

SYDNEY METRO CITY AND SOUTH WEST - LINE-WIDE WORKS

Construction Noise and Vibration Impact Statement Portion 4 - Bulk Power Supply Works (Southern)

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Systems Connect

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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 4 - Power Supply Works delivered under Critical State Significant Infrastructure Approval SSI 8256. Condition E27 of CSSI-8256 requires that:

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

This CNVIS applies to Bulk Power Supply Works (Southern), which includes works to be undertaken along the Bulk Power Supply route between Ausgrid's Canterbury Sub-Transmission Substation and the Campsie bulk supply infeed substation. 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 Bulk Power Supply Works, which includes providing cable routes and cable protection, feeder cables and cable joints, control and pilot cable and connections and terminations 33kV feeders from Ausgrid's Canterbury Sub-Transmission Substation to the Campsie bulk supply infeed substation. Figure 2.1 shows the Bulk Power Supply (Southern) work areas. Details on activities carried out within each stage follow the figure.

Figure 2.1: Bulk Power Supply (Southern) work areas



The Bulk Power Supply (Southern) construction activities will include:

- **Compound** – general worksite, carparking, storage, delivery
- **Site establishment** – installation of environmental controls/ traffic controls.

- **Campsie to Canterbury BPS Route**
 - Cable routes excavation, conduits installation, temporary surface reinstatement
 - Cable Installation and Jointing.

The proposed works, likely plant and equipment and estimated Project timing is summarised in APPENDIX C. Works are planned to occur during standard construction hours, however due to the proximity of the works area to the arterial roads, some works will need to occur under Road Occupancy License, as outlined in Section 2.2.3 and APPENDIX C.

2.1.2 Construction traffic

The Bulk Power Supply (Southern) 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

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

2.2 Construction hours

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

2.2.1 Standard construction hours

The standard construction hours of work are defined by the CSSI-8256 Condition E19. The standard construction hours for the Project are summarised in the Table 2.1 below.

In addition to this, highly noise intensive work that results in an exceedance of the applicable Noise Management Level at the same receiver is limited by CSSI-8256 Condition E24, except where permitted by an Environment Protection License (EPL) as noted in Table 2.1.

Table 2.1: Standard construction hours

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

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

2.2.2 Out of hours work periods

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

The Transport for NSW (TfNSW) Construction Noise and Vibration Strategy (CNVS) [10] provides a hierarchy of Out of Hours (OOH) work periods. The impact of OOH works may be reduced by scheduling work and activities with greater impact during the preferred periods when receivers are likely to be less sensitive to noise and vibration, such as in the day out of hours (OOHD) and evening out of hours (OOHE) periods. Table 2.2 presents the construction work periods as Standard Hours, Out of Hours Work (OOHW) Period 1 and OOHW Period 2.

Table 2.2: Construction hours

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-8256 Condition E19 as: Monday to Friday 7:00am to 6:00pm and Saturdays from 8:00am to 6:00pm.
- 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 Saturday 6:00pm to 10:00pm (evenings; OOHE), Saturday 7:00am to 8:00am (days; OOHD) and Sunday and public holidays 8:00am to 6:00pm (days; OOHD).
 - OOHW Period 2** is the most sensitive OOH period and is defined as Monday to Saturday 10:00pm to 7:00am (nights; OOHN) and Sundays and public holidays 6:00pm to 8:00am (nights, OOHN).

2.2.3 Justification for OOHW

Construction works for the Bulk Power Supply Works (Southern) will be undertaken where reasonable and feasible during standard construction hours, as described above. However, some works will need to be undertaken outside of standard construction hours due to safety or quality control considerations, or to comply with regulatory requirements.

Out of Hours Works that apply to the Bulk Power Supply Works (Southern) works include:

- E22(b) where the relevant road authority has advised the Proponent in writing that carrying out the activities could result in a high risk to road network operational performance
- E22(c) where the relevant utility service operator has advised the Proponent in writing that carrying out the activities could result in a high risk to the operation and integrity of the utility network
- E22(d) where the Transport for NSW Transport Management Centre (or other road authority) has advised the Proponent in writing that a road occupancy licence is required and will not be issued for the activities during the hours specified in Conditions E19 and E20

For example, where works cross intersections of arterial roads, road traffic would impose major risks to construction workers due to the extremely close proximity between all parties involved. Conducting works under a Road Occupancy License would minimise the risks of road traffic and work site interaction, however this disruption to traffic could not occur during standard construction hours without impacting the road traffic network. Works would need to be conducted outside peak road traffic periods (i.e. between 8:00pm and 5:00am) to reduce the impact on the road network.

Oversize deliveries may need to take place outside of standard construction hours in order to comply with RMS requirements for oversize vehicle movements.

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

3 Nearest sensitive receivers

3.1 Residential receivers

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

All relevant 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 and places of worship surrounding the construction area have been identified and are summarised and identified on an aerial photograph located in APPENDIX B.

CSSI-8256 Condition E28 states:

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

Systems Connect 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. Sydney Metro and Systems Connect are working with sensitive receivers to further assess and determine other reasonable arrangements to be implemented.

3.3 Commercial and industrial premises

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

3.4 Heritage receivers

Heritage receivers have been identified in the Land Use Survey in Annexure B of the CNVMP. There are seven heritage-listed receivers close to the work areas, summarised in Table 3.1.

Table 3.1: Assessment heritage receivers

Name	Address/Location	Significance
Campsie Railway Station Group	Wilfred Avenue, Campsie	State
Federation commercial building—Coffill's Buildings	191–197 Beamish Street, Campsie	Local
Inter war commercial building—Station House	203 Beamish Street, Campsie	Local
Inter war court house (former Campsie Court House)	56–58 Campsie Street, Campsie	Local
War memorial clock tower	Anglo Road (Anzac Mall), Campsie	Local
Federation house	40 South Parade, Campsie	Local
Federation villa	44 South Parade, Campsie	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)[11], CSSI-8256 Conditions, in accordance with the Sydney Metro City & Southwest Construction Noise and Vibration Strategy (SMCSNVS) [9] and as set out in the CNVMP.

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

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

Airborne NMLs are summarised and presented in APPENDIX B.

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

Where construction activities are tonal or impulsive in nature and are described in the ICNG as being particularly annoying, 5 dB(A) must be added to the activity noise. Activities that are defined in the Interim Construction Noise Guideline (ICNG) [4] as particularly annoying include but are not limited to the use of 'beeper' style reversing or movement alarms; power saws; vibratory rolling; jack hammering, rock hammering or rock breaking; impact piling.

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

4.1.2 Sleep disturbance

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

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

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

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

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

4.1.3 Construction related road traffic noise objectives

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

4.2 Construction vibration goals

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

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

4.2.1 Disturbance to building occupants (human annoyance)

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

Intermittent vibration is assessed using vibration dose values (VDVs). For the assessment of potential vibration at the nearest vibration sensitive receivers preferred and maximum VDV goals for the day period (7:00am to 10:00pm) are presented in Table 4.1.

Table 4.1: Construction vibration disturbance goals

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

Notes: 1. Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am

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

4.2.2 Structural damage to buildings

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

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

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

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

4.2.3 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

No sensitive scientific or medical equipment are known to be located near the assessed works. If they are identified, relevant vibration criteria should be established for each item in line with Section 5.5.3 of the CNVMP [1], and any corresponding management or mitigation measures determined.

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.
- 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 plan of the likely timing of each activity is presented in Table C.2, based on information of timing of activities provided by the Design and Construction Teams. Table C.2 assists in setting the assumptions for concurrent activities to be carried out as the Project progresses. This ensures that cumulative noise impacts from the site are assessed and managed.

5.2 Predicted noise levels

The Bulk Power Supply Works (Southern) works is a linear worksite that will move progressively between Ausgrid's Canterbury Sub-Transmission Substation and the Campsie bulk supply infeed substation. The active worksite will at any time be between 50 metres and 250 metres long. Typically, a temporary worksite will be established, the works will be undertaken, then the temporary worksite will be closed and relocated to the next work area. The construction work areas are identified in the land use survey drawings presented in APPENDIX B.

A detailed computer noise model was prepared to predict noise levels at all relevant sensitive receivers. Various combinations of work activities outlined in Section 2.1.1 are likely to occur, with some activities using different equipment during out of hours works.

The assessment considered combinations of work activities at key project stages, which are summarised in Table 5.1. In addition, each work aspect was subdivided into the following two categories:

- High impact activities, which will include rock hammer, concrete saw;
- Typical activities, which will exclude high impact sources (e.g. rock hammer, concrete saw).

Table 5.1: Summary of construction activities

Works Area (see APPENDIX B)	Activity	Aspect	Assessment reference	Duration
A1 – Lillian St ^{1,2} A2 – Beamish St intersection ²	Compound	General worksite, car parking, storage, delivery	A1_G, A2_G, A3_G... etc	February 2020 to March 2021
A3 – S Parade / Gould St ¹ A4 – Canterbury Rd intersection ²	Site Establishment	Installation of enviro controls / traffic controls	A1_S, A2_S, A3_S... etc	
A5 – Cooks Ave / Anzac St ¹ A6 – Pat O’Conner Reserve ¹	Construction	Cable routes excavation, conduits installation, temporary surface reinstatement.	A1_CE, A2_CE, A3_CE... etc	October 2020 to March 2021
		Cable Installation and Jointing	A1_CI, A2_CI, A3_CI... etc	

Notes 1 Work period: Standard Hours
 2. Work period: OOHW Periods 1 and 2

Noise emissions were determined by modelling the noise sources during each stage identified in Table 5.1, receiver locations, and construction activities. Details of the plant and adopted sound power levels are presented in APPENDIX C.

Predicted L_{Aeq} noise levels from the worksite are assessed against the NMLs and summarised in Sections 5.2.1 and 5.2.2, 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 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 residential receiver in each NCA. The results are presented in terms of level above the NML. For **Standard Hours** construction noise impacts are presented as follows:

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

Table 5.2: Summary of construction noise impacts at nearby receivers – standard hours

NCA	A1 – Lillian St					A3 – S Parade / Gould St				
	G-T ²	S-T ²	CE-T ²	CE-H ¹	CI-T ²	G-T ²	S-T ²	CE-T ²	CE-H ¹	CI-T ²
BSP_01	-	-	●	●	-	◆	◆	◆	□	◆
S2B_E03	-	-	-	-	-	-	-	-	●	-
S2B_E04	-	-	-	●	-	●	●	●	○	●
S2B_E05	●	●	●	○	●	□	□	□	□	□
S2B_E06	◆	◆	□	□	◆	◆	◆	□	□	◆
OSR	◆	◆	◆	◆	◆	○	○	◆	◆	○
NCA	A5 – Cooks Ave / Anzac St					A6 – Pat O’Conner Reserve				
	G-T ²	S-T ²	CE-T ²	CE-H ¹	CI-T ²	G-T ²	S-T ²	CE-T ²	CE-H ¹	CI-T ²
BSP_01	□	□	□	□	□	□	□	□	□	□
S2B_E03	●	●	●	○	●	●	●	●	○	●
S2B_E04	●	●	●	○	●	●	●	●	○	●
S2B_E05	◆	◆	◆	□	◆	-	-	●	●	-
S2B_E06	●	●	○	◆	●	-	-	-	●	-
OSR	○	○	◆	◆	○	○	○	◆	◆	○

Notes: 1 High impact activities which will include rock hammer and concrete saw

2 Typical activities, which will exclude high impact sources (e.g. rock hammer and concrete saw)

Standard hours (7am to 6pm Monday to Friday and 8am to 6pm Saturday)

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

Exceedances of the NMLs have been predicted at noise sensitive receivers around the works locations. The nearest residential receivers in NCA S2B_E06 during Area 1 works have been identified to be highly noise affected during standard hours, along with, NCA BSP_01, S2B_E05 and S2B_E06 during Area 3 works and primarily NCA BSP_01 during Area 5 and Area 6 works. The activity with the greatest impact has been identified to be CE-H (i.e. Cable routes excavation, conduits installation, temporary surface reinstatement CE-H). Once CE-H is complete exceedances will be substantially reduced.

Construction noise maybe audible within NCA S2B_E03 and S2B_E04 throughout all work areas, where noise levels have been predicted to be within 10dB(A) of the NMLs.

The specific mitigation measures outlined in Table C2 (APPENDIX C) are to be incorporated into the construction work plan to assist in reducing noise impacts during the works period, where practicable. However, as the LAUWs are short term in duration, vary in location and include partial or complete road closure, the options for provision of mitigation are limited, and so need to be managed.

