Division 5.2 and EPBC Act Approval

Appendix D: Construction and operational noise assessment

Proposed changes between Eaton Road, Luddenham and Littlefields Road, Luddenham

The Northern Road Upgrade – Mersey Road, Bringelly to Glenmore Parkway, Glenmore Park

December 2018

NSW GOVERNMENT | Transport Roads & Maritime Services

The Northern Road Stage 6 (TNR6) - Detailed Design

Operational & Construction Noise Modification Assessment

22 October 2018
Document No. 60.00758.01 RPT1R1.DOCX

Roads and Maritime Services
PO Box 973
Parramatta
Sydney
NSW2124

The Northern Road Stage 6 (TNR6) - Detailed Design

Operational & Construction Noise Modification Assessment

Prepared by:

Waves Acoustic Consulting Pty Ltd

Level 7, 56 Pitt Street, Sydney, NSW 2000
ABN 80 610 696 449

T: +61 2 7900 5548
E: info@wavesconsulting.com.au
W: www.wavesconsulting.com.au

TABLE OF CONTENTS

APPENDIX E: ARCHITECTURAL TREATMENTS TABLE – TNR6 vs EIS ALIGNMENTS
APPENDIX F: TRAFFIC DATA USED IN NOISE MODELLING
APPENDIX G: CONSTRUCTION NOISE LEVEL DIFFERENCE MAPS – TNR6 vs EIS ALIGNMENTS
APPENDIX H: CONSTRUCTION NML EXCEEDANCE MAPS

1 Introduction

Stage 6 of The Northern Road (TNR6) upgrade is part of a multistage upgrade of the existing The Northern Road in Western Sydney to facilitate greater transport and traffic demands for the future Western Sydney airport. The TNR6 stage terminates at its northern end approximately 500 m south of Littlefields road. At the southern end the TNR6 road alignment terminates approximately 300 m north of Eaton Road Luddenham. The Northern Road Stage 6 (TNR6) upgrade connects to the TNR5 stage at the northern boundary and the TNR4 stage at the southern boundary.

The predicted environmental impacts of the project were assessed in an Environmental Impact Statement (EIS) completed in May 2017. As part of the EIS, a Noise and Vibration Impact Assessment was undertaken by Jacobs with the Operational Noise Assessment provided by Waves Consulting. This report (IA086100-RP-EN-0129 version J) was issued on 15 May 2017. The project Submissions and Preferred Infrastructure Report (SPIR) was issued in December 2017.

Based on the EIS / SPIR reports (collectively referred to as the 'EIS' in this assessment) the NSW Minister for Planning provided Conditions for Approval which were issued on 30 May 2018 (Application No. SSI 7127). Waves Acoustic Consulting Pty Ltd (Waves Consulting) has been commissioned by the RMS to provide a review of the operational noise impacts of the Detailed Design of the project, in accordance with Condition E36 of the NSW Minister's Conditions of Approval.

In addition, the Commonwealth Conditions of Approval were issued on 15 June 2018. No specific noise conditions were given. No further discussion of the Commonwealth Conditions of Approval will be considered in this report as a result.

The assessment uses specific acoustic terminology throughout. An explanation of common terms is included as Appendix A for reference.

2 Condition of Approval

2.1 Operational Noise

The Ministers Conditions of Approval for the TNR6 stage are the mandatory requirements as per Application No. SSI 7127. The specific operational noise requirements for the Detailed Design assessment are given in Clause E36 as reproduced below with references to where the sub clauses are addressed in this report:

Operational Noise Mitigation Report
E36 A review of the proposed operational noise mitigation measures for the CSSI must be undertaken by the Proponent. The review must be submitted to the Secretary for approval prior to commencing Construction which would affect the identified receivers, or within another timeframe agreed by the Secretary. The review must:

Sub clause	Referenced in this Report
(a) confirm the operational noise predictions of the CSSI based on detailed design. The operational noise assessment shall be based on an appropriately calibrated noise model (which has incorporated additional noise monitoring, where necessary for calibration purposes)	Section 8 and 9
(b) review the suitability of the operational noise mitigation measures identified in the documents listed in Condition A1. The review must take into account the detailed design of the CSSI and where necessary, refine the proposed measures with the objective of meeting the criteria outlined in the NSW Road Noise Policy (DECCW 2011), based on the operational noise performance of the CSSI predicted under (a) above	Section 10
(c) where necessary, investigate additional or alternative noise mitigation measures to achieve the criteria outlined in the NSW Road Noise Policy (DECCW, 2011)	Section 11

Condition A1 refers to the EIS and SPIR reports submitted for the project.

