUGHBY ROAD CROWS NEST	58	34	34	39	39	40	39	50	48	45	34	36	34	-	-	-	36	36	49	-	34	-	-	-	39	-	-	-	34	36	-	-	-	-	45	-	34	-	-	-	-	-	-	34	36	-	35	-	-	
CN_02	76 WILLOUGHBY ROAD CROWS NEST	58	42	38	42	43	42	42	54	53	50	37	39	37	-	-	40	41	49	-	37	-	-	-	42	-	-	-	37	39	-	-	-	-	45	-	37	-	-	-	-	-	-	37	39	-	-	-	-		
CN_02	80A WILLOUGHBY ROAD CROWS NEST	58	47	41	44	45	45	46	54	53	50	39	42	40	-	-	44	46	49	-	41	-	-	-	46	-	-	-	39	42	-	-	-	-	45	-	41	-	-	-	-	-	-	39	42	-	-	-	-		
CN_02	86 WILLOUGHBY ROAD CROWS NEST	58	47	41	44	45	45	43	54	52	49	39	42	40	-	-	44	47	49	-	41	-	-	-	43	-	-	-	39	42	-	-	-	-	45	-	41	-	-	-	-	-	-	39	42	-	-	-	-		
CN_02	88 WILLOUGHBY ROAD CROWS NEST	58	46	41	44	45	45	44	54	52	49	39	42	40	-	-	-	41	43	49	-	41	-	-	-	44	-	-	-	39	42	-	-	-	-	45	-	41	-	-	-	-	-	-	39	42	-	-	-	-	
CN_02	90-92 WILLOUGHBY ROAD CROWS NEST	58</																																																	

