Temporary Noise Barrier Strategy – Bexley

Project Name: WestConnex New M5

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Document Approval

Rev.	Date	Prepared by	Reviewed by	Recommended by	Approved by	Remarks
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Signature:						

Details of Revision Amendments

Document Control

The Project Director is responsible for ensuring that this Strategy is reviewed and approved. The Support Services Director is responsible for updating this Strategy to reflect changes to the Project, legal and other requirements, as required.

Amendments

Any revisions or amendments must be approved by the Project Director before being distributed or implemented.

Revision Details

Revision	Details
00	Submitted for DP&E approval
01	Update to address DP&E comments and update of Appendices. Submitted for DP&E approval.
02	Update to Appendix A. Submitted for DP&E approval
03	Update to address DP&E comments.
04	Update to Appendix A to include the MOC2 construction stage.
05	Updated with comments from SMC, for submission to DPE
06	Updated following consultation with DPE. Additional MOC2 details
07	Minor correction to Appendix C, Table 2

Contents

1. Introduction

1.1. Project Description

WestConnex is one of the NSW Government's key infrastructure projects which aims to ease congestion, create jobs and connect communities. It is the largest integrated transport and urban revitalisation project in Australia.

The 33 kilometre project was a key recommendation of the State Infrastructure Strategy released in October 2012. It brings together a number of important road projects which together form a vital link in Sydney's Orbital Network. They include a widening of the M4 east of Parramatta, a duplication of the M5 East and new sections of motorway to provide a connection between the two key corridors.

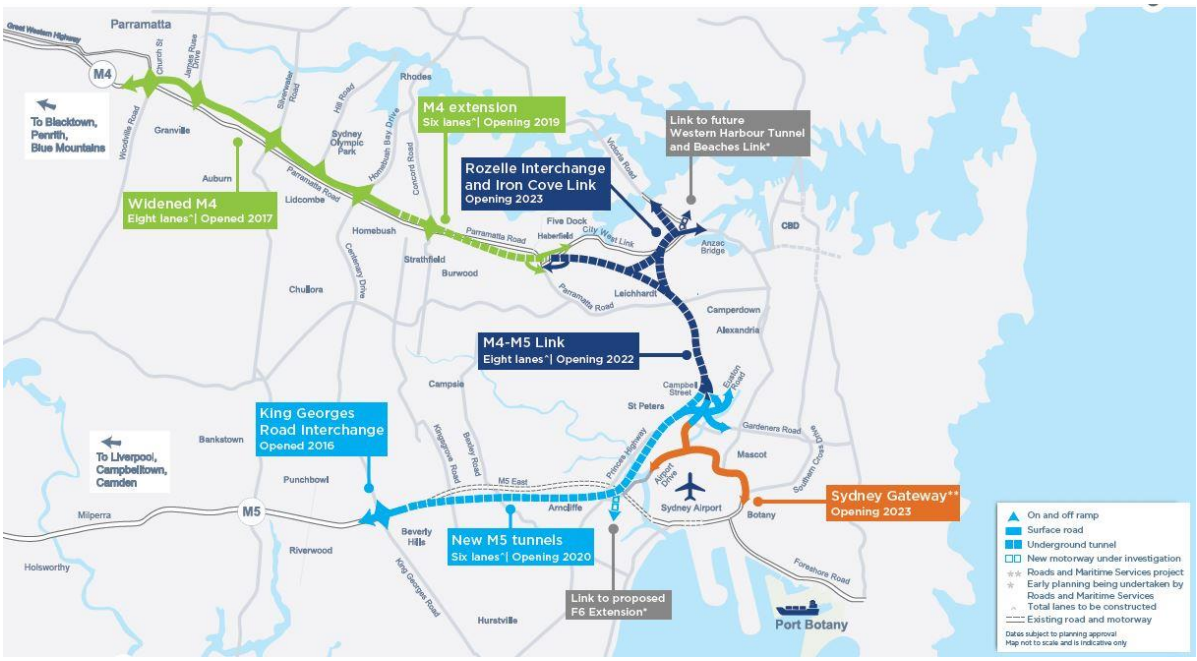


Figure 1: WestConnex Project Map

WestConnex will support Sydney's long term growth and boost the city's economic productivity. It will:

- Provide quicker, more reliable trips between Western Sydney and the Port Botany/Sydney Airport precinct to support Sydney's urban freight task
- Help distribute traffic across the wider road network, removing bottlenecks and relieving congestion for local trips
- Provide better connections along the M4 and M5 corridors to cater for the forecast growth in employment and population along these routes
- Allow urban revitalisation and increase opportunities for active and public transport along and across Parramatta Road.

The WestConnex project includes a number of stages:

- Stage 1a – M4 Widening
- Stage 1b – M4 East
- Stage 2 – New M5
- Stage 3 – M4-M5 Link

In November 2015, the Sydney Motorway Corporation (SMC) awarded the CPB Contractors Dragados Samsung Joint Venture (CDS-JV) the contract for the design and construction of Stage 2 – New M5. The New M5 will run from the existing M5 East corridor at Beverly Hills via a tunnel to St Peters, providing improved access to the airport, south Sydney and Port Botany precincts.

Key features of the New M5 include:

- New twin tunnels which are higher, wider and flatter. These will more than double capacity along the M5 East corridor and provide motorway access to north of Sydney Airport
- A new interchange at an industrial site at St Peters, which reduces the impact on nearby residential areas
- Connections from the interchange to key roads in the area, including Campbell Road/Street, Euston Road and across the canal to Bourke Road
- Widening of Campbell Road/Street and Euston Road through existing road widening reservations
- Western tunnel entry and exit points at Kingsgrove.

Stage 2 of WestConnex is being accelerated following an historic funding agreement signed by the Australian and New South Wales Governments in May 2014.

This has allowed work to start on the M5 - King Georges Road Interchange upgrade.

The duplication of the M5 East corridor will improve travel times and reliability for the 100,000 motorists which use this key route every day.

It will allow for improved movement of freight to and from the Port Botany area and provide an express route between Western Sydney and Sydney Airport once WestConnex is completed.

1.2. Purpose of this Plan

The CDS-JV has prepared this Temporary Noise Barrier Strategy - Bexley (TNBS-BED) in accordance with the Conditions of Approval (CoA), in particular condition D20.

The TNBS for Bexley takes into account works which influence possible noise barriers incorporating construction compounds C4 Bexley North, C5 Bexley South & C6 Bexley East including the construction of the permanent Motorway Operations Complex (MOC). The TNBS-BED details the strategy that CDS-JV will employ to mitigate and manage construction and traffic noise.

1.3. Scope of this Document and Compliance with D20

This document provides the structure and details of the TNBS required for the project as prescribed in CoA D20. This strategy focuses on the Bexley North (C4), Bexley South (C5) and Bexley East (C6) construction compounds. This TNBS will form part of the project wide TNBS as detailed in the NewM5 Staging Report.

Table 1 shows where the compliance with CoA D20 is addressed within this document.

Table 1: Compliance with D20

D20 Requirements	Compliance
The Proponent must develop and implement a **Temporary Noise Barrier Strategy** which includes:	
a) identification and confirmation of all temporary noise barriers including -	**Appendix A** -
(i) the provision of a temporary noise barrier on the northern side of the Kingsgrove North construction compound to provide noise mitigation to highly affected residents at a level greater than that identified in the documents referred to in condition A2(b),	**Section 1.3** - See Temporary Noise Barrier Strategy – Kingsgrove M5N-CN-PLN-WSW-001, CoA D20 (a) (i) is not addressed within this TNBS
(ii) consideration of the installation of temporary noise barriers on the southern and northern side of the M5 East Motorway during the relocation of the existing permanent noise barriers (or detail on why these noise barriers are not considered feasible and reasonable),	**Section 1.3** - See Temporary Noise Barrier Strategy – Kingsgrove M5N-CN-PLN-WSW-001, CoA D20 (a) (ii) is not addressed within this TNBS
(iii) consideration of the installation of temporary noise barriers along Campbell Road, Campbell Street and Euston Road (or detail on why these noise barriers are not considered feasible and reasonable),	**Section 1.3** - A separate TNBS will be developed to address the management and mitigation of construction noise along Campbell Road, Campbell Street and Euston Road, CoA D20 (a) (iii) is not addressed within this TNBS
(iv) temporary noise barriers around construction compounds;	**Section 2** - This TNBS defines noise barriers for construction compounds C4, C5, and C6. Separate TNBSs are being developed in accordance with Pre-Construction Compliance Report M5N-ES-RPT-PWD-0003 for other construction compounds.
b) the consultation and decision-making process for all temporary noise barriers; and	**Section 3** - Details the consultation process including how highly affected residents and stakeholders were consulted. The decision making process which includes key stakeholder feedback prior to adopting the final design is included in **Section 3.4.**
c) an acoustic report detailing the final barrier heights, material analysis and predicted benefits.	**Appendix A** - Construction Noise and Vibration: Temporary Noise Barrier Acoustic Report (Bexley compound)
The temporary barrier options must be developed in consultation with the landowners adjacent to the barrier locations prior to the adoption of a final design.	**Section 3** - Details key stakeholder feedback received through one on one briefings and how feedback trends have been incorporated into final designs. **Appendix B** – Lists the Community Consultation Records
The Temporary Noise Barrier Strategy must be approved by the Secretary prior to site establishment works or construction works at the Kingsgrove North construction compound, the permanent noise barriers on the northern and southern side of the M5 East Motorway are removed, and/or road widening works are undertaken along Campbell Road, Campbell Street or Euston Road.	This TNBS has been revised to include consideration of the construction of the permanent Motorway Operations Complex (MOC) at Bexley from May 2018. This TNBS will be submitted to the Secretary for approval.

2. Temporary Noise Barrier Strategy

2.1. Temporary Barrier Overview

The overall approach of the TNBS is to ensure that reasonable and feasible temporary noise barrier solutions are developed and implemented in accordance with CoA whilst specifically consulting with stakeholders and highly effected residents to address their concerns.

An overarching approach during construction will target the installation of temporary noise barriers identified in Appendix A.

2.2. Identify Sensitive Receivers

A key component of the TNBS is to identify sensitive receivers based on the proposed construction footprint. Sensitive receivers are detailed in the Construction Noise and Vibration: Temporary Noise Barrier Acoustic Report (Bexley compound). Sensitive receivers are reviewed considering CoA D20 and specifically identified for consultation, especially landowners and residents directly adjacent to proposed temporary noise barriers. Reference Appendix B of the Construction Noise and Vibration Management Plan for identified sensitive receivers to Bexley Tunnel Support works.

The nearest affected sensitive receivers to the temporary noise barriers have been classified as the properties with future line of sight to the barriers. These are detailed in Section 3.2. Sensitive receivers are detailed below in Figure 2.

Figure 2 - Sensitive receiver catchments

2.3. Noise Objectives

Construction noise management levels have been developed using NSW Interim Construction Noise Guideline (ICNG), in accordance with CoA D16(a). Objectives have been set in the form of Construction Noise Management Levels and Road Traffic Noise Objectives.

Residential receivers are considered noise affected where construction noise levels are greater than the noise management levels (NMLs) as determined above, NMLs are detailed in Appendix B of Appendix A. Noise affected levels represent the point above which there may be some community reaction to noise. Where this scenario is predicted and/or measured construction noise levels exceed NMLs, all feasible and reasonable work practices will be applied to meet NMLs.

During standard construction hours a highly affected noise objective of LAeq(15min) 75 dB(A) applies at all receivers.

2.4. Construction Noise Assessment

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

The model is used to determine the impact of construction noise for the below listed activities for the Bexley construction compound sites (C4, C5 and C6):

- V01
  - Power generator
  - Installation of environmental controls
  - Demolition of existing structures
  - Vegetation clearing
- V02
  - Power generator
  - Establishment of construction facilities
- V03
  - Power generator
  - Road and intersection modifications and installation of traffic controls (includes OOHW at Bexley)
- V04
  - Piling of shaft / decline (C4 and C5)
- V05
  - Excavation and construction of shaft / decline (C4 and C5)
- V06
  - Tunnel support works (of shaft / decline – includes OOHW)
- V07
  - Construction of Motorway Operations Complex (MOC) 2 permanent facilities
    - Note that all activities for the construction of MOC2 have been modelled together for the purposes of this temporary noise barrier strategy (specifically in Appendix A of this report). However, detailed noise and vibration modelling has been conducted in accordance with the methods described in the Construction Noise and Vibration Management Plan. A summary of this detailed modelling for MOC2 construction is provided separately in Appendix C of this report, along with a guide on the duration of impacts, and justification of noise wall placement.

Impacts to sensitive receivers have been determined and will be continually assessed during design development and construction. Noise mitigation measures including temporary noise barriers, have been developed and are detailed in Appendix A.