This report provides an operational noise modification review as required by clause E36 of the conditions.

2.2 Construction Noise

The conditions of approval do not specify any conditions in relation to the assessment of construction noise impacts. In the absence of specific conditions, the construction noise impacts due to the modifications of the TNR6 stage will be assessed using the Roads and Maritime Construction Noise and Vibration Guideline (CNVG). The CNVG was used for the assessment of the EIS construction noise impacts; therefore, a comparable and like-for-like assessment is possible. This review will:

Assessment Task	Referenced in this Report
(a) confirm the construction noise predictions of the CSSI based on detailed design.	Section 17
(b) review the suitability of the construction noise mitigation measures identified in the documents listed in Condition A1. The review must take into account the detailed design of the CSSI and where necessary, refine the proposed measures with the objective of meeting the Noise Management Levels (NMLs) outlined in the RMS Construction Noise and Vibration Guideline (CNVG), based on the construction noise performance of the CSSI predicted under (a) above.	Section 18
(c) where necessary, investigate additional or alternative noise mitigation measures to achieve the NMLs outlined in the RMS Construction Noise and Vibration Guideline (CNVG).	Section 19

Condition A1 refers to the EIS and SPIR reports submitted for the project.

3 Operational Noise Criteria

3.1 Noise Criteria Guideline (NCG)

The operational noise of a project refers to the noise emissions due to road traffic once the project is completed and open to the public. The potential for operational noise impacts are assessed against the Noise Criteria Guideline (NCG) which describes the Roads and Maritime implementation of the Road Noise Policy (RNP). The NCG provides a consistent approach to identifying road noise criteria for Roads and Maritime projects.

The NCG is designed to apply more stringent criteria for new roads than for redeveloped roads given the greater opportunity to minimise noise impacts, in accordance with the RNP.

3.1.1 NCG Assessment Principles

The NCG provides the following foundational principles for the assessment of operational road traffic noise:

- Criteria are based on the type of road development which affects a residence.
- Adjacent and nearby residences should not have significantly different criteria for the same road.
- Criteria for the surrounding road network are assessed where a road project generates and increases traffic noise by greater than 2 dB on the surrounding road network.
- Protect existing quiet areas from excessive changes in amenity due to traffic noise.

3.2 NCG Criteria for Residential Receivers

Each residential receiver is individually assessed to determine the most stringent criteria at each facade. There are four (4) types of criteria applicable to residential receivers as defined in the NCG, which are:

- New road criteria.
- Redeveloped road criteria.
- Transition zone criteria.
- Relative increase criteria.

3.2.1 New & Redeveloped Road Criteria

The new and redeveloped road criteria are defined in the RNP and adopted in the NCG as per Table 1 below.

Table 1. NCG Residential New & Redeveloped Road Criteria

Road Category	Type of Project / Land Use	Assessment Criteria	
		Daytime (7am-10pm)	Night-time (10pm-7am)
Freeway / arterial / sub-arterial roads	Existing residences affected by noise from new freeway / arterial / sub-arterial road corridors	55 dB $L_{Aeq(15hour)}$	50 dB $L_{Aeq(9hour)}$
	Existing residences affected by noise from redevelopment of existing freeway /arterial / sub-arterial roads	60 dB $L_{Aeq(15hour)}$	55 dB $L_{Aeq(9hour)}$
	Existing residences affected by additional traffic on existing freeways / arterial / sub-arterial roads generated by land use developments		
Local roads	Existing residences affected by noise from new local road corridors	55 dB $L_{Aeq(1hour)}$	50 dB $L_{Aeq(1hour)}$
	Existing residences affected by noise from redevelopment of existing local roads		

Note: 1. All noise levels are external and measured at 1 m from the facade.

