

SYDNEY METRO CITY AND SOUTH WEST - LINE-WIDE WORKS

Construction Noise and Vibration Impact Statement Portion 3 - Waterloo Station early access works

18 June 2020

Systems Connect

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

Supplementary professional advice should be sought in respect of these issues.

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1 Introduction

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

1.1 Relevant requirements and purpose of this CNVIS

As defined in the CNVMP, the works covered by this CNVIS are part of the Portion 3 – Chatswood to Sydenham LWW delivered under Critical State Significant Infrastructure Approval CSSI 7400. Condition E33 of CSSI-7400 requires that:

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

This CNVIS applies to Waterloo Station, which includes works to be undertaken on the site surface and within the station box and tunnels. Works will be completed during standard construction hours as well as works outside of standard construction hours. The construction hours of work are defined by the Project Planning Approval conditions as outlined in the CNVMP.

This CNVIS forms part of the CNVMP for the Project.

1.2 Structure of this CNVIS

This CNVIS is structured as follows:

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

1.3 Quality assurance

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

2 Description of construction works and hours

2.1 Summary of works addressed in this CNVIS

2.1.1 Construction activities

This CNVIS provides an assessment of noise and vibration impacts from activities associated with the LWW at the Waterloo Station site. These activities include:

- Early access activities in the tunnels/ station box
 - Site establishment
 - Materials delivery and handling (including delivery of rail)
 - Track works (including flash butt welding).

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

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

2.1.2 Construction traffic

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

- Light vehicle movements generated by construction personnel travelling to and from work
- Heavy vehicle movements generated by delivery vehicles bringing materials, plant and equipment to the worksite

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

2.1.3 Cumulative construction impacts

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

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

2.2 Construction hours

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

2.2.1 Standard construction hours

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

Table 2-1: Standard construction hours

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

2.2.2 Out of hours work periods

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

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

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

The Transport for NSW (TfNSW) Construction Noise and Vibration Strategy (CNVS) [9] provides a hierarchy of Out of Hours (OOH) work periods. The impact of OOH works may be reduced by scheduling work and activities with greater impact during the preferred periods when receivers are likely to be less sensitive to noise and vibration, such as in the day out of hours (OOHD) and evening out of hours (OOHE) periods.

Table 2-2 presents the construction work periods as Standard Hours, Out of Hours Work (OOHW) Period 1 and OOHW Period 2.

Table 2-2: Construction hours

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

- Standard construction hours are defined in CSSI-7400 Condition E36 as: Monday to Friday 7:00am to 6:00pm and Saturdays from 8:00am to 1:00pm.
- Work outside of standard construction hours is defined as Out-of-Hours Work (OOHW) and has been divided by the CNVS into 2 periods of sensitivity:
 - OOHW Period 1** is the least sensitive OOH period and is defined as Monday to Friday 6:00pm to 10:00pm (evenings), Saturday 7:00am to 8:00am and 1:00pm to 10:00pm (day/ OOH and evening/ OOHE) and Sunday and public holidays 8:00am to 6:00pm (day/ OOH).
 - OOHW Period 2** is the most sensitive OOH period and is defined as Monday to Saturday 10:00pm to 7:00am (night/ OOH) and Sundays and public holidays 6:00pm to 8:00am (evening/ OOHE and night/ OOH).

2.2.3 Justification for OOHW

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

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

Allowing track work and tunnel fitout works to occur as OOHW will:

- Ensure key NSW Government program milestones are met.
- Ensure delivery of community and rail commuter user benefits.
- Allow increased project efficiency.
- Reduce the overall duration of the construction phase and in turn reduce the duration of impacts on the surrounding community.

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

completion of construction works will allow restoration of amenity and, in many respects, an increase in the quality of this amenity.

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

Any work outside standard construction hours must be undertaken in accordance with an EPL, should it be issued, or the Out of Hours Works Protocol (for works not under an EPL) 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 site have been divided into Noise Catchment Areas (NCAs) based on each area's similar acoustic environment prior to the start of construction work. The NCAs are based on those established in the EIS for the Project, with some modifications to allow for site specific characteristics.

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

3.2 Other sensitive receivers (PPA Condition E34)

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

CSSI-7400 Condition E34 states:

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

Sydney Metro and Systems Connect have undertaken and will continue consultation with identified sensitive receivers to determine sensitive periods prior to the commencement of and throughout LWW. Feedback from the consultation would be taken into consideration in finalising respite strategies for high noise impacts.

3.3 Commercial and industrial premises

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

3.4 Heritage receivers

Heritage receivers have been identified in the Land Use Survey in ANNEXURE A.2 of the CNVMP. The closest known heritage item to the site is the Waterloo Congregational Church which is immediately adjacent to the station box.

A structural assessment has been performed on the church and vibration-generating activities will be managed as explained in Section 6.2.1.

4 Construction Noise and Vibration objectives

4.1 Noise goals

4.1.1 Noise management levels (NMLs)

Construction noise management levels (NMLs) have been determined using the Construction Environmental Management Framework (CEMF)[10], CSSI-7400 Conditions, in accordance with the Sydney Metro City & Southwest Construction Noise and Vibration Strategy (SMCSNVS) [8] and as set out in the CNVMP.

For the Waterloo site, internal NMLs are applicable at residential receiver locations during the 8 pm to 7 am period per CSSI-7400 Conditions E41 and E42. During daytime and evening periods (between 7 am and 8 pm), external NMLs are derived from the ICNG, as identified in Section 5.1.1 of the CNVMP[1] and summarised in Table 4-1 below.

Table 4-1: Application of NMLs at C2S Waterloo Station (CSSI 7400 Conditions of Approval)

Time Period	Area	Receiver Type	Condition	Noise management level ³
Day ¹ (D/ D(O))	All	All	CEMF 9.2a ²	ICNG (see Table B1 in APPENDIX B)
Evening ¹ 6pm to 8pm (E1)	All	All	CEMF 9.2a ²	ICNG (see Table B1 in APPENDIX B)
Evening ¹ 8pm to 10pm (E2)	All	All	CEMF 9.2a ²	ICNG (see Table B1 in APPENDIX B)
Night ¹ 10pm to 7am (N)	All	All	CEMF 9.2a ²	ICNG (see Table B1 in APPENDIX B)
Evening ¹ 8pm to 9pm (E2)	Non-residential zones ²	Residential	SSI-7400 E41	L _{Aeq(15minute)} 60 dB(A) (internal)
Evening ¹ 9pm to 10pm				L _{Aeq(15minute)} 45 dB(A) (internal)
Night ¹ 10pm to 7am (N)				
Evening ¹ 8pm to 10pm (E2)	Residential zones ²	Residential	SSI-7400 E42	L _{Aeq(15minute)} 45 dB(A) (internal)
Night ¹ 10pm to 7am (N)				
All	All	All	SSI-7400 E43	L _{Aeq(8hour)} 85 dB(A) (external) near the CCSI

- Day refers to 7am to 6pm Monday to Friday and 8am to 6pm Saturday, Sunday and Public Holidays; Evening refers to Monday to Sunday 6:00pm to 10:00pm; Night refers to Monday to Friday 10:00pm to 7:00am and Saturdays, Sundays and public holidays 10:00pm to 8:00am.
- These are identified by the applicable Local Environmental Plan land zoning of the receiver.
- Construction Environmental Management Framework – City & Southwest (Sydney Metro 2017)
- A 5 dB penalty shall be applied if rock breaking or any other annoying activity likely to result in ground-borne noise or a perceptible level of vibration is planned

ICNG NMLs

For residential receivers, the ICNG NMLs 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]. Additional pre-construction noise monitoring was carried out prior to the Tunnels and Stations Excavation (TSE) works to establish more accurate noise goals. This additional long-term, unattended noise monitoring was carried out in July

2017 by RT&A following a review of the EIS noise monitoring and has been incorporated into the CNVMP.

The NMLs for 'other' sensitive receivers are from the ICNG, as reported in Section 5.2.3 of the CNVMP. These are applicable when the other sensitive receiver is in use.

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) [3] 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.

Internal NMLs (CSSI-7400 Conditions E41 and E42)

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

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

Addendum A of the SMCSNVS notes that the applicable Local Environmental Plan land zoning of the receiver be used to identify if residential receivers are located within residential or non-residential zones. An extract from the City of Sydney Local Environmental Plan (2012) land zoning map (accessed 09/04/2020) is provided in Figure 4.1. Purple and blue areas (R1 and B4) indicate residential and mixed use respectively. The State Environmental Planning Policy (State Significant Precincts) 2005 applies to land marked "MD". The South Sydney Local Environmental Plan 1998 applies to land marked "SS".

Figure 4.2 is an extract from the *South Sydney Local Environmental Plan 1998* land zoning map (accessed 18/10/2017). It shows that the land marked as "SS" on the City of Sydney Local Environmental Plan is zoned 2B Residential (medium density).

The zoning maps indicates that the nearest residential receivers to the Waterloo Station site are in residential areas.

Figure 4.1: Extracts from Sydney Local Environmental Plan 2012 land zoning maps LZN_010 (left) and LZN_017 (right).

