

**APPROVAL**  
**CITY & SOUTHWEST ACOUSTICS ADVISOR**

<b>Review of</b>	<b>Noise and Vibration Assessment Line Wide Works Central Station Integrated Station Development (LW CSISD)</b>	<b>Document reference:</b>	<b>Sydney Metro City &amp; South West – Line Wide Works – OOHW Noise and Vibration Assessment: Central Station Tunnel Trackworks</b>
<b>Prepared by:</b>	Carl Fokkema Alternate Acoustics Advisor		<b>Prepared by Renzo Tonin &amp; Associates Pty Ltd.</b>
<b>Date of issue:</b>	19 January 2022		<i>Report Number TK685-03-18F01 NVA_OOHW C2S_P3 CS (r5)</i>

As approved Alternate Acoustics Advisor for the Sydney Metro City & Southwest project, I have reviewed and provided comment on the Noise and Vibration Assessment (NVA) for proposed OOHW Line Wide Central Station Tunnel Trackworks, as required under A27 (d) of the project approval conditions (SSI 15-7400).

I am satisfied that the NVA is technically valid and includes appropriate noise and vibration mitigation and management (dated 17 January 2022). On this basis I endorse r5 of the NVA in respect of OOHW Line Wide Central Station Tunnel Trackworks.



Carl Fokkema, City & Southwest Alternate Acoustics Advisor

17 January 2022

TK685-03-18F01 NVA\_OOHW C2S\_P3 CS (r5)

Systems Connect

Level 1, 116 Miller Street

North Sydney 2060

## Sydney Metro City & Southwest - Line-wide Works - OOHW Noise and Vibration Assessment: Central Station Tunnel Trackworks

### 1 Introduction

This Out of Hours Works (OOHW) Noise and Vibration Assessment (NVA) 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).

This NVA applies to works at the Central Station underground worksite and includes works to be undertaken wholly within the covered station box and tunnels underground, with no works on the site surface. The expected duration of construction activities is outlined in Table C1 of APPENDIX C. Works will be completed during standard construction hours as well as outside of standard construction hours. The construction hours of work are defined by the Project Planning Approval conditions and Environment Protection Licence (EPL 21423) as outlined in the CNVMP. This NVA forms part of the CNVMP for the Project.

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 NVA

This NVA provides an assessment of noise and vibration impacts from tunnel trackworks (including station box) for the C2S Line Wide Works at the Central Station underground worksite.

The site location and layout 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. The primary construction activity would be tunnel skeleton track works; tunnel slab track works, aluminothermic welding and mechanical and electrical fit-out work (including walkways). In addition, concrete removal is required at track level. All proposed works will be undertaken wholly within the Central Station covered station box and tunnels underground, with no works on the site surface. There will be no movement of Systems Connect material from the surface at Central Station to the station box or tunnels. All materials delivery and ventilation will be via the Marrickville Dive site, with some concrete supplied via the Waterloo Station site. Noise impacts from these activities have been assessed in the CNVIS for Marrickville SMTF-S and southern dive [10] and Waterloo Station [11].

There is one opening remaining at surface level which provide access for other contractors working at Central Station and ventilation of the caverns. As noted above, this opening will not be used by Systems Connect. The noise assessment has considered the potential construction noise from trackworks in the covered station box (at approximately 30 metres below surface level) emanating from the surface opening to the nearest sensitive receivers.

There are no surface traffic movements on public roads at Central Station, therefore construction traffic noise assessment is not required in this report.

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. As works will be wholly underground, the risk of cumulative impact is low.

## 2.2 Construction hours

In relation to the works at the Central Station underground worksite, the construction hours for the Project are defined by Project Planning Approval (PPA) Conditions E36 and E44. The EPL 21423 is consistent with these conditions.

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

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. CSSI-7400 Condition E48 allows 24-hour construction for station and tunnel fitout.