Proposed measures to minimise noise levels are outlined in Section 5.3. For more detailed predictions, see APPENDIX D. For more detailed additional noise management measures, refer to APPENDIX E.

5.2.2 Out of hours work

As part of the Bulk Power Supply (Southern) construction works, there are some planned out of hours work periods, as noted in Table 5.1, between February 2020 and March 2021.

Predicted construction noise level were compared with the project NML to give an indication of the likely noise impact at receiver locations from the construction stages identified in Table 5.1. The impacts presented in Table 5.3 are as follows:

- 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

Where reasonable and feasible, high impact activities (i.e. H) should be undertaken prior to 12am. However, due to late ROLs this may not always be possible. Therefore, high impact, as well as typical activities, have been assessed during the night period in this CNVIS.

Table 5.3: Summary of construction noise impacts at nearby receivers – OOH

NCA	A1 – Lillian St									
	OOH E					OOH N				
	G-T ³	S-T ³	CE-T ²	CE-H ¹	CI-T ²	G-T ³	S-T ³	CE-T ²	CE-H ¹	CI-T ²
BSP_01	-	-	●	●	-	-	-	●	○	-
S2B_E04	-	-	-	●	-	-	-	-	○	-
S2B_E05	-	-	○	◆	●	-	-	◆	■	○
S2B_E06	-	-	□	□	□	-	-	□	□	□
OSR	-	-	□	□	■	-	-	□	□	□

NCA	A2 – Beamish St intersection									
	OOH E					OOH N				
	G-T ²	S-T ²	CE-T ²	CE-H ¹	CI-T ²	G-T ²	S-T ²	CE-T ²	CE-H ¹	CI-T ²
BSP_01	-	-	●	●	-	-	-	●	○	-
S2B_E03	-	-	-	●	-	-	-	-	●	-
S2B_E04	-	-	●	●	-	-	-	●	○	-
S2B_E05	◆	◆	◆	■	◆	◆	◆	■	□	◆
S2B_E06	□	□	□	□	□	□	□	□	□	□
OSR	■	■	■	□	■	■	■	■	□	■
NCA	A4 – Canterbury Rd intersection									
	OOH E					OOH N				
	G-T ²	S-T ²	CE-T ²	CE-H ¹	CI-T ²	G-T ²	S-T ²	CE-T ²	CE-H ¹	CI-T ²
BSP_01	■	■	□	□	■	□	□	□	□	□
S2B_E03	-	-	-	●	-	-	-	-	●	-
S2B_E04	●	●	●	◆	●	●	●	○	◆	●
S2B_E05	□	□	□	□	□	□	□	□	□	□
S2B_E06	◆	◆	◆	■	◆	◆	◆	■	□	◆
OSR	◆	◆	■	□	◆	◆	◆	■	□	◆

Notes: 1 High impact activities which will include rock hammer and concrete saw

2 Typical activities, which will exclude rock hammer and concrete saw

3 No OOHW scheduled

OOH E: evening period out-of-hour (6pm to 10pm, Monday to Sunday).

OOH N: night period out-of-hour (10pm to 7am Monday to Friday and 10pm to 8pm Saturdays, Sundays and Public Holidays).

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

Exceedances of the NMLs have been predicted at the closest noise sensitive receivers around the work locations, especially in NCA S2B_E06 during Area 1 and Area 2 works and BSP_01 and S2B_E05 during Area 4 works.

Specific mitigation measures outlined in Table C2 (APPENDIX C) and in Section 5.3 are to be incorporated into the construction work plan to assist in reducing noise impacts during the works period, where practicable. However, as some of these works include partial road closure, the options for mitigation are limited and impacts need to be managed.

Measures for managing potential noise impacts are provided in Section 5.3. For more detailed predictions, see APPENDIX D. For more detailed additional noise measures, refer to APPENDIX E.

5.2.3 Sleep disturbance

Construction equipment may produce instantaneous noise events during operation. Due to the proximity of the residential receivers to the works, it is likely that maximum noise levels from sources such as truck airbrakes and banging from metal on metal contact will exceed the sleep disturbance NML

of 65 dB(A) $L_{A,max}$ during the night period works. These activities would be more prevalent during the site set up in the first hour of the night shift, which may be completed prior to 10 pm. They would also occur during the pack up process in the last hour of the night shift.

These activities will be managed by setting up relevant traffic management measures to minimise the use of compression brakes when leaving the work area, installing air brake silencers and broadband reversing alarms on heavy vehicles, and minimising heavy vehicle movements where possible. Truck drivers will be instructed to avoid excessive acceleration from a stopped position and vigorous slamming of truck doors. The potential of loose items or plant/equipment that could generate metal-on-metal bangs will be identified and managed.

In addition, Toolbox talks will be used to advise all personnel of the need to follow quiet work practices during OOHW periods, including limiting the need for car door closing and warning personnel of the need to respect the residential receivers surrounding the local area work sites. Where high noise impact activities are required after 10 pm, these activities will be managed to be completed prior to 12 am, where practicable.

Other management measures are outlined in Section 5.3.3 to aid in providing additional noise reduction benefits where predicted levels are above the objective.

5.3 Noise mitigation and management

5.3.1 Consultation with affected receivers

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

- Ongoing direct contact with residents and businesses on streets surrounding the site via doorknocks, phone and email.
- Bi-annual newsletters distributed to businesses and residents within 500m of the site.
- Monthly notification distributed to businesses and residents within 100m of the site and include updates on recent works and works coming up.
- Community information session on site with environment, engineers, community on an as-needed basis.
- Specific consultation with businesses impacted by our works (adjacent to work areas).
- Invitation to all property owners within 500m to register for weekly email updates included in the bi-annual newsletter.

5.3.2 Site Noise Control Measures

The following standard noise control measures, in addition to those outlined in APPENDIX C, are recommended to reduce potential noise impacts:

Table 5.4: Site Noise Control Measures

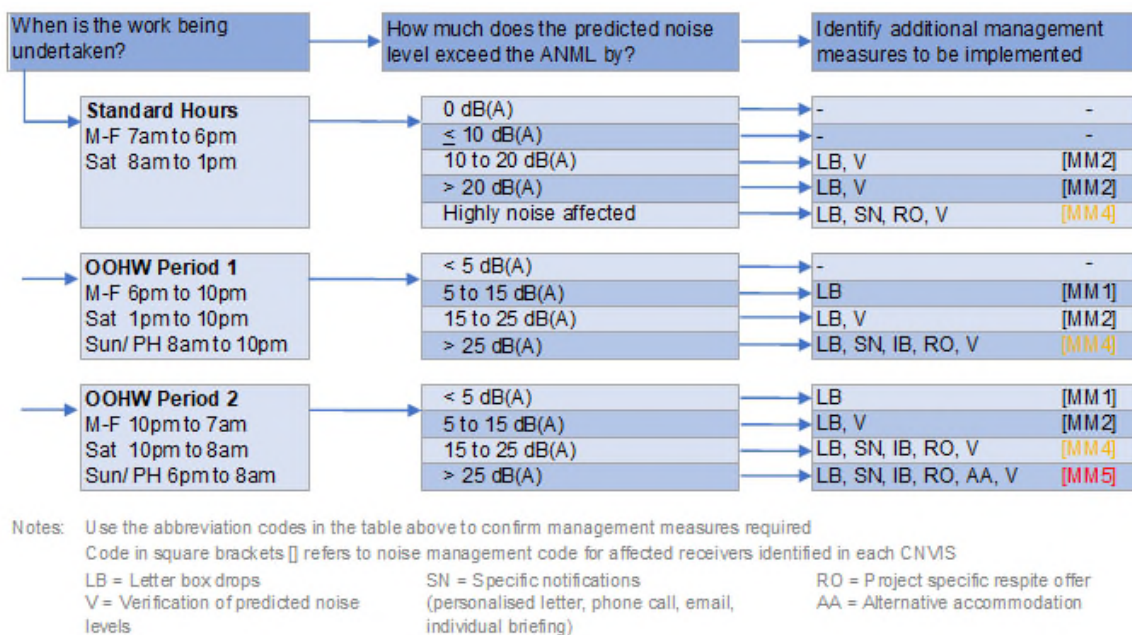
Control type	Control measure	Typical use
At-Source Control Measures	Noise control kits	Plant that is brought to site for regular use should meet the sound power limits identified in Table C1. Where plant are above limits then the plant may require installation of 'noise control kits' to comply with the noise limits in Table C1. Such 'noise control kits' comprise: <ul style="list-style-type: none"> high performance 'residential-grade' exhaust mufflers, additional engine cowling / enclosure lined inside with sound absorbent industrial-grade foam, and air intake and discharge silencers / louvres. The need to fit 'noise control kits' onto the identified plant, will be confirmed once each plant item is tested prior to its regular use on site.
	Limit equipment in use	Only the equipment necessary during each stage of the OOHW will be used.
	Timing of equipment in use	Where practicable, activities and plant will be limited as outlined in Table C1 (APPENDIX C).
	Limit activity duration	Any equipment not in use for extended periods shall be switched off. For example, heavy vehicles should switch engines off when not in use.
	Use and siting of plant	Avoid/ limit simultaneous operation of noisy plant and equipment within discernible range of a sensitive receiver. Direct noise-emitting plant away from sensitive receivers where practicable. Locate fixed location plant items as far from sensitive receivers as practicable.
	Equipment selection	Use quieter and less noise/ vibration emitting construction methods where feasible and reasonable.
	Temporary noise screens	Extended hours works and out of hours works should utilise temporary noise screens (e.g. Echo-barrier, or similar) to provide noise screening during noisier works, such as refuelling, concrete pours etc that are required to be completed during more sensitive time periods. For example, a temporary noise screen adjacent to the refuelling area during the morning shoulder period. Temporary noise screens can provide 5 to 10 dB noise reduction, where they can break line of site.
	Truck movements	Avoid the use of park air brakes outside the sheds at night. Set up relevant traffic management measures to minimise the use of air brakes when leaving the site. Air brake silencers are to be correctly installed and fully operational for any heavy vehicles (as per CNVMP). Minimise unnecessary acceleration on site.
Noise Management Measures	Non-tonal reversing alarms	Alternative reverse alarms, such as 'quackers' will be installed on all plant and equipment, where practicable.
	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"> location of nearest sensitive receivers relevant project specific and standard noise and vibration mitigation measures; permitted hours of work; OOHW Procedure and Form construction employee parking areas.
	Community consultation	Inform community of construction activity and potential impacts.

Control type	Control measure	Typical use
	Respite periods	High noise impact activities are carried out in continuous blocks of up to 3 hours. Respite from high noise impact activities will be provided between each block for at least 1 hour. No high noise impact activities will be carried out during this 1 hour respite period.
	Work scheduling around sensitive areas	Where feasible and reasonable, construction would be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels would be scheduled during less sensitive time periods. When working adjacent to schools, medical facilities and childcare centres, scheduling noisy activities around HSC exam times, child care sleep times and other identified sensitive times should be considered, where feasible and reasonable. When working adjacent to churches and places of worship noisy activities should be scheduled outside services, where feasible and reasonable.
	Behavioural practices	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors.
	Noise monitoring	Noise monitoring is to be carried out as detailed in Section 5.3.4.

5.3.3 Additional Noise Mitigation Measures

Table 5.5 below should be used to advise the appropriate additional noise mitigation during construction, based on the CNVS [10] and the CNVMP [1].

Table 5.5: Additional Airborne Noise Mitigation Measures



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

Prior to the commencement of the site establishment works, residential receivers around the Bulk Power Supply (Southern) worksite, in particular those identified in APPENDIX E will be notified to advise that

noise from the works may at times be audible. All potentially impacted receivers will be kept informed of the nature of works to be carried out, the expected noise levels and duration, as well as be given the project enquiries and complaints 1800 numbers (see Section 0).

5.3.4 State Environmental Planning Policy (Infrastructure) 2007

State Environmental Planning Policy (Infrastructure) 2007 (Infrastructure SEPP) facilitates the effective delivery of infrastructure in NSW. One of its objectives is to ensure that development adjacent to infrastructure corridors achieves an appropriate acoustic amenity by meeting the internal noise criteria specified in the Infrastructure SEPP. Building developments approved after 1 January 2008 need to comply with the Infrastructure SEPP.