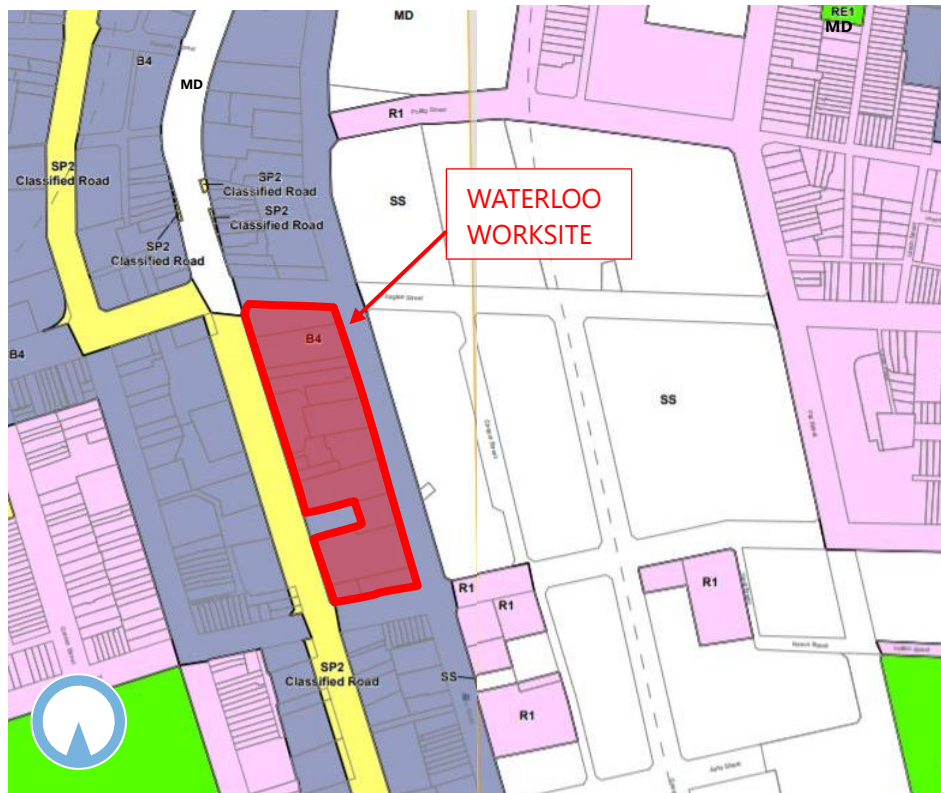
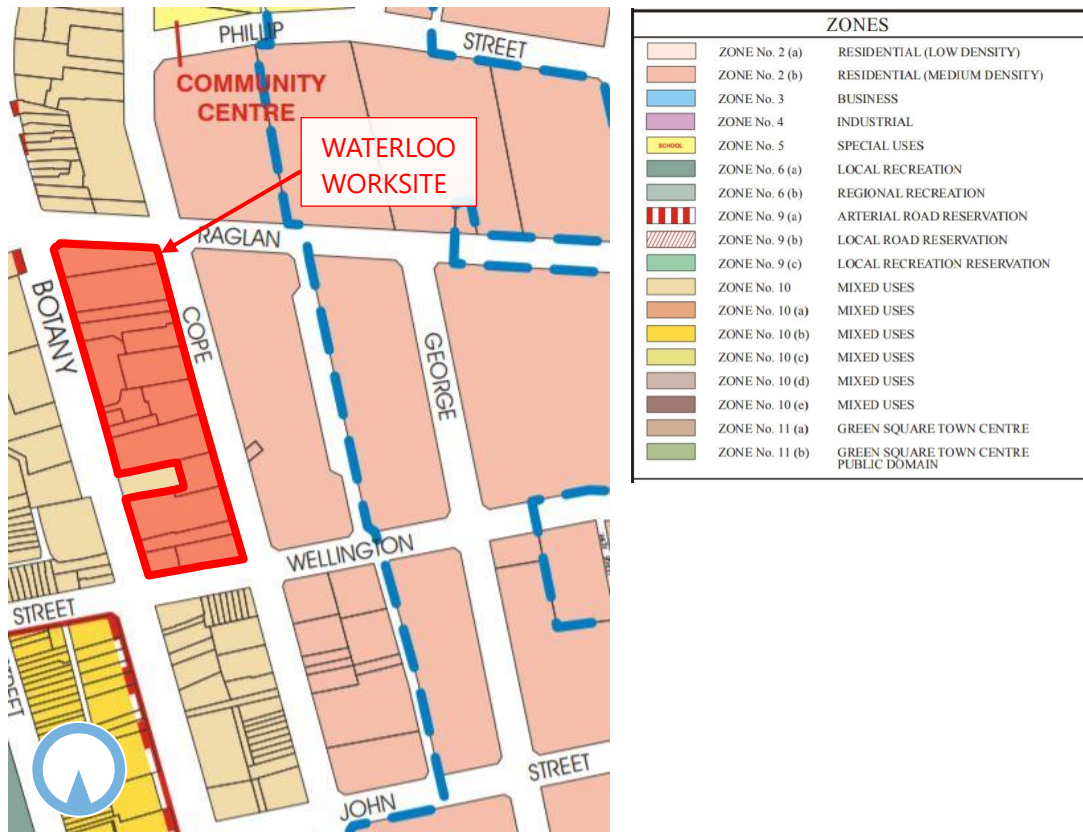


Figure 4.2: Extract from South Sydney LEP 1998 land zoning map



For this assessment, all residential receivers are conservatively assumed to be in residential zones, with a corresponding internal noise threshold level of $L_{Aeq(15\text{minute})}$ 45 dB(A) between 8pm and 7am. Based on a minimum (conservative) external to internal noise difference of 10 dB(A) (assuming windows open), an equivalent external noise threshold of $L_{Aeq(15\text{minute})}$ 55 dB(A) is applicable between 8pm and 7am for all receivers. Where these external equivalent levels are above the external noise threshold, additional mitigation are required in accordance with the SMCSNVS.

For some residential receivers along Botany Road, it is likely that the design of the buildings included upgraded window glazing and air conditioning systems to reduce the potential impact of road traffic noise and rail noise. At these locations, the external to internal noise reduction is likely to be 20 dB(A) or more.

The assessment presented in Section 5.3 has assessed all receivers against the approach outlined in the SMCSNVS [8] and the CNVMP [1] which achieves the requirements of PPA Conditions E41 and E42, and is consistent with the ICNG [3] and the EIS [2].

4.1.2 Respite for high noise impact works

The CSSI-7400 Conditions set no specific requirements for respite from high noise impact at the Waterloo site. In accordance with the ICNG, respite will be provided for activities which result in any residential receiver being highly noise affected (affected by noise more than 75 dB(A)).

To coordinate respite periods with other contractors working on the Waterloo site, respite from other high noise impact work will be provided by limiting activities to:

- Between the hours of 8:00am to 6:00pm Monday to Friday
- Between the hours of 8:00am to 1:00pm Saturday, and
- In continuous blocks not exceeding three hours each with a minimum respite from those activities and works of not less than one hour between each block, except as expressly permitted by the licence.

Continuous' includes any period during which there is less than one-hour respite between ceasing and recommencing any of the work that is subject to this requirement.

4.1.3 Sleep disturbance

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

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

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

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

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

4.1.4 National Standard for exposure to noise

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

4.1.5 Construction related road traffic noise objectives

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

4.2 Construction vibration goals

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

- for human exposure, the acceptable vibration values set out in the Environmental Noise Management Assessing Vibration: A Technical Guideline (Department of Environment and Conservation, 2006) [4]
- for structural damage, the vibration limits set out in the
 - British Standard BS 7385-2:1993 Evaluation and measurement for vibration in buildings. Guide to damage levels from ground-borne vibration [5] and

- German Standard DIN 4150-3: Structural Vibration - effects of vibration on structures [6].

4.2.1 Disturbance to building occupants (human annoyance)

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

Intermittent vibration is assessed using vibration dose values (VDVs). For the assessment of potential vibration at the nearest vibration sensitive receivers preferred and maximum VDV goals for the day period (7:00am to 10:00pm) are presented in Table 4-2.

Table 4-2: Construction vibration disturbance goals

Location	Assessment period 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 is given below:

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

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

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

4.2.3 Heritage

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

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

4.2.4 Sensitive scientific and medical equipment

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 and the likely timing of each activity/aspect.
- Separation distances between sources and receivers.
- Ground type between sources and receivers.
- Attenuation from barriers (natural and purpose built).

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

5.1.1 Detailed design outcomes

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

- Noise barriers between 2.1 metres and 4 metres high around the site that were established for the TSE works, including:
 - 4m high barrier located at the SE corner of the site, which extends along the majority of the southern boundary and a portion of the eastern boundary,
 - 2.1m high barrier for the remaining site boundary, and

- 3.5m high barrier (approx. 15m long) located adjacent to Raglan Street entry point (i.e. north of the LWW surface works.
- The tunnel ventilation system that was utilised for the TSE works will be inherited for LWW works. The ventilation system will be located at track level and/or in the tunnel and will be attenuated.
- Concrete deliveries and the use of the demolition saw will be restricted to standard construction hours.
- Crane activities during OOH will operate at 50% capacity (i.e. 7 minutes of operation per 15 minute period). Due to traffic restrictions, rail deliveries will be undertaken during the evening and night, with a maximum of two deliveries per hour during the OOH period. The crane will only be operational to unload the rail deliveries into the station box.
- Site entry and exit during the evening and night-time will be via the Botany Street access points that were established for the TSE works. During the daytime, site entry will be via Botany street and site exit will be via Raglan Street.

The design input assumptions for the site are outlined in Table C1 of APPENDIX C.

5.1.2 Construction activities

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

Table 5-1: Summary of construction activities

Activity	Aspect	Assessment reference	Duration
Site establishment	Set-up of crawler crane	S01 ¹	August 2020 (3 days)
Deliveries (surface works)	Concrete deliveries/transfer to station box Material deliveries/transfer to station box via crane	S02 ^{1,2}	August 2020 to November 2020
Weld Production (station box works)	Weld production and rail distribution	S03 ^{1,2}	August 2020 to November 2020
Track Works (tunnel activities between Waterloo station & Central station)	Rail distribution Material handling (sleepers, jewellery etc) Track construction Survey and drilling		

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

5.2 Predicted noise levels

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

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

5.2.1 ICNG NMLs

5.2.1.1 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	S01	S02	S03	S02 & S03
WS_01	●	●	●	○
WS_02	●	●	●	●
WS_03	●	●	●	●
WS_04	●	●	●	●
OSR	●	○	◆	◆

Notes:

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

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

Based on the results presented in Table 5-2 above, noise levels are predicted to comply with the daytime NMLs at the residential receivers during site establishment, surface deliveries and weld production. When deliveries and weld production occur concurrently, noise levels are predicted to be less than 10dB(A) above the NML in NCA WS_01.

During surface deliveries and weld production the main sources of noise on the surface would be concrete trucks and crane activities and the main source of noise at track level would be demolition sawing and grinding.

5.2.1.2 OOHW period 1

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

Table 5-3: Summary of construction noise impacts at nearby receivers – OOHW period 1 (ICNG)

NCA	E1 ¹ /E2 ²		
	S02	S03	S02 & S03
WS_01	○	○	◆
WS_02	○	●	◆
WS_03	●	○	○
WS_04	○	●	○
OSR	●	○	○

Notes:

1. E1: early evening period from 6pm to 8pm.

2. E2: late evening period from 8pm to 10pm. Assessment against ICNG NMLs for this period is used to guide additional mitigation measures (Section 5.3.3). PPA Conditions E41/42 are applicable for this assessment period (see Section 5.2.2)

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

During surface deliveries and weld production noise levels have been predicted to be less than 5dB(A) above the NML. When deliveries and weld production occur concurrently, noise levels are predicted to be up to 6dB(A) above the NML at 2 receiver locations (92-110 Cope Street and 104 Raglan Street). The main sources of noise on the surface would be from crane activities and the main source of noise at track level would be from grinding.