Relevant to the track works at the Central Station underground worksite, construction may be undertaken outside standard construction hours in accordance with EPL (21423) Condition L4.4 where:

- Construction works and activities that does not cause, when measured at the boundary of the most affected noise [or vibration] sensitive receiver:
  - $L_{Aeq(15 \text{ minute})}$  noise levels greater than 5 dB(A) above the day, evening and night rating background level, as applicable;
  - $L_{A1(1 \text{ minute})}$  or  $L_{Amax}$  noise levels greater than 15dB above the night RBL for night works;
  - Continuous or impulsive vibration values greater than those for human exposure to vibration, set out for residences in Table 2.2 of Assessing Vibration: a technical guideline (DEC, 2006); and
  - Intermittent vibration values greater than those for human exposure to vibration, set out for residences in Table 2.4 of Assessing Vibration: a technical guideline (DEC, 2006).

### 3 Nearest sensitive 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. In addition, 'other' noise and vibration sensitive receivers such as passive recreation areas, recording studios, places of worship and heritage items surrounding the construction area have been identified.

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

## 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)[9], 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. The noise goals are presented in Table B1 of APPENDIX B.

### 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].

## 5 Construction noise and vibration assessment

### 5.1 Construction noise assessment

The track and concrete removal works at the Central Station underground worksite will be completed underground, within the tunnels and covered station box. There is one opening to the surface through which noise from the works may emanate. This opening is partly obstructed by tunnel ventilation equipment, which is operated by the Central Station contractor. Airborne noise emission from the System Connect works inside the tunnels and caverns has been predicted based on the plant and equipment list outlined in Table C1 of APPENDIX C. the results are summarised in the table below.

**Table 5-1: : Predicted construction noise levels at the closest noise sensitive receivers**

Address	Type of receiver	Predicted external construction noise level, RBL+5, dB(A)		Night	
		Tunnel track works	Concrete Removal		
30-34 CHALMERS STREET, SURRY HILLS	Mixed use (Residential)	<41	<53	58	50
38 CHALMERS STREET, SURRY HILLS	Mixed use (Residential)	<40	<52	58	50
28 CHALMERS STREET, SURRY HILLS	Hotel/Motel /Hostel	<37	<49	60	60

Predicted  $L_{Amax}$  noise levels for the night period are below  $L_{Amax}$  60 dB(A) at all receivers for all works.

#### 5.1.1 Tunnel track works

Noise generated by the tunnel track works to the nearest residential receiver are expected to be:

- $L_{Aeq(15min)}$  noise levels no more than 5 dB(A) above the day, evening and night rating background level, as applicable
- $L_{Amax}$  noise levels less than 15dB above the night rating background level.

Therefore, EPL 21423 Condition L4.4 is satisfied and works may be completed during and outside of standard construction hours. It is noted that due to the low noise levels from the Central Station underground trackworks, the likelihood of cumulative impact is low.

### 5.1.2 Concrete Removal works

Noise generated by the concrete removal works to the nearest residential receiver are expected to be:

- $L_{Aeq(15min)}$  noise levels no more than 5 dB(A) above the evening rating background level, and
- $L_{Amax}$  noise levels less than 15dB above the night rating background level.

Therefore, EPL 21423 Condition L4.4 is satisfied during the evening period (i.e. 6pm to 10pm) and works may be completed during and outside of standard construction hours, up until 10pm. It is noted that due to the low noise levels from the Central Station underground trackworks, the likelihood of cumulative impact with OOHW on the surface by others is low.

Noise generated by the concrete removal works to the nearest residential receivers may be up to 3 dB higher than the low noise impact works limit of 5 dB(A) above the rating background level during the night period (i.e. 10pm to 7am Monday to Friday; and 10pm to 8am on Saturday, Sunday and public holidays). The potential exceedance is based on conservative assumptions about works inside the cavern and tunnels, including that the location of the works is below the opening. The nearest point of the concrete removal works is more than 30 metres from the molehole when works are in the station box cavern; and more than 100 metres from the molehole when works are in the tunnels. On this basis noise emission from the concrete removal works is likely to be below the levels presented in Table 5-1 and potentially below the low noise impact works limit of 5 dB(A) above the rating background level at night.