OOH work in Area 4 will be limited to the Canterbury Road intersection, between Gould Street and Cooks Avenue. There are three apartment buildings on the southern side of Canterbury Road that will be potentially impacted by these works:

- 344-350 Canterbury Road, Canterbury (Construction 2017)
- 352-356 Canterbury Road, Canterbury (Construction 2009)
- 364-374 Canterbury Road, Canterbury (Construction 2017)

The buildings at 344-350 and 364-374 Canterbury Road were constructed in 2017 and the Development Consent Approval for both buildings required road traffic noise from Canterbury Road to be mitigated to satisfy requirements under Clause 102(3) of Infrastructure SEPP. As a minimum, the buildings would be designed to be habitable with the doors/ windows closed to reduce traffic noise. This would allow an increase of the NML of 10 dB for these two buildings to account for additional transmission loss through a closed door/ window. The adjustment is applicable to the night NML only as outdoor spaces are unlikely to be used during this period. The results presented in Appendix D and E include the adjusted NML.

Details for the building at 352-356 Canterbury Road were not available at the time of preparation of this CNVIS. Should this information become available during consultation for the BPS Campsie works, a similar adjustment would be made to the night NML for this property.

It is noted that even with the adjustment to account for additional transmission loss, high impact activities may be more than 25 dB above the night NML. These activities would be scheduled during the early part of the OOH period and where practicable, limited after 12:00 am.

5.3.5 Attended Noise Monitoring

Attended noise monitoring will be undertaken during works at one of the representative residential receivers identified in the table below in the NCAs most impacted by the works (i.e. a minimum of one location for each NCA). Nominated attended measurement locations have been selected with the best opportunity to validate the predicted noise levels. Noise monitoring is subject to obtaining the property

owner/occupier's consent to access the property (where required). If consent to access property is denied, monitoring will be done on public land on the property boundary, provided it is safe to do so.

Table 5.6: Nominated verification monitoring locations

NCA	Nominated receiver address	Monitoring location
A1 – Lillian St		
S2B_06	19 WILFRED AVENUE, CAMPSIE	Southern property boundary
S2B_06	48 LILIAN STREET, CAMPSIE	Northern property boundary
A2 – Beamish St		
S2B_06	203 BEAMISH STREET, CAMPSIE	Northern property boundary
A3 – S Parade / Gould St		
S2B_05	26 SOUTH PARADE, CAMPSIE	Eastern property boundary
S2B_05	35 WARATAH STREET, CANTERBURY	Western property boundary
A4 – Canterbury Rd intersection		
S2B_05	349 CANTERBURY ROAD, CANTERBURY	Southern property boundary
A5 – Cooks Ave / Anzac St		
BPS_01	5 COOKS AVENUE, CANTERBURY	Eastern property boundary
BPS_01	1 NAPIER STREET, CANTERBURY	Western property boundary
A6 – Pat O'Conner Reserve		
BPS_01	18 ANZAC STREET, CANTERBURY	Southern property boundary
BPS_01	38 FULLER AVENUE, EARLWOOD	Western property boundary
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.	

If verification monitoring shows that the external noise levels are consistently above the predicted levels, investigation will be undertaken to understand the cause of the exceedance.

Periodic assessment of plant noise levels will be undertaken in accordance with Section 9.2.3 and Table 20 of the CNVMP to confirm the plant noise levels are within the APPENDIX C Table C1.

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

5.3.6 Managing site specific activities and cumulative noise impacts (Gateway)

This CNVIS has established the overall impacts associated with the Bulk Power Supply (Southern) construction works. A 3D construction noise and vibration management tool (Gateway, www.gateway.com.au) has been developed specifically for the Sydney Metro City & Southwest LWW to allow specific work areas and activities to be assessed as construction works progress. It also allows cumulative noise impact from other aspects of the Project or, where relevant noise from other construction projects, to be assessed and managed in accordance with the CNVMP.

Gateway will be used regularly to plan, assess and manage works progressively and to coordinate works to ensure relevant mitigation measures are in place.

Gatewave incorporates ground elevation contours, building heights, the built environment and atmospheric conditions to predict construction noise in accordance with the International Standard ISO 9613-2:1996 implementing quality standard ISO 17534-1:2015. All sensitive receivers identified by the land use survey (see Section 3) are integrated into the Gatewave tool.

5.3.7 Complaints Handling

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

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

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

6 Construction vibration impacts

6.1 Minimum working distances for vibration intensive plant

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

- Compactor / roller (4 tonnes)
- Excavator with rock hammer (12 tonnes);

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. These distances are conservatively based on excavation of hard rock. Site specific buffer 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) ¹	Unreinforced or light framed structures (e.g. residential buildings) ¹	Sensitive structures (e.g. heritage structures) ²
Compactor / roller (4t) - low vibration	5	5	10
Excavator with rock hammer (12T)	5	10	15

Note 1: Initial screening test criteria reduced by 50% due to potential dynamic magnification in accordance with BS7385.

Note 2: In accordance with Section 5.8.1 of CNVMP, a site inspection should determine whether a heritage structure is structurally unsound.

Note 3: Minimum working distances are in 5m increments only to account for the intrinsic uncertainty of this screening method. Jackhammers and direction drills are likely to have minimum working distances smaller than 5 m (e.g. 1m in accordance with TfNSW CNS).

Table 6.2: Minimum working distances (m) for human annoyance (continuous vibration)

Plant item	Minimum working distances, m				
	Critical areas ^{1,4}	Residences Day ²	Night ²	Offices ^{3,4}	Workshops ⁴
Compactor / roller (4t) - low vibration	25	10	15	10	5
Excavator with rock hammer (12T)	45	30	40	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.
- 5: Operating for 30% of the time in high vibration mode.

6.2 Vibration assessment

6.2.1 Structural damage

The number of buildings which are close to or within the minimum working distances for cosmetic damage are shown in Table 6.3 and in APPENDIX F.

Table 6.3: Number of buildings within minimum working distances for cosmetic damage

Work Area	Plant item	Number of buildings ¹	
		Screening criteria for non-heritage structures	Screening criteria for heritage structures ²
A1	Excavator with rock hammer (12T)	9	2
A2		2	2
A3		11	0
A4		5	0
A5		9	0
A6		2	0

Note:

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

There are up to 38 non-heritage structures (some properties are affected by multiple work areas) that are located within the minimum working distances established for cosmetic damage during the works. There are up to 4 heritage structures that are potentially located within the minimum working distances. These buildings/structures are identified in APPENDIX F and Table 6.3.

Vibration monitoring is recommended to determine site specific conditions and/or to verify that vibration levels achieve compliance with the structural damage objectives where plant is required to operate within the safe working distance identified in Table 6.1. If the monitoring above identifies that vibration is likely to exceed the structural damage objectives, a different construction method with lower source vibration levels will be considered.

6.2.2 Human annoyance

APPENDIX F and Table 6.4 identifies specific receivers that may be exposed to vibration that may cause adverse comments during construction works. However, due to the limited time the vibration intensive plant will be operating close to these properties, the risk of annoyance is considered low.

Attended vibration measurement should be carried out in the event of complaint from the nearest receiver to confirm that vibration is within the acceptable range for human annoyance (see Section 6.3.3). The assessing vibration guideline [5] notes that inside dwellings, adverse comments often arise when occupants can perceive (feel) vibration, particularly when the vibration arises from a source located outside their home (or outside their control), and assume that the vibration has the potential to damage their building or contents.

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

At properties near the worksite, it is likely that the nearest receivers will be able to feel vibration levels when vibration-generating equipment is being utilised. Properties where vibration levels may be above the vibration disturbance goals in Table 4.1 and there is a probability of adverse comment are shown in Table 6.4.

Table 6.4: Number of buildings within minimum working distances for human annoyance

Work Area	Plant item	Critical areas ^{1,4}	Residences ⁵		Offices ^{3,4}	Workshops ⁴
			Day ²	Night ²		
A1	Excavator with rock hammer (12T)	–	–	9	12	–
A2		–	–	4	6	–
A3		–	–	93	5	–
A4		–	–	4	6	–
A5		–	–	90	1	–
A6		–	–	11	0	–

Notes:

1: Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring.

2: Daytime is 7 am to 10 pm; Night-time is 10 pm to 7am.

3: Examples include offices, schools, educational institutions and place of worship.

4: Applicable when in use.

5: Hotels and childcare centres are included in the residence category.

From the above table, there are residential properties (up to 211 – some properties are affected by multiple work areas) and commercial properties (up to 30 some properties are affected by multiple work areas) that may experience vibration which can cause adverse comment when vibration-generating plant is operated nearby (rockhammers and vibratory rollers). Properties are further identified in APPENDIX F.

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

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

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

6.2.3 Sensitive equipment

Vibration levels may be above vibration objectives for sensitive equipment at the electrical Substation at 16 Hansen Avenue, Earlwood during cable route excavation and surface reinstatement/compaction works. This facility should be investigated prior to undertaking high vibration generating activities to determine the presence of potential vibration sensitive structures. Should such items be identified by Systems Connect, then relevant vibration criteria will be established for each item per Section 5.5.3 of the CNVMP [1], and any corresponding management or mitigation measures determined.

6.3 Vibration mitigation measures

6.3.1 Vibration control and management measures

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

Table 6.5: Site vibration control measures

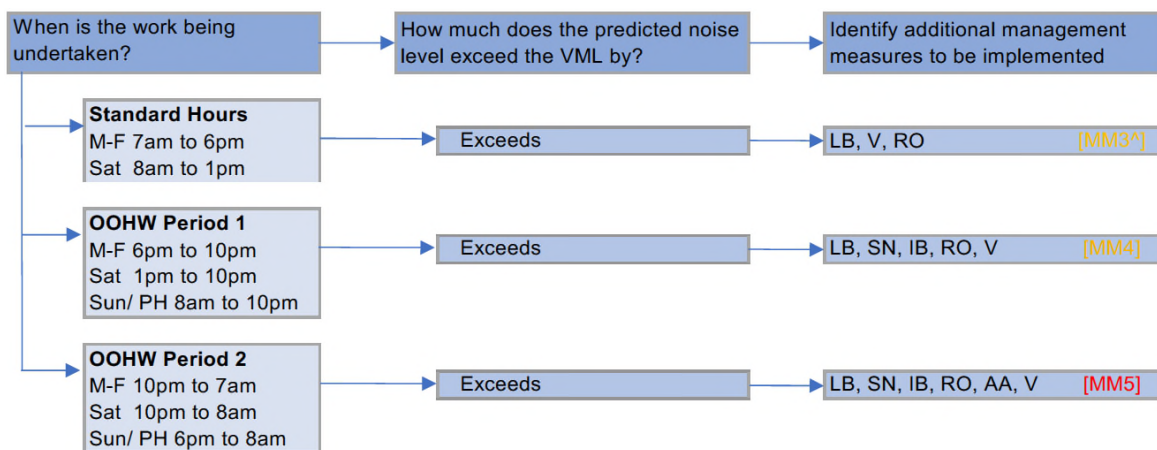
Control type	Control measure	Typical use
Construction Planning	Building condition surveys	Undertake building dilapidation surveys on all buildings located within the buffer zones established for cosmetic damage prior to commencement of activities with the potential to cause property damage (see Section 6.1).
	Community consultation	Implement community consultation measures – inform community of construction activity & potential impacts – inform community that the level of vibration at which people perceive it, or at which loose objects may rattle, is far lower than the level at which minor cosmetic damage is expected to occur
	Equipment selection/construction method	Use less vibration emitting construction methods where feasible & reasonable, for example vibratory rollers can, where practicable, be operated with the vibratory mode switched off to reduce vibration impact.
	Plan work activities to minimise vibration.	Plan traffic flow, parking & loading/unloading areas to maximise distances between truck routes and sensitive receivers.

Control type	Control measure	Typical use
Complaints Management	Construction Complaints Management System	Complaints will be managed in accordance with the Construction Complaints Management System (see Section 6.2.2). Each complaint shall be investigated and where vibration levels are established as exceeding the set limits, appropriate amelioration measures shall be put in place to mitigate future occurrences. Management measures may include modification of construction methods such as using smaller equipment and establishment of safe buffer zones as mentioned above.

6.3.2 Additional vibration mitigation measures

After applying all feasible and reasonable mitigation measures identified in Table 6.5, if vibration monitoring at representative locations are still above relevant vibration objectives for human annoyance, the appropriate additional vibration mitigations measures, as outlined in Section 8.2 of the CNVMP.