Specific mitigation measures outlined 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.

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

5.2.1.3 OOHW period 2

Predicted construction noise levels were compared with the ICNG NMLs during the night time period to determine applicable additional mitigation measures (Section 5.3.3) at the noise affected receivers from the construction stages identified in Table 5-1. The impacts presented in Table 5-4 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

Table 5-4: Summary of construction noise impacts at nearby receivers – OOHW period 2 (ICNG)

NCA	N ¹		
	S02	S03	S02 & S03
WS_01	◆	◆	◆
WS_02	◆	◆	◆
WS_03	○	◆	◆
WS_04	◆	○	◆
OSR	●	○	○

Notes:

1. N: Night-time period from 10pm to 7am
2. OSR: this includes all commercial, industrial and other sensitive receivers.
3. Assessment against ICNG NMLs for this period is used to guide additional mitigation measures (Section 5.3.3). PPA Conditions E41/42 are applicable for this assessment period (see Section 5.2.2).

Noise levels have been predicted to be less than 15dB(A) above the NML at the nearest sensitive receivers within NCAs WS_01, WS_02, WS_03 and WS_04. The main sources of noise on the surface would be from crane activities and the main source of noise at track level would be from grinding.

Specific mitigation measures outlined 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.

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

5.2.2 PPA Conditions E41/42

Table 5-5 summarises the predicted noise impacts for each construction stage in each NCA compared with the internal NMLs in CSSI-7400 Conditions E41 and E42. Where predicted levels are above the

NMLs at residential receivers, additional mitigation measures will be implemented in accordance with the documented procedure in Addendum A of the SMCSNVS.

The impacts presented are as follow:

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

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

NCA	E2 ¹ /N ²		
	S02	S03	S02 & S03
WS_01	●	□	□
WS_02	□	●	□
WS_03	●	●	●
WS_04	●	●	●

Notes:

1. E2: late evening period from 8pm to 10pm.

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

The results in Table 5-5 indicate that construction noise is predicted to comply with the internal noise threshold of PPA Conditions E41/E42 at the nearest residential receivers within NCA WS_03 and WS_04.

Noise levels have been predicted to be above Condition E41/42 internal NML at 2 receiver locations within NCA WS_01 (125 Raglan Street and 149 Cope Street) and 2 locations within WS_02 (209 Cope Street and 104 Raglan Street). The maximum noise level is predicted to be 3dB(A) above the internal NML at 104 Raglan Street, when deliveries and weld production occur concurrently, whilst a noise level 1-2 dB(A) above the internal NML is predicted when deliveries and weld production occur in isolation.

These noise level predictions above the NMLs are considered marginal and within the variation in noise level expected for these specific activities. As such, verification monitoring is to be undertaken (see Section 5.3.4) to ensure that the proposed works achieve the external equivalent NMLs at the nearby receiver locations.

Proposed measures for managing potential noise impacts are provided in Section 5.3. For more detailed predictions, see APPENDIX D. For more detailed additional noise mitigation 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 (ie. dropped chains) will exceed the sleep disturbance NML of 65 dB(A) L_{A1} (1 minute) during the night period works.

There are a limited number of truck deliveries movements proposed for LWW. Up to 10 truck deliveries will occur per 24 hour period and a maximum of 2 truck deliveries per hour are anticipated during the night-time period. The *Waterloo CNVIS* [ref: TH511-02 01.09.04 F01 Waterloo Station CNVIS (r8)], indicated an existing heavy vehicle traffic volume along Botany Street of 359 per night. Given the existing high frequency of heavy vehicle traffic along Botany Street, the low number of LWW movements are not expected to significantly increase sleep disturbance at the nearest residential receivers. Furthermore, the LWW night-time truck movements are significantly lower than what occurred for the TSE works (36 per night for the nozzle and stub tunnel excavation and lining).

These activities will be managed by instructing truck drivers to minimise unnecessary acceleration, avoid vigorous slamming of truck doors, installing air brake silencers and broadband reversing alarms on heavy vehicles, and minimising heavy vehicle movements where practicable. The potential of loose items or plant/equipment that could generate metal-on-metal bangs will be identified and managed accordingly. Where practical the use of slings rather than chains will be utilised for lifts.

In addition, Toolbox talks will be used to advise all personnel of the need to follow quiet work practices during OOHW periods, including warning personnel of the need to respect the residential receivers surrounding the local area work sites. 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.

Noise monitoring will be undertaken to determine if sleep disturbance is higher than the NML of 65 dB(A) L_{A1} (1 minute) during the night period. If verification monitoring shows noise levels are consistently above the sleep disturbance NML (i.e. 2 or more consecutive verification monitoring events that find the works to be the primary contributor noise above the sleep disturbance NML), investigation will be undertaken to understand the cause of the exceedance and additional mitigation and management measures will be implemented in accordance with Sydney Metro City and South West Noise and Vibration Strategy.

5.3 Noise mitigation and management

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

As outlined in Section 5.4.1 of the *Waterloo CNVIS*, and consistent with the CSSI-7400 Condition E33, consultation with affected receivers is required to assist in determining site-specific mitigation measures to be included in this CNVIS.

Systems Connect will continue to consult with potentially affected sensitive receivers, both prior to and following commencement of early access works at Waterloo Station LWW. That consultation would include email and phone calls whilst COVID-19 restrictions are in place. Where possible, doorknocking of affected residents and businesses will be carried out prior to night time early access works.

Consultation with affected sensitive receivers is informing and will continue to inform the identification of specific mitigation measures for the Waterloo Station LWW. These measures may include minimising high noise impact works during night time hours; limiting night time works in individual locations to no

more than two consecutive nights; scheduling high noise impact works around sensitive periods where feasible and reasonable; offers of movie or dinner vouchers; alternative accommodation offers.

It must be noted that offers of such vouchers or alternative accommodation may not be viable during COVID-19 restrictions, in which case alternative respite arrangements may need to be developed in consultation with affected receivers.

As presented in Table 5-2, during standard construction hours, the predicted noise levels exceed the external equivalent NML in accordance with the ICNG at one receiver building with two noise sensitive receivers, which are listed in Table 5-6. As such, further review will be undertaken prior to works commencing, to determine if these premises may be in use during the works, and if so, if the noise impact would actually exceed the internal NML. If this is the case, then these works are to be included as part of the consultation process in accordance with PPA Condition E34.

Table 5-6: E34 potentially-affected receiver locations – deliveries and weld production

Other sensitive receivers (Condition E34)	Description	Noise management levels as per ICNG	Consultation needed for airborne noise
Recording studio			
44-54 Botany Road, Alexandria	FBI Radio	25 dB(A)	If in use during the Works - Yes
44-54 Botany Road, Alexandria	Grumpy Sailor Creative	25 dB(A)	If in use during the Works - Yes

5.3.2 Site Noise Control Measures

Table 5-7 shows the noise control measures recommended to reduce potential noise impacts.

Table 5-7: Site Noise Control Measures

Control type	Control measure	Typical use
At-Source Control Measures	Limit equipment in use	Only the equipment necessary during each stage of the works will be used.
	Timing of equipment in use	Where practicable, activities and plant will be limited as outlined in Table C1 (APPENDIX C).
	Limit activity duration	Any equipment not in use for extended periods shall be switched off. For example, heavy vehicles should switch engines off when not in use.
		The crane will only be operational to unload rail deliveries into the station box. Due to traffic restrictions, rail deliveries will be undertaken during the evening and night, with a maximum of two deliveries per hour during the OOH period. The construction team will be toolboxed regarding operational constraints regarding limiting use of the crane to <7.5 minutes in a 15 minute period. Inspection and verification monitoring will be undertaken to confirm noise from crane operations are within the NMLs.
	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.

Control type	Control measure	Typical use
	Truck movements	Where practicable, avoid the use of park air brakes at night. Set up relevant traffic management measures to minimise the use of air brakes when leaving site. Air brake silencers are to be correctly installed and fully operational for any heavy vehicles (as per CNVMP). Minimise unnecessary acceleration on site and avoid vigorous slamming of truck doors.
	Limit clangs and bangs at night	Identify potential of loose items or plant/equipment that could generate metal-on-metal bangs and managed accordingly. E.g. where practicable use slings instead of chains for crane lifts into the station box.
	Non-tonal reversing alarms	Alternative reverse alarms, such as 'quackers' will be installed on all vehicles & mobile plant regularly used on site and on all vehicles & mobile plant required for OOHV.
Path mitigation measures	Temporary noise screens	Where practicable, temporary noise screens (e.g. Flexshield, Echo-barrier, or similar) should be used to provide additional noise reduction during works. Temporary noise screens can provide 5 to 10 dB noise reduction, where they can break line of sight.
Noise Management Measures	Site inductions & Toolbox Talks	All employees, contractors and subcontractors will receive a Project induction. The environmental component may be covered in toolboxes and should include: <ul style="list-style-type: none"> • location of nearest sensitive receivers • relevant project specific and standard noise and vibration mitigation measures; • permitted hours of work; • OOHV Procedure and Form • construction employee parking areas.
	Community consultation	Inform community of construction activity and potential impacts.
	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 5-8 below should be used to advise the appropriate additional noise mitigation during construction, based on the CNVS [9] and the CNVMP [1].