Concrete removal works are not likely to occur concurrently with the track works in the station box. However, should this occur we note that predicted noise levels for the tunnel track works are more than 10 dB below predicted noise levels for the concrete removal works. The likelihood of cumulative impact is negligible.

Noise monitoring would be undertaken during the evening period to confirm noise emission from the open molehole, as described in Section 5.3.1. Where measured noise levels are below the low noise impact works limit for the night period, works would be extended into the night period.

## 5.2 Construction vibration assessment

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

- Hi-Rail Excavator 17t with Pneumatic Hammer attachment

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 5-2 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 5-2).

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 5-2: 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 pneumatic hammer (up to 35T)	5	10	10

Notes

- 1) Initial screening test criteria reduced by 50% due to potential dynamic magnification in accordance with BS7385.
- 2) In accordance with Section 5.8.1 of CNVMP, a site inspection should determine whether a heritage structure is structurally unsound.
- 3) Minimum working distances are in 5m increments only to account for the intrinsic uncertainty of this screening method.

**Table 5-3: Minimum working distances (m) for human annoyance (continuous vibration)**

Plant item	Minimum working distances, m				
	Critical areas <sup>1,4</sup>	Residences		Offices <sup>3,4</sup>	Workshops <sup>4</sup>
		Day <sup>2</sup>	Night <sup>2</sup>		
Excavator with pneumatic hammer (up to 35T)	40	25	30	20	15

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.

The proposed works are more than 30 metres from the nearest residential receiver, consistent with EPL Condition L4.4. In addition, the works are more than 40 metres from the Sydney Dental Hospital. Construction vibration impacts are considered to be negligible.

Therefore, EPL 21423 Condition L4.4 is satisfied and works may be completed during and outside of standard construction hours.

### 5.3 Noise and vibration mitigation measures

Noise and vibration mitigation and management measures presented in the CNVMP will be applied to the track works undertaken at the Central Station underground worksite.

### 5.3.1 Attended monitoring

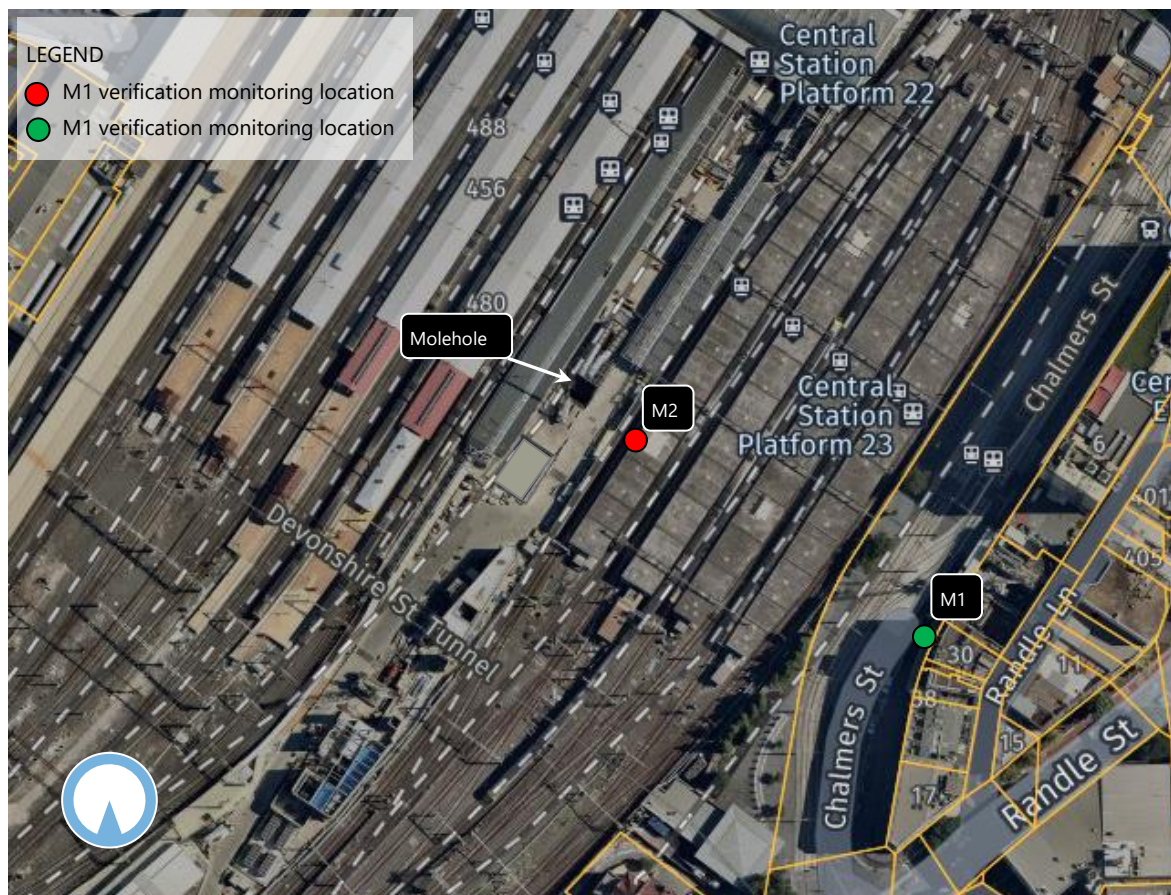
Attended noise monitoring will be undertaken during works at one of the representative receivers identified in the table below. Nominated attended measurement locations have been selected with the best opportunity to verify that noise from the track works and concrete removal works is below the NMLs (see in Table 5-4 and Figure 5-1).