3.2.2 Transition Zone Criteria

In a transition zone, between a new and redeveloped road, a residential receiver is exposed to noise from two road types. Transition zone criteria reflect the degree to which the residence is exposed to noise from each road type. The aim of the transition zone is to ensure noise criteria change smoothly between the two road types. The same criteria are applied at each facade of a residence.

The transition zone criteria are identified from the noise contribution difference from each road type at the residential receiver using Table 2 below. Where the transition zone criteria change across the location of a residence the most stringent of the criteria apply.

Projects typically find new and redeveloped road interfaces where existing roads are diverted to bypass a town or cluster of receivers.

Table 2. Assignment of New and Redeveloped Transition Zone Criteria

Contribution Difference (dB) (New minus Redeveloped Noise Level)	Day Criteria $L_{Aeq(15hour)}$	Night Criteria $L_{Aeq(9hour)}$
Contribution Difference ≥ +3.0	55 (new road criteria)	50 (new road criteria)
+3.0 > Contribution Difference ≥ +1.5	56	51
+1.5 > Contribution Difference ≥ +0.0	57	52
+0.0 > Contribution Difference ≥ -1.5	58	53
-1.5 > Contribution Difference ≥ -3.0	59	54
-3.0 > Contribution Difference	60 (redeveloped road criteria)	55 (redeveloped road criteria)

3.2.3 Relative Increase Criteria

The relative increase criteria are designed to protect residences within quiet areas from large increases in noise (greater than 12 dB) due to new roads or redeveloped roads. Table 3 shows how the relative increase criteria are defined as per the NCG and RNP.

Table 3. NCG Relative Increase Criteria

Road Category	Type of Project / Land Use	Assessment Criteria	
		Daytime (7am-10pm)	Night-time (10pm-7am)
Freeway / arterial / sub-arterial roads	Existing residences affected by increases in traffic noise of 12 dB or more from new freeway / arterial / sub-arterial roads	$L_{Aeq(15hour)}$ + 12 dB	$L_{Aeq(9hour)}$ + 12 dB
	Existing residences affected by increases in traffic noise of 12 dB or more from redeveloped freeway / arterial / sub-arterial roads	$L_{Aeq(15hour)}$ + 12 dB	$L_{Aeq(9hour)}$ + 12 dB

Note: 1. All noise levels are external and measured at 1 m from the facade.

3.3 NCG Criteria for Non-Residential Receivers

Non-residential receivers are assigned fixed noise criteria. Noise criteria for non-residential land uses are presented in Table 4. These criteria are based on the level of impact, below which, normal operations or use can continue with minimal interruption or disturbance.

Table 4. NCG Criteria for Relevant Non-Residential Land Uses

Existing Sensitive Land Use	Assessment Criteria (dB)		Additional Considerations
	Daytime (7am-10pm)	Night-time (10pm-7am)	
School Classrooms	40 $L_{Aeq(1hour)}$ (internal) when in use	–	In the case of buildings used for education or health care, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the 'maximum' levels shown in Australian Standard AS2107:2016
Places of Worship	40 $L_{Aeq(1hour)}$ (internal)	40 $L_{Aeq(1hour)}$ (internal)	The criteria are internal. Areas outside the place of worship, such as a churchyard or cemetery, may also be a place of worship. Therefore, in determining appropriate criteria for such external areas, it should be established what is in these areas that may be affected by road traffic noise.
Open Space (active use)	60 $L_{Aeq(15hour)}$ (external) when in use	–	Active recreation is characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion.
Open Space (passive use)	55 $L_{Aeq(15hour)}$ (external) when in use	–	Passive recreation is characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, eg playing chess, reading. For areas where there may be a mix of passive and active recreation, eg school playgrounds, the more stringent criteria apply. Open space may also be used as a buffer zone for more sensitive land uses.
Childcare Facilities	Sleeping rooms $L_{Aeq(1hour)}$ 35 (internal) Indoor play areas $L_{Aeq(1hour)}$ 40 (internal) Outdoor play areas $L_{Aeq(1hour)}$ 55 (external)	–	Multi-purpose spaces eg shared indoor play / sleeping rooms should meet the lower of the respective criteria. Measurements for sleeping rooms should be taken during designated sleeping times for the facility, or if these are not known, during the highest hourly traffic noise level during the opening hours of the facility.
Aged Care Facilities	-	-	Residential land use noise assessment criteria should be applied to these facilities (as per Table 1).