Table D1: Predicted construction noise levels assessed to ICNG NMLs

CROWS NEST STATION - EARLY ACCESS

		Predicted noise levels, dB(A)																																																						
		Day (Standard)														Evening (OOHW)														Night (OOHW)																										
NCA	Address	NML	SE	D	W_H	D+W_H	CB_H	DEM	TER_H (	TER_H (	TER_H (	W_L	D+W_L	CB_L	R_North	R_South	TER_L	TB	NML	SE	D	W_H	D+W_H	CB_H	DEM	TER_H (	TER_H (	TER_H (	W_L	D+W_L	CB_L	R_North	R_South	TER_L	TB	NML	SE	D	W_H	D+W_H	CB_H	DEM	TER_H (	TER_H (	TER_H (	W_L	D+W_L	CB_L	R_North	R_South	TER_L	TB				
CN_04	35-51 NICHOLSON STREET WOLLSTONECRAFT	69	-	-	41	41	42	40	56	54	51	37	37	35	-	-	37	39	60	-	-	-	-	-	-	39	-	-	-	37	37	-	-	-	-	-	-	45	-	-	-	-	-	-	-	-	-	-	37	37	-	-	34	34	-	-
CN_04	35-51 NICHOLSON STREET WOLLSTONECRAFT	69	-	-	41	41	41	39	55	54	51	36	36	34	-	-	36	37	60	-	-	-	-	-	-	37	-	-	-	36	36	-	-	-	-	-	-	45	-	-	-	-	-	-	-	-	-	-	36	36	-	-	35	-	-	
CN_04	35-51 NICHOLSON STREET WOLLSTONECRAFT	69	-	-	41	41	42	39	57	55	52	36	37	34	-	-	37	38	60	-	-	-	-	-	-	39	-	-	-	36	36	-	-	-	-	-	-	45	-	-	-	-	-	-	-	-	-	-	36	36	-	-	36	-	-	
CN_05	3-15 CHRISTIE STREET WOLLSTONECRAFT	55	36	34	43	43	44	43	51	49	46	39	39	37	37	-	-	41	43	50	-	-	-	-	-	43	-	-	-	38	38	-	-	-	-	-	-	45	-	-	-	-	-	-	-	-	-	38	38	-	-	36	-	-		
CN_05	7 HUME STREET WOLLSTONECRAFT	55	42	40	47	47	47	50	52	50	47	42	42	41	-	-	47	51	50	-	36	-	-	-	-	50	-	-	-	40	40	-	-	-	-	-	-	45	-	36	-	-	-	-	-	-	40	40	-	-	37	36	-	-		
CN_05	9-15 HUME STREET WOLLSTONECRAFT	55	46	46	51	51	51	53	52	51	48	46	46	46	-	-	52	57	50	-	41	-	-	-	-	53	-	-	-	43	43	-	-	-	-	-	-	45	-	41	-	-	-	-	-	-	43	43	-	-	38	-	-			
CN_05	20-26 HUME STREET WOLLSTONECRAFT	55	37	40	46	46	46	47	54	53	50	41	41	41	-	-	44	48	50	-	36	-	-	-	-	46	-	-	-	40	40	-	-	-	-	-	-	45	-	36	-	-	-	-	-	-	40	40	-	-	35	37	-	-		
CN_05	11 LAMONT STREET WOLLSTONECRAFT	55	-	-	40	40	41	42	48	47	44	35	36	34	-	-	34	35	50	-	42	-	-	-	-	41	-	-	-	35	35	-	-	-	-	-	-	45	-	-	-	-	-	-	-	-	35	35	-	-	37	-	-			
CN_05	12 LAMONT STREET WOLLSTONECRAFT	55	36	-	41	41	42	43	52	51	48	37	37	35	-	-	36	37	50	-	43	-	-	-	-	41	-	-	-	36	36	-	-	-	-	-	-	45	-	-	-	-	-	-	-	-	36	36	-	-	40	-	-			
CN_05	28 NICHOLSON STREET WOLLSTONECRAFT	55	36	-	41	41	42	41	53	52	49	36	37	35	-	-	38	40	50	-	-	-	-	-	-	40	-	-	-	36	36	-	-	-	-	-	-	45	-	-	-	-	-	-	-	-	-	36	36	-	-	-	-	-		
CN_05	2 NICHOLSON STREET WOLLSTONECRAFT	55	34	-	41	41	42	43	50	49	46	37	37	35	-	-	34	36	50	-	-	-	-	-	-	41	-	-	-	36	37	-	-	-	-	-	-	45	-	-	-	-	-	-	-	-	36	37	-	-	39	-	-			