**Table 5-4: Nominated verification monitoring locations**

NCA	Nominated receiver address	Monitoring location
CS_GD	30 Chalmers Street, Surry Hills	M1 - Footpath on Chalmers Street
-	Verification location near molehole	M2 Platform 16, opposite open molehole (near opening in noise barrier) at 1.5 metres above platform level

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

**Figure 5-1: Nominated verification monitoring locations**



To confirm whether concrete removal works would comply with the low noise impact limit during the night period, noise monitoring would be undertaken at location M2 during the evening period, prior to 10pm when the concrete removal is at the closest point to the molehole. Where measured noise levels are below the predicted level of 61 dB(A) at Location M2 there is a high probability that noise levels at the nearest receiver would be low noise impact during the night period. Works could then be extended



into the night period, followed by further measurements at Location M1 to verify noise levels are below 50 dB(A) from construction activity at night.

If verification monitoring shows that noise from the underground works is audible and above the relevant NMLs at night, more detailed analysis would be conducted to determine additional on-site mitigation measures or other management measures. Additional on-site mitigation measures, such as providing temporary screening of the opening where noise is escaping to the surface, and other management measures will be determined based on what aspect of the activity causes the measured exceedance, on a case-by-case basis, or management measures restricting concrete removal works to the day and evening periods only will continue.

Vibration monitoring would only be undertaken in response to a complaint in relation to vibration from the proposed works.

### 5.3.2 Complaints handlings

Any noise or vibration complaints received and responded to will be managed in accordance with the CNVMP and the Community Consultation Strategy.

Transport for NSW operate a 24-hour construction complaints line (1800 171 386). Enquiries/ complaints may also be received through the Sydney Metro project email (linewide@transport.nsw.gov.au).

## 6 Conclusion

Works associated with the C2S tunnel track and concrete removal works at the Central Station underground worksite have been identified and described in this report. The expected duration of construction activities is outlined in Table C1 of APPENDIX C.

Airborne noise and vibration generated by the proposed track works are anticipated to be below the noise and vibration objectives established in Section 4. Therefore, works may be undertaken during and outside of Standard Construction Hours, in accordance with CSSI-7400 Condition E44(d) and EPL Condition L4.4.

Airborne noise generated by concrete removal works in the station box and tunnels are anticipated to be below the noise objectives established in Section 4 during the evening period. Therefore, works may be undertaken during and outside of Standard Construction Hours up to 10:00pm, in accordance with CSSI-7400 Condition E44(d) and EPL Condition L4.4. If verification monitoring confirms that noise from concrete removal works is below the noise objectives established in Section 4 for the night period, works may be extended into the night period.