Table 6.6: Additional vibration mitigation measures



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

LB = Letter box drops

SN = Specific notifications

RO = Project specific respite offer

V = Verification monitoring

IB = individual briefing

AA = Alternative accommodation

6.3.3 Vibration monitoring

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

6.3.4 Managing site specific activities and cumulative vibration impacts (Gatewave)

The Project environment team will use Gatewave to manage construction vibration impact by defining specific work areas and identifying properties within minimum working distances established for cosmetic damage and human annoyance.

6.3.5 Management of complaints

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

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

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

7 Ground-borne noise assessment

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

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

8 Traffic noise assessment

Low levels of heavy vehicle movements are likely to be associated with Bulk Power Supply (Southern) works, and the majority of these will be at the start and end of the works period. As such, the increase in road traffic noise levels is likely to be less than 2 dB(A) and so construction traffic will have minimal impact on the main roads used to access the site.

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

9 Cumulative impacts

All concurrent Sydney Metro construction works have been considered and addressed in this CNVIS, including works within the South West Corridor which fall under the Systems Connect work scope. Systems Connect are aware of ongoing, potentially concurrent construction activities within the vicinity of the Bulk Power Supply (Southern) worksite. The works, summarised in Table 9.1, may have the potential to generate cumulative noise impacts on receivers.

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

Gatewave, a 3D construction noise and vibration management tool (www.gatewave.com.au) would be used to assess and manage cumulative noise impact from other aspects of the Project or, where relevant noise from other construction projects, in accordance with the CNVMP.

Table 9.1: Other construction works close to C2S Bulk Power Supply (Southern) worksite

Construction company	Project	Timing of activities	Hours of works	Works location	Activity types	General plant types
John Holland & Laing O'Rourke	Sydney Metro – Sydenham Metro Upgrade	TBC	Standard construction hours, outside construction hours and rail possession works	Sydenham Station	New station entrances at Burrows Road and Railway Parade New concourse over the station with lifts and stairs to each platform, including the two new Sydney Metro platforms	
Not awarded yet	Sydney Metro - South West Corridor Station Works	TBC	Standard construction hours, outside construction hours and rail possession works	Stations from Sydenham to Bankstown	Station upgrade construction works	
Sydney Trains	Sydney Train maintenance works	Based on Sydney Trains trackwork schedule	Based on Sydney Trains trackwork schedule	Any point along the railway corridor. Immediately adjacent to Systems Connect worksite	Rail and signalling maintenance works	Utility relocation, minor earthworks, signal and rail modification.

10 Conclusion

Works associated with the Bulk Power Supply (Southern) worksite have been identified and described in this report. Potentially affected noise and vibration sensitive receivers and relevant construction noise and vibration objectives have been identified and discussed to allow the assessment of potential construction impacts.

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

The highest noise impacts are predicted to occur when excavators with rock hammer attachments and road saws are utilised in proximity to sensitive receivers. Where possible, and subject to Road Occupancy Licence (ROL) approvals, these activities will be completed prior to midnight (where possible) to minimise impacts. The potential noise and vibration impacts associated with remaining activities are significantly reduced.

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. The night NML for two properties impacted by Area 4 works has been increased by 10 dB to account for the building's design in accordance with the State Environmental Planning Policy (Infrastructure) 2007. Additional mitigation measures have been determined based on the adjusted NML.

Gatewave will allow specific work areas and activities to be assessed as construction works progress. It will also allow cumulative noise impact from other aspects of the Project to be assessed and managed in accordance with the CNVMP.

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

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

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

References

- [1] Sydney Metro City & Southwest – Line Wide Works Contract Construction Noise and Vibration Management Plan (SMCSWLWC-SYC-1NL-PM-PLN-000032-A-CNVMP-C2B)
- [2] SLR Consulting Australia Pty Ltd 2017 Sydney Metro Sydenham to Bankstown - Technical Paper 2: Noise and Vibration Report Number 610.15897-R02 – 28 August 2017
- [3] SLR Consulting Australia Pty Ltd 2016 Sydney Metro Chatswood to Sydenham - Technical Paper 2: Noise and Vibration Report Number 610.14718R1 – 28 April 2016
- [4] Department of Environment and Climate Change 2009 NSW Interim Construction Noise Guideline
- [5] Department of Environment Conservation NSW 2006 Assessing Vibration; a technical guideline
- [6] British Standard BS 7385 Part 2 1993, Evaluation and measurement for vibration in buildings. Guide to damage levels from groundborne vibration
- [7] German Standard DIN 4150-3:2016-12 Vibration in buildings – Part 3: Effects on structures
- [8] British Standard BS 6472-2008, Evaluation of human exposure to vibration in buildings (1-80Hz)
- [9] Transport for NSW Sydney Metro City & Southwest Construction Noise Strategy (ref: 610.14213-R3) 08 August 2016
- [10] Transport for NSW Construction Noise and Vibration Strategy (ref: 7TP-ST-157/4.0) May 2018
- [11] Transport for NSW Sydney Metro Construction Environmental Management Framework August 2016
- [12] Department of Environment, Climate Change and Water 2011 NSW Road Noise Policy
- [13] NSW Department of Planning – Development near rail corridors and busy road – interim guideline 2008

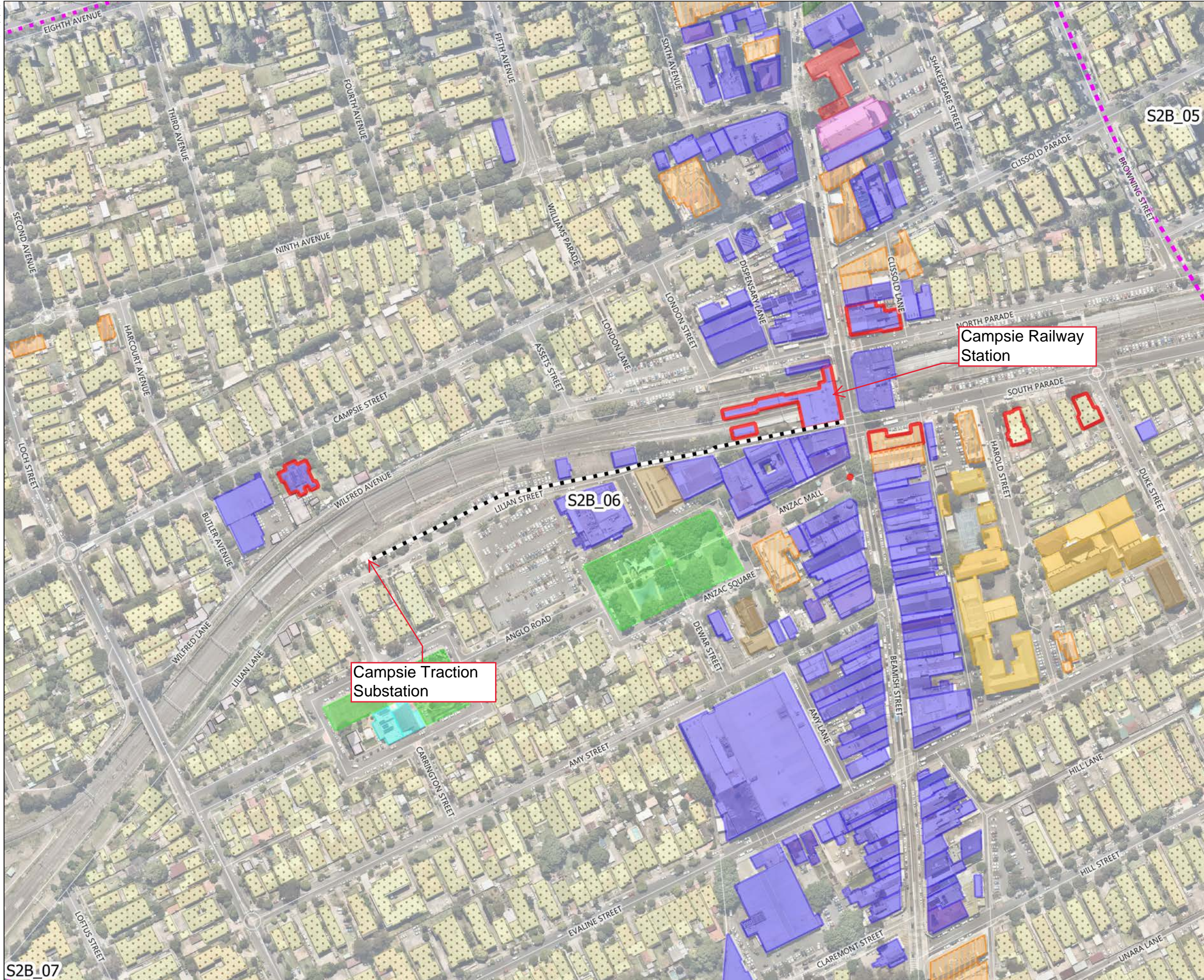
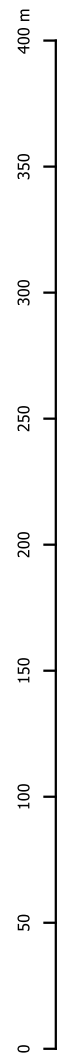
APPENDIX A Glossary of terminology

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

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

L ₁	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L ₁₀	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L ₉₀	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
L _{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
OOH	Out of Hours (i.e. outside standard construction hours)
OOHW	Out of Hours Work (i.e. works carried out outside standard construction hours)
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain L _{eq} 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**



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



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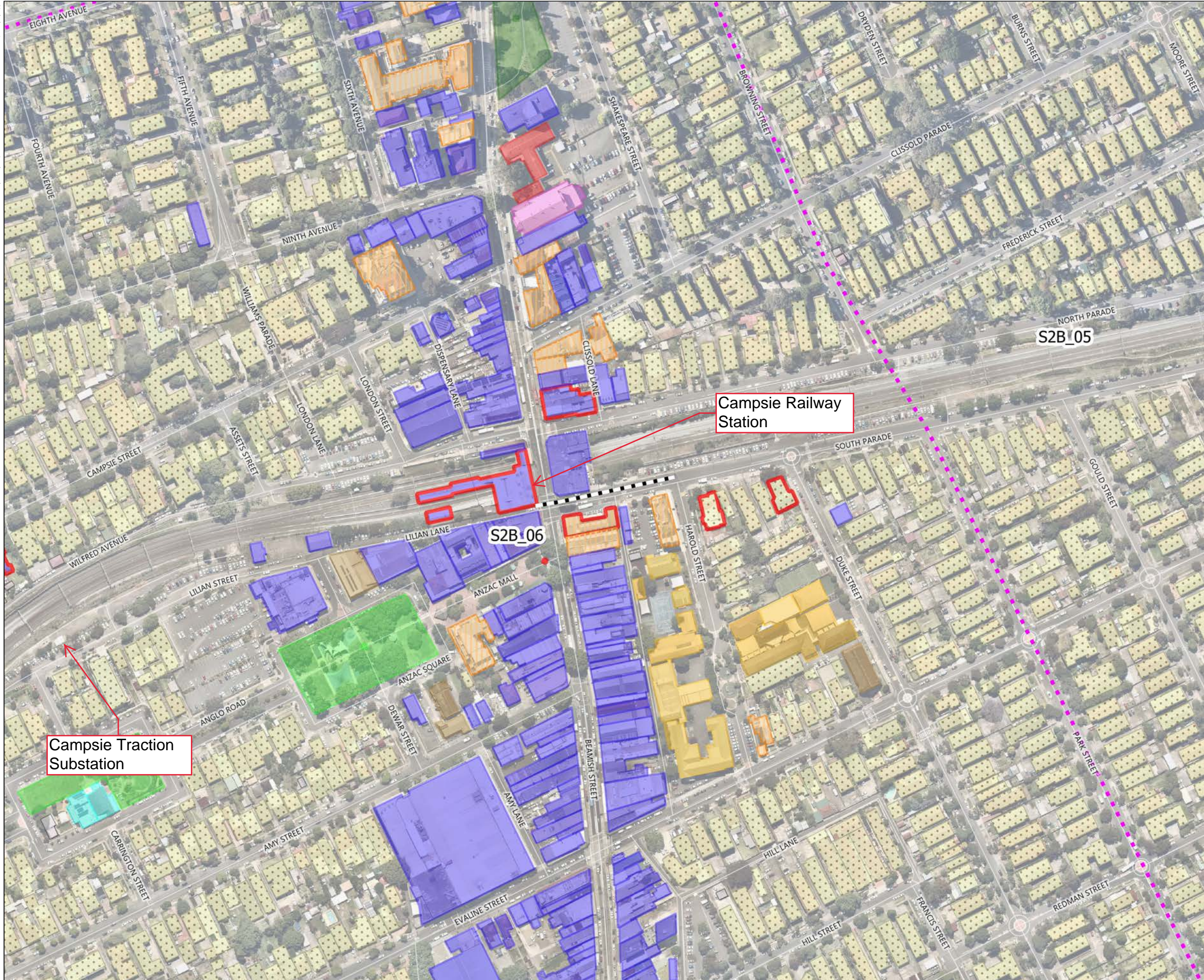
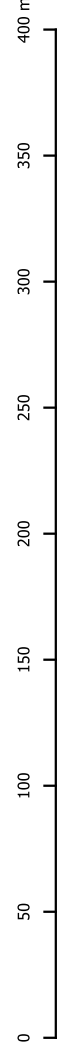
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Line wide works - Bulk power supply works (Southern)