Construction methods will be incorporated which will reduce noise levels. Jack-hammering and rock breaking which have been identified as high noise impact activities. The Elliot method of pile breaking (or similarly effective methods) will be utilised to reduce jackhammering by up to 90%. Terrain levellers were also considered, but are inappropriate for the small quantity of rock to be excavated.

To mitigate the impact of high impact activities in accordance with CoA D14 high impact activities will be subject to respite periods and maximum durations.

Mitigation measures will be continually developed as design and construction methods are finalised. Mitigation measures will be detailed in construction work packs and the Construction Noise and Vibration Impact Statement for the Bexley site compounds.

2.5. Traffic Noise Assessment

Modelling and assessment of traffic noise impacts have been determined using SoundPLAN v7.3 software, the modelling considers three different source heights to account for the different vehicle noise sources such as car exhaust/engine noise, tyre noise, truck engine noise, and high truck exhausts.

For the purpose of this assessment the model has taken into account:

- traffic volume and heavy vehicle forecasts;
- vehicle speed;
- road gradient;
- location of the noise sources on the two carriageways;
- ground reference levels of the road and receivers;
- separation distances of the road to receivers;
- ground type between the road and receivers; and
- angles of view of the road from the receiver's position.

A noise management schedule has been prepared for the site identifying the noise mitigation strategies that are to be incorporated into the site design to minimise noise impact where it may occur. Predicted traffic noise impacts have been determined taking into account the removal of spoils from the Bexley north and south compounds.

2.6. Noise Barrier Design

The strategy focuses on modelling impacts based on proposed construction methodologies, determining the noise impacts of such methodologies, identifying sensitive receivers, consultation with sensitive receivers to help develop and finalise temporary noise barrier options based on Sections 2.4 and 2.5 above. Barrier options have been developed considering a variety of acoustic ratings and noise wall performance levels, options have been subsequently matched to required Rw ratings determined from the modeming process. Noise barrier design specifications have been classified using the below performance criteria;

Low – Rw 10 to 15
Medium – Rw 15 to 20
Medium to High – Rw 20 to 25
High – Rw 25 to 30
Very High – Rw > 30

Noise barriers are specified below in Table 2 which is derived from Appendix A. Barriers are specified by location and required Rw rating as determined by noise modelling, a variety of barrier options were considered where chosen barrier options were based on ensuring actual barrier acoustic ratings are greater than specified Rw ratings. In all instances traditional plywood hoardings meet required Rw ratings as detailed below.

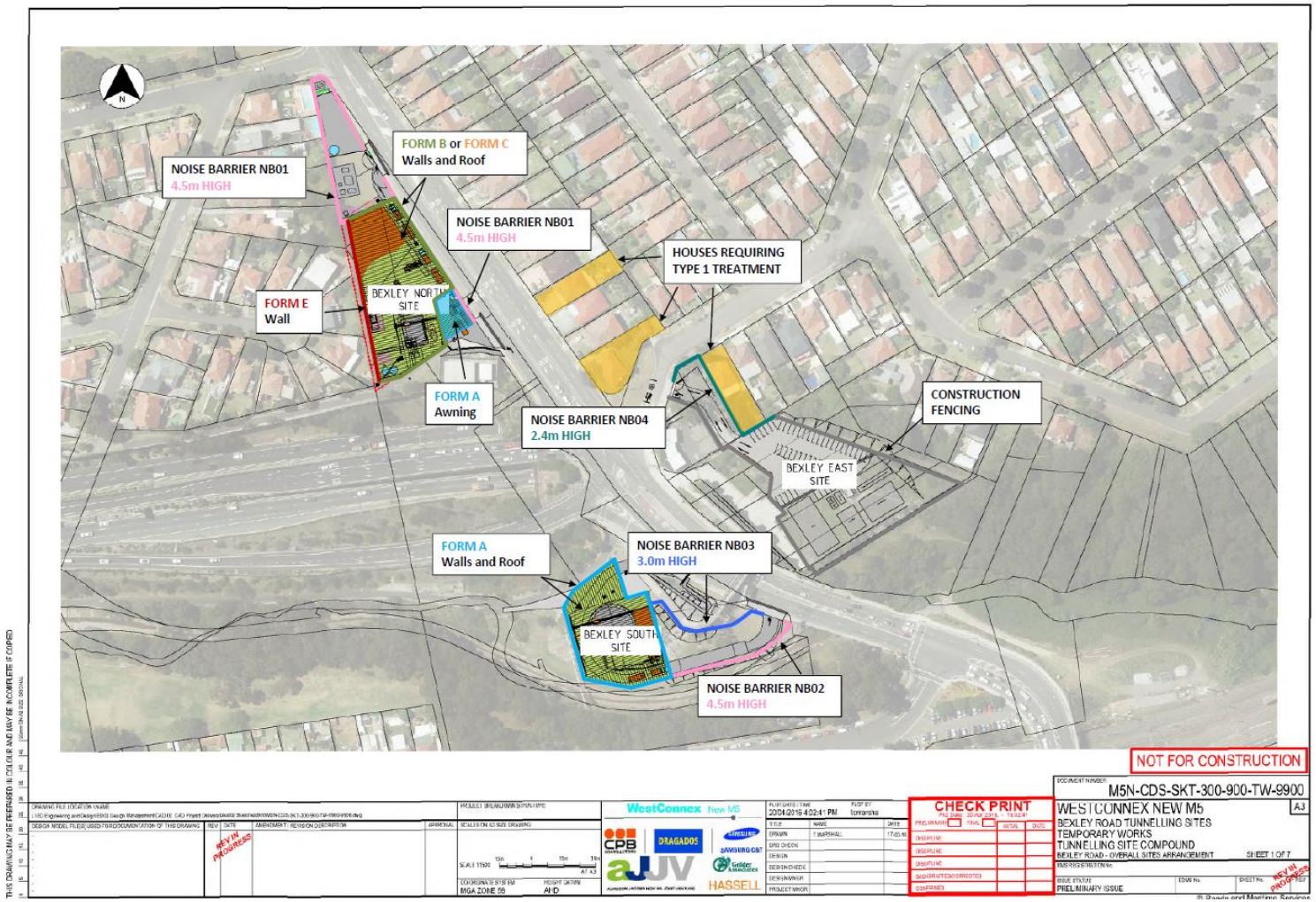
Noise barriers (Table 2 and Figure 3a and 3b) have been designed and positioned to achieve noise reduction required to achieve the ICNG goal levels for surrounding sensitive receivers. Further discussion on noise wall design as related to MOC2 construction impacts is provided in Appendix C.

Table 2 - Noise Barrier Distance to Nearest Resident

Noise Barrier	Location	Barrier Height	Distance to Nearest Resident	Anticipated completion date	Required performance (RW)	Proposed construction	Acoustic rating of construction
NB01	Northern Site – As per layout	4.5m	Approximately 0m	September 2016	Rw 25 High	Sandwich construction of 17mm plywood (45mm air gap); or Speedwall panel; or 150mm hebel	Rw 28 Rw 41 Rw 40
NB02	Southern Site – South of spoil shed exit ramp	4.5m	Approximately 150m	December 2016			
NB03	Southern site – As per layout	3m	Approximately 90m	September 2016	Rw 15-20 Medium	17mm Plywood hoarding	Rw 24
NB03a	Southern site – As per layout	1.8m	Approximately 90m	May 2018			
NB04	Compound (C6) access area – North and east boundaries	2.4m	Approximately 0m	September 2016			

Note: Noise wall NB03 will be realigned to form noise wall NB03a following the completion of tunnelling support operations at the Bexley Road southern site (C5), and prior to the commencement of building works for the Motorways Operations Complex (MOC2). The realignment of this noise wall is required to facilitate works to realign the shared pedestrian and cyclist path over Bexley Road and the construction of the permanent Motorway Operation Complex at Bexley, which includes a substation and emergency smoke extraction facility. NB03a will be erected prior to the removal of NB03 so that there is a temporary noise barrier in this vicinity throughout the transition.

Figure 3a: Site General Arrangement showing noise mitigation for tunnelling support activities



Note: Architectural treatments (Type 1A: Mechanical ventilation only) were identified for tunnelling excavation activities for three properties on Bexley Road due to impacts related to out of hours concrete deliveries. The impact date for these works, when treatments need to be installed is March 2017 (Refer to the CNVMP: Table 6.4).

Figure 3b: Site general arrangement with noise mitigation for Motorway Operations Complex construction

Note: Noise barrier NB03a is highlighted in green and is the primary difference between noise mitigation measures for tunnel support operations and MOC2 construction.

3. Stakeholder Consultation

3.1. Consultation

CDS JV has adopted a well-coordinated, targeted and personalised approach to consult with highly effected landowners and other key stakeholders regarding the TNBS following the principles and processes outlined in the Community Communication Strategy. Consultation has been carried out with landowners directly adjacent the temporary barrier locations at Bexley north (C4) and Bexley east (C6).

3.2. Affected stakeholders

During temporary noise barrier design development and optioneering phases, landowners adjacent to proposed noise barrier locations have been identified via a desktop analysis and verified by site assessments. Identified landowners were consulted as above and where possible feedback included in designs of the temporary noise barrier construction. Further information will be provided just prior to the commencement of temporary noise barrier construction. Properties consulted with and a report on the consultation for the Bexley north (C4) and Bexley east (C6) construction compounds is attached as Appendix B.

Consultation was undertaken with 10 residential properties located directly adjacent to the proposed temporary noise barriers. Figure 4 – properties consulted

Figure 4 – Identified Sensitive Receivers

In addition to consulting with the above directly impacted landowners, CDS-JV also consulted with the following key stakeholders:

- City of Canterbury Bankstown
- RMS

Recognising the close proximity of 8 and 4 Jones Ave to the barriers and construction compounds, these landowners have also been informed.

The Bexley south (C5) compound is separated from the nearest residential receivers by Wolli Creek and vegetation to the west and busy main roads to the north and east. As such there are no adjacent property owners to consult for the realignment of NB03 to form NB03a.

3.3. Communication and Consultation Activities

CDS-JV has in the first round of consultations, used a suite of specific TNBS targeted communication and engagement activities to achieve the aims of this strategy including one-on-one briefings, council interface meetings and notifications.

- One-on-one briefings

  Briefings were conducted with each landowner adjacent to proposed barriers. The purpose of these briefings was to consult with impacted stakeholders prior to the adoption of the final design.

  These briefings were undertaken by a door-knock and arranged via phone and undertaken by the Place Manager and Construction Manager for the area.

  The following tools were used during these briefings to facilitate stakeholder's understanding of the proposed barriers options:

  - Maps and plans to illustrate the barrier location, compound layout and project design.
  - Barrier material and colour samples
  - Survey rod to demonstrate the proposed height of the barriers
  - Bexley fact sheet, community update and other relevant project communications

- Council Interface Meetings

  Regular interface meetings are held with the City of Canterbury Bankstown and provide a forum to inform and consult with the council regarding a range of project matters, including the temporary noise barriers options.
  Temporary noise barrier options have been presented at council interface meetings, providing council representatives with an opportunity to provide feedback. The final barrier design will be tabled at a subsequent meeting.

- Notification

  Notifications will be sent to affected stakeholders to inform them of final temporary noise barrier designs. CDS JV recognises the importance of closing out the consultation process regarding temporary noise barrier options to ensure that further consultation and feedback is forthcoming. Ongoing notifications and project updates will be provided as works progress.

3.4. Decision Making Process

During consultation with residents, it was clear there were several key design elements which residents desired and there were no significant issues raised regarding proposed options. Key trends are evident in the feedback received as detailed in Appendix B and are summarised below;

- No objection to proposed height of 4.5m at Bexley north and 2.4m at Bexley east
- Preferred colour is grey (Dune)
- No preference towards noise barrier type finish other than colour

The above key trends have been considered and will be accounted for in the final design as below;

- A grey tone will be incorporated

- Proposed heights will be incorporated into final design.

The above demonstrates that residents adjacent to proposed temporary noise barriers have been consulted and feedback received has been incorporated in the development of final barrier designs.

3.5. Monitoring and reporting

All stakeholder interactions regarding the implementation of the TNBS with landowners and community representatives will be recorded in the project's community contact database and included in the monthly and quarterly progress reports. Appendix B outlines the report for consultation associated with this TNBS for the Bexley area.

4. Ongoing Monitoring

The strategy sets the overall approach to how construction and traffic noise will be mitigated during construction. The effectiveness of the strategy will rely on multiple iterations of implementation of the strategy principles as design and construction methodologies are refined and implemented. The TNBS will be assessed for effectiveness and site based compliance. The TNBS will be updated as required to account for key learning's as they are identified and in accordance with the reviews detailed above.