CN_05	4-6 NICHOLSON STREET WOLLSTONECRAFT	55	38	34	44	44	44	42	54	52	49	39	39	37	-	-	37	38	50	-	-	-	-	-	-	41	-	-	-	39	39	-	-	-	-	-	-	45	-	-	-	-	-	-	-	-	39	39	-	-	38	37	-	-		
CN_05	8 NICHOLSON STREET WOLLSTONECRAFT	55	-	-	39	40	40	38	54	52	49	35	35	-	-	-	36	37	50	-	38	-	-	-	-	37	-	-	-	35	35	-	-	-	-	-	-	45	-	-	-	-	-	-	-	-	35	35	-	-	-	-	-			
CN_05	10 NICHOLSON STREET WOLLSTONECRAFT	55	-	-	39	40	40	37	54	52	49	35	35	-	-	-	36	37	50	-	37	-	-	-	-	36	-	-	-	35	35	-	-	-	-	-	-	45	-	-	-	-	-	-	-	-	35	35	-	-	-	-	-			
CN_05	12 NICHOLSON STREET WOLLSTONECRAFT	55	-	-	39	39	40	37	53	52	49	35	35	-	-	-	36	37	50	-	37	-	-	-	-	36	-	-	-	35	35	-	-	-	-	-	-	45	-	-	-	-	-	-	-	-	35	35	-	-	-	-	-			
CN_05	14 NICHOLSON STREET WOLLSTONECRAFT	55	-	-	38	38	39	36	52	51	48	34	34	-	-	-	34	35	50	-	-	-	-	-	-	35	-	-	-	34	34	-	-	-	-	-	-	45	-	-	-	-	-	-	-	-	34	34	-	-	-	-	-			
CN_05	16A NICHOLSON STREET WOLLSTONECRAFT	55	-	-	38	38	39	36	52	50	47	-	34	-	-	-	35	36	50	-	36	-	-	-	-	35	-	-	-	-	34	-	-	-	-	-	-	45	-	-	-	-	-	-	-	-	-	34	-	-	-	-	-	-		
CN_05	16 NICHOLSON STREET WOLLSTONECRAFT	55	-	-	39	39	40	37	53	52	49	35	35	-	-	-	36	37	50	-	-	-	-	-	-	37	-	-	-	34	35	-	-	-	-	-	-	45	-	-	-	-	-	-	-	-	34	35	-	-	-	-	-			
CN_05	18 NICHOLSON STREET WOLLSTONECRAFT	55	-	-	39	39	40	37	53	52	49	34	34	-	-	-	35	36	50	-	-	-	-	-	-	37	-	-	-	34	34	-	-	-	-	-	-	45	-	-	-	-	-	-	-	-	34	34	-	-	-	-	-			
CN_05	20 NICHOLSON STREET WOLLSTONECRAFT	55	-	-	40	40	40	38	53	52	49	35	35	34	-	-	35	36	50	-	-	-	-	-	-	37	-	-	-	35	35	-	-	-	-	-	-	45	-	-	-	-	-	-	-	-	35	35	-	-	36	-	-			
CN_05	22 NICHOLSON STREET WOLLSTONECRAFT	55	-	-	40	40	41	38	52	50	47	35	36	34	-	-	34	36	50	-	-	-	-	-	-	36	-	-	-	35	35	-	-	-	-	-	-	45	-	-	-	-	-	-	-	-	35	35	-	-	41	-	-			
CN_05	24 NICHOLSON STREET WOLLSTONECRAFT	55	-	-	39	40	41	38	53	51	48	35	36	35	-	-	34	35	50	-	-	-	-	-	-	37	-	-	-	35	36	-	-	-	-	-	-	45	-	-	-	-	-	-	-	-	35	36	-	-	44	-	-			
CN_05	3-15 CHRISTIE STREET WOLLSTONECRAFT	55	43	44	50	50	50	54	50	49	46	45	45	45	-	-	51	55	50	-	40	-	-	-	53	-	-	-	42	42	-	-	-	-	-	-	45	-	40	-	-	-	-	-	-	42	42	-	-	36	40	-	-			
CN_05	28 NICHOLSON STREET WOLLSTONECRAFT	55	40	35	45	45	45	46	53	52	49	40	40	38	-	-	39	41	50	-	-	-	-	-	-	45	-	-	-	39	40	-	-	-	-	-	-	45	-	-	-	-	-	-	-	-	39	40	-	-	38	-	-			
CN_05	28 NICHOLSON STREET WOLLSTONECRAFT	55	39	35	45	45	45	46	53	52	49	40	40	38	-	-	39	41	50	-	-	-	-	-	-	44	-	-	-	39	39	-	-	-	-	-	-	45	-	-	-	-	-	-	-	-	39	39	-	-	40	-	-			
OSR	6-8 CLARKE STREET CROWS NEST	50																																																						