No motels, aged care facilities or hospital wards were identified within the study area of this assessment.

For sensitive receivers such as schools, places of worship and childcare facilities, the NCG criteria presented in Table 4 are based on internal noise levels.

Internal NCG criteria have been converted to external criteria for the purposes of assessment against external noise level predictions. The non-residential receivers in the TNR6 study have been visually assessed to determine the construction of the building facades and to determine the appropriate internal to external conversion factor for this assessment. Table 5 summarises the non-residential noise sensitive receivers in the TNR6 study area and the internal to external conversion factor used in this assessment.

Table 5. Summary of Non-residential Internal to External Noise Level Conversion Factors

Non-residential Noise Sensitive Receiver	Facade Construction	Internal to External Noise Level Conversion Factor
Luddenham Public School	Standard masonry construction with standard sized glazing. Naturally ventilated.	10 dB
St James Anglican Church	Solid stone construction with small stain glass windows. Naturally ventilated.	10 dB
Luddenham Uniting Church	Solid stone construction with small stain glass windows. Naturally ventilated.	10 dB

3.4 Sleep Disturbance

Guidance for the assessment of sleep disturbance is given in the RNP and is reproduced below:

> *Triggers for, and effects of sleep disturbance from, exposure to intermittent noise such as noise from road traffic are still being studied. There appears to be insufficient evidence to set new indicators for potential sleep disturbance due to road traffic noise. The NSW Roads and Traffic Authority's Practice Note iii (NSW Roads and Traffic Authority 2008) outlines a protocol for assessing and reporting on maximum noise levels and the potential for sleep disturbance.*

The protocol for assessing the potential for sleep disturbance, detailed within *Practice Note iii* of the Roads and Maritime Environmental Noise Management Manual (ENMM), is determined by performing an L_{AFmax} - $L_{Aeq(1hour)}$ calculation on individual vehicle passby noise measurements. A maximum noise level event is then defined as a passby for which the night-time L_{AFmax} - $L_{Aeq(1hour)}$ difference is greater than 15 dB and the L_{AFmax} is greater than 65 dB.

The reaction to potential sleep disturbance events is discussed in the RNP, which gives the following guidance:

> *From the research on sleep disturbance to date it can be concluded that:*
> - *maximum internal noise levels below 50 – 55 dB are unlikely to awaken people from sleep*
> - *one or two noise events per night, with maximum internal noise levels of 65 –70 dB, are not likely to affect health and wellbeing significantly.*

As per the discussion in Section 3.3 internal noise levels can be converted to external noise levels with a 10 dB conversion factor. Based on the above, the first conclusion above suggests that short term external noise levels of 60 - 65 dB L_{AFmax} are unlikely to cause awakening reactions.

It is further concluded that one or two noise events per night with maximum external noise levels of 75 – 80 dB L_{AFmax} are not likely to affect health and wellbeing significantly.

Practice Note iii states that the maximum noise level assessment should be used as a tool to help prioritise and rank mitigation strategies but should not be applied as a decisive criterion.

3.5 Operational Noise Criteria for the TNR6 Stage

The TNR6 study area is predominately affected by a single (1) transition zone. The transition zone is centred at the Elizabeth Drive interchange where the project transitions from a redeveloped section of the road (redevelopment of the existing TNR) into a new section of road (ie the new Luddenham bypass section of road).

North of Elizabeth Drive the residential receivers are classified with redeveloped road criteria. South of Elizabeth Drive the residential receivers are classified with new road criteria. The residential receivers near to the transition zone (at Elizabeth Drive) will have noise criteria that depend on the contribution of the nearby new and redeveloped road sections as per Table 2. The transition zone and the distribution of road criteria are discussed in more detailed in Section 5.7.