Table 5-8: Additional Airborne Noise Mitigation Measures

When is the work being undertaken?	How much does the predicted noise level exceed the ANML by?	Identify additional management measures to be implemented
Standard Hours M-F 7am to 6pm Sat 8am to 1pm	0 dB(A)	-
	≤ 10 dB(A)	-
	10 to 20 dB(A)	LB, V [MM2]
	> 20 dB(A)	LB, V [MM2]
	Highly noise affected	LB, SN, RO, V [MM4]
OOHW Period 1 M-F 6pm to 10pm Sat 1pm to 10pm Sun/ PH 8am to 10pm	< 5 dB(A)	-
	5 to 15 dB(A)	LB [MM1]
	15 to 25 dB(A)	LB, V [MM2]
	> 25 dB(A)	LB, SN, IB, RO, V [MM4]
OOHW Period 2 M-F 10pm to 7am Sat 10pm to 8am Sun/ PH 6pm to 8am	< 5 dB(A)	LB [MM1]
	5 to 15 dB(A)	LB, V [MM2]
	15 to 25 dB(A)	LB, SN, IB, RO, V [MM4]
	> 25 dB(A)	LB, SN, IB, RO, AA, V [MM5]

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

LB = Letter box drops
V = Verification of predicted noise levels
SN = Specific notifications (personalised letter, phone call, email, individual briefing)
RO = Project specific respite offer
AA = Alternative accommodation

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 (as outlined in Section 5.3.2), predicted construction noise levels still exceed the NMLs.

Prior to the commencement of the site establishment works, residential receivers around the Waterloo Station LWW, in particular those identified in APPENDIX E will be notified to advise that noise from the works may at times be audible. All potentially impacted receivers will be kept informed of the nature of works to be carried out, the expected noise levels and duration, as well as be given the project enquiries and complaints 1800 numbers (see Section 5.3.5).

5.3.4 Attended Noise Monitoring

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

Attended noise monitoring will be undertaken to verify that the construction activities are consistent with the assessed noise modelling scenarios and that noise levels resulting from construction works are not higher than the noise management levels, noting in some cases the predicted noise levels were above these noise levels. Attended monitoring on private property is subject to obtaining the property owner/occupier's consent (where required). If consent to access property is denied, monitoring will be conducted on public land on the property boundary, provided it is safe to do so.

Attended noise monitoring will be undertaken in the NCAs most impacted by the works. Indicatively, a minimum of one representative receiver in each most noise affected NCA is to be monitored. The

nominated monitoring locations are identified in Table 5-9, and have been selected as they present the best opportunity to validate the predicted noise levels.

Table 5-9 presents the noise levels to be achieved at these receivers in order to comply with PPA conditions E41/E42 (as a minimum). Where noise monitoring is undertaken at ground level, a lower noise level is required to ensure that compliance is achieved at higher receiver locations. As noted in the Table 5-9, the noise levels presented are the highest at the nearest noise-sensitive receiver. The noise level in brackets (XX) is the noise level predicted (or required) at the ground level.

Table 5-9: Nominated verification monitoring locations and applicable noise monitoring targets

Ref.	NCA	Nominated receiver address	Required $L_{Aeq\ 15\ minute}$ noise monitoring level, dB(A)		
			Deliveries	Weld Production	Deliveries + Weld Production
1	WS_01	125 RAGLAN STREET WATERLOO	53 (51)	52 (50)	55 (52) ¹
2	WS_01	149 COPE STREET WATERLOO	52 (51)	55 (42) ¹	55 (50) ¹
3	WS_02	104 RAGLAN STREET WATERLOO	55 (51) ¹	50 (48)	55 (51) ¹
4	WS_02	209 COPE STREET WATERLOO	55 (50) ¹	50 (48)	55 (51) ¹

Note:

1. Required noise level is lower than the predicted noise level presented in APPENDIX D. This is the level required to be within the NML specified in PPA Conditions E41/E42
2. Monitoring on private property is subject to owner consent and where relevant, occupier consent
3. The noise levels presented is the highest predicted (or required to comply with NML) at the nearest noise-sensitive receiver. The noise level in brackets (XX) is the noise level that is predicted (or required, to comply with NML at all receivers) at the ground level adjacent to the building (free-field). The ground level location is provided to allow verification monitoring to be undertaken at ground level where property access is not available.

Noise monitoring will be undertaken to determine if the construction noise levels are higher than the external equivalent NML specified in PPA Conditions E41/E42. If verification monitoring shows that the external noise levels are consistently above the predicted (or required) noise levels (i.e. 2 or more consecutive verification monitoring events that find the works to be the primary contributor noise above the E41/E42 NML) presented in Table 5-9, investigation will be undertaken to understand the cause of the exceedance and additional mitigation and management measures will be implemented in accordance with Sydney Metro City and South West Noise and Vibration Strategy.

5.3.5 Complaints Handling

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

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

Enquiries/ complaints may also be received through the Sydney Metro project email (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:

- Demolition saw

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

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

The data relied upon in this assessment (tabulated below) is taken from a database of vibration levels measured at various sites or obtained from other sources (such as BS5228-2:2009). They are not specific to this project as final vibration levels are dependent on many factors including the actual plant used, its operation and the intervening geology between the activity and the receiver.

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

Plant item	Minimum working distance (m)		
	Reinforced or framed structures (e.g. commercial buildings) ¹	Unreinforced or light framed structures (e.g. residential buildings) ¹	Sensitive structures (e.g. heritage structures) ²
Demolition saw	5	5	5

Notes

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

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

3) Minimum working distances are in 5m increments only to account for the intrinsic uncertainty of this screening method.

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

Plant item	Minimum working distances, m				
	Critical areas ^{1,4}	Residences		Offices ^{3,4}	Workshops ⁴
		Day ²	Night ²		
Demolition saw	15	10	10	5	5

Plant item	Minimum working distances, m			
	Critical areas ^{1,4}	Residences		Offices ^{3,4} Workshops ⁴
		Day ²	Night ²	

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

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

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

4: Applicable when in use.

6.2 Vibration assessment

6.2.1 Structural damage

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

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

Plant item	Number of buildings ¹	
	Screening criteria for non-heritage structures	Screening criteria for heritage structures ²
Demolition saw	0	0

The demolition saw will be used at track level within the station box. There are no buildings within the minimum working distances established for cosmetic damage during use of the demolition saw.

6.2.2 Human annoyance

The assessing vibration guideline [4] notes that inside dwellings, adverse comments often arise when occupants can perceive (feel) vibration, particularly when the vibration arises from a source located outside their home (or outside their control), and assume that the vibration has the potential to damage their building or contents.

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

Properties where vibration levels may be above the vibration disturbance goals in Table 4-2 and there is a probability of adverse comment are shown in Table 6-4.

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

Plant item	Critical areas ^{1,4}	Residences ⁵		Offices ^{3,4}	Workshops ⁴
		Day ²	Night ²		
Demolition saw	0	0	0	0	0

Plant item	Critical areas ^{1,4}	Residences ⁵		Offices ^{3,4}	Workshops ⁴
		Day ²	Night ²		

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

There are no receivers predicted to experience vibration which can cause adverse comment when vibration-generating plant is operated nearby.

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).

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.

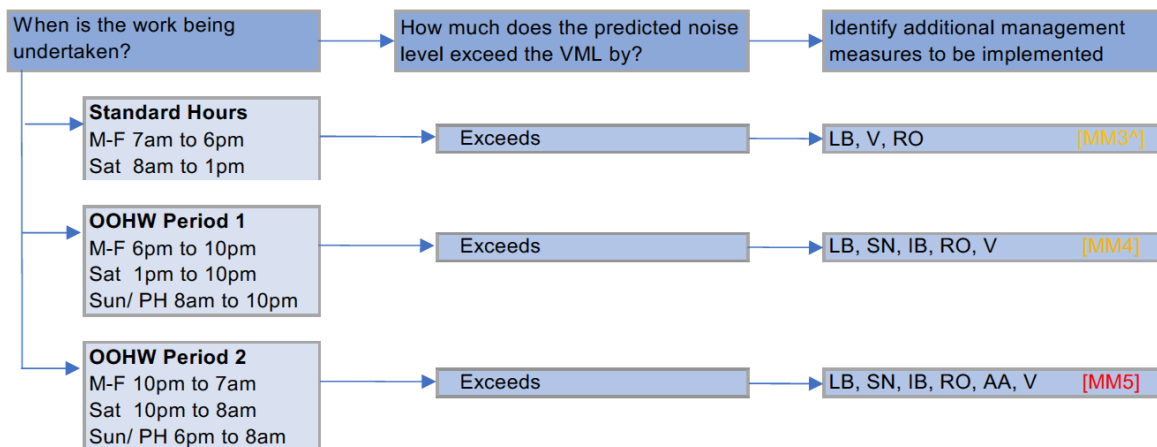
Table 6-5: Site vibration control measures

Control type	Control measure	Typical use
Construction Planning	Community consultation	Implement community consultation measures – inform community of construction activity & potential impacts – inform community that the level of vibration at which people perceive it, or at which loose objects may rattle, is far lower than the level at which minor cosmetic damage is expected to occur.
	Equipment selection/ construction method	Use less vibration emitting construction methods where feasible & reasonable, for example vibratory rollers can, where practicable, be operated with the vibratory mode switched off to reduce vibration impact.
	Plan work activities to minimise vibration.	Plan traffic flow, parking & loading/unloading areas to maximise distances between truck routes and sensitive receivers.
Complaints Management	Construction Complaints Management System	Complaints will be managed in accordance with the Construction Complaints Management System (see Section 6.3.4). Each complaint shall be investigated and where vibration levels are established as exceeding the set limits, appropriate amelioration measures shall be put in place to mitigate future occurrences. Management measures may include modification of construction methods such as using smaller equipment and establishment of minimum working distances as mentioned above.

6.3.2 Additional vibration mitigation measures

After applying all feasible and reasonable mitigation measures identified in Table 6-5, if vibration monitoring at representative locations are still above relevant vibration objectives for human annoyance, the appropriate additional vibration mitigations measures, 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

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

6.3.4 Management of complaints

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

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

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

7 Ground-borne noise assessment

Airborne noise in the vicinity of Waterloo Station is expected to be much higher than ground-borne noise levels at the nearest sensitive receivers due to the works occurring at the surface and in the station box. Furthermore, the proposed works that are occurring within the tunnel are not vibration intensive.

The risk of annoyance due to ground-borne noise is therefore considered low and has not been addressed further in this CNVIS.

8 Traffic noise assessment

Low levels of heavy vehicle movements are associated with Waterloo Station LWW. As such, the increase in road traffic noise levels is likely be less than 2 dB(A) and so construction traffic will have minimal impact on the 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 Systems Connect construction works have been considered and addressed in this CNVIS.

It is noted that the permanent works being undertaken by the TSE Contractor are forecast to be completed by the end of July 2020. The Waterloo Station Contractor is forecast to commence work on site in August 2020.