Table D2: Predicted construction noise levels assessed to Planning Approval NMLs

CROWS NEST STATION - EARLY ACCESS

		Predicted noise levels, dB(A), where "-" means less than 34 dB(A)															PPA Condition E41/E42 (residential only)										PPA Condition E41/E42 (residential only)									
		Day / Evening 1 - with high noise impact plant (rock hammers and saws)										Respite - without high noise impact plant (rock hammers and saws)										N														
NCA	Address	NML	SE	D	W,H	D+W,H	CB,H	DEM	TER_H (SAW)	TER_H (H20)	TER_H (H13)	W,L	D+W,L	CB,L	TER,L	TB	E2	NML	SE	D	W,L	D+W,L	NML	SE	D	W,L	D+W,L	R_North	R_South							
CN_01	22 CLARKE STREET CROWS NEST	80	47	56	64	64	65	80	84	82	79	59	60	57	65	66	79	65	41	56	59	60	65	41	56	59	60	55	39							
CN_01	34 OXLEY STREET ST LEONARDS	85	49	46	53	53	55	56	60	59	56	48	50	50	52	47	70	37	37	46	48	50	70	37	46	48	50	53	37							
CN_01	36 OXLEY STREET ST LEONARDS	85	46	43	54	54	55	56	71	70	56	49	50	47	55	70	35	35	42	42	49	50	70	35	42	49	50	52	37							
CN_01	545 PACIFIC HIGHWAY ST LEONARDS	80	47	52	59	59	60	61	80	78	75	54	56	55	61	62	65	39	52	54	55	65	39	52	54	55	61	47								
CN_01	563-565 PACIFIC HIGHWAY ST LEONARDS	80	36	46	50	51	51	56	56	54	51	45	48	46	45	43	65	-	46	45	48	65	-	46	45	48	60	44								
CN_02	11 ERNEST STREET CROWS NEST	80	47	40	44	45	45	44	52	51	48	40	42	39	43	45	65	-	40	40	42	65	-	40	40	42	39	39								
CN_02	13 ERNEST STREET CROWS NEST	80	46	39	44	45	45	46	51	49	46	39	41	39	43	46	65	-	39	39	41	65	-	39	39	41	-	36								
CN_02	39 HUME STREET CROWS NEST	85	62	57	56	59	57	60	58	56	53	51	57	54	57	61	70	39	57	51	57	70	39	57	51	57	40	42								
CN_02	43 HUME STREET CROWS NEST	85	60	55	55	58	57	56	57	56	53	51	56	53	57	60	70	37	55	50	56	70	37	55	50	56	37	41								
CN_02	45-47 HUME STREET CROWS NEST	85	57	53	53	56	55	53	56	54	51	49	54	51	52	55	70	34	53	48	54	70	34	53	48	54	35	39								
CN_02	51A HUME STREET CROWS NEST	85	53	52	54	53	53	51	55	52	53	50	47	52	50	54	70	-	52	47	52	70	-	52	47	52	34	36								
CN_02	35 WILLOUGHBY ROAD CROWS NEST	85	34	-	39	40	41	40	52	50	47	35	36	36	36	38	70	-	-	35	36	70	-	-	35	36	-	34								
CN_02	37 WILLOUGHBY ROAD CROWS NEST	85	35	-	39	40	41	40	52	50	47	35	36	36	36	38	70	-	-	35	36	70	-	-	35	36	-	34								
CN_02	39A WILLOUGHBY ROAD CROWS NEST	85	44	36	40	41	41	40	52	50	47	36	38	37	35	37	70	-	36	36	38	70	-	36	36	38	-	34								
CN_02	41 WILLOUGHBY ROAD CROWS NEST	85	47	36	41	42	43	44	54	52	49	37	39	38	36	38	70	-	36	37	39	70	-	36	37	39	-	35								
CN_02	43 WILLOUGHBY ROAD CROWS NEST	85	45	36	42	42	43	46	54	52	49	37	39	37	37	39	70	-	36	37	39	70	-	36	37	39	-	34								
CN_02	45 WILLOUGHBY ROAD CROWS NEST	85	43	34	40	41	41	46	52	51	48	36	38	36	39	42	70	-	34	36	38	70	-	34	36	38	-	-								
CN_02	47A WILLOUGHBY ROAD CROWS NEST	85	49	41	42	44	43	45	52	51	48	38	42	38	43	46	70	-	41	38	42	70	-	41	38	42	-	35								
CN_02	71 WILLOUGHBY ROAD CROWS NEST	85	37	35	41	41	42	41	51	50	47	36	38	36	38	39	70	-	35	36	38	70	-	35	36	38	-	-								
CN_02	74 WILLOUGHBY ROAD CROWS NEST	85	44	39	44	45	45	44	56	55	52	40	41	39	42	43	70	-	39	39	41	70	-	39	39	41	-	-								
CN_02	75 WILLOUGHBY ROAD CROWS NEST	85	34	34	39	39	40	39	50	48	45	34	36	34	36	36	70	-	34	34	36	70	-	34	34	36	35	-								
CN_02	76 WILLOUGHBY ROAD CROWS NEST	85	42	38	42	43	42	42	54	53	50	37	39	37	40	41	70	-	37	37	39	70	-	37	37	39	-	-								
CN_02	80A WILLOUGHBY ROAD CROWS NEST	85	47	41	44	45	45	46	54	53	50	39	42	46	44	46	70	-	41	39	42	70	-	41	39	42	-	-								
CN_02	86 WILLOUGHBY ROAD CROWS NEST	85	47	41	44	45	45	43	54	52	49	39	42	40	44	47	70	-	41	39	42	70	-	41	39	42	-	-								
CN_02	88 WILLOUGHBY ROAD CROWS NEST	85	46	41	44	45	45	44	54	52	49	39	42	40	41	43	70	-	41	39	42	70	-	41	39	42	-	-								
CN_02	90-92 WILLOUGHBY ROAD CROWS NEST	85	42	40	44	45	46	44	55	53	50	40	42	41	41	43	70	-	39	40	42	70	-	39	40	42	-	-								
CN_02	94 WILLOUGHBY ROAD CROWS NEST	70	43	38	43	43	44	41	53	51	48	38	40	38	39	40	55	-	38	38	40	55	-	38	38	40	-	-								
CN_02	96 WILLOUGHBY ROAD CROWS NEST	85	39	36	41	42	42	40	54	53	50	37	38	37	38	39	70	-	36	37	38	70	-	36	37	38	-	-								
CN_02	98 WILLOUGHBY ROAD CROWS NEST	85	37	-	38	39	39	37	52	51	48	37	-	35	34	36	37	70	-	-	-	35	70	-	-	-	35	-	-							
CN_02	100 WILLOUGHBY ROAD CROWS NEST	85	44	37	42	42	43	40	53	51	48	37	39	37	38	40	70	-	37	37	39	70	-	37	37	39	37	-								
CN_02	102 WILLOUGHBY ROAD CROWS NEST	70	37	34	38	39	39	37	51	49	46	-	36	35	35	36	55	-	34	-	36	55	-	34	-	36	34	-								
CN_02	104A WILLOUGHBY ROAD CROWS NEST	85	38	35	39	40	40	38	51	49	46	34	37	36	37	38	70	-	35	34	37	70	-	35	34	37	36	-								
CN_03	4 CLARKE STREET CROWS NEST	85	39	50	55	56	56	65	65	63	60	51	53	50	53	56	70	34	50	51	53	70	34	50	51	53	39	45								
CN_03	429 PACIFIC HIGHWAY CROWS NEST	85	34	40	45	46	46	51	53	52	49	41	43	40	44	47	70	-	40	41	43	70	-	40	41	43	46	51								
CN_03	433-435 PACIFIC HIGHWAY CROWS NEST	85	-	38	43	43	43	51	50	38	45	38	40	38	36	38	70	-	36	37	39	70	-	36	37	39	46	52								
CN_03	437 PACIFIC HIGHWAY CROWS NEST	85	-	38	43	44	44	53	53	51	48	39	40	38	39	42	70	-	37	38	39	70	-	37	38											