4 Operational Noise Mitigation

4.1 Noise Mitigation Guideline (NMG)

The NMG provides guidance in managing and controlling road traffic generated noise and describes the principles to be applied when reviewing noise mitigation. These principles are:

- Communities should receive reasonable and equitable outcomes.
- Noise mitigation should be designed to reduce noise levels to the criteria at qualifying receivers.
- Priority should be first given to reducing noise during corridor planning and road design where there may be greater opportunity to provide cost effective and integrated outcomes with better urban design.
- Following corridor and road design residual exceedances of noise criteria may be addressed at qualifying receivers using, in order of preference, quieter road surfaces, barriers and at-property treatments.
- Incidental benefits from the noise mitigation designed for qualifying receivers should be recognised at all receivers within a community where noise levels exceed WHO guidelines (facade noise levels of 50 dB day and 45 dB night).
- Noise barrier evaluation processes must:
  a. Give preference to reducing outdoor noise levels and the number of at-property treatments.
  b. Provide efficient barrier heights and extents without disregarding lengths of effective noise barrier in front of eligible groups of receivers.
- Noise mitigation shall be evaluated and installed where feasible and reasonable.

4.2 NMG Additional Mitigation Triggers

The NMG has three (3) mitigation triggers which are used to identify if a receiver qualifies for consideration of additional mitigation (beyond the adoption of road design and traffic management measures). The mitigation triggers are:

Trigger 1

- The predicted BUILD noise level exceeds the NCG controlling criterion and the noise level increase due to the project (ie the noise predictions for the BUILD minus the NO BUILD scenario) is greater than 2 dB.

Trigger 2

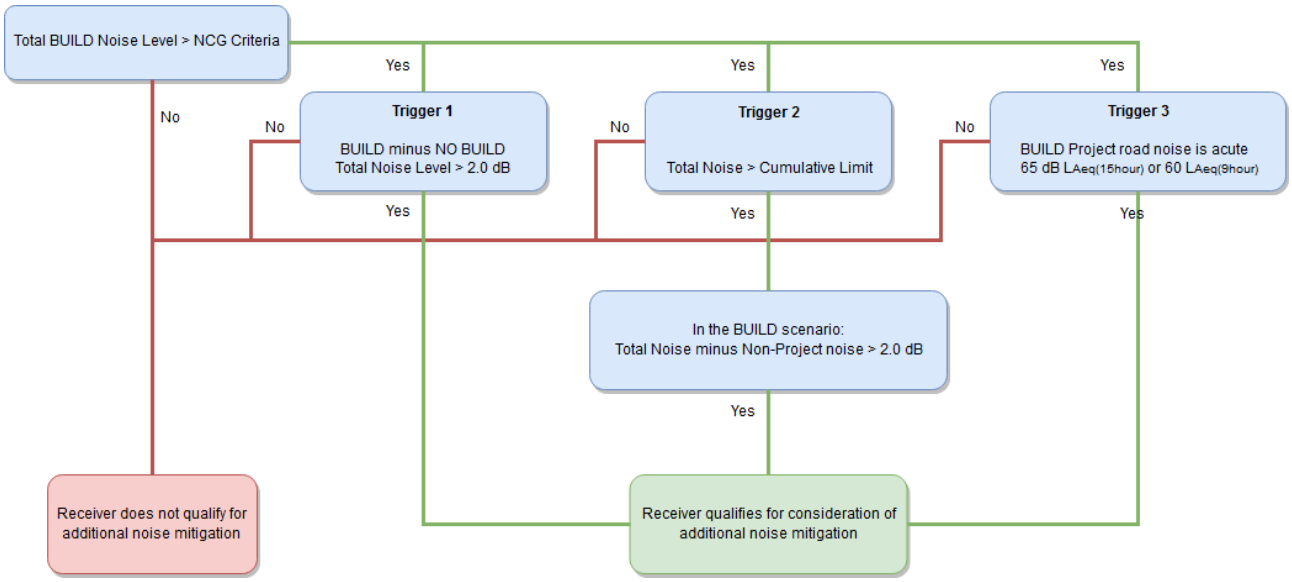
- The predicted BUILD noise level is 5 dB or more above the criteria (exceeds the Cumulative Limit) and the receiver is significantly influenced by project road noise, regardless of the incremental impact of the project.