5. Conclusion

The CDS-JV has prepared this TNBS in accordance with the Conditions of Approval (CoA), in particular condition D20.

The strategy sets the overall approach to how construction and traffic noise will be mitigated during construction. The strategy focuses on modelling impacts based on proposed construction methodologies, determining the noise impacts of such methodologies, identifying sensitive receivers, consultation with sensitive receivers to help develop and finalise temporary noise barrier options and ongoing monitoring of the overall effectiveness of the strategy. This strategy demonstrates that optimum barrier solutions have been developed utilising sound analytical modelling which demonstrates the benefit of proposed solutions and at the same time is a desired solution for highly affected residents as the consultation process demonstrates.

A key component of the implementation of the overall strategy is found in Appendix A.

Appendix A: Construction Noise and Vibration: Temporary Noise Barrier Acoustic Report (Bexley compound)

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Construction Noise and Vibration: Temporary Noise Barrier Acoustic Report (Bexley compound)

2 May 2018

CPB Dragados Samsung Joint Venture

TH014-05 01F14.1 WXC_M5N Temp Nse Barrier Rep_BXR (r5)

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27.09.2016	Updated to incorporate Condition D21 modification	-	1	[redacted]	[redacted]	[redacted]
20.10.2016	Minor amendments		2	[redacted]	[redacted]	[redacted]
15.12.2016	Minor amendments	-	3	[redacted]	[redacted]	[redacted]
18.04.2018	Updated to include permanent facility construction at MOC2	-	4	[redacted]	[redacted]	
02.05.2018	Updated for documented review		5	[redacted]	[redacted]	

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1 Introduction

1.1 Relevant requirements and purpose of this report

This Construction Noise and Vibration Temporary Noise Barrier Acoustic Report (TNBAR) has been prepared to address the Conditions of Approval for the WestConnex New M5 Project (New M5 or Project), more specifically Condition D20.

D20 The Proponent must develop and implement a Temporary Noise Barrier Strategy which includes:

(a) identification and confirmation of all temporary noise barriers including -

(i) the provision of a temporary noise barrier on the northern side of the Kingsgrove North construction compound to provide noise mitigation to highly affected residents at a level greater than that identified in the documents referred to in condition A2(b),

(ii) consideration of the installation of temporary noise barriers on the southern and northern side of the M5 East Motorway during the relocation of the existing permanent noise barriers (or detail on why these noise barriers are not considered feasible and reasonable),

(iii) consideration of the installation of temporary noise barriers along Campbell Road, Campbell Street and Euston Road (or detail on why these noise barriers are not considered feasible and reasonable),

(iv) temporary noise barriers around construction compounds;

(b) the consultation and decision-making process for all temporary noise barriers; and

(c) an acoustic report detailing the final barrier heights, material analysis and predicted benefits.

The temporary barrier options must be developed in consultation with the landowners adjacent to the barrier locations prior to the adoption of a final design.

The Temporary Noise Barrier Strategy must be approved by the Secretary prior to site establishment works or construction works at the Kingsgrove North construction compound, the permanent noise barriers on the northern and southern side of the M5 East Motorway are removed, and/or road widening works are undertaken along Campbell Road, Campbell Street or Euston Road. This identifies the temporary noise walls to be installed at the Kingsgrove Road site, at the Western end of the M5N.

This TNBAR forms part of the Temporary Noise Barrier Strategy and has been prepared to address the temporary noise barriers associated with the Project's Bexley Road compounds C4, C5 and C6 to satisfy condition D20(a)(iv).

Separate acoustic reports have been prepared to address the temporary noise barriers at other compounds associated with the Project, including:

- Kingsgrove Road compounds C1, C2 and C3 and western surface works
- Arncliffe compound (C7)
- St Peters Interchange compounds C8, C9 and C10
- Local Roads compounds C11, C12, C13 and C14.

This report will be submitted to the Department of Environment and Planning (DEP) as part of the Temporary Noise Barrier Strategy required by Condition D20.

1.2 Structure of this report

This report is structured as follows:

- **Section 2** Description of work area and noise sensitive receivers surrounding the site;
- **Section 3** Noise objectives; and
- **Section 4** Construction Noise Assessment.

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 Work area and sensitive receivers

2.1 Description of work area

This TNBAR provides information on the temporary noise barriers associated with the Bexley Road compounds of the M5N Project, more specifically in relation to:

- Temporary noise barriers to mitigate construction noise associated with the Bexley North construction compound C4, located on the northern side of the M5 Motorway, west of Bexley Road
- Temporary noise barriers to mitigate construction noise associated with the Bexley South construction compound C5, located on the southern side of the M5 Motorway, west of Bexley Road
- Temporary noise barriers to mitigate construction noise associated with the Bexley East construction compound C6, located on the eastern side of Bexley Road, directly above the existing M5 Motorway tunnel
- Temporary noise barriers to mitigate construction noise impacts from activities associated with the construction of the Bexley Road MOC 2 permanent facilities at the Bexley South construction compound after the completion of tunnelling works.

Appendix B shows the Bexley construction work areas addressed in this report.

2.2 Sensitive receivers

In order to assess and manage construction noise impact, the residential areas surrounding the Project have been divided into Noise Catchment Areas (NCAs) based on each area's similar acoustic environment prior to the commencement of construction works. The NCAs have been based on those established in the EIS, with some modifications to allow for site specific characteristics identified during the detailed assessment and delivery phase. The NCAs are identified in more detail in the Construction Noise and Vibration Management Plan (CNVMP) prepared for the Project.

An indicative list of the nearest and potentially worst affected noise and vibration sensitive receivers and their respective NCAs are summarised in Table 2.1 below.

Table 2.1 Nearest Residential Noise and Vibration Sensitive Receivers

NCA	Receiver Type	Nearest construction work area	Distance from receiver to works
NCA15	Residential Recreation	Bexley Road East compound (C6)	10-450 m
NCA16	Residential Recreation	Bexley Road north compound (C4)	10 to 500 m

NCA	Receiver Type	Nearest construction work area	Distance from receiver to works
NCA17	Residential Recreation	Bexley Road North compound (C4) Bexley Road South compound (C5) Bexley Road East compound (C6)	30 to 750 m
NCA26	Residential Place of worship Educational facility Recreation	Commercial Road construction compound (C3) Bexley Road North construction compound (C4) Bexley Road South construction compound (C5) Bexley Road East construction compound (C6)	50 to 1000 m

All relevant residential sensitive receivers in the vicinity of the worksites are identified on aerial photographs located in APPENDIX B.

3 Noise Objectives

3.1 Construction Noise Management Levels

Construction noise management levels have been determined using the NSW Interim Construction Noise Guideline (ICNG), in accordance with Condition D16(a).

Figure B1 and Table B1 in APPENDIX B identify the adopted construction noise management levels (NMLs) for the nearest noise sensitive receivers to the worksite. The NMLs for residential receivers are based on long-term noise monitoring conducted by AECOM on behalf of SMC to quantify ambient noise levels for the Environmental Impact Statement (EIS) as noted in the CNVMP. The NMLs are derived from the lowest measured RBLs within each NCA and are generally considered to be conservative.

The NMLs for 'other' sensitive receivers are from the ICNG, as reported in Section 3.1.1 of the CNVMP.

Residential 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 exceed NMLs, all feasible and reasonable work practices will be applied to meet the NMLs.

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

Any construction related activities that could exceed the NMLs shall be identified and managed in accordance with the CNVMP.

4 Construction Noise Assessment

4.1 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 are included in Table C2 in Appendix C - Construction Timetable/ Activities/ Equipment. Table C2 also identifies the plant and equipment that will be operating during standard construction hours and outside of standard construction hours.
- Separation distances between sources and receivers;
- Ground type between sources and receivers; and
- 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.

4.2 Preliminary detailed design outcomes

During the development of the site design, Renzo Tonin & Associates are playing a key role in assisting CDS JV to determine the physical noise mitigation measures required to reduce noise impact from the operation of the site. The following sections describe briefly the noise design methodology and outcomes, including the location of acoustic sheds and the length, height and location of noise walls required around the site. To ensure the timely and efficient provision of inputs to the design process, these mitigation measures were documented in the Noise Design Report.

A noise management schedule has been prepared for the site identifying the noise mitigation strategies that are to be incorporated into the site design to minimise noise impact where it may occur. The schedule is presented in Table C2 in APPENDIX C. Further to this, Table C3 sets out the noise wall schedule in relation to temporary noise barriers for the construction phase of the Project.

Figure B1 in APPENDIX B identifies noise wall/ hoarding locations around each work site for the tunnel works at all compounds. Figure B1 applies to construction stages V01 to V06 in Table 4.1 below.

Prior to commencement of the MOC2 permanent facilities construction at the Bexley southern compound, the site boundary noise walls will be modified in order to allow the construction works to proceed. Figure B2 in APPENDIX B identifies modified noise wall/ hoarding locations the southern compound. The modified noise wall/hoarding locations at the southern compound apply to stage V07 as detailed in Table 4.1 below.

4.3 Key construction activities

The stages/operations considered in the noise model are summarised in the table below. For more detail on specific works being undertaken for each modelling scenario see the activity and timing Table C.1 in APPENDIX C.

Table 4.1 Noise modelling assumptions - Bexley Road tunnelling support sites

Activity/ Work Area	Aspect	Includes OOHW?	Approx. timing	Modelled construction stage						
				V01	V02	V03	V04	V05	V06	V07
Bexley compounds				**Site establishment**					**TS**	**MOC2**
Bexley Road North (C4) and South (C5) Tunnelling Support Sites and Bexley Road East Compound (C6)	Installation of enviro controls	No	07-09 2016							
	Demolition of existing structures	No	07-09 2016							
	Vegetation clearing	No	07-09 2016							
	Establishment of construction facilities	No	07-09 2016							
	Road and intersection modifications and installation of traffic controls	Yes	07-09 2016							
	Piling (shaft and buildings)	No	09-12 2016							
	Shaft Excavation & Construction (acoustic shed in place)	No	09-12 2016							
	Tunnel support works	Yes	2016-2018							
	MOC2 permanent facility construction	No	2018-2019							

Sections 4.4 and 4.6 below summarise the impacts for each construction stage in each NCA in terms of compliance with the NMLs during standard construction hours and for OOHW respectively. The colours in the table indicate whether receivers in the NCA comply with the NML and, where exceedance of the NML occurs, the perceived impact of the exceedance.

APPENDIX D provides a summary, for comparative purposes of the predicted noise levels from the:

- EIS Technical working paper: Noise and vibration;
- detailed design incorporating the design noise mitigation.

4.4 Predicted noise levels for standard-hours works

The impacts presented are as follows for **Standard Hours**:

- Complies with NML
- Exceeds NML by less than 10 dB(A) – noise affected
- Exceeds NML by more than 10 dB(A) – noise affected
- > 75 dB(A) – highly noise affected

Table 4.2 Summary of construction noise impacts (standard hours)

NCA	Level of compliance with NML for construction stage						
	V01	V02	V03	V04	V05	V06	V07
Bexley compounds	**Site establishment**					**TS**	**MOC2 Construction**
NCA15	–	–	–	–	–	–	–
NCA16	–	–		–	–		–
NCA17	–						–
NCA26	–			–	–		–

Notes All works to be undertaken during Standard construction hours (7am to 6pm Monday to Friday; 8am to 1pm Saturday)

TS refers to tunnel support activities, which will be undertaken 24 hours per day, 7 days per week.

4.5 Discussion of results (standard hours)

Noise impacts associated with the standard hours works at the **Bexley Road compounds** include:

- Site establishment works at the Bexley Road compounds will have high noise impacts due to the close proximity of residential receivers to the three compound sites. The nearest affected receivers in NCA 15, 16, 17 and 26 will be noise affected during the site establishment works.
- Some receivers in NCAs 15 and 16 will be highly noise affected as a result of vegetation clearing and demolition of structures during site establishment. These activities will generate higher noise impact; however, the extent of demolition and vegetation clearing on each site is minimal.
- Noise generated by the establishment of construction facilities and the road modification works are likely to be clearly audible at the nearest receivers in NCA 15 and 16. It is noted that during early site establishment works the temporary noise barriers and the acoustic shed outlined in APPENDIX C will not be in place. Under the proposed modification to D21,

acoustic sheds would be installed concurrently with construction works at the commencement of construction activities. The acoustic spoil sheds on sites C4 and C5 both form part of the perimeter 'noise barrier' on these sites as well as the acoustic enclosure for works carried out inside the shed once the tunnelling site becomes operational.