Table D2: Predicted construction noise levels assessed to Planning Approval NMLs

CROWS NEST STATION - EARLY ACCESS

Predicted noise levels, dB(A), where "-" means less than 34 dB(A)																	PPA Condition E41/E42 (residential only)					PPA Condition E41/E42 (residential only)									
Day / Evening 1 - with high noise impact plant (rock hammers and saws)																	Respite - without high noise impact plant (rock hammers and saws)					E2					N				
NCA	Address	NML	SE	D	W,H	D+W,H	CB,H	DEM	TER_H (SAW)	TER_H (H20)	TER_H (H13)	W,L	D+W,L	CB,L	TER,L	TB	NML	SE	D	W,L	D+W,L	NML	SE	D	W,L	D+W,L	R_North	R_South			
CN_05	18 NICHOLSON STREET WOLLSTONECRAFT	70	-	-	39	39	40	37	53	52	49	34	34	-	35	36	55	-	-	-	34	34	55	-	-	-	34	-	-		
CN_05	20 NICHOLSON STREET WOLLSTONECRAFT	70	-	-	40	40	40	38	53	52	49	35	35	34	35	36	55	-	-	-	35	35	55	-	-	-	35	35	36		
CN_05	22 NICHOLSON STREET WOLLSTONECRAFT	70	-	-	40	40	41	38	52	50	47	35	36	34	34	36	55	-	-	-	35	35	55	-	-	-	35	35	41		
CN_05	24 NICHOLSON STREET WOLLSTONECRAFT	70	-	-	39	40	41	38	53	51	48	35	36	35	34	35	55	-	-	-	35	36	55	-	-	-	35	36	44		
CN_05	3-15 CHRISTIE STREET WOLLSTONECRAFT	80	43	44	50	50	50	54	50	49	46	45	45	45	51	55	65	-	-	40	42	42	65	-	-	40	42	36	40		
CN_05	28 NICHOLSON STREET WOLLSTONECRAFT	70	40	35	45	45	45	46	53	52	49	40	40	38	39	41	55	-	-	-	39	40	55	-	-	-	39	40	-		
CN_05	28 NICHOLSON STREET WOLLSTONECRAFT	70	39	35	45	45	45	46	53	52	49	40	40	38	39	41	55	-	-	-	39	39	55	-	-	-	39	39	38		
OSR	6-8 CLARKE STREET CROWS NEST	85	48	55	62	62	63	76	75	73	70	58	59	56	58	64															
OSR	10-12 CLARKE STREET CROWS NEST	80	68	66	66	69	67	71	82	80	77	61	66	63	67	71															
OSR	11 CLARKE STREET CROWS NEST	80	56	53	52	55	54	52	58	56	53	47	53	51	49	51															
OSR	20 CLARKE STREET CROWS NEST	80	77	65	66	67	67	72	82	80	77	61	65	60	67	68															
OSR	28-34 CLARKE STREET CROWS NEST	85	47	55	64	64	65	67	85	82	79	59	60	58	65	64															
OSR	2 ERNEST PLACE CROWS NEST	85	43	41	44	45	45	44	52	50	47	39	42	39	39	41															
OSR	31-33 HUME STREET CROWS NEST	85	63	59	60	62	61	63	60	58	55	55	59	57	61	65															
OSR	35 HUME STREET CROWS NEST	85	63	58	59	61	60	63	59	57	54	54	58	56	60	63															
OSR	36 HUME STREET CROWS NEST	85	56	50	48	52	54	52	59	58	55	44	51	53	42	45															
OSR	41 HUME STREET CROWS NEST	85	59	53	52	55	54	56	57	56	53	48	54	51	52	56															
OSR	49 HUME STREET CROWS NEST	85	56	53	53	55	54	53	55	54	51	48	53	51	51	55															
OSR	360 PACIFIC HIGHWAY CROWS NEST	85	56	55	62	62	62	70	67	65	62	57	57	56	59	63															
OSR	378 PACIFIC HIGHWAY CROWS NEST	85	57	61	67	67	66	66	68	66	63	62	62	61	65	69															
OSR	382 PACIFIC HIGHWAY CROWS NEST	85	53	58	63	64	64	63	66	65	62	59	59	58	63	67															