Land Use, NCAs and Work areas

Campsie work area: A1

Sheet 1 of 6



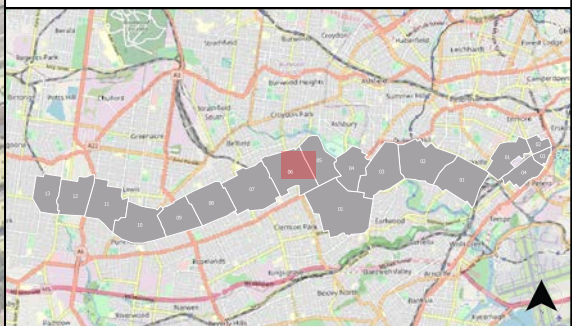
LEGEND

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



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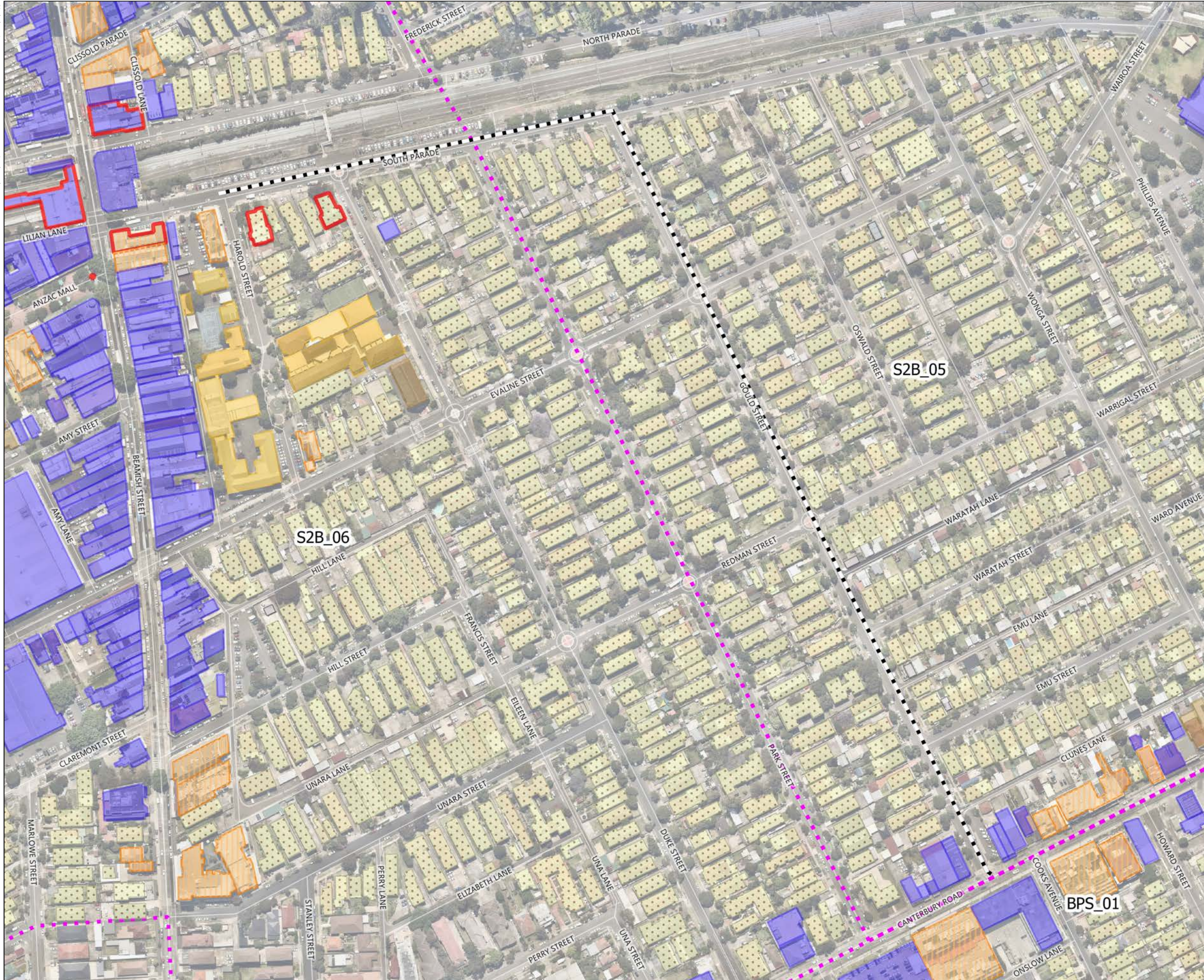
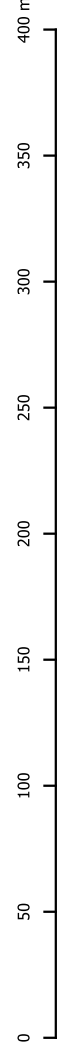
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Line wide works - Bulk power supply works (Southern)

Land Use, NCAs and Work areas

Campsie work area: A2

Sheet 2 of 6



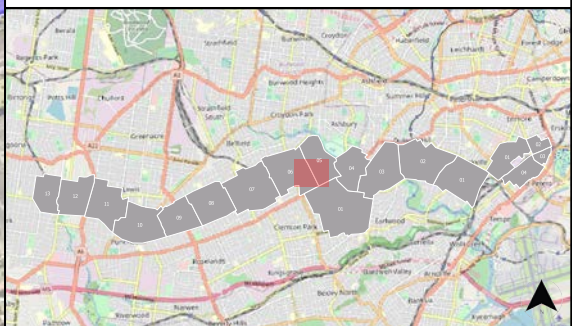
LEGEND

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



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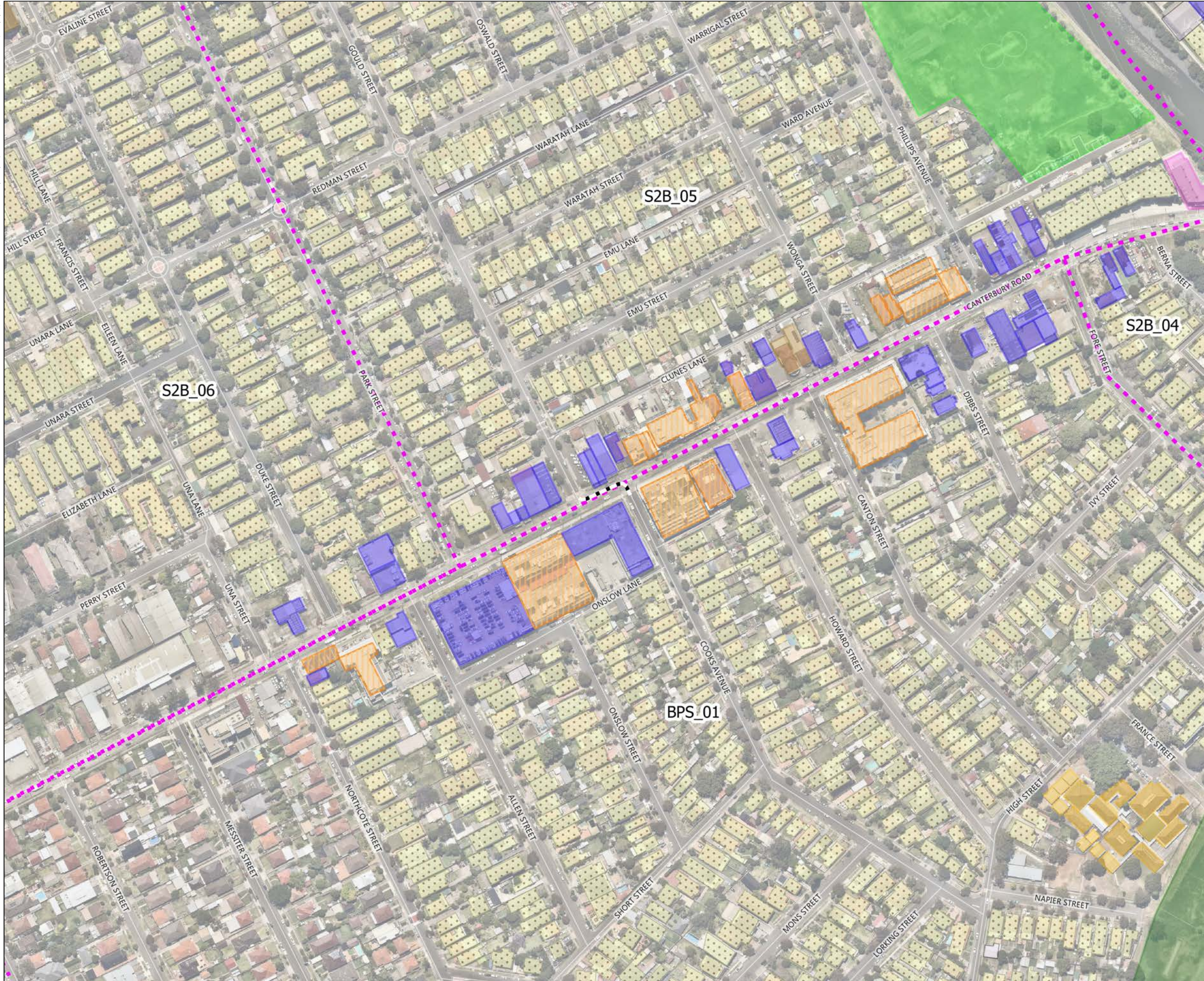
SYDNEY METRO - SYDENHAM TO BANKSTOWN

Line wide works - Bulk power supply works (Southern)

Land Use, NCAs and Work areas

Campsie work area: A3

Sheet 3 of 6



LEGEND

Noise sensitive receivers

Childcare

Commercial

Educational

Hotel/Motel/Hostel

Industrial

Medical

Place of Worship

Recording studio

Recreational - Active

Recreational - Passive

Residential

Theatre/Auditorium

Mixed use

Project acquisition

Film/TV studio

Cinema

Community centre

Library

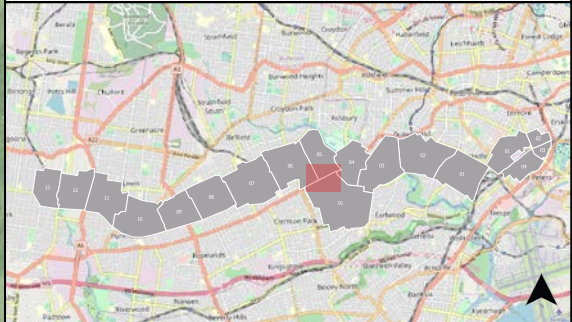
Laboratory

Other

Heritage

NCA

Work areas



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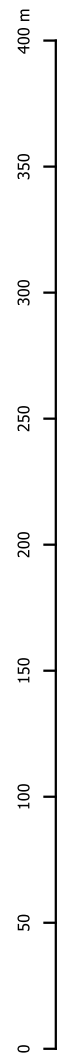
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SYDNEY METRO - SYDENHAM TO BANKSTOWN

Line wide works - Bulk power supply works (Southern)
Land Use, NCAs and Work areas
Campsie work area: A4