- The spoil sheds (which form part of the noise wall at Bexley North and South) will not be in place when piling for the shaft and spoil shed building commences. The piling works are therefore predicted to generate noise levels that will cause receivers to be highly noise affected in NCA 16. Noise from these activities may also be clearly audible at the nearest affected receivers in NCAs 15 and 26. The use of temporary noise screens around the shaft area will reduce noise to the nearest affected receivers by 5 to 10 dB(A) thereby reducing impact from piling to below the 'highly noise affected' level. Where practicable, relocatable noise screens will be installed around the piling rig to reduce noise impacts to NCA 15 and 16.

- Excavation of the shaft and construction of the spoil shed will occur at a similar time. In line with a conservative assessment it is assumed that the spoil shed is incomplete during the shaft excavation. The use of temporary noise screens around the shaft area will reduce noise to the nearest affected receivers by 5 to 10 dB(A) thereby reducing impact from piling to below the 'highly noise affected' level, except at the nearest receivers in NCA16. As the shed is built, it will provide additional attenuation. The part-constructed shed will provide 15-20 dB(A) noise reduction even without the roof in place. Airborne noise from shaft excavation is predicted to lessen as the shaft depth increases. The use of alternative construction methods is also being investigated, such as eccentric rippers in place of rock hammers. These have been found to be approximately 5 dB(A) less than rock hammers and the impulsive character of the noise is removed.

- Construction noise impacts from the tunnelling support operations are predicted to comply with the NMLs during standard construction hours, with the exception of 1 receiver in NCA15 where noise levels may exceed the NML by up to 2 dB(A).

- During the construction of the permanent facilities for MOC2, there are generally high numbers of receivers exceeding the NMLs. The exceedances are caused from variety of construction plant and equipment, the dominate sources of noise ranging from excavators with rock breaker attachments, power saws, jack hammers and use of other hand tools. With the separation distance of approximate 80 metres to the nearest residences, there are up to two residences predicted to be highly noise affected. The predictions assume all plant and equipment is operating concurrently at any given time, which is likely conservative given the high numbers of plant and equipment that have been taken into account in the noise model. During piling works for the facilities construction at the southern compound, noise wall NB02 will temporarily be removed. This change is indicated as a dashed blue line in Figure B2 of APPENDIX B.

Measures for managing the noise impacts are outlined in Section 4.8.

4.6 Predicted noise levels for OOHW

The impacts presented are as follows for **OOHW Evening and Night**:

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

Table 4.3 Summary of construction noise impacts (OOHW)

NCA	Level of compliance with NML for construction stage						
	V01	V02	V03	V04	V05	V06	V07
Bexley compounds	**Site establishment**					**TS**	**MOC2 construction**
NCA15	–	–	–	–	–	–	–
NCA16	–	–	–	–	–	–	–
NCA17	–	–	–	–	–		–
NCA26	–	–	–	–	–		–

Notes All works to be undertaken during OOHW Evening 6pm to 10pm Monday to Sunday; or OOHW Night 10pm to 7am Monday to Friday and 10pm to 8am Saturday, Sunday and public holidays; OOHW Day 1pm to 6pm Saturday and 8am to 6pm Sundays and public holidays.

Level of compliance reported is based on worst case impact for OOHW period (typically night period)

TS refers to tunnel support activities, which will be undertaken 24 hours per day, 7 days per week.

4.7 Discussion of results (OOHW)

Noise impacts associated with the OOHW at the Bexley Road compounds include:

- The site establishment road and intersection modifications and installation of traffic controls (V03) require a Road Occupancy Licence and will therefore need to be completed as OOHW. Receivers in NCA15 and NCA16 will be impacted by noise levels 15 to 25dB(A) above the NML. Noise from these activities may be moderately intrusive to residents in these NCAs. Note that there is potential for short duration concrete saw cutting to impact the receivers nearest to the works in NCA15 by noise levels greater than 25dB(A) above the NML, which is considered to be highly intrusive. These works will be managed by using relocatable noise screening to shield the works and by completing the works before 10 pm where practicable, with no saw cutting beyond midnight.
- Receivers in NCA17 and NCA26 will be impacted by noise levels 5 to 15dB(A) above the NML during the site establishment OOHW. Noise from these activities may be clearly audible to residents in these NCAs.

- Construction noise impacts from the tunnelling support operations are predicted to comply with the NMLs during the OOHW period. There is a marginal exceedance [within 2 dB(A)] at 3 receivers in NCA15 during the night period, caused by concrete trucks and spoil haul trucks moving on site.

Measures for managing the noise impacts outlined in Section 4.8.

4.8 Noise mitigation and management

4.8.1 High noise impact activities

To limit the potential impact from high noise impact activities such as piling, jack hammering and rock hammering, the works will be carried out with respite periods as set out in condition of approval D16, such that:

- High noise impact activities (including jackhammering and rock breaking) are only carried out between:
  - 8 am and 6pm Monday to Friday; and
  - 8 am and 1 pm Saturday;
- 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.

4.8.2 Other noise control measures

Other noise mitigation measures and noise monitoring requirements are addressed in the following documents:

- Construction Noise and Vibration Impact Statement: Site Establishment (Project Wide) [ref: TH014-05 01F02 WCX_NM5]
- Construction Noise Mitigation Design Report: Bexley Tunnel Support Site [TH014-05 01F05 WCX_NM5 Design Rep Bexley TS]
- Construction Noise and Vibration Impact Statement: Bexley Road Site Establishment OOHW [ref: TH014-05 01F10 WCX_NM5]
- Construction Noise and Vibration Impact Statement: Bexley Road Tunnel Support site [ref: TH014-06 01F22 WXC_NM5 CNVIS BXR TS]
- Construction Noise and Vibration: Temporary Noise Barrier Acoustic Report (Bexley compound)[TH014-05 01F29 WCX_NM5 CNVIS BXR MOC2 (r1)].

The required locations, heights and performance requirements of the site boundary noise walls and hoardings are presented **Table C3** in APPENDIX C and **Figure B1** in APPENDIX B. The Weighted Sound

Reduction Index (Rw) for each noise wall is nominated. Based on the required acoustic rating, suitable noise wall constructions have been established through discussion with CDS.

Prior to commencement of the permanent facilities construction at the Bexley site compound, the site boundary noise walls will be modified in order to allow the construction works to proceed. The updated locations, heights and performance requirements of the site boundary noise walls and hoardings are presented **Table C8** in APPENDIX C and **Figure B2** in APPENDIX B.

There are two noise sheds to be constructed at the Bexley tunnel support site:

- Northern Spoil Shed (C4 compound); and
- Southern Spoil Shed (C5 compound).

An acoustic enclosure schedule has been developed and is presented as **Table C4** in APPENDIX C.

Plant and equipment used on site shall achieve the noise level requirements in **Table C1** of APPENDIX C. More specifically, tunnel ventilation fans and front end loaders used in the spoil shed shall be managed to achieve the performance requirements in **Table C5** of APPENDIX C.

5 Conclusion

This Construction Noise and Vibration Temporary Noise Barrier Acoustic Report has been prepared to identify and confirm:

- Temporary noise barriers to mitigate construction noise associated with the Bexley North construction compound C4, located on the northern side of the M5 Motorway, west of Bexley Road
- Temporary noise barriers to mitigate construction noise associated with the Bexley South construction compound C5, located on the southern side of the M5 Motorway, west of Bexley Road
- Temporary noise barriers to mitigate construction noise associated with the Bexley East construction compound C6, located on the eastern side of Bexley Road, directly above the existing M5 Motorway tunnel.
- Temporary noise barriers to mitigate construction noise impacts from activities associated with the construction of the Bexley Road MOC 2 permanent facilities at the Bexley South construction compound after the completion of tunnelling works.

Impacts predicted as a result of construction activity following the installation of temporary noise barriers have been quantified and reported in Section 4, in relation to construction noise impact.

Noise management schedules for the site have been developed identifying the noise mitigation strategies that are to be incorporated into the site design to minimise noise impact where it may occur. The schedules are:

- Table C2 in APPENDIX C setting out the Construction Noise Management schedule
- Table C3 in APPENDIX C setting out the Noise Wall / Hoarding Design specifications
- Table C4 in APPENDIX C setting out the Noise Shed/ Enclosure Design specifications
- Figure B1 in APPENDIX B identifying noise walls and hoarding locations around the site
- Table C8 in APPENDIX C setting out the updated Noise Wall / Hoarding Design specifications for the MOC2 permanent facility construction.

A comparison of the predicted noise levels in the EIS compared to those predicted from the detailed design is presented in APPENDIX D.

References

1. Department of Environment and Climate Change 2009 NSW Interim Construction Noise Guideline (ICNG),
2. Environment Protection Authority 1999 NSW Environmental Criteria for Rd Traffic Noise
3. Department of Environment Conservation NSW 2006 Assessing Vibration; a technical guideline
4. British Standard BS 6472-2008, Evaluation of human exposure to vibration in buildings (1-80Hz)
5. British Standard BS 7385 Part 2-1993, Evaluation and measurement for vibration in buildings
6. German Standard DIN 4150-3 : 1999-02, Structural vibration - Effects of vibration on structures, February 1999
7. ASHRAE Applications Handbook (SI) 2003, Chapter 47 Sound and Vibration Control, pp47.39-47.40
8. Australian Standard 2834-1995 Computer Accommodation, Chapter 2.9 Vibration, p16
9. Australian Standard AS/NZS 2107:2000 *Acoustics - Recommended design sound levels and reverberation times for building interiors*
10. Roads and Maritime Services 2014 QA Specification G36 Environmental Protection Edition 4 / Revision 3
11. AECOM Australia Pty Ltd 2015 WestConnex The New M5 – Technical Working Paper: Noise and Vibration Report Revision 8 – 20-Nov-2015
12. Renzo Tonin & Associates WestConnex Stage 2 M5 East Operational Noise Management Report (ONMR), 8 July 2015 [ref: TH014-01 01BF01 ONMR (r5)]
13. Transport for NSW Construction Noise Strategy (ref: 7TP-ST-157/2.0) April 2012
14. Minister for Planning Infrastructure approval SSI 6788 dated 20 April 2016

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.

Absorption Coefficient α	The absorption coefficient of a material, usually measured for each octave or third-octave band and ranging between zero and one. For example, a value of 0.85 for an octave band means that 85% of the sound energy within that octave band is absorbed on coming into contact with the material. Conversely, a low value below about 0.1 means the material is acoustically reflective.
Adverse weather	Weather effects that enhance noise (particularly wind and temperature inversions) occurring at a site for a significant period of time. In the NSW INP this occurs when wind occurs for more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of nights in winter.
Active recreation	Active recreation area, characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion, e.g. school playground, golf course
Air-borne noise	Noise which is fundamentally transmitted by way of the air and can be attenuated by the use of barriers and walls placed physically between the noise source and receiver.
Alternate Solution	An Alternative Solution is a design that complies with the relevant Performance Requirements of the National Construction Code other than by using Deemed-to-Satisfy Provisions.
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.
Amenity	A desirable or useful feature or facility of a building or place.
AS	Australian Standard
Assessment period	The time period in which an assessment is made. e.g. Day 7am-6pm, Evening 6pm-10pm, Night 10pm-7am.
Assessment Point	A location at which a noise or vibration measurement is taken or estimated.
Attenuation	The reduction in the level of sound or vibration.
Audible Range	The limits of frequency which are audible or heard as sound. The normal hearing in young adults detects ranges from 20 Hz to 20 kHz, although some people can detect sound with frequencies outside these limits.
A-weighting	A filter applied to the sound recording made by a microphone to approximate the response of the human ear.
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. 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 LA90 noise level if measured as an overall level or an L90 noise level when measured in octave or third-octave bands.
Barrier (Noise)	A natural or constructed physical barrier which impedes the propagation of sound and includes fences, walls, earth mounds or berms and buildings.
Berm	Earth or overburden mound.
Buffer	An area of land between a source and a noise-sensitive receiver and may be an open space or a noise-tolerant land use.
Bund	A bund is an embankment or wall of brick, stone, concrete or other impervious material, which may form part or all of the perimeter of a compound.
BS	British Standard
CoRTN	United Kingdom Department of Environment entitled "Calculation of Road Traffic Noise (1988)"

Decibel [dB]	The units of sound measurement. The following are examples of the decibel readings of every day sounds: 0dB The faintest sound we can hear, defined as 20 micro Pascal 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 decibel. 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 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. The dB(C) level is not widely used but has some applications.
Diffraction	The distortion of sound waves caused when passing tangentially around solid objects.
DIN	German Standard
DnT,w	Weighted Standardised Field Level Difference A measure of sound insulation performance of a building element. It is characterised by the difference in noise level on each side of a wall or floor. It is measured in-situ. It is a field measurement that relates to the Rw laboratory measured value but is not equal to it because an in-situ space is not of the same quality as a laboratory space. The value is indicative of the level of speech privacy between spaces. The higher its value the better the insulation performance.
ECRTN	Environmental Criteria for Road Traffic Noise, NSW, 1999
EPA	Environment Protection Authority
Field Test	A test of the sound insulation performance in-situ. See also 'Laboratory Test' The sound insulation performance between building spaces can be measured by conducting a field test, for example, early during the construction stage or on completion. A field test is conducted in a non-ideal acoustic environment. It is generally not possible to measure the performance of an individual building element accurately as the results can be affected by numerous field conditions.
Fluctuating Noise	Noise that varies continuously to an appreciable extent over the period of observation.
Free-field	An environment in which there are no acoustic reflective surfaces. Free field noise measurements are carried out outdoors at least 3.5m from any acoustic reflecting structures other than the ground.
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.
Ground-borne noise	Vibration propagated through the ground and then radiated as noise by vibrating building elements such as wall and floor surfaces. This noise is more noticeable in rooms that are well insulated from other airborne noise. An example would be vibration transmitted from an underground rail line radiating as sound in a bedroom of a building located above.