Trigger 3

- The noise level contribution from the road project is acute: greater than 65 dB $L_{Aeq(15hour)}$ or 60 $L_{Aeq(9hour)}$ (regardless of the noise contribution from non-project roads).

Figure 1 illustrates a flow diagram of the decision tree required to assess the additional mitigation triggers applicable through the NMG.

Figure 1. NMG Additional Mitigation Triggers – Flow Diagram



4.3 NMG Feasible & Reasonable Additional Mitigation Measures

Where operational noise levels from the project (without mitigation) are predicted to exceed the NCG criteria the assessment must determine the acoustic benefit from the following additional mitigation measures (in priority order):

- Low noise road pavements.
- Noise mounds / barriers.
- Architectural treatments.

The priority of the additional mitigation measures recognises that at source noise control is preferable to control of the propagation path or mitigation directly at the receiver.

The NMG notes that the additional mitigation measures should be both feasible and reasonable. Selecting reasonable measures from those that are deemed feasible requires judging whether the overall noise benefits outweigh the overall social, economic and environmental effects, including the cost of the mitigation measure. To make this type of judgement, consideration must be given to noise impacts, noise mitigation benefits, the cost effectiveness of noise mitigation and community views.

For example, the NMG considers it is not reasonable to provide low noise road pavements or noise barriers where there are fewer than four (4) closely spaced receivers. In this case, it is considered reasonable and cost-effective to provide architectural treatments to each receiver instead.

5 Operational Noise Methodology

5.1 Noise Model Prediction Algorithms

Noise modelling of the study area was carried out using the *Calculation of Road Traffic Noise* (CORTN) (UK Department of Transport, 1988) algorithms incorporated in SoundPLAN V7.1. The modelling allows for traffic volume and mix, type of road surface, vehicle speed, road gradient, reflections off building surfaces, ground absorption and shielding from ground topography and physical noise barriers.

The output of the CoRTN algorithms are designed to predict the L_{A10} noise metric. This CoRTN L_{A10} output has been modified to calculate the relevant daytime $L_{Aeq(15hour)}$ and night-time $L_{Aeq(9hour)}$ road traffic noise emission levels at noise sensitive receivers, as required by the RNP.

The CoRTN traffic source line as modelled in SoundPLAN has also been modified to incorporate four effective noise sources (and associated heights) for each carriageway. This is done to simulate one (1) car noise source and three (3) separate noise sources of heavy vehicles (ie tyres, engine and exhaust). These sources each have a different height and noise level.

5.2 Noise Model Calculation Parameters

A summary of the noise model calculation parameters used in this assessment are provided in Table 6 below.

Table 6. Summary of Noise Model Calculation Parameters

Calculation Parameter	Assigned Attribute	
Proportion of Absorbing Ground	0.50 (residential areas) 0.75 (rural areas)	
Vehicle Speed (2021 and 2031 BUILD and NO BUILD)	Existing The Northern Road Redeveloped The Northern Road Sections New Bypass The Northern Road Sections Surrounding network roads	Posted speeds 90 km/h 90 km/h Posted speeds
Source Heights & Source Correction (dB)	Cars Truck tyres Truck engines Truck exhausts	0.5 m (0.0 dB) 0.5 m (-5.4 dB) 1.5 m (-2.4 dB) 3.6 m (-8.5 dB)
Road Surface Corrections (applied to all modelled source lines as a surface correction)	Existing The Northern Road Redeveloped The Northern Road Sections New Bypass The Northern Road Sections Surrounding network roads	All roads as per the EIS and TNR6 design are Dense Graded Asphalt (AC14) which has a 0 dB correction.
Congestion / Intersections	Noise modelling is based on the free-flowing traffic. This is consistent with traffic flow conditions reported during traffic surveys undertaken for the EIS and this assessment. No corrections have been applied at intersections.	
Sensitive Receiver Points	All sensitive receiver buildings, all facades and all floors, excluding facades shorter than 3.0 meters. Facade assessment point located at the centre of the facade.	
Receiver Location (@ 1m from facade)	Ground floor First floor	1.5 m 4.5 m
Facade Correction	+2.5 dB	
ARRB	-1.7 dB for facade conditions -0.7 dB for free-field conditions	
L_{A10} to L_{Aeq}	-3 dB	
$L_{Aeq(period)}$ to $L_{Aeq(1hour)}$ correction[4]	$L_{Aeq(15hour)}$ to $L_{Aeq(1hour)}$ +2.3 dB[1] $L_{Aeq(9hour)}$ to $L_{Aeq(1hour)}$ +3.9 dB[1]	
Validation Safety Factors[2]	+0.9 dB $L_{Aeq(15hour)}$ +1.5 dB $L_{Aeq(9hour)}$	