## Document control

Date	Revision history	Non-issued revision	Issued revision	Prepared	Instructed	Reviewed / Authorised
25.11.2021	Initial issue	0	1	T. Gowen	-	M. Tabacchi
29.11.2021	Update following AA review	-	2, 3	T. Gowen	-	M. Tabacchi
12.01.2021	Update to include rock breaking in tunnel/ cavern	-	4	T. Gowen	-	M. Tabacchi
17.01.2021	Update following AA review	-	5	T. Gowen	-	M. Tabacchi

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### Important Disclaimers:

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

This document is issued subject to review and authorisation by the suitably qualified and experienced person named in the last column above. If no name appears, 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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## 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 Sydney Metro Construction Environmental Management Framework August 2016
- [10] Renzo Tonin & Associates 2020 Sydney Metro City and South West Line-Wide Works - Construction Noise and Vibration Impact Statement Portion 3 – SMTF-S and southern dive (ref: TK685-03-16F01 (r4) CNVIS C2S\_P3 SMTF-S)
- [11] Renzo Tonin & Associates 2020 Sydney Metro City and South West Line-Wide Works - Construction Noise and Vibration Impact Statement Portion 3 - Waterloo Station early access works (ref: TK685-03-07F01 CNVIS C2S\_P3 Waterloo (r4))

## 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 Leq 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.

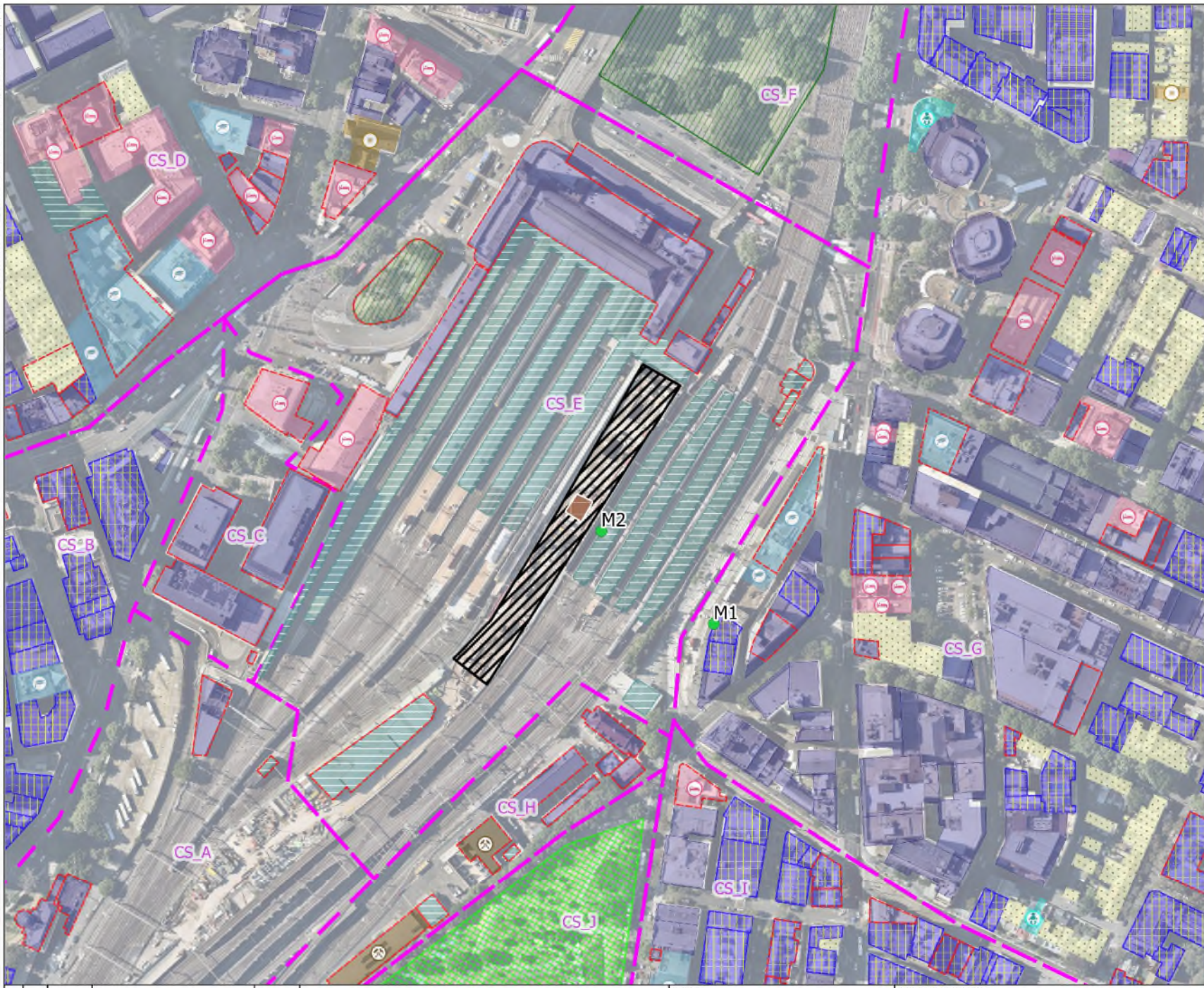
## **APPENDIX B**      **Nearest sensitive receivers and noise management levels**