Habitable Area	Includes a bedroom, living room, lounge room, music room, television room, kitchen, dining room, sewing room, study, playroom, family room, home theatre and sunroom. Excludes a bathroom, laundry, water closet, pantry, walk-in wardrobe, corridor, hallway, lobby, photographic darkroom, clothes drying room, and other spaces of a specialised nature occupied neither frequently nor for extended periods.
Heavy Vehicle	A truck, transporter or other vehicle with a gross weight above a specified level (for example: over 8 tonnes).
Impact Noise	The noise in a room, caused by impact or collision of an object onto the walls or the floor. Typical sources of impact noise are footsteps on the floor above a tenancy and the slamming of doors on cupboards mounted on the common wall between tenancies.
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.
INP	NSW Industrial Noise Policy, EPA 1999
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.
Intrusive noise	Refers to noise that intrudes above the background level by more than 5 dB(A).
ISEPP	State Environmental Planning Policy (Infrastructure), NSW, 2007
ISEPP Guideline	Development Near Rail Corridors and Busy Roads - Interim Guideline, NSW Department of Planning, December 2008
L1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L10	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L10(1hr)	The L10 level measured over a 1 hour period.
L10(18hr)	The arithmetic average of the L10(1hr) levels for the 18 hour period between 6am and 12 midnight on a normal working day.
L90	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).
LAeq or Leq	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time, which would produce the same energy as a fluctuating sound level. When A-weighted, this is written as the LAeq.
LAeq(1hr)	The LAeq noise level for a one-hour period. In the context of the NSW EPA's Road Noise Policy it represents the highest tenth percentile hourly A-weighted Leq during the period 7am to 10pm, or 10pm to 7am (whichever is relevant).
LAeq(8hr)	The LAeq noise level for the period 10pm to 6am.
LAeq(9hr)	The LAeq noise level for the period 10pm to 7am.
LAeq(15hr)	The LAeq noise level for the period 7am to 10pm.
LAeq (24hr)	The LAeq noise level during a 24 hour period, usually from midnight to midnight.
Lmax	The maximum sound pressure level measured over a given period. When A-weighted, this is usually written as the LAmax.
Lmin	The minimum sound pressure level measured over a given period. When A-weighted, this is usually written as the LAmin.
Ln,w	Weighted Normalised Impact Sound Pressure Level A measure of the sound level transmitted from impacts on a floor to a tenancy below. It is measured in very controlled conditions in a laboratory and is characterised by how much sound reaches the receiving room from a standard tapping machine. A lower value indicates a better performing floor.

LnT,w	Weighted Standardised Field Impact Sound Pressure Level As for Ln,w but measured in-situ and therefore subject to the inherent accuracies involved in such a measurement. The equivalent measurement in a laboratory is the Ln,w. A lower value indicates a better performing floor.
Laboratory Test	The performance of a building element when measured in a laboratory. The sound insulation performance of a building element installed in a building however can differ from its laboratory performance for many reasons including the quality of workmanship, the size and shape of the space in which the measurement is conducted, flanking paths and the specific characteristics of the material used which may vary from batch to batch.
Loudness	A rise of 10 dB in sound level corresponds approximately to a doubling of subjective loudness. That is, a sound of 85 dB is twice as loud as a sound of 75 dB which is twice as loud as a sound of 65 dB and so on. That is, the sound of 85 dB is four times or 400% the loudness of a sound of 65 dB.
Microphone	An electro-acoustic transducer which receives an acoustic signal and delivers a corresponding electric signal.
NCA	Noise Catchment Area. An area of study within which the noise environment is substantially constant.
Noise	Unwanted sound
NRC	Noise Reduction Coefficient. A measure of the ability of a material to absorb sound. The NRC is generally a number between 0 and 1 but in some circumstances can be slightly greater than 1 because of absorption at the edges of the material. A material with an NRC rating of 1 absorbs 100% of incoming sound, that is, no sound is reflected back from the material. The NRS is the average of the absorption coefficient measured in the octave bands 250Hz, 500Hz, 1kHz & 2kHz which correspond to the predominant frequencies associated with the human voice.
Passive recreation	Area specifically reserved for passive recreation, characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion e.g. reading, meditation
Reflection	Sound wave reflected from a solid object obscuring its path.
Reverberation Time	The time (in seconds) it takes for a noise signal within a confined space to decay by 60dB. The longer the reverberation time (usually denoted as RT60), the more echoic a room. Longer reverberation times generally result in higher noise levels within spaces.
RMS	Root Mean Square value representing the average value of a signal.
Rw	Weighted Sound Reduction Index A measure of the sound insulation performance of a building element. It is measured in very controlled conditions in a laboratory. The term supersedes the value STC which was used in older versions of the Building Code of Australa. Rw is measured and calculated using the procedure in ISO 717-1. The related field measurement is the DnT,w. The higher the value the better the acoustic performance of the building element.
R'w	Weighted Apparent Sound Reduction Index. As for Rw but measured in-situ and therefore subject to the inherent accuracies involved in such a measurement. The higher the value the better the acoustic performance of the building element.
RNP	Road Noise Policy, NSW, March 2011
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.

Sound absorption	The ability of a material to absorb sound energy by conversion to thermal energy.
Sound Insulation	Sound insulation refers to the ability of a construction or building element to limit noise transmission through the building element. The sound insulation of a material can be described by the Rw and the sound insulation between two rooms can be described by the DnT,w.
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 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 of 1 pico watt.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone referenced to 20 mico Pascal.
Spoil	Soil or materials arising from excavation activities.
Standardised	A method of adjusting the measured noise indices in-situ so that they are independent of the measuring space. The noise level in a room is affected by reverberation in the room. For example, the L'n,w impact sound pressure level measured in a room is dependent upon the amount of absorptive material in the receiving room. The value is adjusted to what would be measured if the reverberation time in the receiving room is set at 0.5 seconds. This enables the same value to be reported independent of whether the room contains carpet and furnishings and the like. See also 'Normalised'.
STC	Sound Transmission Class A measure of the sound insulation performance of a building element. It is measured in controlled conditions in a laboratory. The term has been superseded by Rw.
Structure-borne Noise	Audible noise generated by vibration induced in the ground and/or a structure. Vibration can be generated by impact or by solid contact with a vibrating machine. Structure-borne noise cannot be attenuated by barriers or walls but requires the isolation of the vibration source itself. This can be achieved using a resilient element placed between the vibration source and its support such as rubber, neoprene or springs or by physical separation (using an air gap for example). Examples of structure-borne noise include the noise of trains in underground tunnels heard to a listener above the ground, the sound of footsteps on the floor above a listener and the sound of a lift car passing in a shaft. See also 'Impact Noise'.
Tonal Noise	Sound containing a prominent frequency and characterised by a definite pitch.
Transmission Loss	The sound level difference between one room or area and another, usually of sound transmitted through an intervening partition or wall. Also the vibration level difference between one point and another. For example, if the sound level on one side of a wall is 100dB and 65dB on the other side, it is said that the transmission loss of the wall is 35dB. If the transmission loss is normalised or standardised, it then becomes the Rw or R'w or DnT,w.

APPENDIX B Nearest Sensitive Receivers and Noise Management Levels

Building Type

- Residential
- Mixed Use
- Community Centre
- Commercial
- Heritage
- Compound sites
- NCAs

Legend

- Temporary 4.5m Barrier
- Temporary 3m Barrier
- Temporary 4.5m Awning
- Temporary 2.4m Barrier
- Chain-link fence
- Site Building
- Acoustic Shed

Client: WestConnex New M5

CPB CONTRACTORS | DRAGADOS | SAMSUNG C&T

25 0 25 50 75 100 m

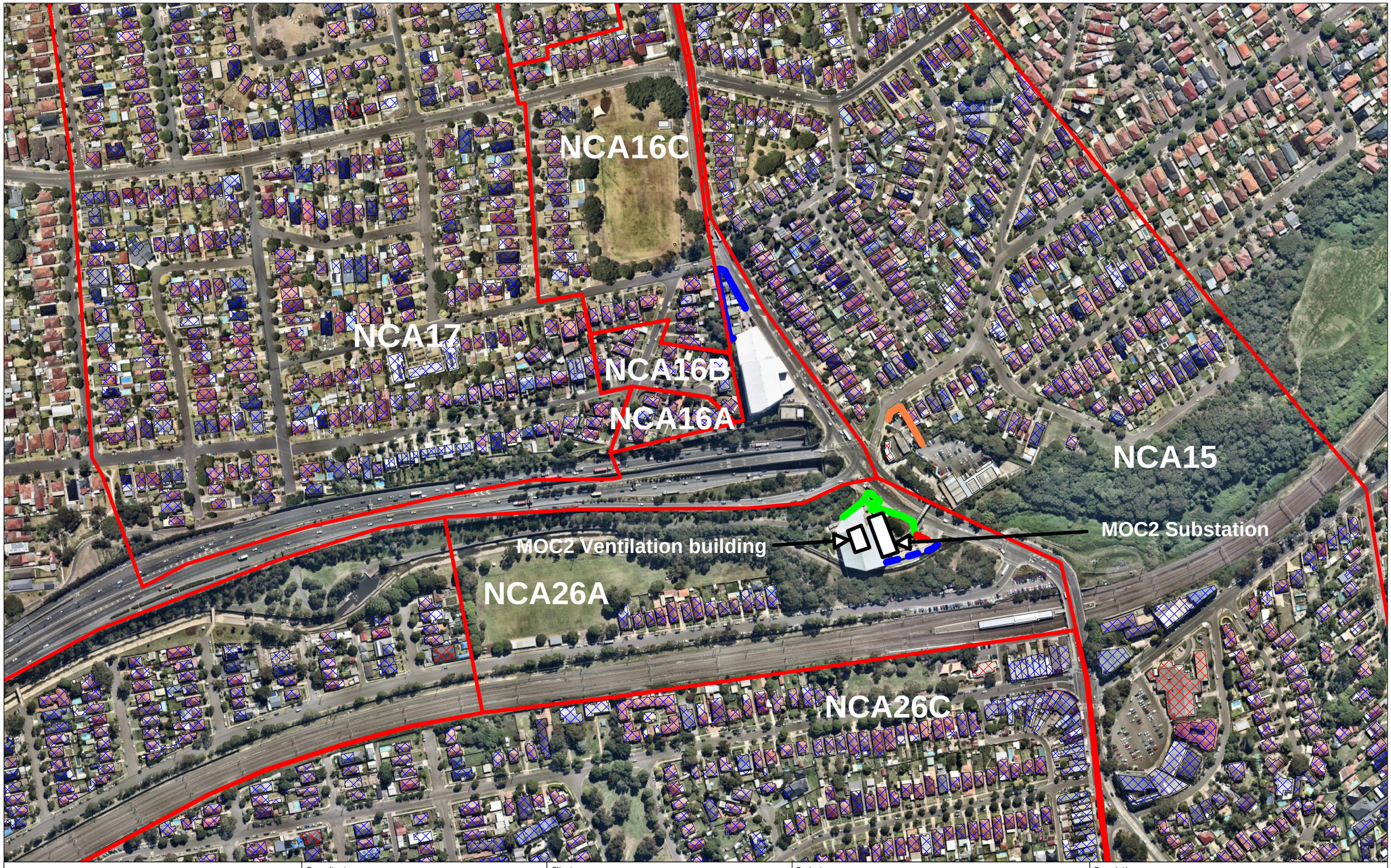
Noise Levels are approximate due to interpolation of contours and should be used for reference only.
For information only and not for construction.