OSR	388 PACIFIC HIGHWAY CROWS NEST	85	53	57	62	62	62	62	66	64	61	57	58	57	56	61															
OSR	16A WILLOUGHBY ROAD CROWS NEST	85	35	42	47	48	48	52	54	53	50	43	44	41	44	46															
OSR	21 WILLOUGHBY ROAD CROWS NEST	85	-	-	40	41	41	42	51	50	47	36	37	35	38	39															
OSR	30 WILLOUGHBY ROAD CROWS NEST	85	36	51	52	53	53	62	62	60	57	48	51	47	49	52															
OSR	31 WILLOUGHBY ROAD CROWS NEST	85	-	-	38	39	39	39	53	51	48	34	35	-	36	36															
OSR	38 WILLOUGHBY ROAD CROWS NEST	85	40	-	43	43	44	44	56	54	51	39	39	37	40	40															
OSR	40-44 WILLOUGHBY ROAD CROWS NEST	85	35	-	44	44	44	43	57	55	52	40	40	38	40	42															
OSR	46 WILLOUGHBY ROAD CROWS NEST	85	42	34	44	44	45	43	59	57	54	40	40	39	39	41															
OSR	48 WILLOUGHBY ROAD CROWS NEST	85	42	35	41	42	43	42	57	55	52	37	39	39	38	40															
OSR	49 WILLOUGHBY ROAD CROWS NEST	85	49	40	44	45	45	45	54	52	49	40	42	40	43	47															
OSR	50 WILLOUGHBY ROAD CROWS NEST	85	40	41	41	44	46	44	57	55	52	37	42	44	38	40															
OSR	51 WILLOUGHBY ROAD CROWS NEST	85	40	37	41	42	42	42	52	51	48	37	39	37	38	40															
OSR	52-54 WILLOUGHBY ROAD CROWS NEST	85	50	41	43	45	46	47	58	56	53	39	43	44	39	41															
OSR	55 WILLOUGHBY ROAD CROWS NEST	85	41	37	41	42	42	41	52	51	48	36	39	36	40	42															
OSR	56 WILLOUGHBY ROAD CROWS NEST	85	55	46	48	49	49	47	56	55	52	43	47	45	39	42															
OSR	57 WILLOUGHBY ROAD CROWS NEST	85	41	38	42	43	42	41	52	51	48	37	39	37	41	43															
OSR	58 WILLOUGHBY ROAD CROWS NEST	85	56	46	49	50	50	49	58	56	53	45	48	46	40	43															
OSR	59-61 WILLOUGHBY ROAD CROWS NEST	85	42	37	42	42	42	38	53	52	49	37	39	36	39	43															
OSR	60-62 WILLOUGHBY ROAD CROWS NEST	85	55	45	49	50	50	51	56	54	51	44	47	44	49	51															
OSR	63 WILLOUGHBY ROAD CROWS NEST	85	43	42	45	46	46	43	53	51	48	41	43	40	39	41															
OSR	64 WILLOUGHBY ROAD CROWS NEST	85	47	40	46	47	47	46	57	55	52	42	43	41	45	46															
OSR	65 WILLOUGHBY ROAD CROWS NEST	85	38	36	42	42	43	43	52	51	48	37	38	37	41	42															
OSR	66 WILLOUGHBY ROAD CROWS NEST	85	46	42	46	47	47	46	57	55	52	41	44	40	44	46															
OSR	67 WILLOUGHBY ROAD CROWS NEST	85	36	34	40	40	41	41	50	49	46	35	37	35	37	38															
OSR	68 WILLOUGHBY ROAD CROWS NEST	85	44	42	45	46	46	45	56	54	51	41	43	40	43	45															
OSR	69 WILLOUGHBY ROAD CROWS NEST	85	35	34	39	40	40	41	50	49	46	35	36	35	36	37															
OSR	70 WILLOUGHBY ROAD CROWS NEST	85	45	41	46	46	46	43	56	54	51	41	43	40	39	40															
OSR	72A WILLOUGHBY ROAD CROWS NEST	85	47	45	49	50	49	44	56	54	51	44	46	44	49	53															
OSR	78 WILLOUGHBY ROAD CROWS NEST	85	38	34	40	40	41	39	55	54	51	35	36	34	38	38															
OSR	82 WILLO																														