Sheet 4 of 6



LEGEND

Noise sensitive receivers

Childcare

Commercial

Educational

Hotel/Motel/Hostel

Industrial

Medical

Place of Worship

Recording studio

Recreational - Active

Recreational - Passive

Residential

Theatre/Auditorium

Mixed use

Project acquisition

Film/TV studio

Cinema

Community centre

Library

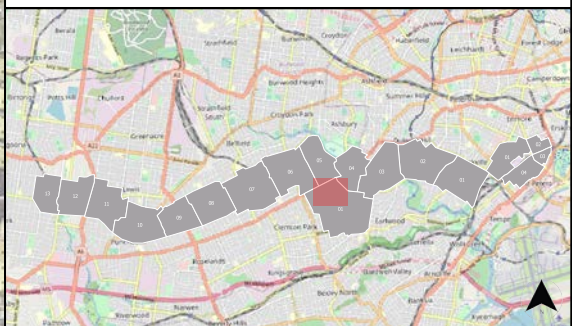
Laboratory

Other

Heritage

NCA

Work areas



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SYDNEY METRO - SYDENHAM TO BANKSTOWN

Line wide works - Bulk power supply works (Southern)

Land Use, NCAs and Work areas

Campsie work area: A5

Sheet 5 of 6

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Sheet 6 of 6

Table B1: Noise Sensitive Receivers and Construction Noise Management Levels

BULK POWER SUPPLY WORKS

NCA	Receiver Type	Reference RBL	Existing Noise Levels, dB(A)			Residential NMLs based on ICNG (external)				Sleep Dist. L _{eq,1}		Comments
			RBL Day	RBL Evening	RBL Night	D(S)	D(O)	E	N	Screening	L _{eq,max}	
S2B_01	Predominantly Residential	EIS B.04	41	41	34	51	46	46	39	49	65	
S2B_02	Predominantly Residential	EIS B.05	40	40	33	50	45	45	38	48	65	
S2B_03	Predominantly Residential	EIS B.06	38	38	34	48	43	43	39	49	65	
S2B_04	Commercial and Residential	EIS B.07	40	40	35	50	45	45	40	50	65	
S2B_05	Predominantly Residential	EIS B.09	36	36	32	46	41	41	37	47	65	
S2B_06	Commercial and Residential	EIS B.10	45	42	35	55	50	47	40	50	65	
S2B_07	Commercial and Residential	EIS B.13	41	41	35	51	46	46	40	50	65	
S2B_08	Commercial and Residential	EIS B.14	47	47	41	57	52	52	46	56	65	
S2B_09	Predominantly Residential	EIS B.16	44	44	36	54	49	49	41	51	65	
S2B_10	Commercial and Residential	EIS B.19	47	47	41	57	52	52	46	56	65	
S2B_11	Predominantly Residential	EIS B.20	47	47	39	57	52	52	44	54	65	
S2B_12	Commercial and Residential	EIS B.22	54	51	42	64	59	56	47	57	65	
S2B_13	Predominantly Residential	EIS B.23	42	42	39	52	47	47	44	54	65	
BPS_01	Predominantly Residential	EIS B.07	40	40	35	50	45	45	40	50	65	
Other sensitive receivers												
Studio building (music recording studio)						25						AS2107 'maximum' (internal noise level)
Studio building (film or television studio)						30						AS2107 'maximum' (internal noise level)
Cinema Space						35						AS2107 'maximum' (internal noise level)
Hotel (Sleeping areas: Hotels near major roads)						40						AS2107 'maximum' (internal noise level)
Classrooms at schools and other educational institutions						45						ICNG (internal noise level)
Hospital wards and operating theatres						45						ICNG (internal noise level)
Places of worship						45						ICNG (internal noise level)
Library (reading areas)						45						AS2107 'maximum' (internal noise level)
Office building (general office areas)						45						AS2107 'maximum' (internal noise level)
Community centres – Municipal Buildings						50						AS2107 'maximum' (internal noise level)
Cafe/ Restaurant/ Bar (bars and lounges) – indoor areas						50						AS2107 'maximum' (internal noise level)
Medical facilities						55						AS2107 'maximum' (internal noise level)
Railway platform and concourse areas						55						AS2107 'maximum' (internal noise level)
Cafe/ Restaurant/ Bar (bars and lounges) – outdoor areas						60						AS2107 'maximum' ¹ (external noise level)
Passive recreation areas (e.g. area used for reading, meditation)						60						ICNG (external noise level)
Active recreation areas (e.g. sports fields)						65						ICNG (external noise level)
Commercial premises (including offices and retail outlets)						70						ICNG (external noise level)
Industrial premises						75						ICNG (external noise level)

Notes: 1 - Outdoor noise level based on recommended maximum internal noise level in AS 2107 plus 10 dB (10dB is a conservative estimate of the difference between internal and external noise levels, taken from ICNG p13)

D(S): standard construction hours from 7 am to 6 pm Monday to Friday and from 8 am to 6 pm Saturday

E: evening period from 6pm to 10pm (Monday to Saturday) - OOHWP1

N: night-time period from 10 pm to 7 am Monday to Friday, from 10 pm to 8 am Saturday, Sunday and Public holidays - OOHWP2

APPENDIX C Construction timetable/ activities/ management

Table C1: Construction Timetable/ Activities/ Equipment BULK POWER SUPPLY WORKS

Activity/ Work Area	Aspect	Timing of Activity (Aprox No. weeks/ months)	Plant/ Equipment	Net Power kW	Operating Weight kg	Day	Evening	Night	Sound Power Level (Lw re: 1pW) in Noise Model, dB(A)			Notes
						7am - 6pm	6pm - 10pm	10pm - 7am	L _{Aeq}	Penalty	L _{amax}	
COMPOUND												
Campsie to Canterbury BSP Route - Construction Compound / Laydown Area	General worksite, car parking, storage, delivery	Feb 2020 to Mar 2021	Light Vehicle			3	3	3	89		-	
			Truck			1	1	1	106		111	
			Water Cart		5T	1	1	1	104		111	
			Telehandler		4T	1	1	1	98		-	
			Power Tools			Various	Various	Various	107		110	
SITE ESTABLISHMENT												
Campsie to Canterbury BSP Route - Site Establishment	Installation of enviro controls / traffic controls	Feb 2020 to Mar 2021	Small Truck <20T			1	1	1	103		111	
			Telehandler		4T	1	1	1	98		-	
			Light Vehicle			3	3	3	89		-	
			Power Tools			Various	Various	Various	107		110	
CONSTRUCTION												
Campsie to Canterbury BSP Route - Cable route excavation, conduits installation, surface reinstatement.	Earthworks and Electrical Installation	Feb 2020 to Mar 2021	Truck/Tipper		15T	1	1	1	103		111	
			Excavator 12T with hammer			2	2	2	118	5	126	
			Excavator 12T			2	2	2	103		110	
			Road Saw	55kW		2	2	2	121	5	124	
			Compactor			1	1	1	108		112	
			Generator	10kVA		1	1	1	94		96	
			Light Vehicle			3	3	3	89		-	
			Crane			1	1	1	105		109	
			Concrete Truck			1	1	1	108		111	
			Concrete pump			1	1	1	104		107	
			Lighting Tower			1	1	1	93		-	
			Water Cart		5T	1	1	1	104		111	
			Grader			1	1	1	113		-	
			Roller		4T	1	1	1	111		114	
			Skidsteer bobcat		1T	1	1	1	101		-	
			Power Tools			Various	Various	Various	107		110	
Campsie to Canterbury BSP Route - Cable Installation and Jointing	Earthworks and Electrical Installation	Oct 2020 to Mar 2021	Truck			1	1	1	106		111	
			Crane			1	1	1	105		109	
			Cable Winch			1	1	1	98		-	
			EWP			1	1	1	95		98	
			Lighting Tower			1	1	1	93		-	
			Generator	10kVA		1	1	1	94		96	
			Light vehicle			1	1	1	89		-	
			Power Tools			Various	Various	Various	107		110	

Table C2: Construction Noise Management Schedule

BULK POWER SUPPLY WORKS

Mitigation/ Management Measure		Comments
1	Temporary screens	Temporary noise screens (e.g. FlexShield, Echo-barrier or similar) will be installed around the work areas. The screen should be located on all sides of the work areas and as close as possible to the plant. This will reduce the noise from the construction activities by up to 10 dB(A) when there is no direct line of sight between construction plant and receivers. The exceptions are for areas where work is carried out during standard construction hours.
2	High noise impact works	High noise activities such as saw cutting and excavator with hammers are to be limited to before midnight, where feasible with consideration of the ROL.
3	Sleep Disturbance - Maximum noise level management	1.Maximum noise levels with potential to cause sleep disturbance may be caused by activities such as use of air brakes and general clangs and bangs on site. These activities will be managed by personnel of the need to respect the residential receivers surrounding the local area work sites as part of the toolbox talk for these works, stressing the lower night-time background noise levels in the works areas. 2. Minimise the use of air brakes when travelling to and from the site. 3. Identify and eliminate or manage the potential of loose items or plant/equipment that could generate metal-on-metal bangs during the night period.
4	Verification monitoring - Noise	Verification monitoring must be conducted to validate predictions in the nominated positions against the project requirements, as outlined in Section 5.3.4
5	Receiver notification/briefing - Noise	A large range of receivers may be impacted by the works. Some properties close to the work areas will be exposed to highly noise impacts during the OOHW period. All additional mitigation measures outlined in APPENDIX E should be applied.
6	Verification monitoring - Vibration	Plant and equipment have been identified to operate within the minimum buffer distances for both cosmetic damage and human annoyance. Verification monitoring must be conducted to validate predictions in the nominated positions against the project requirements, as outlined in Section 6.3.3
7	Receiver notification/briefing - Vibration	Plant and equipment have been identified to operate within the minimum buffer distances for human annoyance. Vibration may be perceivable at times. Notifications should be sent to receivers included within the minimum working distances shown in APPPENDIX F, and additional mitigation measures where applicable following monitoring.

APPENDIX D Detailed predicted noise levels

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

For **Standard Hours**:

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

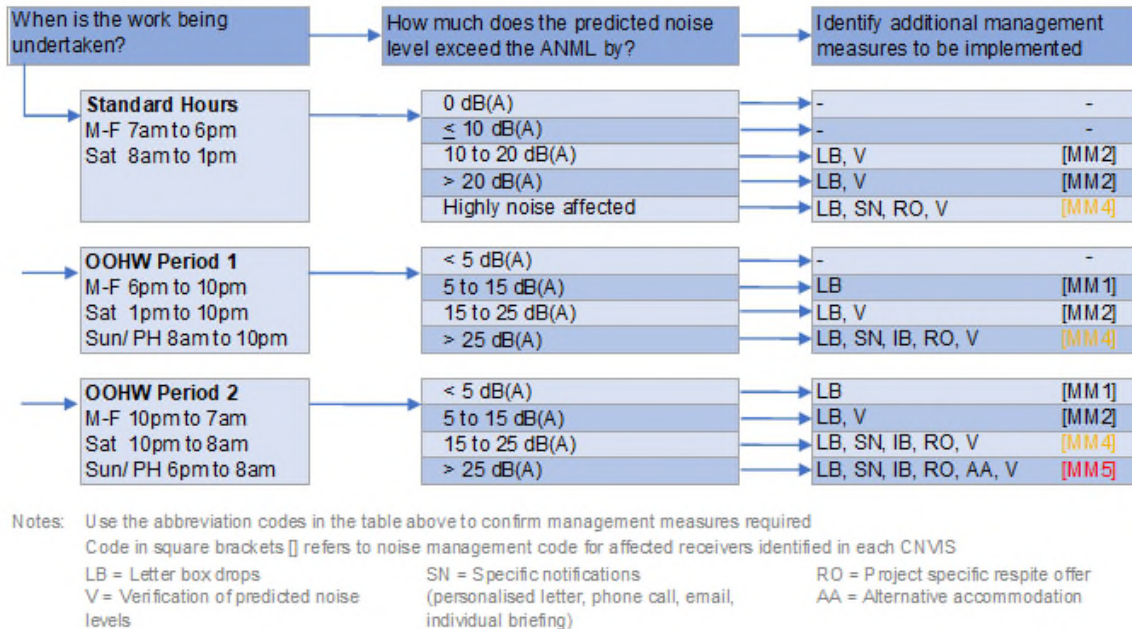
For **OOH**

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

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

APPENDIX E Additional noise mitigation

The table below is replicated from Table 5.5, and identifies the additional mitigation measures to be applied at construction noise affected receivers.