Project: WestConnex Stage 2 M5

Description:
Bexley compound
Noise catchment areas & Sensitive Receivers
Temporary and permanent noise barrier locations

RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Created by: THW
Figure No: TH014-05 6 0 1 007 (r1)
Date: 29.07.2016
Scale: 1:3,000 @ A3



Legend

- Residential receiver
- Other sensitive receiver
- NCA

Barrier Height (m)

- 1.8m hoarding
- 2.4m noise wall
- 3m noise wall
- 4.5m noise wall

Consultant:
RENZO TONIN & ASSOCIATES
inspired to achieve
Acoustics, Vibration & Structural Dynamics
Sydney Melbourne Brisbane Gold Coast Kuwait
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client:
WestConnex New M5
CPB CONTRACTORS | DRAGADOS | SAMSUNG C&T

Project:
WESTCONNEX STAGE 2 NEW M5

Description:
BEXLEY ROAD COMPOUND
NCAs, SENSITIVE RECEIVERS
UPDATED TEMPORARY NOISE BARRIER
LOCATIONS FOR MOC2 PERMANENT
FACILITIES CONSTRUCTION

Noise levels are approximate due to interpolation of contours and should be used for reference only.
For information only and not for construction.

Project No.: TH014-05	Created by: SP
Fig Ref: FIGURE B2	
Date: 2018.04.16	Scale: 1: 3500 A3

Table B1: Noise sensitive receivers and construction noise management levels **Bexley Road Tunnel Support**

NCA	Receiver Type	Reference RBL	Rating Background Levels (RBLs)			Residential Noise Management Levels (NMLs) $L_{Aeq(15\ min)}$				Sleep Dist. L_{Amax}		Comments
			Day	Evening	Night	Day (S)	Day (O)	Evening	Night	Screening	Max	
NCA15	Residential Commercial	EISL23	51	51	43	61	56	56	48	58	65	Based on NCAs and NMLs presented in the EIS.
NCA16A	Residential	EISL09	48	48	43	58	53	53	48	58	65	Based on NCAs and NMLs presented in the EIS.
NCA16B	Residential	DD NL03	49	48	36	59	54	53	41	51	65	Based on NCAs and NMLs presented in the EIS.
NCA16C	Residential Active recreation	EISL07	54	54	40	64	59	59	45	55	65	Based on NCAs and NMLs presented in the EIS.
NCA16D	Residential Educational institution	DD NL03	49	48	36	59	54	53	41	51	65	Based on NCAs and NMLs presented in the EIS.
NCA17	Residential	EISL09	48	48	43	58	53	53	48	58	65	Based on NCAs and NMLs presented in the EIS.
NCA26A	Residential Active recreation	DD NL04	47	47	41	57	52	52	46	56	65	Based on NCAs and NMLs presented in the EIS.
NCA26B	Residential	EISL08	50	49	40	60	55	54	45	55	65	Based on NCAs and NMLs presented in the EIS.
NCA26C	Residential Commercial	EISL24	47	47	41	57	52	52	46	56	65	Based on NCAs and NMLs presented in the EIS.
ID	**Other Sensitive Recievers**											
OSR	Educational facility	ICNG	-	-	-	55	55	55	55	-	-	When premise 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	Hotel/ motel	AS2107	-	-	-	60	60	60	60	-	-	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 premise is in use. External.
OSR	Industrial receivers	ICNG	-	-	-	75	75	75	75	-	-	When premise is in use. External.

APPENDIX C Construction Timetable/ Activities/ Management

Figure C1: Site layout showing mitigation **Bexley Road Tunnel Support**

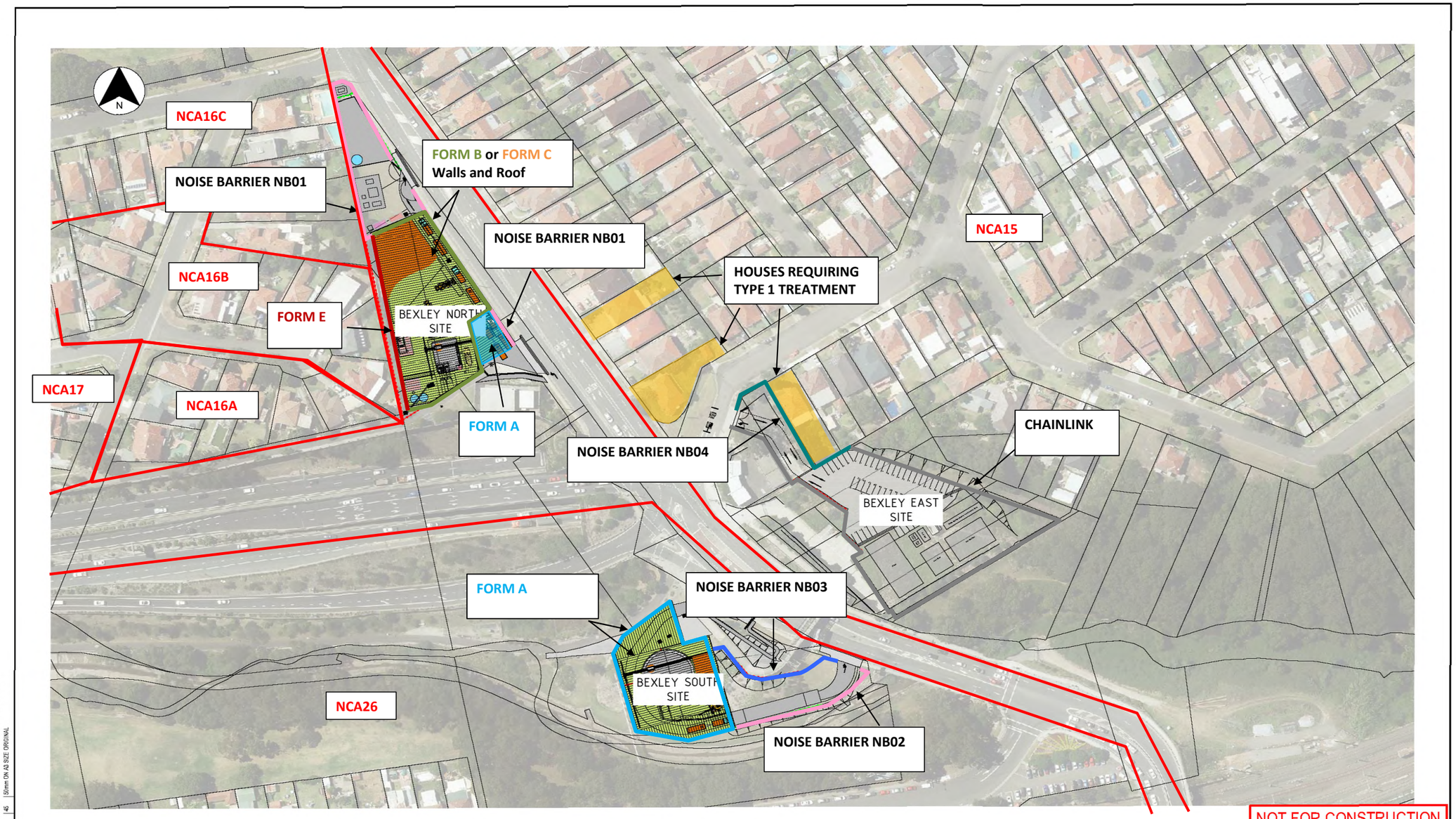


Table C1: Tunnel support construction timetable/ activities/ equipment **Bexley Road Tunnel Support**

Activity/ Work Area	Aspect	Plant/ Equipment	Net Power kW	Operating Weight kg	Day 7am - 6pm	Evening 6pm - 10pm	Night 10pm - 7am	Sound Power Level (Lw re: 1pW) in L_{Aeq}	L_{A1}	Notes
TUNNELLING SUPPORT										
Construction Compound & Car Park (Bexley East C6)	General worksite and Car parking	Light vehicle	80		20 per hour	12 p.h.	12 p.h.	89		Surface; Compound and car park will operate for the entire duration of construction works. Busy on shift changes only.
		Water treatment plant pumps	10		2	2	2	82		
Site sheds, workshop, car parking & laydown areas	Workshop; Deliveries; Maintenance; Storage	Road truck (deliveries to site)			4 p.h.	-	-	108		Surface
		Compressor	110	2660	2	2	2	70		Located inside northern shed.
		Workshop Hand Tools			1	1	1	107		Located inside northern shed.
		Franna Crane	205	20 tonne	1	1	-	99	106	Located inside northern shed.
		Water cart		15kL	4 p.h.	4 p.h.	-	104		Surface
Tunnelling Support Site (Bexley North C4)	Tunnelling & Support	Road Header 1,000V Electric	350		2	2	2	111		Underground
		Dust Scrubber			2	2	2	110 (no attenuator)		Underground; Attenuator to be confirmed
		Ventilation fan Zitron 2xZVN 1-18-180/4. 68.25 m3/s (Drive 3). With silencers	600		1	1	1	85 (113 no additional attenuator)		Surface; Additional attenuator required - see Schedule C5
	Spoil Handling	Moxie (spoil out of tunnel)	95	38T	10 p.h.	10 p.h.	8 p.h.	110		Underground
		Truck & Dog (spoil haulage)			8 p.h.	8 p.h.	0 p.h.	108		Surface
		Gantry Crane (in shed)			1	1	1	90		At surface within spoil shed. See C5 for details
		FE Loader in spoil loading shed	130		1	1	1	105		At surface within spoil shed. See C5 for details
	Tunnel Lining (concreting)	Concrete pump	130		1	-	-	N/A		Underground
		Compressor	90		1	1	1	N/A		Underground
		Concrete truck	120		4 p.h.	4 p.h.	4 p.h.	108	117 (air brakes)	Surface
Tunnelling Support Site (Bexley South C5)	Tunnelling & Support	Road Header 1,000V Electric	350		2	2	2	111		Underground
		Dust Scrubber			2	2	2	110 (no attenuator)		Underground; Attenuator to be confirmed
		Ventilation fan Zitron 2xZVN 1-18-90/4. 68.25 m3/s (Drive 1 & 2). With silencers	600		1	1	1	91 (118 no additional attenuator)		Surface; Additional attenuator required - see Schedule C5
	Spoil Handling	Moxie (spoil out of tunnel)	95	38T	10 p.h.	10 p.h.	8 p.h.	110		Underground
		Truck & Dog (spoil haulage)			8 p.h.	8 p.h.	8 p.h.	108	117 (air brakes)	Surface
		Gantry Crane (in shed)			1	1	1	90		In shed
		FE Loader in spoil loading shed	130		1	1	1	105		At surface within spoil shed. See C5 for details
	Tunnel Lining (concreting)	Concrete pump	130		1	-	-	N/A		Underground
		Compressor	90		1	1	1	N/A		Underground
		Concrete truck	120		4 p.h.	4 p.h.	4 p.h.	108	117 (air brakes)	Surface

Table C2: Construction noise management schedule

Bexley Road Tunnel Support

	Area to be Managed	Mitigation/ Management Measure	Typical Details	Comments
Bexley North C4 - Tunnel RH Support, Spoil Handling and Tunnel Lining				
1	Noise Barriers	4.5m temporary noise barrier around Bexley North support site, including awning over spoil shed entrance	see Table C3 for details	
2	Work outside Standard Construction Hours	EVE works (6 pm to 10 pm): Restricted as outlined below NIGHT works (10 pm to 7 am): Restricted as outlined below		
3	Workshop	Inside main shed. High noise generating activities to generally be conducted in tunnel.		
4	Spoil bin area	Acoustic shed DAY/ EVE: 1 Front End Loader (FEL); NIGHT: 1 FEL. Roller door to be partly closed during EVE/ NGT period to the minimum height required to allow trucks to access the shed	see Table C4 for details see Table C5 for performance requirements	
5	Water Treatment Plant Pumps	N/A	see Table C4 for performance requirements	
6	Compressors	Inside main shed		
7	Ventilation Fan	Attenuator/ acoustic enclosure	see Table C5 for performance requirements	
8	Concrete Truck restrictions for OOHW period	EVE: ≤ 4 trucks per hour NIGHT: ≤ 4 trucks per hour	Up to 6 in total during OOHW period (i.e. 6 pm to 7 am)	Sleep disturbance issues TBC during first 12 months on site - Compression braking and air brake release will be managed on site
9	Spoil Truck restrictions for OOHW period	EVE: ≤ 8 trucks per hour NIGHT: 0 trucks per hour		- Subject to on site verification testing during first 12 months on site
10	Water Cart restrictions for OOHW period	EVE: ≤ 4 trucks per hour NIGHT: 0 trucks per hour		
11	Residual impacts	Properties where (after application of the above) noise levels exceed NML	DAY: none EVE: none NIGHT: 4 (See Table C7)	Subject to on site verification testing during first 12 months on site
Bexley South C5 - Tunnel RH Support, Spoil Handling and Tunnel Lining				
1	Noise Barriers	4.5m temporary noise barrier around southern side of Bexley South exit ramp from spoil shed to Bexley Road 3m temporary noise barrier around northern side of Bexley South exit ramp from spoil shed to the Bexley Road	see Table C3 for details see Table C3 for details	
2	Work outside Standard Construction Hours	EVE works (6 pm to 10 pm): Restricted as outlined below		
3	Workshop	N/A	see Table C4 for details	
4	Spoil bin area	Acoustic shed DAY/ EVE: 1 Front End Loader (FEL); NIGHT: 1 FEL. Roller door to be partly closed during EVE/ NGT period to the minimum height required to allow trucks to access the shed	see Table C4 for details see Table C5 for performance requirements	
5	Water Treatment Plant Pumps	Attenuator/ acoustic enclosure	see Table C5 for performance requirements	
6	Compressors	N/A		
7	Ventilation Fan	Attenuator/ acoustic enclosure	see Table C5 for performance requirements	
8	Concrete Truck restrictions for OOHW period	EVE/ NIGHT: ≤ 4 trucks per hour		Compression braking and air brake release will be managed on site
9	Spoil Truck restrictions for OOHW period	EVE/ NIGHT: ≤ 8 trucks per hour		
10	Water Cart restrictions for OOHW period	EVE: ≤ 4 trucks per hour NIGHT: 0 trucks per hour		
11	Residual impacts	Properties where (after application of the above) noise levels exceed NML	As above	
Bexley East C6 - Construction Compound and Carpark				
1	Noise Barriers	2.4m temporary noise barrier around north and east sides of Bexley East compound	see Table C3 for details	
2	Water Cart restrictions for OOHW period	EVE: ≤ 4 trucks per hour NIGHT: 0 trucks per hour		