During standard construction hours, cumulative noise levels may be at times 2dB(A) higher than indicated in this assessment at receivers closer to Waterloo Station worksite. This is not considered a significant increase for work activities undertaken during standard construction hours. The Waterloo Station contractor, who will prepare a separate CNVIS, would have only limited works outside standard construction hours, except where OOHW comply with ICNG NMLs. They will therefore have a negligible impact at the nearby noise sensitive receivers compared to the OOH LWW works which are required to meet the internal NMLs in PPA Conditions E41 and E42.

Systems Connect are aware of other ongoing, potentially concurrent construction activities within the vicinity of the Waterloo Station worksite. These 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, Systems Connect will endeavour to take all reasonable steps to collaborate with other Projects to minimise cumulative noise and vibration impact where Systems Connect are above management levels and coordinate respite for affected sensitive receivers, whenever practicable.

Table 9.1: Other construction works close to Waterloo Station site

Construction company	Project	Timing of activities	Hours of works	Works location	Activity types	General plant types
JHCPBG JV	Sydney Metro TSE Works	February 2019 to July 2020	Standard construction hours and outside construction hours works.	Station box	Construction - station box/nozzle/tunnel (XP) permanent lining	Crawler crane (100T), delivery trucks; FE loader, concrete trucks & pumps, power tools, EWP
John Holland	Sydney Metro OSD	August 2020 to June 2024	Standard construction hours, outside construction hours and Road Occupancy Licence (ROL) works.	Station box	Station Building Construction	Crawler cane, delivery trucks, concrete trucks and pumps, power tools, telehandlers.

10 Conclusion

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

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

For the worst case construction scenario, where surface deliveries and weld production occur concurrently, noise levels are predicted to be marginally above the NMLs at four receiver buildings. As the predicted noise levels are only marginally above the NMLs at a small number of receivers, verification noise monitoring during the works is to be undertaken to ensure that the works achieve (as a minimum) the PPA Condition E41/E42 requirements at nearby receivers. Noise monitoring will be undertaken on a regular basis to verify compliance with the predicted noise levels and NMLs.

Noise mitigation and management measures have been presented in Section 5.3 to aid in providing additional noise reduction benefits where exceedance of the objective occurs.

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

The potential impact of ground-borne noise from construction activities is expected to be negligible due to the expectation that airborne noise (potentially from sources other than construction, such as road traffic) 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 2016 Sydney Metro Chatswood to Sydenham - Technical Paper 2: Noise and Vibration Report Number 610.14718R1 – 28 April 2016
- [3] Department of Environment and Climate Change 2009 NSW Interim Construction Noise Guideline
- [4] Department of Environment Conservation NSW 2006 Assessing Vibration; a technical guideline
- [5] British Standard BS 7385 Part 2 1993, Evaluation and measurement for vibration in buildings. Guide to damage levels from groundborne vibration
- [6] German Standard DIN 4150-3:2016-12 Vibration in buildings – Part 3: Effects on structures
- [7] British Standard BS 6472-2008, Evaluation of human exposure to vibration in buildings (1-80Hz)
- [8] Transport for NSW Sydney Metro City & Southwest Construction Noise Strategy (ref: 610.14213-R3) 08 August 2016
- [9] Transport for NSW Construction Noise and Vibration Strategy (ref: 7TP-ST-157/4.0) May 2018
- [10] Transport for NSW Sydney Metro Construction Environmental Management Framework August 2016
- [11] Department of Environment, Climate Change and Water 2011 NSW Road Noise Policy
- [12] NSW Department of Planning – Development near rail corridors and busy road – interim guideline 2008

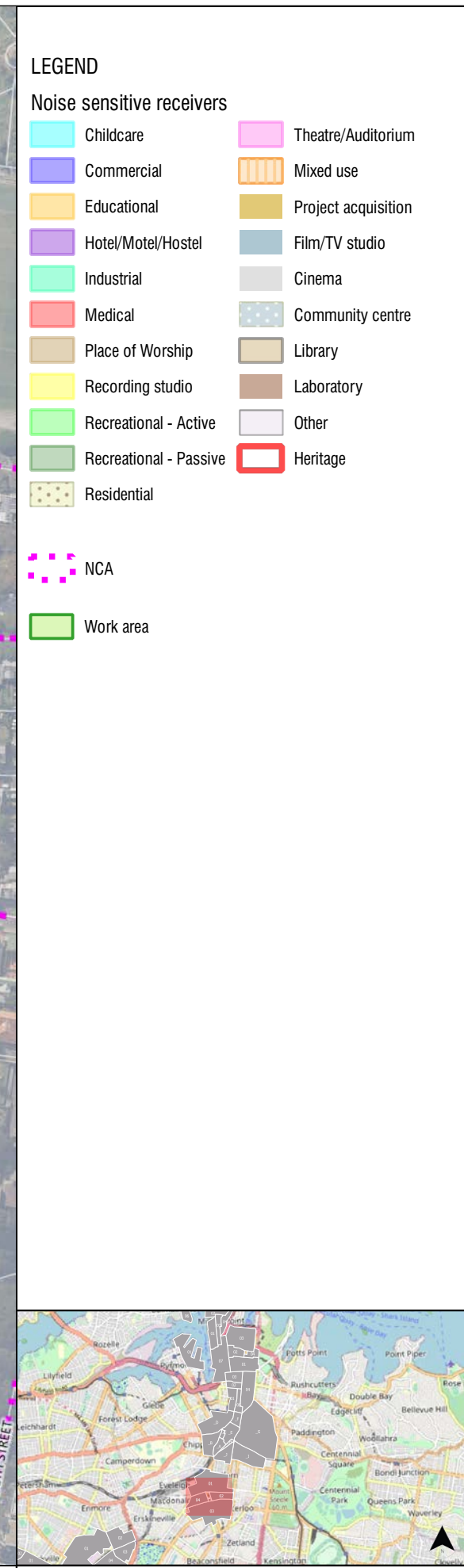
APPENDIX A Glossary of terminology

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.
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.
Sensitive receiver	Includes residences, educational institutions (including preschools, schools, universities, TAFE colleges), health care facilities (including nursing homes, hospitals), religious facilities (including churches), child care centres, passive recreation areas (including outdoor grounds used for teaching), active recreation areas (including parks and sports grounds).
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**



SYDNEY METRO - CHATSWOOD TO SYDENHAM

Waterloo early access work area
Land Use, NCAs

Sheet 1 of 1

Table B1: Noise sensitive receivers and construction noise management levels [dB(A)]**WATERLOO - EARLY ACCESS**

NCA	Receiver Type	Reference RBL	Rating Background Levels (RBLs)			Existing L_{Aeq} Noise Levels			Residential Noise Management Levels (NMLs)				Sleep Dist. L_{Amax}		Comments
			Day	Evening	Night	Day	Evening	Night	Day (S)	Day (O)	E1	E2/N *	Screening	Max	
WS_01	Residential	EIS B.06	54	47	39	65	62	58	64	59	52	55-65	54	65	
WS_02	Residential	EIS B.06	54	47	39	65	62	58	64	59	52	55-65	54	65	
WS_03	Residential	EIS B.06	54	47	39	65	62	58	64	59	52	55-65	54	65	
WS_04	Residential	EIS B.06	54	47	39	65	62	58	64	59	52	55-65	54	65	
Other Sensitive Receivers															
OSR	Recording Studio	ICNG	-	-	-	-	-	-	25	25	25	25	-	-	When premises is in use. Internal.
OSR	Educational facility	ICNG	-	-	-	-	-	-	55	55	55	55	-	-	When premises is in use. External.
OSR	Childcare centre	ICNG	-	-	-	-	-	-	55	55	55	55	-	-	Daytime NML of 55dB(A) is external equivalent of 45dB(A) internal goal for classrooms with windows open.
OSR	Places of worship	ICNG	-	-	-	-	-	-	55	55	55	55	-	-	NML of 55dB(A) is external equivalent of 45dB(A) internal goal for places of worship with windows open, when in use. Ref: ICNG p13
OSR	Café/ Restaurant/ Bar - indoors	AS2107	-	-	-	-	-	-	50	50	50	50	-	-	When premises is in use. Internal.
	- outdoors	ICNG	-	-	-	-	-	-	60	60	60	60	-	-	When premises is in use. External.
OSR	Hotel/ motel	AS2107	-	-	-	-	-	-	60	60	60	60	65	65	NML of 60dB(A) is external equivalent of 40dB(A) internal goal for hotels on busy roads based on AS2107 assuming windows closed
OSR	Active recreation areas	ICNG	-	-	-	-	-	-	65	65	65	65	-	-	Ref: ICNG p13
OSR	Commercial receivers/ offices	ICNG	-	-	-	-	-	-	70	70	70	70	-	-	When premises is in use. External.
OSR	Industrial receivers	ICNG	-	-	-	-	-	-	75	75	75	75	-	-	When premises is in use. External.

Notes:

* the E2/N external equivalent noise management level is based on Project Planning Approval Condition number E41/E42 and depends on the assumed façade loss

Day (S): standard hours 7am to 6pm Monday to Friday and 8am to 1pm Saturday.

Day (O): day outside standard hours 7am to 8am and 1pm to 6pm Saturday, 8am to 6pm Sunday and Public Holidays.

E1: evening from 6pm to 8pm.

E2/N: evening and night from 8pm to 7am.