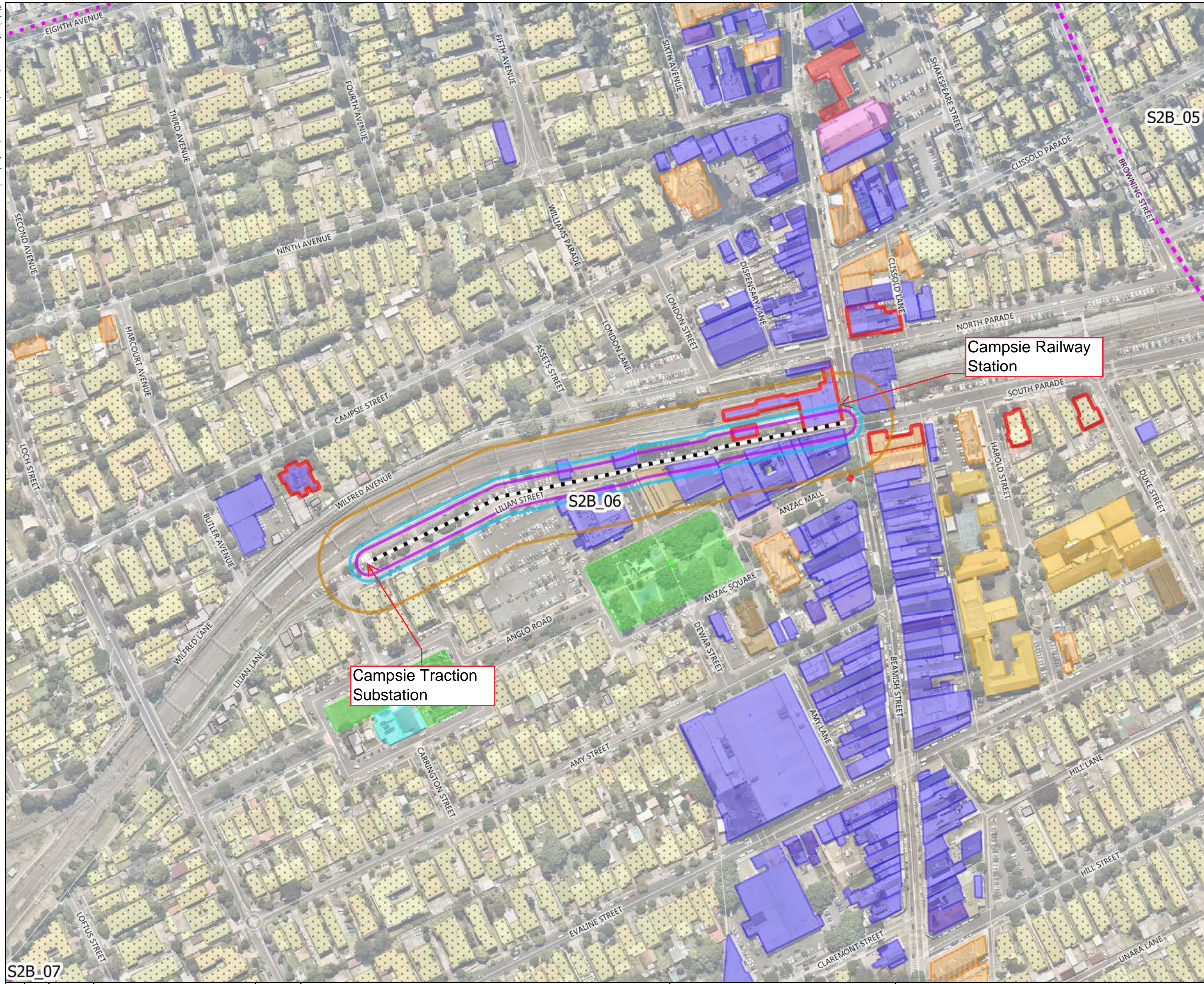


In the following results table, an additional management measure code (MM1, MM2 et al) is given to each receiver if construction noise levels are expected to exceed the Noise Management Level (NML). Each additional management measure code corresponds to a collection of measures identified in the CNVS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

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

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

APPENDIX F Minimum working distances



LEGEND

Noise sensitive receivers

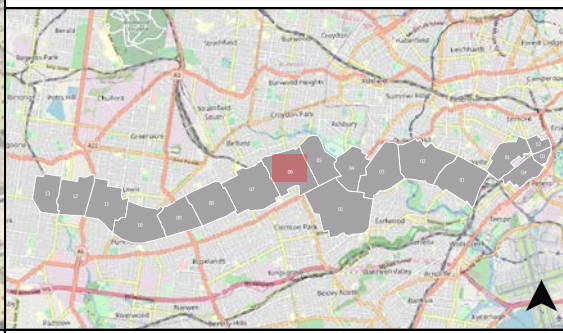
- | | |
|------------------------|---------------------|
| Childcare | Theatre/Auditorium |
| Commercial | Mixed use |
| Educational | Project acquisition |
| Hotel/Motel/Hostel | Film/TV studio |
| Industrial | Cinema |
| Medical | Community centre |
| Place of Worship | Library |
| Recording studio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

NCA

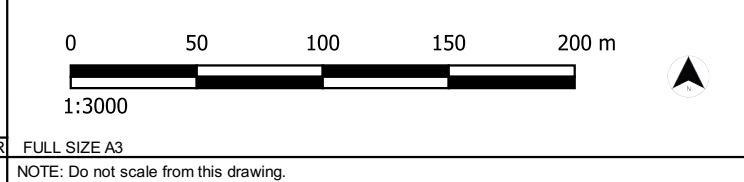
MWD for cosmetic damage and human annoyance for Excavator with rock hammer (12T)

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

Work areas



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r1	MS	13/05/20	Update Figure	TG	
r0	MS	09/12/19	Prepare figures	TG	
REV	BY	DATE	DESCRIPTION	APPROVER	
A3 Original			Co-ordinate System: MGA Zone 56		



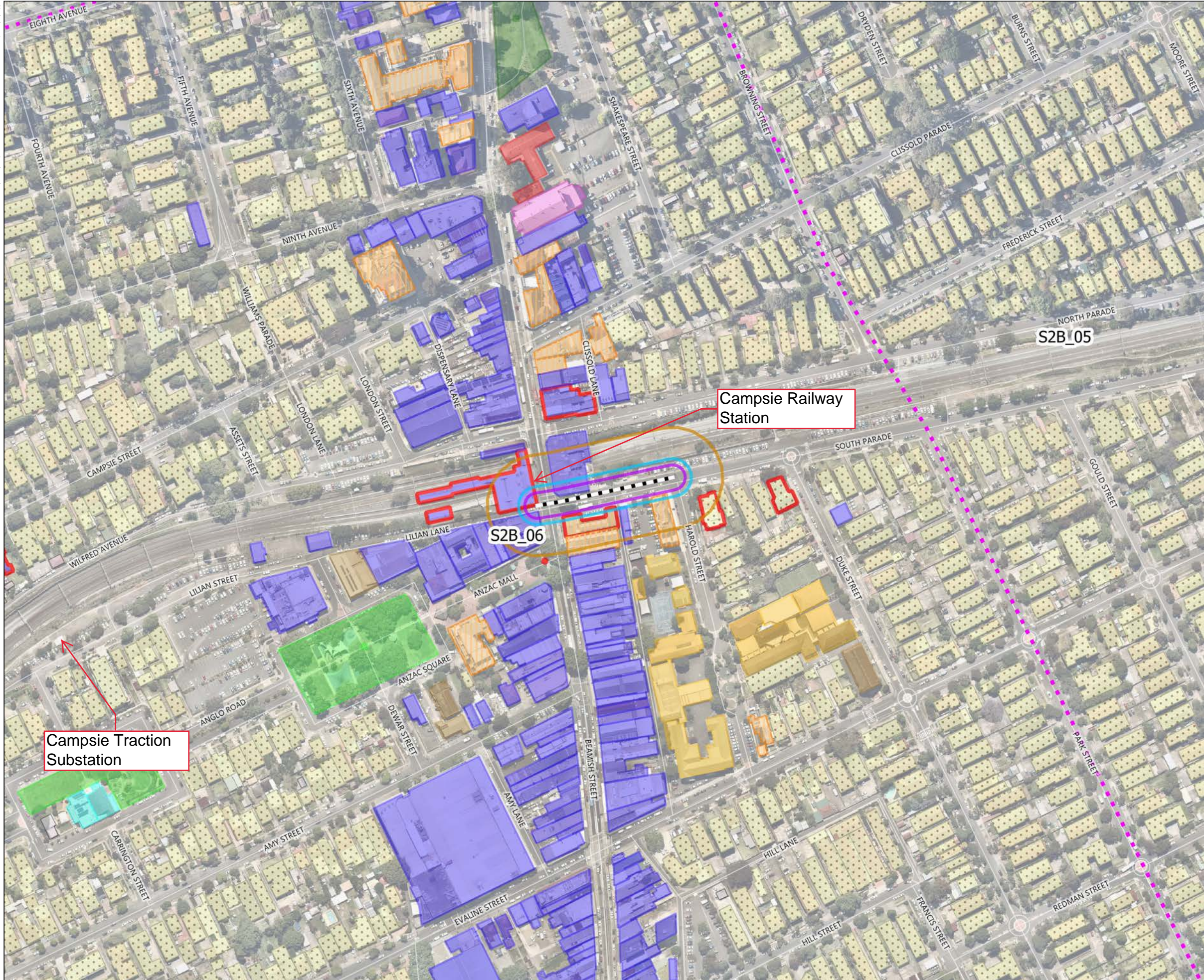
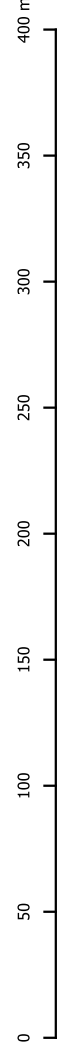
SYDNEY METRO - SYDENHAM TO BANKSTOWN

Line wide works - Bulk power supply works (Southern)

MWD for cosmetic damage and human annoyance

Campsie work area: A1

Sheet 1 of 6



LEGEND

Noise sensitive receivers

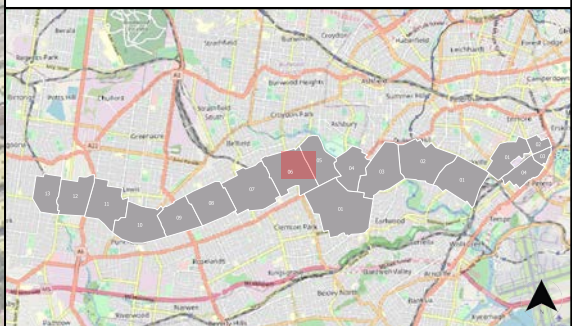
Childcare	Theatre/Auditorium
Commercial	Mixed use
Educational	Project acquisition
Hotel/Motel/Hostel	Film/TV studio
Industrial	Cinema
Medical	Community centre
Place of Worship	Library
Recording studio	Laboratory
Recreational - Active	Other
Recreational - Passive	Heritage
Residential	

NCA

MWD for cosmetic damage and human annoyance for Excavator with rock hammer (12T)

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

Work areas



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r1	MS	13/05/20	Update Figure	TG
r0	MS	09/12/19	Prepare figures	TG
REV	BY	DATE	DESCRIPTION	APPROVER
A3	Original		Co-ordinate System: MGA Zone 56	

0 50 100 150 200 m

1:3000

FULL SIZE A3

NOTE: Do not scale from this drawing.