Table C3: Noise barrier design specifications **Bexley Road Tunnel Support**

Noise barrier reference	Location	Noise barrier height	Required Rw	Proposed Construction	Acoustic Rating of Construction*
NB01	Bexley North (C4) As shown on B1 Site Layout	4.5m	Rw 25 High	Sandwich construction of 17mm plywood on either side of 45mm frame (45mm air gap between plywood sheets); OR Speedwall panel; OR 150mm Hebel	Rw 28 Rw 41 Rw 40
NB02	Bexley South (C5) South side of spoil shed exit ramp	4.5m	Rw 25 High	Sandwich construction of 17mm plywood on either side of 45mm frame (45mm air gap between plywood sheets); OR Speedwall panel; OR 150mm Hebel	Rw 28 Rw 41 Rw 40
NB03	Bexley South (C5) As shown on B1 Site Layout	3m	Rw 15-20 Medium	17 mm plywood hoarding	Rw 24
NB04	Bexley East (C6) North and east boundaries	2.4m	Rw 15-20 Medium	17 mm plywood hoarding	Rw 24

Notes:
Noise barrier performance: Low - Rw 10-15; Medium - Rw 15-220; Medium-High - Rw 20-25; High - Rw 25; Very High - Rw 30
* estimated by calculations and/or reference to other similar barrier type data
GENERAL
• The specified 'required rating' must be achieved by the product selected.
• By way of explanation, the Sound Insulation Rating Rw is a measure of the noise reduction property of the assembly, a higher rating implying a higher sound reduction performance.
• Note that the Rw rating of systems measured as built on site (R'w Field Test) may be up to 5 points lower than the laboratory result.
• The sealing of all gaps is critical in a sound rated construction. Use only sealer approved by the acoustic consultant.
• Check design of all junction details with acoustic consultant prior to construction.
• Check the necessity for HOLD POINTS with the acoustic consultant to ensure that all building details have been correctly interpreted and constructed.
• The information provided in this table is subject to modification and review without notice.
• The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.

Table C4: Noise shed / enclosure design specifications **Bexley Road Tunnel Support**

Area to be Mitigated	Construction component	Acoustic element type
1. Northern Spoil Shed	North/east/south walls	Form B or Form C
	West wall	Form E
	Roof	Form B or Form C
	Acoustic lining	Acoustic lining with roofing blanket with perforated foil e.g. Permastop building blanket 55mm Sisilation Light Duty on inner skin facing inside shed of: - upper section of south & west facing walls; - above 2.5 m of north facing & east facing walls; and - Underside of roof
	Doors	oversized roller door (larger than wall opening) and rubber seals side and bottom
	Ventilation Openings	Any necessary ventilation openings should face away from neighbours, placed down low so that noise walls can effectively shield them from neighbours, and also fitted with acoustic louvres / attenuators.
2. Southern Spoil Shed	Walls	Form A
	Roof	Form A
	Acoustic lining	Acoustic lining with roofing blanket with perforated foil e.g. Permastop building blanket 55mm Sisilation Light Duty on inner skin facing inside shed of: - upper section of south & west facing walls; - above 2.5 m of north facing & east facing walls; and - Underside of roof
	Doors	oversized roller door (larger than wall opening) and rubber seals side and bottom
	Ventilation Openings	Any necessary ventilation openings should face away from neighbours, placed down low so that noise walls can effectively shield them from neighbours, and also fitted with acoustic louvres / attenuators.

Notes:

LEGEND * estimated by calculations and/or reference to other similar wall type data. The client is advised not to commit to materials which have not been tested in an approved laboratory or for which an opinion only is available. Testing materials is a component of the quality control of the design process and should be viewed as a priority because there is no guarantee the forecast results will be achieved thereby necessitating the use of an alternative which may affect the cost and timing of the project. No responsibility is taken for use of or reliance upon untested materials, estimates or opinions.

GENERAL

- The underside of the roof and (where possible) internal walls should be lined with acoustic insulation to reduce the build-up of sound inside the shed
- The specified performances must be achieved by the product selected.
- The sealing of all gaps is critical in a sound rated construction. Use only sealer approved by the acoustic consultant.
- Check design of all junction details with acoustic consultant prior to construction.
- Check the necessity for HOLD POINTS with the acoustic consultant to ensure that all building details have been correctly interpreted and constructed.
- The information provided in this table is subject to modification and review without notice.
- The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.

Table C4a: Specification for acoustic elements of noise sheds/ acoustic enclosures

Wall/ roof type	Sound transmission loss per octave spectrum dB						
	63	125	250	500	1000	2000	4000
FORM A	8	10	14	18	18	21	25
FORM B	8	10	25	38	50	60	69
FORM C	16	20	24	29	33	35	41
FORM D	20	24	29	33	38	41	46
FORM E	20	30	36	44	51	63	72

Table C5: Plant and equipment specifications **Bexley Road Tunnel Support**

Building/ Area to be Mitigated	Item	Acoustic Requirement	Octave spectrum dB									Lw dB(A)
			31.5	63	125	250	500	1000	2000	4000	8000	
Tunnel ventilation	North ventilation fan Drive 3 (with silencer)	Plant sound power level based on manufacturers specification		100	111	113	105	103	104	108	105	113
	+ Fantech Silencer. RT17G-337-280. 70 m3/s. 2.4m length	Plant sound power level to be confirmed in accordance with CNVMP Appendix F.1		89	90	75	54	48	60	77	84	85
	+ 5 dB enclosure ##											
Tunnel ventilation	South ventilation fan Drive 1&2 (with silencer)	Plant sound power level based on manufacturers specification		110	116	119	113	108	104	111	113	118
	+ Fantech Silencer. RT17G-337-280. 70 m3/s. 2.4m length	Plant sound power level to be confirmed in accordance with CNVMP Appendix F.1		95	96	81	60	54	66	83	90	91
	+ 5 dB enclosure ##											
Plant item	Front end loader 25 t	Plant sound power level to be confirmed in accordance with CNVMP Appendix F.1		110	102	101	100	99	97	97	88	105
	+ high grade muffler											
Plant item	Workshop Franna Crane 20 t	Plant sound power level to be confirmed in accordance with CNVMP Appendix F.1	112	105	97	94	95	91	91	85	77	98
Plant item	Water Treatment Plant Pumps	Plant sound power level to be confirmed in accordance with CNVMP Appendix F.1		83	78	79	77	77	76	69	59	82

Notes:

LEGEND * estimated by calculations and/or reference to other similar plant type data. The client is advised not to commit to fans which have not been tested in an approved laboratory. Testing plant is a component of the quality control of the design process and should be viewed as a priority because there is no guarantee the forecast results will be achieved thereby necessitating the use of an alternative which may affect the cost and timing of the project. No responsibility is taken for use of or reliance upon untested materials, estimates or opinions. The advice provided here is in respect of acoustics only.

GENERAL

- Sound power level of plant assumed based on sound power level of similar plant type, incorporating attenuation (acoustic attenuator/ muffler/ duct lining as required)
- The specified performances must be achieved by the product selected.
- Check the necessity for HOLD POINTS with the acoustic consultant to ensure that all building details have been correctly interpreted and constructed.
- The information provided in this table is subject to modification and review without notice.
- The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.

Fans need a detailed design completed once fan detail available.

Table C6: Managing residual impacts during 'out of standard hours' work **Bexley Road Tunnel Support**

ID	Noise Mitigation/ Management Measure
1	At some receiver locations noise levels may exceed the NMLs and there are no physical mitigation measures that can be applied to achieve the NMLs Therefore, after all reasonable and feasible noise mitigation measures have been applied, the way forward is to seek a negotiated agreement with the affected receiver
2	The Construction Noise and Vibration Management Plan (CNVMP) identifies the management measures that can be applied to deal with residual impacts, including noise monitoring, letter box drops, phone calls, individual briefings, respite offers and alternative accomodation. Further mitigation measures may include changing operational procedures at night in order to reduce noise impacts, e.g. reduce the number of trucks on site during the night period (10 pm to 7am). The appropriate management measure would be determined by the degree of exceedance of the NML.
3	Where, after the application of all reasonable and feasible mitigation measures, noise levels still exceed the NML, then at property treatments may need to be considered. The following provides guidance on the level of treatment required in relation to the exceedance above the external NML.

Treatment 1A	**Mechanical ventilation only**
<5dB(A) reduction	Where external noise levels are less than 5dB(A) above the external assessment criteria, the internal noise goals may be achieved with windows closed. A light framed building with single glazed windows will provide a minimum noise reduction of up to 15dB(A) from outside to inside when windows are closed. If the internal noise goals can only be achieved with windows closed, then mechanical ventilation should be considered to ensure fresh airflow inside the dwelling so to meet the requirements of the Building Code of Australia.
Treatment 1B	**Mechanical ventilation and sealing of wall vents**
5-10 dB(A) reduction	Where external noise levels are less than 10dB(A) above the external assessment criteria, the internal noise goals may be achieved with windows closed. A light framed building with single glazed windows will provide a minimum noise reduction of up to 20dB(A) from outside to inside (ENMM p20) when windows are closed and wall vents are sealed. If the internal noise goals can only be achieved with windows closed, then mechanical ventilation should be considered to ensure fresh airflow inside the dwelling so to meet the requirements of the Building Code of Australia. It is important to ensure that mechanical ventilation does not provide a new noise leakage path into the dwelling and does not create a noise nuisance to neighbouring residential premises.
Treatment 2	**Upgraded seals for windows and doors**
10-12dB(A) reduction	Where external noise levels are only slightly greater than 10dB(A) above the external assessment criteria, then in addition to installing mechanical ventilation (Treatment 1) and sealing of wall vents (Treatment 2), special acoustic grade seals should be installed on windows and perimeter doors exposed to road traffic noise to enable the internal noise criteria to be achieved with windows and doors shut.
Treatment 3	**Upgraded windows, glazing and doors**
>12 dB(A) reduction	Where the predicted external noise level exceeds the external assessment criteria by significantly more than 10dB(A), then upgraded windows and glazing and the provision of solid core doors would be required on the facades exposed to the works, in addition to the mechanical ventilation, sealing of wall vents and acoustic seals for windows and doors described in Treatments 1, 2 and 3, respectively. Note that these upgrades are only suitable for masonry type buildings. It is unlikely that this degree of upgrade would provide significant benefits to light framed structures should there be no acoustic insulation in the walls.

4 All reasonable and feasible mitigation has been explored for the site. Exceedance of the sleep disturbance NML is predicted to occur at up to 15 receivers in NCA 15 in the area opposite the driveway exit from the site. The following at-property treatment may be required to reduce noise impact from the site:

Treatment Type	No. Residences	No. Apartment Blgs
Treatment 1A	3	-
Treatment 1B	-	-
Treatment 2	-	-
Treatment 3	-	-

5 At property treatment requirements will be reviewed once site access is gained and prior to the commencement of 24 hour operations. The review will include on site testing of trucks driving on site and entering/existing the site to verify noise levels predicted by the noise model. Once the noise model is verified, properties likely to exceed the OOHW (NIght) NML and the sleep disturbance NML will be identified for consideration of at-property treatment.