APPENDIX C

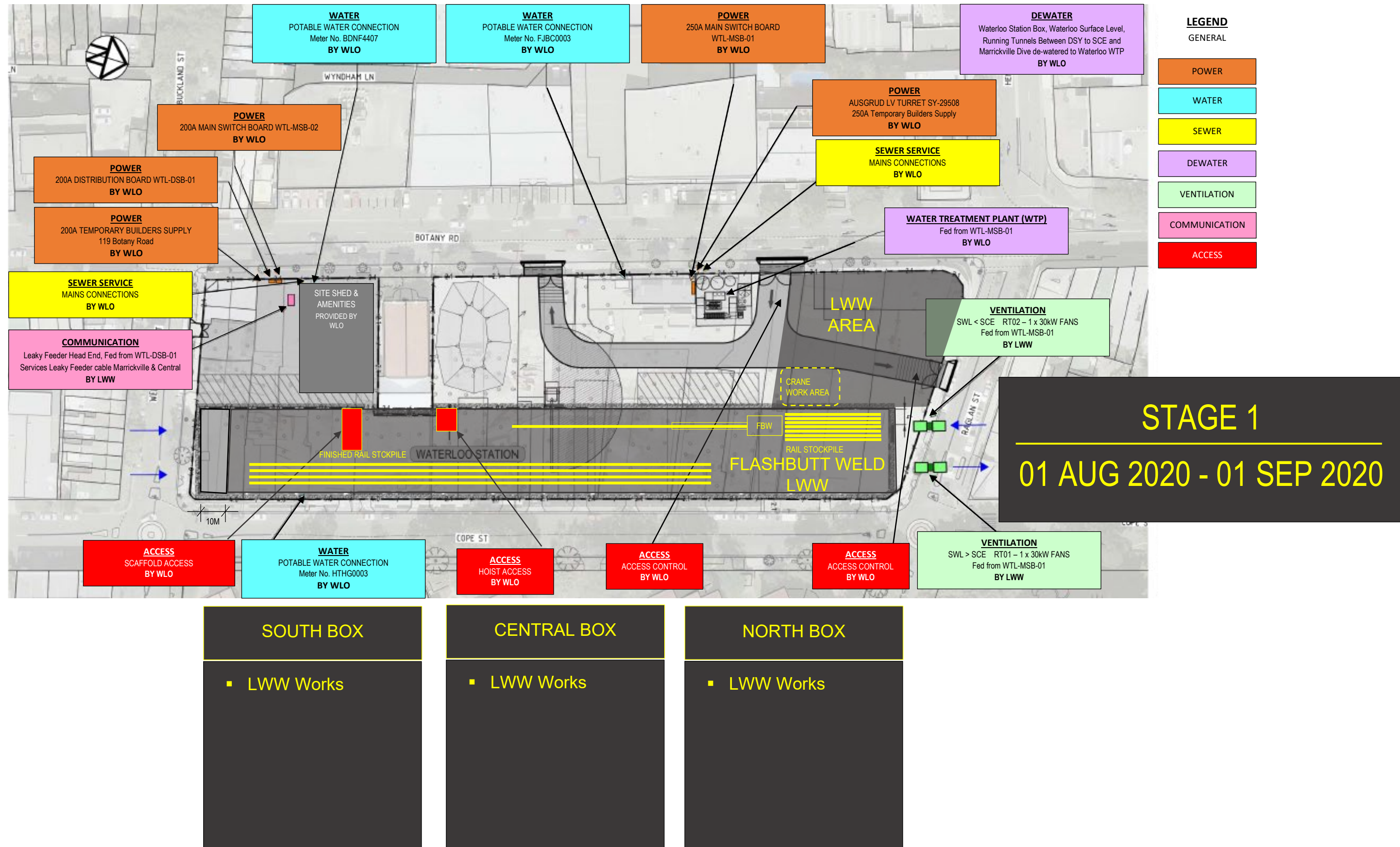
Construction details

Table C1: Construction Timetable/ Activities/ Equipment WATERLOO - EARLY ACCESS

Activity/ Work Area	Aspect	Indicative timing/ duration	Modelling ID	Plant/ Equipment (as provided by client)	Day	Evening	Night	Sound Power Level (Lw re: 1pW) in Noise Model, dB(A)			High noise plant (EPL E1)	Vibration intensive plant	Notes
					7am - 6pm	6pm - 10pm	10pm - 7am	L _{Aeq}	Penalty	L _{Amax}			
WATERLOO STATION													
Site Establishment	Set-up of crawler crane	1/08/2020 3 days duration		Mobile crane (Franna)	2	-	-	99	-	103	-	-	
				Hand Tools	1	-	-	107	-	111	-	-	
				Crawler crane truck	1	-	-	106	-	111	-	-	
Surface works	Deliveries	August 2020 to November 2020		Crawler crane	1	1	1	101	-	108	-	-	Operate at 50% capacity during the evening and night (i.e. 7mins operation per 15 minute period)
				Road truck (deliveries to site)	10 per day		106	-	111	-	-		
				Concrete truck and pump	4 per hour	-	-	105	-	111	-	-	
				Light vehicles	8 per hour	8 per hour	8 per hour	89	-	100	-	-	
				Fork lift	1	1	1	99	-	103	-	-	
				Station box works (station box 22m deep)	Weld Production	August 2020 to September 2020		Grinding	1	1	1	114	
Demolition saw	1	-	-					121	5	129	HN	X	
Telehandler	1	1	1					99	-	103	-	-	
Flash Butt Welder	1	1	1					102	-	105	-	-	
Rubber tyre Excavator	1	1	1					103	-	108	-	-	
Front end loader	1	1	1					110	-	115	-	-	During crane activities, not to operate at the same time as grinding
Rail trolleys	1	1	1					89	-	100	-	-	
Hand tools	Various	Various	Various					107	-	111	-	-	
TRACK WORKS - Tunnel WLO to CEN (All activities in the tunnel)													
Rail distribution	Rail distribution	August 2020 to November 2020		Telehandler	1	1	1	99	-	103	-	-	
				Rubber tyre Excavator	1	1	1	103	-	108	-	-	
				Front end loader	1	1	1	110	-	115	-	-	
				Rail trolleys	1	1	1	89	-	100	-	-	
				Hand tools	Various	Various	Various	107	-	111	-	-	
Track Materials (Sleepers, jewellery etc) Handling	Material handling	August 2020 to November 2020		Hand held tools	Various	Various	Various	114	-	118	-	-	
				Loader 950 Equ. = Excavator w bucket	1	1	1	103	-	108	-	-	
				Fork lift	1	1	1	99	-	103	-	-	
Tunnel Track Activities (tunnel only)	Track Construction	October 2020 to November 2020		hand held saw	2	2	2	114	-	118	-	-	
				Hand held tools	Various	Various	Various	114	-	118	-	-	
				Loader 950 Equ. = Excavator w bucket	1	1	1	103	-	108	-	-	
				Hi-Ab Truck (Hi-Rail)	4 per hour	4 per hour	2 per hour	98	-	102	-	-	
				Light vehicle	8 per hour	8 per hour	8 per hour	89	-	100	-	-	
Survey and Drilling	Survey and Drilling	August 2020 to October 2020		Drill Gantry	1	1	1	114	-	120	-	-	Comprising acombination of Hilti TE30s and TE50s - will have non percussive operation
				Light vehicles	2	2	2	89	-	100	-	-	

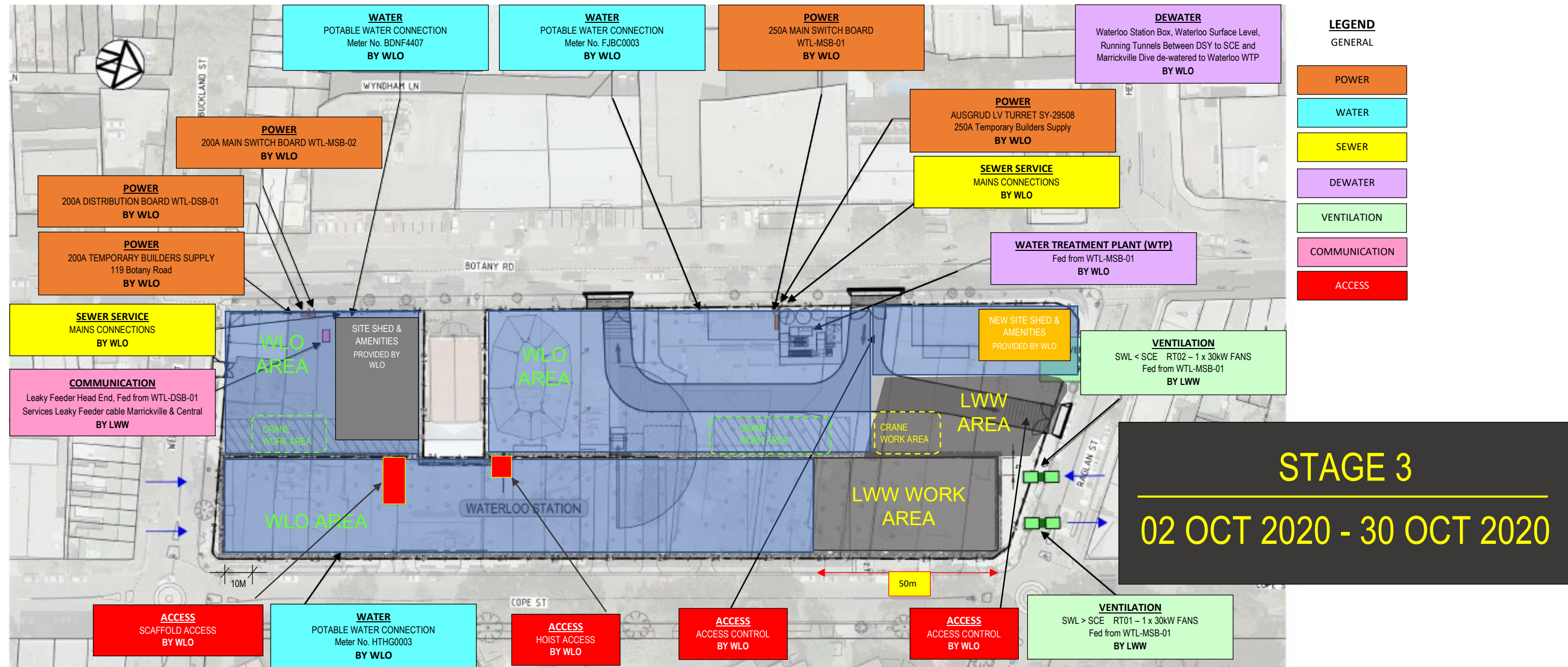
John Holland Option 7a – STAGE 1

Rev Date: 03/02/2020



John Holland Option 7a – STAGE 3

Rev Date: 03/02/2020



SOUTH BOX

- Piling (01st Oct)
- Waterproofing (9th Oct)
- Base Slab (20th Oct)
- Portal Wall (30th Oct)