## APPENDIX E      Additional noise mitigation

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



**Table E1: Additional noise mitigation and receiver notifications**

Receiver		N					
NCA	Address	SE	D	W_L	D+W_L	R_North	R_South
CN_03	463 PACIFIC HIGHWAY CROWS NEST						-
CN_03	469A PACIFIC HIGHWAY CROWS NEST						MM2
CN_03	471A PACIFIC HIGHWAY CROWS NEST						MM2
CN_04	332 PACIFIC HIGHWAY CROWS NEST						-
CN_04	334 PACIFIC HIGHWAY CROWS NEST						-
CN_04	336 PACIFIC HIGHWAY CROWS NEST						-
CN_04	348 PACIFIC HIGHWAY CROWS NEST						MM2
CN_04	368 PACIFIC HIGHWAY CROWS NEST						MM4
CN_04	370 PACIFIC HIGHWAY CROWS NEST						-
CN_04	374 PACIFIC HIGHWAY CROWS NEST						MM2
CN_04	402-420 PACIFIC HIGHWAY CROWS NEST					-	

## APPENDIX F Consultation required under conditions E37/E38

*The required consultation have provided to Systems Connect in a spreadsheet table in order to more adequately mitigate and manage potential noise impacts.*

**Table F1** identifies ('E38 consultation required') the locations where consultation is required to determine appropriate hours of respite from air-borne noise in accordance with PPA Conditions E37 and E38.

**Table F2** identifies the locations where consultation is required to determine appropriate hours of respite from ground-borne noise in accordance with PPA Conditions E37 and E38.

Table F1: Consultation triggered by condition E38 - Air-borne noise

CROWS NEST STATION - EARLY ACCESS

Receiver		E38 Consultation Required?													
NCA	Address	SE	D	W_H	D+W_H	CB_H	DEM	TER_H (SAW)	TER_H (H20)	TER_H (H13)	W_L	D+W_L	CB_L	TER_L	TB
CN_01	22 CLARKE STREET CROWS NEST							Yes	Yes						
CN_04	368 PACIFIC HIGHWAY CROWS NEST						Yes								
OSR	10-12 CLARKE STREET CROWS NEST							Yes							
OSR	20 CLARKE STREET CROWS NEST							Yes							

Table F2: Consultation triggered by condition E37 and E38 - Ground-borne noise

CROWS NEST STATION - EARLY ACCESS

Receiver		E37 & E38 Consultation Required?													
NCA	Address	SE	D	W_H	D+W_H	CB_H	DEM	TER_H (SAW)	TER_H (H20)	TER_H (H13)	W_L	D+W_L	CB_L	TER_L	TB
CN_01	22 CLARKE STREET CROWS NEST					Yes									
OSR	28-34 CLARKE STREET CROWS NEST								Yes						

## APPENDIX G      Predicted ground-borne noise levels

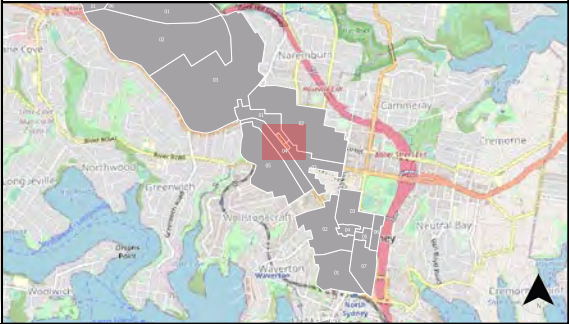
## **G.1 Crane base construction with 30t rock hammer**



180 m  
160  
140  
120  
100  
80  
60  
40  
20  
0



LEGEND  
Maximum GBN levels dB(A):  
for Heavy rock breaker  
HR: > 60  
Crane pads



..	..	..	..	..
..	..	..	..	..
..	..	..	..	..
..	..	..	..	..
..	..	..	..	..
r1	MS	29/05/20	Update figures	BC
r0	MS	21/05/20	Prepare figures	BC
REV	BY	DATE	DESCRIPTION	APPROVER
A3	Original		Co-ordinate System: MGA Zone 56	

020406080

1:1500

▲

CLIENT

System  
Connect

ACOUSTIC CONSULTANT

RENZO TONIN  
& ASSOCIATES

inspired to achieve

Ph (02) 8218 0500 Fax (02) 8218 0501



## **G.2 Trench construction with 20t rock hammer**



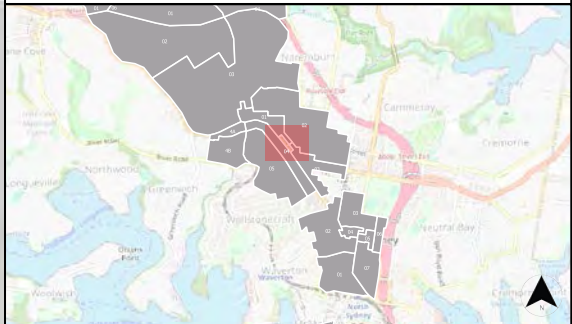


## LEGEND

Maximum GBN levels dB(A):  
for Excavator with rock hammer (20t)

LR: > 60

 Trench



..	..	..	..	..
..	..	..	..	..
..	..	..	..	..
..	..	..	..	..
..	..	..	..	..
..	..	..	..	..
r0	MS	20/11/20	Prepare figures	BC
REV	BY	DATE	DESCRIPTION	APPROVER
A3 Original			Co-ordinate System: MGA Zone 56	

FULL SIZE A3

NOTE: Do not scale from this drawing.