Table C8: Noise barrier design specifications **MOC2 Permanent facilities construction**

Noise barrier reference	Location	Noise barrier height	Required Rw	Proposed Construction	Acoustic Rating of Construction*
NB01	Bexley North (C4) As shown on B1 Site Layout	4.5m	Rw 25 High	Sandwich construction of 17mm plywood on either side of 45mm frame (45mm air gap between plywood sheets); OR Speedwall panel; OR 150mm Hebel	Rw 28 Rw 41 Rw 40
NB02	Bexley South (C5) South side of spoil shed exit ramp *Will be removed during piling works*	4.5m	Rw 25 High	Sandwich construction of 17mm plywood on either side of 45mm frame (45mm air gap between plywood sheets); OR Speedwall panel; OR 150mm Hebel	Rw 28 Rw 41 Rw 40
NB03	Bexley South (C5) As shown on B1 Site Layout	1.8m	Rw 15-20 Medium	17 mm plywood hoarding	Rw 24
NB04	Bexley East (C6) North and east boundaries	2.4m	Rw 15-20 Medium	17 mm plywood hoarding	Rw 24

Notes:
Noise barrier performance: Low - Rw 10-15; Medium - Rw 15-220; Medium-High - Rw 20-25; High - Rw 25; Very High - Rw 30
* estimated by calculations and/or reference to other similar barrier type data
GENERAL
• The specified 'required rating' must be achieved by the product selected.
• By way of explanation, the Sound Insulation Rating Rw is a measure of the noise reduction property of the assembly, a higher rating implying a higher sound reduction performance.
• Note that the Rw rating of systems measured as built on site (R'w Field Test) may be up to 5 points lower than the laboratory result.
• The sealing of all gaps is critical in a sound rated construction. Use only sealer approved by the acoustic consultant.
• Check design of all junction details with acoustic consultant prior to construction.
• Check the necessity for HOLD POINTS with the acoustic consultant to ensure that all building details have been correctly interpreted and constructed.
• The information provided in this table is subject to modification and review without notice.
• The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.

APPENDIX D Comparison of EIS predictions to detailed design

The noise modelling assumptions for Bexley Road tunnelling support sites (C4, C5 and C6) are as follows:

- V01
  - Power Generator
  - Installation of enviro controls
  - Demolition of existing structures
  - Vegetation Clearing
- V02
  - Power Generator
  - Establishment of construction facilities
- V03
  - Power Generator
  - Road and intersection modifications and installation of traffic controls (includes OOHW at Bexley)
- V04 – Piling of shaft and buildings (C4 and C5)
- V05 – Shaft Excavation & Construction
- V06 – Tunnel support works (of shaft/ decline - includes OOHW)
- V07 – Construction of MOC2 permanent facilities

The impacts presented in the following tables show a comparison between the predicted impacts presented in the EIS compared with the detailed design. Note that Renzo Tonin & Associates did not prepare the EIS for the New M5. The results presented for the EIS noise predictions are therefore based on our best interpretation of the results presented in the EIS Technical Working Paper; Noise and Vibration [11].

The impacts presented are as follows for **Standard Hours**:

- Complies with NML
- Exceeds NML by less than 10 dB(A) – noise affected
- Exceeds NML by more than 10 dB(A) – noise affected
- > 75 dB(A) – highly noise affected

The impacts presented are as follows for **OOHW Evening and Night**:

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

Table D.1 Summary of construction noise impacts (standard hours)

NCA	Level of compliance with NML for construction stage													
	V01		V02		V03		V04		V05		V06		V07	
	EIS	DD	EIS	DD	EIS	DD	EIS	DD	EIS	DD	EIS	DD	EIS	DD
Bexley compounds	Site establishment										Tunnel support			
NCA15	⬟	⬟	⬟	⬟	⬟	⬟	⬟	⬟	⬟	⬟	⬟	⬟	⬟	⬟
Level above NML, dB(A)	22	22	22	6	23	13	29	8	29	5	7	2	14	14
NCA16A-D	⬟	⬟	⬟	⬟	⬟	⬟	⬟	⬟	⬟	⬟	⬟	⬟	⬟	⬟
Level above NML, dB(A)	11	21	7	4	7	0	28	11	28	7	7	0	0	5
NCA17	⬟	⬟	⬟	⬟	⬟	⬟	⬟	⬟	⬟	⬟	⬟	⬟	-	⬟
Level above NML, dB(A)	5	2	0	0	0	0	15	0	15	0	0	0	-	3
NCA26A-C	⬟	⬟	⬟	⬟	⬟	⬟	⬟	⬟	⬟	⬟	⬟	⬟	⬟	⬟
Level above NML, dB(A)	14	14	9	0	10	0	26	7	26	7	4	0	29	20

Notes

All works to be undertaken during Standard construction hours (7am to 6pm Monday to Friday; 8am to 1pm Saturday)

EIS refers to results presented in EIS noise and vibration assessment report

DD refers to detailed design noise assessment. Number in brackets refers to noise predictions without temporary noise barriers/ acoustic shed.

Table D.2 Summary of construction noise impacts (OOHW)

NCA	Level of compliance with NML for construction stage											
	V01		V02		V03		V04		V05		V05	
	EIS	DD	EIS	DD	EIS	DD	EIS	DD	EIS	DD	EIS	DD
Bexley compounds												
NCA15	-	-	-	-	**	[1]	-	-	-	-	2	[1]
Level above NML, dB(A)						22					20	1
NCA16A-D	-	-	-	-	**	[1]	-	-	-	-	1	[1]
Level above NML, dB(A)						25					26	2
NCA17	-	-	-	-	**	[2]	-	-	-	-	3	[3]
Level above NML, dB(A)						8					3	0
NCA26A-C	-	-	-	-	**	[2]	-	-	-	-	2	[2]
Level above NML, dB(A)						13					15	0

Notes All works to be undertaken during OOHW Evening 6pm to 10pm Monday to Sunday; or OOHW Night 10pm to 7am Monday to Friday and 10pm to 8am Saturday, Sunday and public holidays; OOHW Day 1pm to 6pm Saturday and 8am to 6pm Sundays and public holidays.

Level of compliance reported is based on worst case impact for OOHW period (typically night period)

EIS refers to results presented in EIS noise and vibration assessment report. ** Activity not modelled as OOHW in EIS

DD refers to detailed design noise assessment. Number in brackets refers to noise predictions without temporary noise barriers.

Appendix B: Community Consultation Record

Stage 2 Beverly Hills-St Peters Snapshot Report

Door knock: 1 June 2016

Event Type	Door knock
Event Date	1 June 2016 10:00 AM
Event End Date	1 June 2016 2:00 PM
Location	Kingsgrove and Earlwood
Summary	Door knock to consult about Temporary Noise Barriers - Bexley.
Team Response	Ran through the height, location and colours (Pale Eucalypt, Dune or Windspray) for the proposed temporary noise barriers. Also ran through site establishment works and construction timing for noise barriers. General consensuses from residents on colour were Dune. 10 properties consulted. Left a sorry we missed you card for those not home asking to call back to discuss temporary noise walls. Residents were given three days contact us.
Issues	Consultation: WestConnex Initiated Information
Address	AUSTRALIA
Projects	Stage 2 Beverly Hills-St Peters
Restricted to	Selected Projects Only

Stakeholders:

Full Name	*Address*	*Comments or discussion*
[redacted]	[redacted]	No issue with the noise walls or site establishment works. Wants dune colour.
[redacted]	[redacted]	No issue with the noise walls or site establishment works. Wants dune colour.
[redacted]	[redacted]	No issue with the noise walls or site establishment works. Wants dune colour.
	[redacted]	Not home, left sorry we missed you card asking resident to call back to discuss temporary noise walls.

Stage 2 Beverly Hills-St Peters Snapshot Report

Full Name	*Address*	*Comments or discussion*
[redacted]	[redacted]	No issue with the noise walls or site establishment works. Wants dune colour.
[redacted]	[redacted]	No issue with the noise walls or site establishment works. Wants dune colour.
	[redacted]	Door knocked 1 June - not home, left sorry we missed you card asking resident to call back to discuss temporary noise walls. Phone call - landowner called back on 3 June to discuss noise and vegetation clearing. No issue with the height or the noise wall, and wants dune colour.
	[redacted]	Not home, left sorry we missed you card asking resident to call back to discuss temporary noise walls.
[redacted]	[redacted]	No issue with the noise wall but does not want it more than 2.5 metres high. Likes her views and does not mind looking into the site compound. Wants dune colour.
[redacted]	[redacted]	No issue with the noise walls or site establishment works. Wants dune colour.

Team Members:

Full Name	*Organisation*	*Phone*	*Mobile*	*Email*	*Projects*
[redacted]				[redacted]	

Appendix C: Extract of detailed noise modelling related to the construction of MOC2.

Noise modelling of the key construction activities associated with the Motorways Operation Complex 2 at Bexley Road South Construction Compound has been conducted based on the timeframe of the expected works. The various construction activities and noise model variants that were used in the Construction Noise and Vibration Impact Statement (CNVIS) for the Motorways Operation Complex works are displayed in Table 1 below.

Table 1: Key construction activities associated with Motorway Operations Complex 2.

Activity	Aspect	Timeframe	Noise model variant									
			V1	V2	V3	V4	V5	V6	V7	V8	V9	V10
Early Works	Site Establishment, demolition	April 2108 to May 2018	V1	V2								
Construction of Substation building and installation of Tower Crane	Installation of piles for substation	May 2018		V2								
	Breaking of piles	May 2018		V2								
	Excavation of Crane base and Substation basement	April 2018	V1									
	FRP works	June 2018 to October 2018			V3	V4						
	Steelwork / Precast / Cladding installation to substation	October to November 2018					V5					
Construction of Ventilation building	Excavation of footings in shaft	May 2018		V2								
	FRP works	May 2018 to December 2018		V2	V3	V4	V5	V6				
	Steelwork / Precast / Cladding installation to ventilation building	August 2018 to December 2018				V4	V5	V6				
Civil Works	Installation of piles for Retaining Wall	Feb 2019							V7			
	Breaking of piles	Feb 2019							V7			
	FRP works	April 2019 to May 2019								V8	V9	
	Utilities installation, backfill, pavements	May 2019 to June 2019									V9	V10

Table 2 (below) summarises the predicted impacts for each construction stage in each NCA in terms of compliance with the Noise Management Levels for the construction of Motorways Operation Complex 2 at the Bexley Road South Compound. The colours in the table indicate whether or not receivers in the NCA comply with the NML and, where exceedance of the NML occurs, the perceived impact of the exceedance. There are no regular night-time construction activities planned during the construction of MOC2.

The impacts presented are as follow for **Standard Hours:**

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

Table 2: Key construction activities associated with Motorway Operations Complex 2.

NCA	Level of compliance with NML									
	V01	V02	V03	V04	V05	V06	V07	V08	V09	V10
	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day
NCA15	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
NCA16A	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
NCA16B	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
NCA16C	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
NCA17	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
NCA26A	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
NCA26C	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
OSR	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆

The Other Sensitive Receiver (OSR) listed in Table 2 is the current M5 East facility on Bexley Road adjacent to the site.

The construction and placement of temporary noise barriers has been considered in the development of detailed design for the Motorways Operations Complex. Noise walls are already nearby to site at various locations, including:

- to the north of the site, along the M5 East tunnel portal; and
- at the south of site near the East Hills Railway Line.

The position of the MOC2 adjacent to Wolli Creek, Bexley Road and the 132kv Transgrid cable also provide constraints on the construction and positioning of new temporary noise walls. The nearest residential receivers to the works for MOC2 are approximately 80metres west of the construction site, on the opposite side of Wolli Creek. Due to the topography of the site and the adjacent reserve, it is not feasible to install noise walls between the works and these residences for the following reasons:

- The worksite is directly adjacent to Wolli Creek. A noise wall within the project boundary would need to be built directly adjacent to the concrete channel of Wolli Creek and would require placement within the Probable Maximum Flood (PMF) zone with significant work within the waterway;
- The noise wall would need to be of a significant height (up to 15metres) in order to break line of sight, which would have significant visual impact, as well as impacts on the waterway to construct/support the wall and further construction impacts on the surrounding receivers.

With the separation distance of approximately 80 metres to the nearest residences, there are up to two residences predicted to be highly noise affected by these works. The predictions assume all plant and equipment is operating concurrently at any given time, which is a conservative estimate given the high numbers of plant and equipment that have been taken into account in the noise model. High impact noise activities are also expected to be of relatively short duration.