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SYDNEY METRO - SYDENHAM TO BANKSTOWN

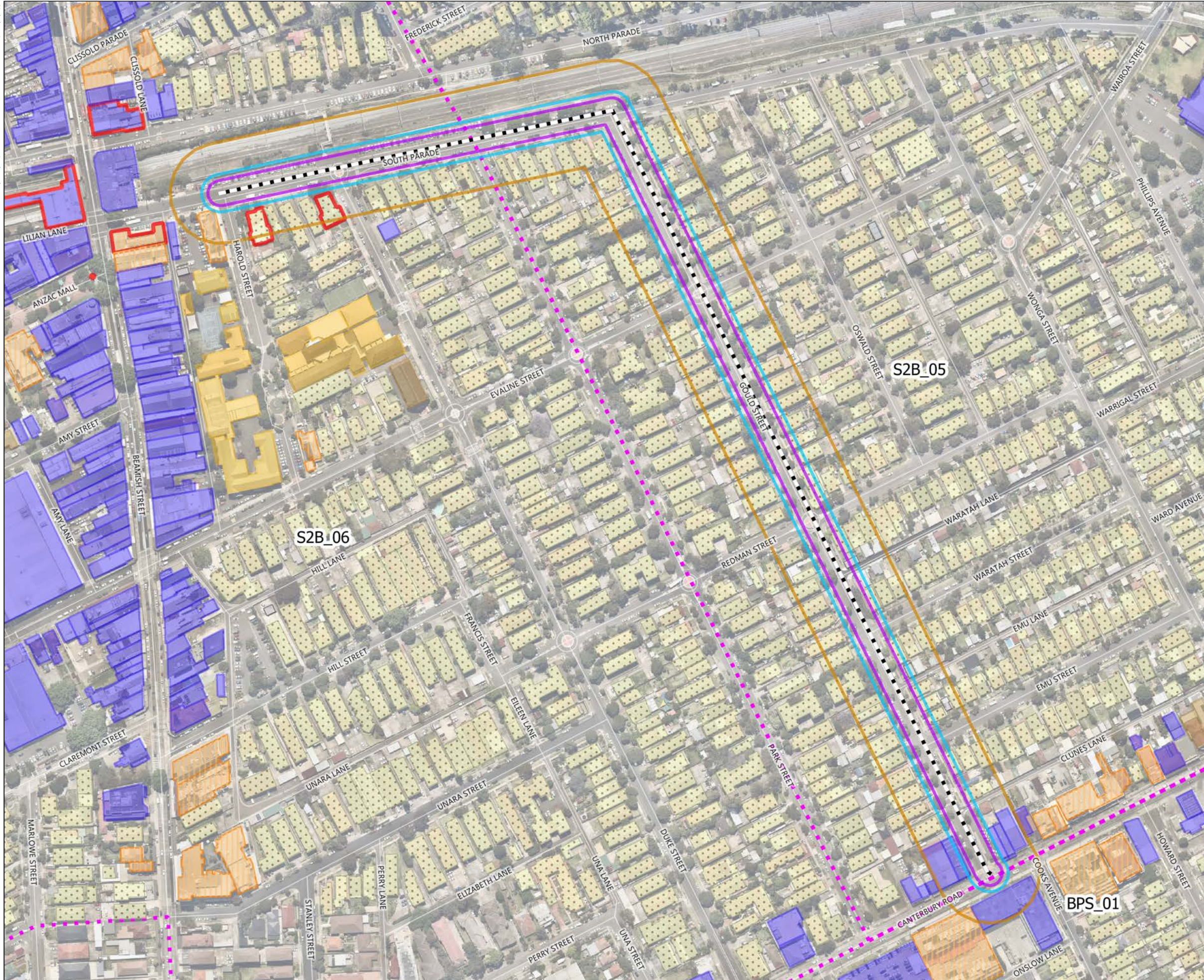
Line wide works - Bulk power supply works (Southern)

MWD for cosmetic damage and human annoyance

Campsie work area: A2

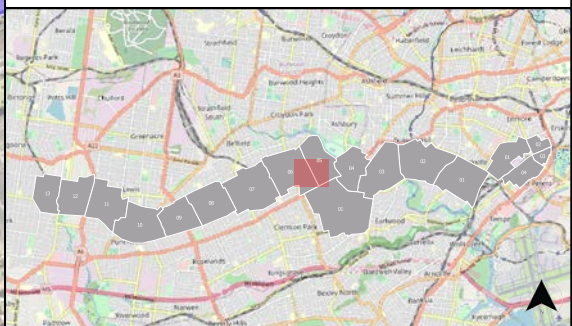
Sheet 2 of 6

400 m
350
300
250
200
150
100
50
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
- MWD for cosmetic damage and human annoyance for Excavator with rock hammer (12T)
- Unreinforced structures (7.5mm/s ppv)
 - Heritage structures (2.5mm/s ppv)
 - Human annoyance - Residential (day)
- Work areas



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r1	MS	13/05/20	Update Figure	TG	
r0	MS	09/12/19	Prepare figures	TG	
REV	BY	DATE	DESCRIPTION	APPROVER	
A3 Original			Co-ordinate System: MGA Zone 56		

0 50 100 150 200 m

1:3000

FULL SIZE A3

NOTE: Do not scale from this drawing.

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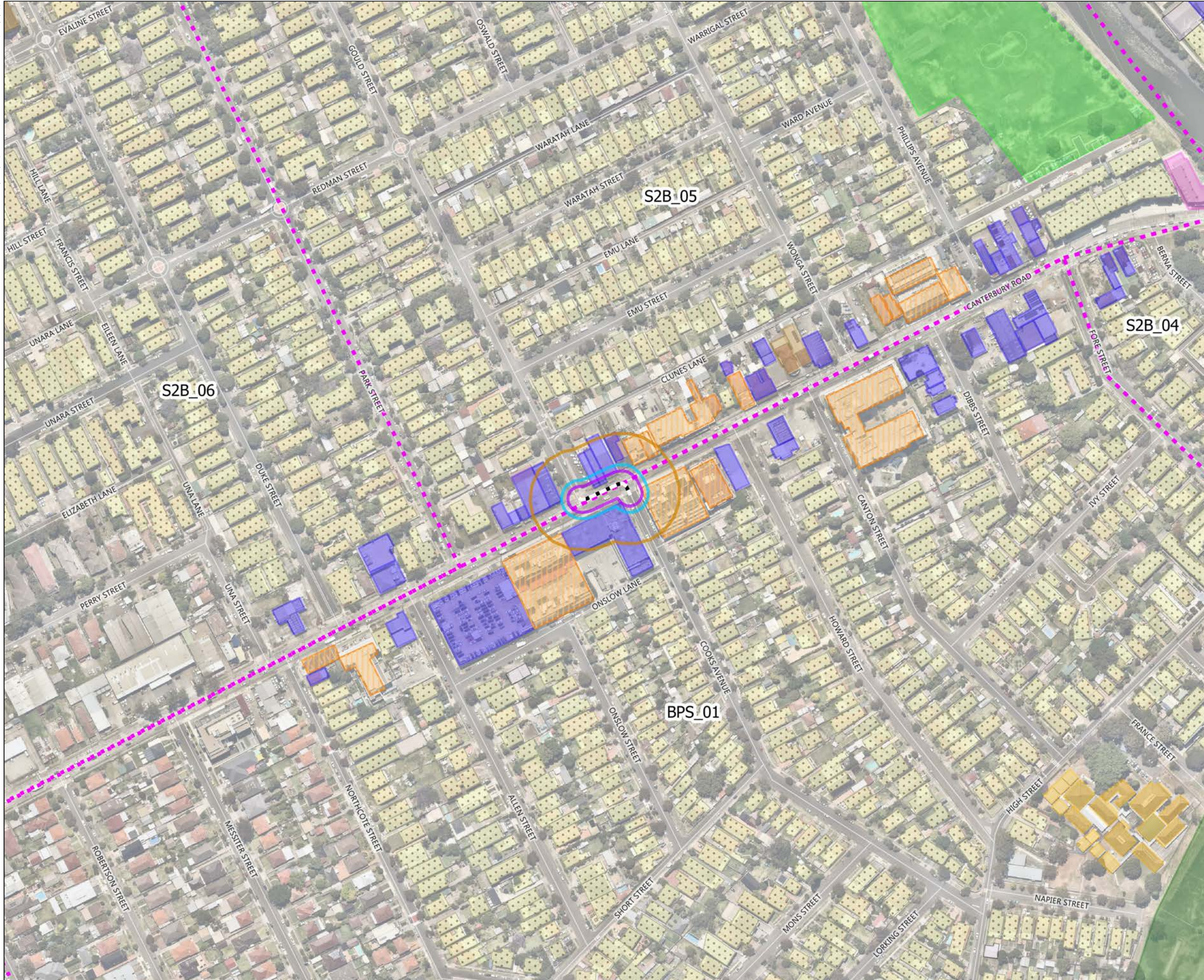
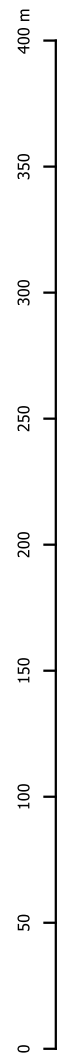
SYDNEY METRO - SYDENHAM TO BANKSTOWN

Line wide works - Bulk power supply works (Southern)

MWD for cosmetic damage and human annoyance

Campsie work area: A3

Sheet 3 of 6



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

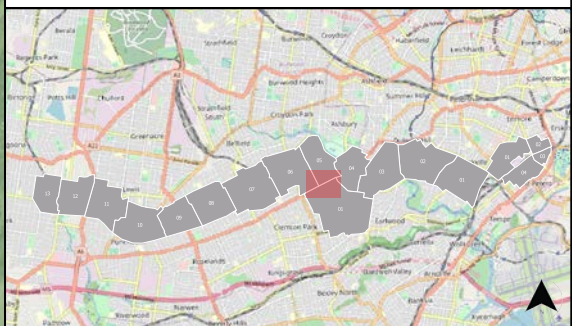
MWD for cosmetic damage and human annoyance for Excavator with rock hammer (12T)

Unreinforced structures (7.5mm/s ppv)

Heritage structures (2.5mm/s ppv)

Human annoyance - Residential (day)

Work areas



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r1	MS	13/05/20	Update Figure	TG
r0	MS	09/12/19	Prepare figures	TG
REV	BY	DATE	DESCRIPTION	APPROVER
A3	Original		Co-ordinate System: MGA Zone 56	

0 50 100 150 200 m

1:3000

FULL SIZE A3

NOTE: Do not scale from this drawing.

CLIENT

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SYDNEY METRO - SYDENHAM TO BANKSTOWN

Line wide works - Bulk power supply works (Southern)
MWD for cosmetic damage and human annoyance
Campsie work area: A4

Sheet 4 of 6

400 m
350
300
250
200
150
100
50
0



LEGEND

Noise sensitive receivers

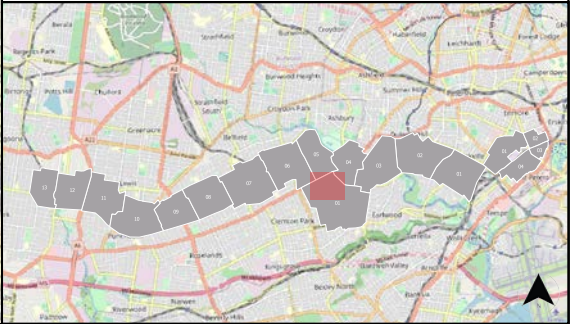
- | | |
|------------------------|---------------------|
| Childcare | Theatre/Auditorium |
| Commercial | Mixed use |
| Educational | Project acquisition |
| Hotel/Motel/Hostel | Film/TV studio |
| Industrial | Cinema |
| Medical | Community centre |
| Place of Worship | Library |
| Recording studio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

NCA

MWD for cosmetic damage and human annoyance for Excavator with rock hammer (12T)

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

Work areas



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r1	MS	13/05/20	Update Figure	TG
r0	MS	09/12/19	Prepare figures	TG
REV	BY	DATE	DESCRIPTION	APPROVER
A3	Original		Co-ordinate System: MGA Zone 56	

0 50 100 150 200 m

1:3000

FULL SIZE A3

NOTE: Do not scale from this drawing.

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SYDNEY METRO - SYDENHAM TO BANKSTOWN

Line wide works - Bulk power supply works (Southern)
MWD for cosmetic damage and human annoyance
Campsie work area: A5

Sheet 5 of 6







LEGEND

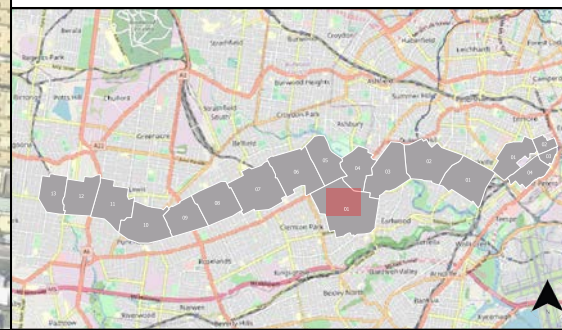
Noise sensitive receivers

- | | | | |
|---|------------------------|---|---------------------|
|  | 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 | | |



MWD for cosmetic damage and human annoyance
for Excavator with rock hammer (12T)

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



r1	MS	13/05/20	Update Figure		TG
r0	MS	09/12/19	Prepare figures		TG
REV	BY	DATE	DESCRIPTION		APPROVER
A3 Original			Co-ordinate System: MGA Zone 56		

FULL SIZE A3

NOTE: Do not scale from this drawing.

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SYDNEY METRO - SYDENHAM TO BANKSTOWN

Line wide works - Bulk power supply works (Southern)
MWD for cosmetic damage and human annoyance
Campsie work area: A6