CENTRAL BOX

- Piling (10th Oct)* depending on progress / No. of rigs

NORTH BOX

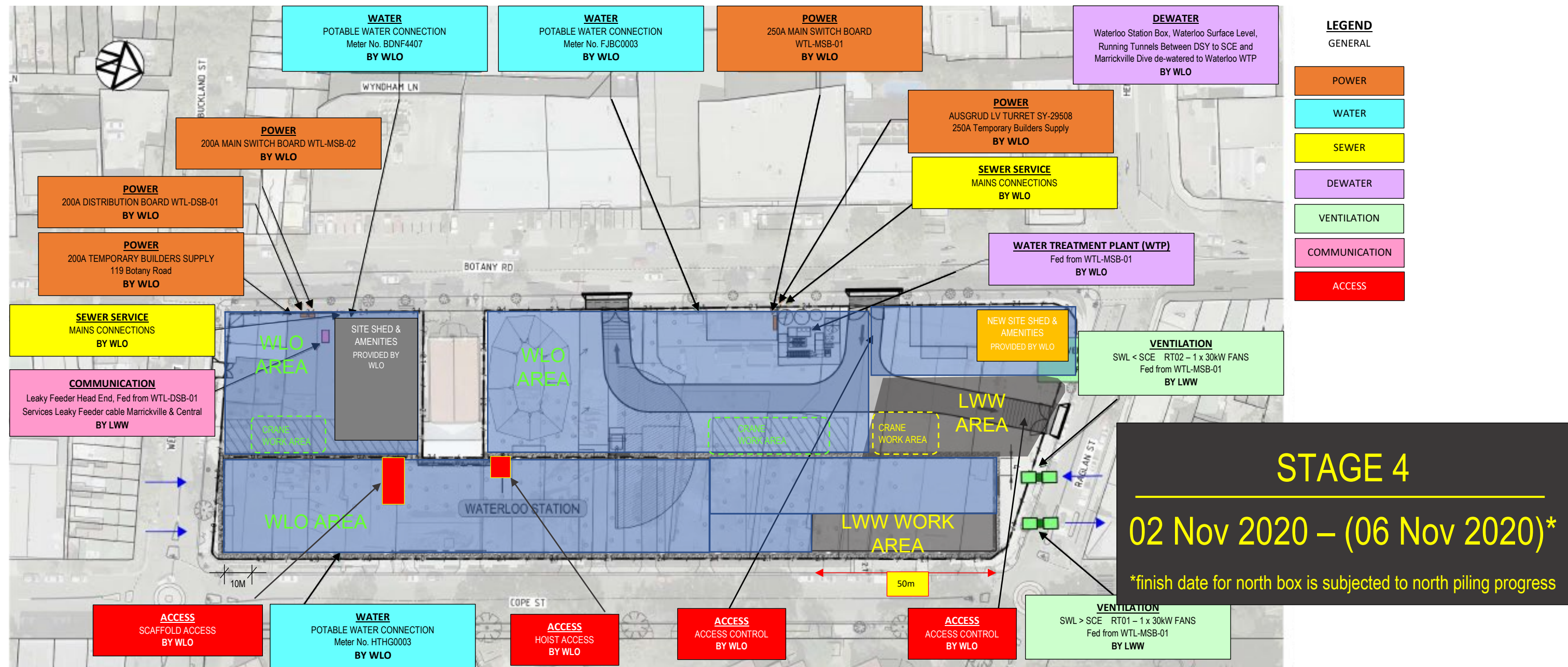
- LWW Works East

OTHER

- Install New Site Sheds
- Demob Existing Site Sheds
- South Jump Form Mobilisation

John Holland Option 7a – STAGE 4

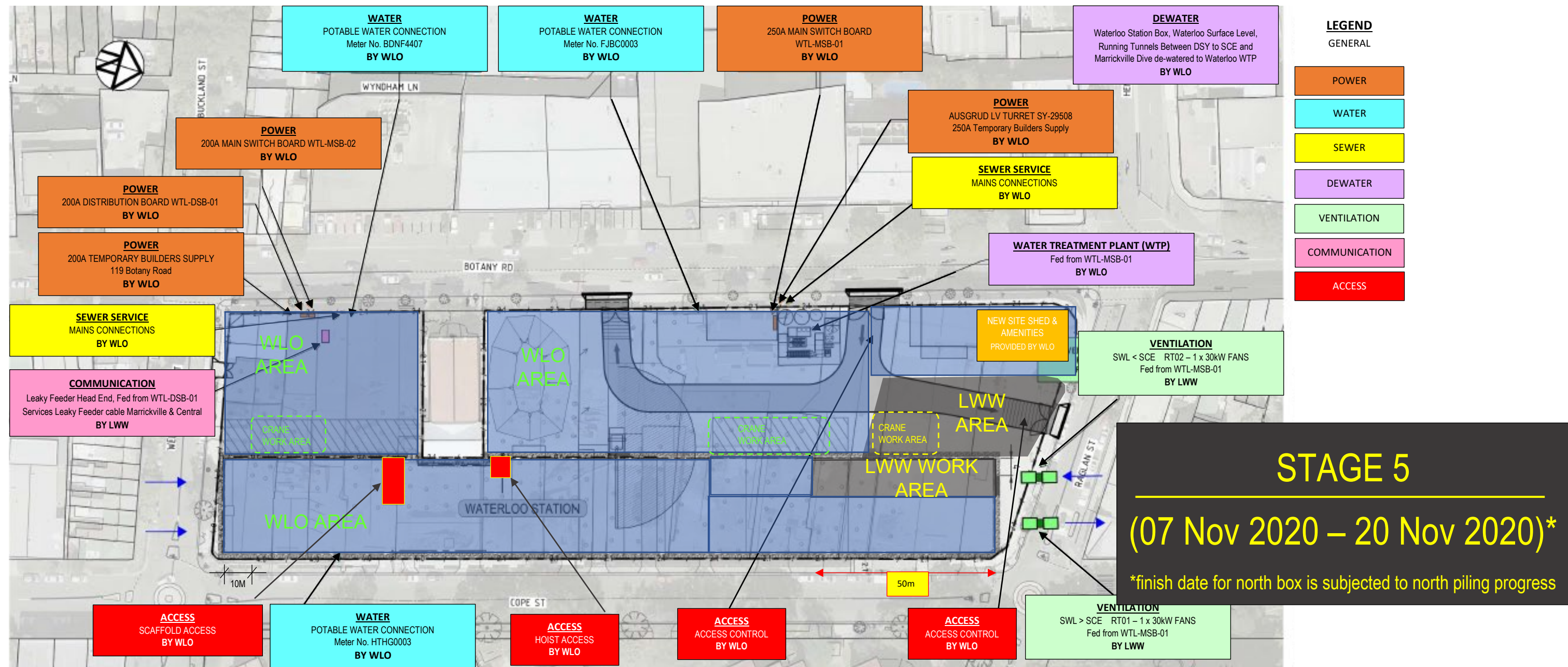
Rev Date: 03/02/2020



SOUTH BOX	CENTRAL BOX	NORTH BOX	OTHER
<ul style="list-style-type: none"> Piling (Cont) Waterproofing (Cont) Base Slab (Cont) External Walls (Cont) Portal Wall (Cont) 	<ul style="list-style-type: none"> Piling (Cont) Waterproofing (13th Nov) Slabs (16th Nov) 	<ul style="list-style-type: none"> Piling East (2nd Nov) LWW Works East 	<ul style="list-style-type: none"> Continue new Site Sheds installation

John Holland Option 7a – STAGE 5

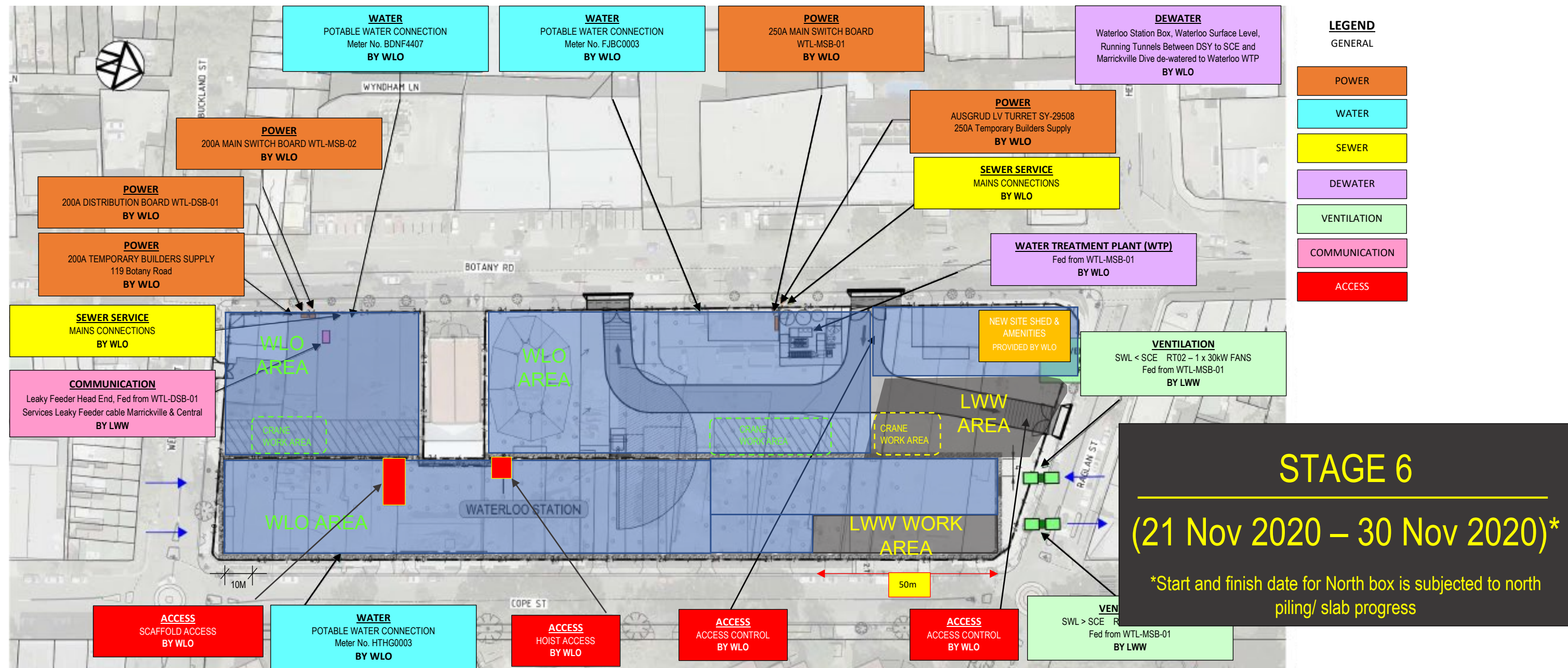
Rev Date: 03/02/2020



SOUTH BOX	CENTRAL BOX	NORTH BOX	OTHER
<ul style="list-style-type: none"> Base Slab (Cont) External Walls (Cont) Stair Core Walls (14th Nov) Portal Wall (Cont) 	<ul style="list-style-type: none"> Piling (Cont) Waterproofing (13th Nov) Base Slabs (16th Nov) 	<ul style="list-style-type: none"> Piling West (9th Nov) Waterproofing West (10th Nov) Base Slabs West (11th Nov) LWW Works West 	<ul style="list-style-type: none"> North Jump Form Mobilisation