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

**CENTRAL STATION WORKS**

NCA	Nearest construction work area	Receiver Type	Reference RBL	Existing Noise Levels $L_{A90(15min)}$ , dB(A)			Residential NMLs based on ICNG (external), $L_{Aeq(15min)}$				Sleep Dist. $L_{Amax}$		Comments	
				RBL Day	RBL Evening	RBL Night	NML DS	NML DO	NML E	NML N	Screening	Max		
CS_A	Central Station	Residential CBD	C2S EIS B.26	58	56	52	68	63	61	57	67	65		
CS_B	Central Station	Residential CBD	C2S EIS B.26	58	56	52	68	63	61	57	67	65		
CS_C	Central Station	Residential CBD	C2S EIS B.26	58	56	52	68	63	61	57	67	65		
CS_D	Central Station	Residential CBD	C2S EIS B.26	58	56	52	68	63	61	57	67	65		
CS_G	Central Station	Residential CBD	C2S EIS B.09	56	53	45	66	61	58	50	60	65		
CS_I	Central Station	Residential CBD	C2S EIS B.09	56	53	45	66	61	58	50	60	65		
<b>Other sensitive receivers</b>							<b>Sensitive Receiver NMLs based on ICNG (see comments for details), <math>L_{Aeq(15min)}</math></b>							
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)
Childcare 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 to 8 am Saturday, Sunday and Public holidays - OOHW P2

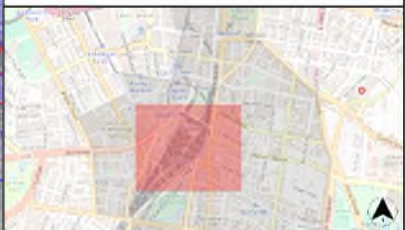


### LEGEND

	Childcare
	Educational
	Theatre/Auditorium
	Cinema
	Laboratory
	Flight simulator
	Horse Stable
	Recreational - Passive
	Recreational - Active
	Other
	Heritage

	NCA's
	Central Station Worksite (note: underground worksite)
	Opening (mole hole)
	Noise Monitoring Location



REV	BY	DATE	DESCRIPTION	APPROVER
12	SS	15/01/22	Modify Mole Holes	TG
11	SS	28/11/21	Add Mole Holes	TG
10	SS	25/11/21	Prepare figures	TG

Co-ordinate System: MGA Zone 56

0 20 40 60 80 100 120 140 160 m

1:2,500

CLIENT: **Systems Connect**

ACUSTIC CONSULTANT: **RENZO TONIN & ASSOCIATES**  
*inspired to achieve*

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NOTE: Do not scale from this drawing.