CLIENT



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SYDNEY METRO - CHATSWOOD TO SYDENHAM
--------------------------------------

Location	Observed maximum GBN levels with Excavator with rock hammer (20t)	Predicted maximum GBN levels with Excavator with rock hammer (20t)
1	10	10
2	10	10
3	10	10
4	10	10
5	10	10
6	10	10
7	10	10
8	10	10
9	10	10
10	10	10
11	10	10
12	10	10
13	10	10
14	10	10
15	10	10
16	10	10
17	10	10
18	10	10
19	10	10
20	10	10
21	10	10
22	10	10
23	10	10
24	10	10
25	10	10
26	10	10
27	10	10
28	10	10
29	10	10
30	10	10
31	10	10
32	10	10
33	10	10
34	10	10
35	10	10
36	10	10
37	10	10
38	10	10
39	10	10
40	10	10
41	10	10
42	10	10
43	10	10
44	10	10
45	10	10
46	10	10
47	10	10
48	10	10
49	10	10
50	10	10
51	10	10
52	10	10
53	10	10
54	10	10
55	10	10
56	10	10
57	10	10
58	10	10
59	10	10
60	10	10
61	10	10
62	10	10
63	10	10
64	10	10
65	10	10
66	10	10
67	10	10
68	10	10
69	10	10
70	10	10
71	10	10
72	10	10
73	10	10
74	10	10
75	10	10
76	10	10
77	10	10
78	10	10
79	10	10
80	10	10
81	10	10
82	10	10
83	10	10
84	10	10
85	10	10
86	10	10
87	10	10
88	10	10
89	10	10
90	10	10
91	10	10
92	10	10
93	10	10
94	10	10
95	10	10
96	10	10
97	10	10
98	10	10
99	10	10
100	10	10



## APPENDIX H      Vibration minimum working distances

## **H.1 Crane pad construction - minimum working distances with 30t rock hammer**





## LEGEND

### Noise sensitive receivers

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

NCA

### Receivers affected by MWD for Heavy rock breaker

- |                                     |
|-------------------------------------|
| Human annoyance - Residential (day) |
| Human annoyance - Commercial        |
| Human annoyance - Critical          |

Crane pads



..	..	..	..	..
..	..	..	..	..
..	..	..	..	..
..	..	..	..	..
..	..	..	..	..
r1	MS	29/05/20	Update figure	BC
r0	MS	20/05/20	Prepare figures	BC
REV	BY	DATE	DESCRIPTION	APPROVER
A3	Original		Co-ordinate System: MGA Zone 56	

0	20	40	60	80 m
1:1500				
FULL SIZE A3				
NOTE: Do not scale from this drawing.				

CLIENT

 **Systems Connect**

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*inspired to achieve*

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SYDNEY METRO - CHATSWOOD TO SYDENHAM

Crows Nest early access  
MWD for human annoyance

Sheet 1 of 1



## **H.2 Trench construction - minimum working distances with 13-20t rock hammer**





## LEGEND

### Noise sensitive receivers

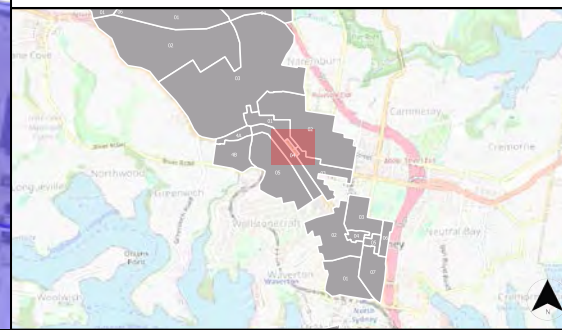
- |   |                        |   |                     |
|---|------------------------|---|---------------------|
|  | Childcare              |  | Theatre/Auditorium  |
|  | Commercial             |  | Mixed use           |
|  | Educational            |  | Project acquisition |
|  | Hotel/Motel/Hostel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



Receivers affected by MWD  
for Excavator with rock hammer (13-20t)

- Human annoyance - Residential (day)  
Human annoyance - Commercial  
Human annoyance - Critical

 Trench



..	..	..	..	..
..	..	..	..	..
..	..	..	..	..
..	..	..	..	..
..	..	..	..	..
..	..	..	..	..
..	..	..	..	..
r0	MS	20/11/20	Prepare figures	BC
REV	BY	DATE	DESCRIPTION	APPROVER
A3 Original			Co-ordinate System: MGA Zone 56	

0      20      40      60      80 m

1:1500



CLIENT	
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SYDNEY METRO - CHATSWOOD TO SYDENHAM

Crows Nest early access  
MWD for human annoyance