John Holland Option 7a – STAGE 6

Rev Date: 03/02/2020



SOUTH BOX

- External Walls (Cont)
- Stair Core Walls (Cont)
- Portal Wall (Cont)

CENTRAL BOX

- Waterproofing (Cont)
- Base Slabs (Cont)
- External Walls (30th Nov)

NORTH BOX

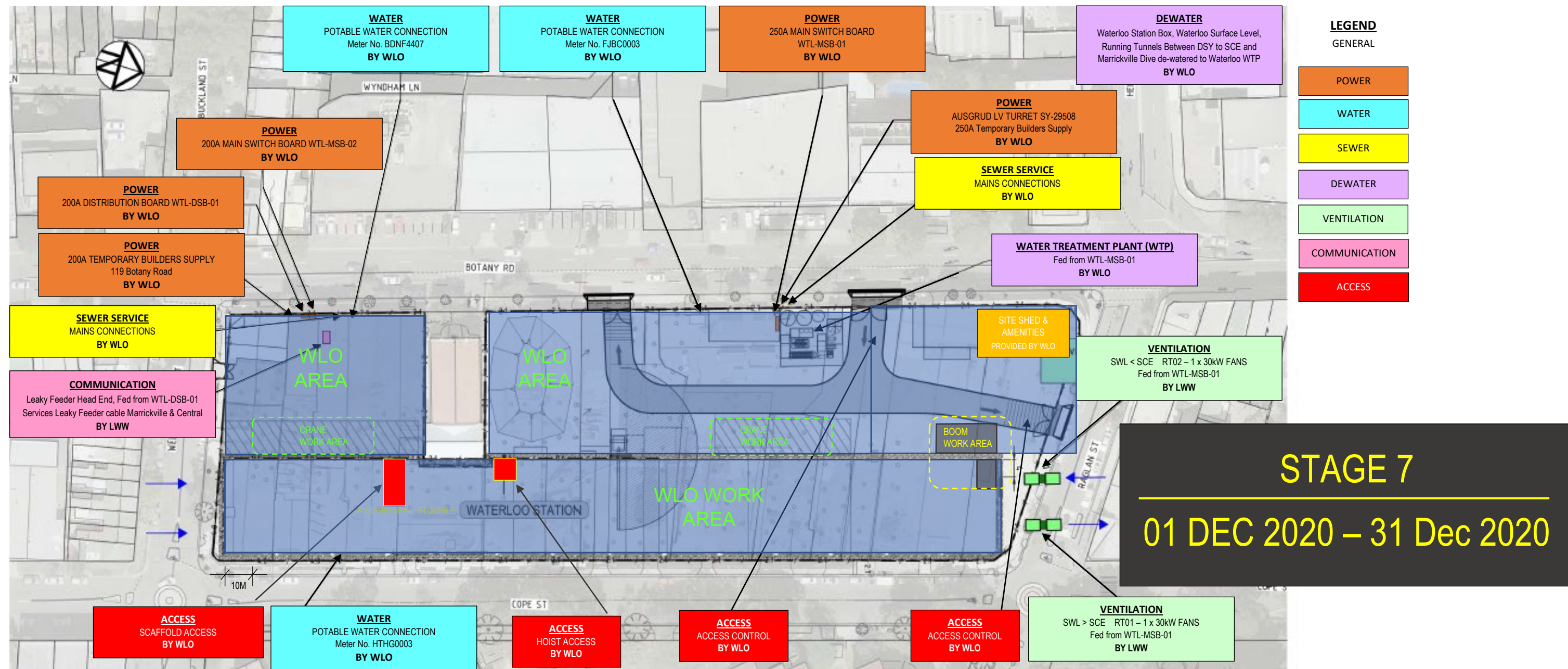
- Waterproofing East (23rd Nov)
- Base Slabs West (24th Nov)
- LWW Works East

OTHER

- North Jump Form Mobilisation (Cont.)

John Holland Option 7a – STAGE 7

Rev Date: 03/02/2020



SOUTH BOX	CENTRAL BOX	NORTH BOX	OTHER
<ul style="list-style-type: none"> Station Structure 	<ul style="list-style-type: none"> Station Structure 	<ul style="list-style-type: none"> Station Structure 	<ul style="list-style-type: none"> LW Boom Concrete Pumping at North Face (Weekly Coordination)

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

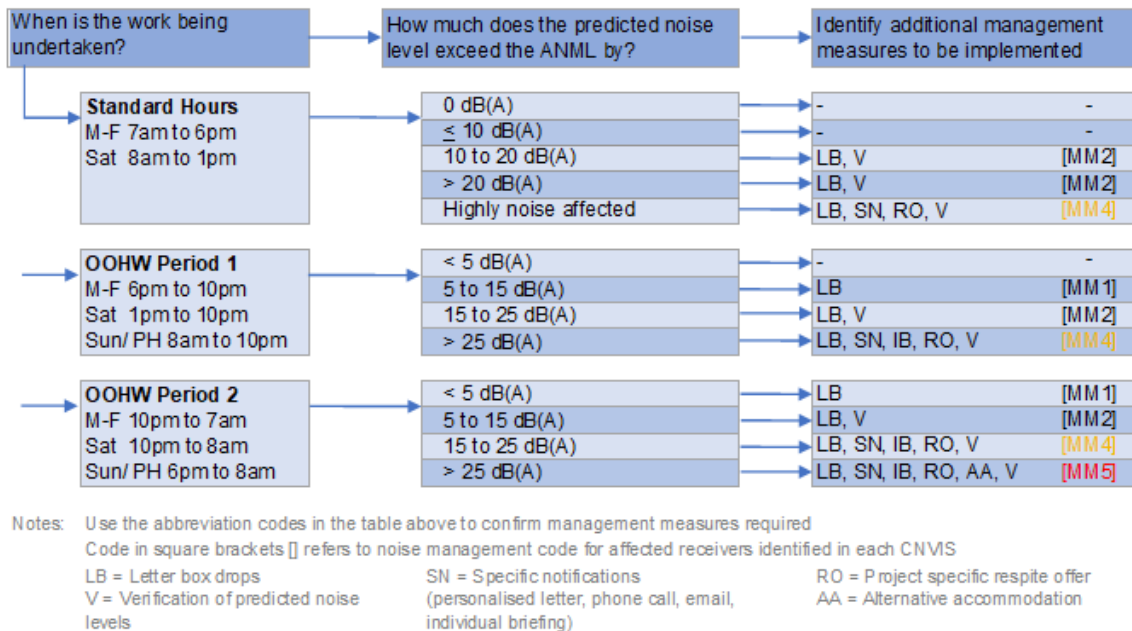
For **OOH**

- 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 5-8, 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 [9]. 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.

ENDORSEMENT

CITY & SOUTHWEST ACOUSTIC ADVISOR

Review of	Construction Noise and Vibration Impact Statement for Line-Wide works Portion 3 Waterloo Station early access works	Document reference:	Construction Noise and Vibration Impact Statement Portion 3 – Waterloo Station early access works Prepared by Renzo Tonin and Associates for Systems Connect.
Prepared by:	Larry Clark, Alternate Acoustics Advisor		TK685-03-07F01 CNVIS C2S_P3 Waterloo (r4)
Date of issue:	2 July 2020		Dated 18 June 2020

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

At this time NSW continues to respond to the COVID-19 situation. One outcome is that at least some of these works may take place whilst people are working from home. Sydney Metro, its contractors and other stakeholders should continue to work closely to review work practices and ensure that all feasible and reasonable noise and vibration mitigation measures are implemented, in light of the COVID-19 situation, at the time of the works. The details should be confirmed as part of the Out Of Hours Applications for the works.

I note that the CNVIS includes that:

- concrete deliveries and the use of the demolition saw will be restricted to standard construction hours;
- verification monitoring is to be undertaken to ensure that the proposed works achieve the external equivalent NMLs at the nearby receiver locations; and,
- if verification monitoring shows noise levels to be above the sleep disturbance NML on two consecutive nights that the activity occurs, this will be investigated and additional mitigation and management measures implemented in accordance with the CNVIS.

Systems Connect has confirmed in subsequent discussion that the crane can be swapped out for an excavator, rubber tyred, which would use a rail clamp attachment to unload rails one at a time to a surface stockpile with minimal movement of the excavator.

I am satisfied that revision 4 of the CNVIS is technically valid, and includes appropriate noise and vibration mitigation and management. On this basis I endorse revision 4 of the CNVIS for Line-Wide works in respect of the Waterloo Station early access works.



Larry Clark, City & Southwest Alternate Acoustics Advisor

Hugh Chapman
Associate Director Environment
Sydney Metro
Transport for NSW
PO Box K659
HAYMARKET NSW 1240
Rev01

7 July 2020

Ref: CSW LWW WSEAW CNVIS r4

Dear Hugh

RE: Endorsement of Sydney Metro City & Southwest – Waterloo Station Early Access Works - Construction Noise and Vibration Impact Statement Rev 4

Thank you for providing the following document for Environmental Representative (ER) review and endorsement as requested by Sydney Metro.

- Sydney Metro City & Southwest - Construction Noise and Vibration Impact Statement – Waterloo Station Early Access Works r4

The document was prepared by Renzo Tonin & Associates on behalf of Systems Connect.

I have reviewed the CNVIS and can confirm that it complies with the requirements of SSI-7400 MCoA E33 and Section 9.2(b) of the Construction Environmental Framework (CEMF) Chatswood to Sydenham (February 2017).

As an approved ER for the Sydney Metro City & Southwest project, I consider that the CNVIS is consistent with the requirements under the CEMF and SSI-7400 and is endorsed for implementation.

Yours sincerely



Peter Hatton
Environmental Representative – Sydney Metro – City and South West