CLIENT: **Systems Connect**

ACUSTIC CONSULTANT: **RENZO TONIN & ASSOCIATES**  
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## APPENDIX C    Construction details

Table C1: Construction Activities/ Equipment

CENTRAL STATION WORKS

Work activity	Details	Indicative timing/ duration	Work Status for CNVIS	Plant/ Equipment (as provided by client)	Day	Evening	Night	Sound Power Level (Lw re: 1pW) in Noise Model, dB(A)			High noise plant (EPL E1)	Vibration intensive plant	Notes
					7am - 6pm	6pm - 10pm	10pm - 7am	L <sub>Aeq</sub>	Penalty	L <sub>Amax</sub>			
CENTRAL STATION SURFACE ACCESS													
No plant access via Central Station	(Note 1) Delivering and removing equipment, machinery and materials - access via Southern Dive/Marrickville (Note 2) Delivering of concrete via pressured pipe at Waterloo Station and Southern Dive/Marrickville	Nov 2021 - May 2022											
TUNNEL TRACK WORKS INCLUDING STATION BOX													
TUNNEL TEMPORARY SUPPORT SYSTEMS	Install temporary lightng, ventilation fans, access gates and dewatering pipes	Nov 2021 - Dec 2021		Hi-Rail Excavator Hi-Rail EWP Rail trolley	1 1 1	1 1 1	1 1 1	103 95 -	- - -	108 98 -	- - -	- - -	
TUNNEL SKELETON TRACK	Distribute Rail through Central Station	Nov 2021 - Dec 2021		Hi-Rail Excavator Front end loader Handtool - grinder Hand tools (Power)	1 1 2 2	1 1 2 2	1 1 2 2	103 110 107 107	- - 5 5	108 115 118 118	- - HN HN	- - - X	
	Distribute sleepers to Central Station	Nov 2021 - Dec 2021		Positrack Hi-Rail Excavator Hi-Rail Trailer Rail trolley	1 2 1 1	1 2 1 1	1 2 1 1	104 103 - -	- - - -	109 108 - -	- - - -	- - - -	
	Distribute sleepers through Central Station	Nov 2021 - Dec 2021		Positrack Hi-Rail Excavator Hi-Rail Trailer Rail trolley	1 2 1 1	1 2 1 1	1 2 1 1	104 103 - -	- - - -	109 108 - -	- - - -	- - - -	
TUNNEL TRACKSLAB	Tunnel Concrete Placement - tunnel concrete consist	Dec 2021 - Feb 2022		Concrete Pump (Putz 1409) Rail set (train consist) Hi-Rail Excavator Concrete remixer Concrete vibrator Compressor Hammer drill/ power saw	1 3 2 2 6 2 1	1 3 2 2 6 2 1	1 3 2 2 6 2 1	116 98 103 108 97 102 107	- - - - - 5 5	118 102 108 111 100 103 118	- - - - - HN HN	- - - - - - X	
ALUMINOTHERMIC WELDING	Track welding works	Jan 2021 - Feb 2022		Welding tools /oxy Handtool - grinder	2 2	2 2	2 2	102 107	- 5	105 118	- HN	- -	
M&E TUNNEL FITOUT INCL. WALKWAYS	Walkway, Handrail, CSR, Noise Attenuation & OHW Installation	Feb 2022 - May 2022		Handtool - rattle qun Handtool - grinder Welding tools /oxy Generator Hi-Rail EWP Hi-Rail Truck	2 2 1 1 2 2	2 2 1 1 2 2	2 2 1 1 2 2	107 107 102 94 95 103	- 5 - - - -	118 118 105 95 98 111	- HN - - - -	- - - - - -	
TUNNEL TRACK WORKS INCLUDING STATION BOX - CONCRETE REMOVAL													
CONCRETE REMOVAL AT TRACK LEVEL	Concrete-breaking activities at Central Station Track level	Jan 2022 - Feb 2022		Hi-Rail Excavator 17t with Pneumatic Hammer attachment	1	1	1 (TBC)	118	5	123	HN	X	Operation of Hi-Rail Excavator 17t with Pneumatic Hammer attachment at night is subject to verification monitoring.