Notes: 1. Corrections are derived from noise monitoring data for Location 16, 18 Eaton Road, Luddenham as per the EIS validation.
2. See Section 8.3 for details.

5.3 Noise Model Input Data

A summary of the new and existing input data used to generate the noise models is provided in Table 7 below.

Table 7. Summary of the Noise Model Input Data

Input Data	Source of Data
Ground Topography of the Surrounding Environment	As per the EIS and provided by Jacobs (December 2016): The TNR terrain data was derived from NSW Land Property Information (LPI) 1m resolution bare earth Digital Elevation Model (DEM). The DEM was produced from a standard LiDAR survey conducted by LPI. *Reference: NSW Land Property Information (LPI) LiDAR Product Specifications, Version 3.0, March 2013.*
Receiver Locations	As per the EIS and provided by Jacobs (December 2016) and updated in January & July 2018: Footprints taken from aerial photography. Building heights determined from site inspections and Google Streetview.
Traffic Data	As per the EIS and provided by Jacobs (December 2016) and updated in August 2018: The overall traffic volumes, speeds and vehicle mix assessed during the EIS for the NO BUILD scenario on Project roads have not changed. The overall traffic volumes, speeds and vehicle mix assessed during the EIS for the NO BUILD scenarios on Non-Project roads have changed. The overall traffic volumes, speeds and vehicle mix assessed during the EIS for the BUILD scenario on both Project and Non-Project roads have changed. The number of vehicle lanes for the BUILD Project roads (mainlines of the TNR6) have changed which is discussed in more detail in Section 7. All traffic data used in the noise modelling is provided in Appendix F.
NO BUILD Road Design & Topography	Provided by Jacobs (December 2016): The NO BUILD scenario road design and topography remain unchanged from the EIS.
BUILD Road Design & Topography	Provided by Mott MacDonald (June 2018): TNR6 Detailed Design road alignment topography. TNR6 Detailed Design road centre lines.

5.4 Noise Model Validation

Noise model validation was investigated in this assessment as per Clause E36 (a) of the Ministers Conditions of Approval. Section 8 details the additional noise model validation undertaken as part of this assessment.

5.5 Assessment Scenarios

The following four (4) scenarios have been modelled in this assessment as per the requirements of the NCG:

- 2021 NO BUILD

  Modelling is based on 2021 (year of opening) traffic on the existing road network.
- 2021 BUILD

  Modelling is based on 2021 (year of opening) traffic volumes for the road network that includes the newly-upgraded The Northern Road and the diversion around the planned western Sydney airport.
- 2031 NO BUILD

  Modelling is based on the 2031 (year of opening + 10 years) traffic volumes on an unchanged road network (ie The Northern Road is not upgraded). This future traffic scenario includes the additional trips generated by forecast land use changes (ie western Sydney airport and Western Sydney Priority Growth Area) and other road network changes (proposed M12, Bringelly Road upgrade, etc).
- 2031 BUILD

  Modelling is based on the 2031 (year of opening + 10 years) traffic volumes based on a road network that includes The Northern Road, the diversion around the planned western Sydney airport. This future traffic scenario includes the additional trips generated by forecast land use changes (ie western Sydney airport and Western Sydney Priority Growth Area) and other road network changes (proposed M12, Bringelly Road upgrade, etc).

Each of these scenarios is modelled for both daytime (7am-10pm) and night-time (10pm-7am) periods.

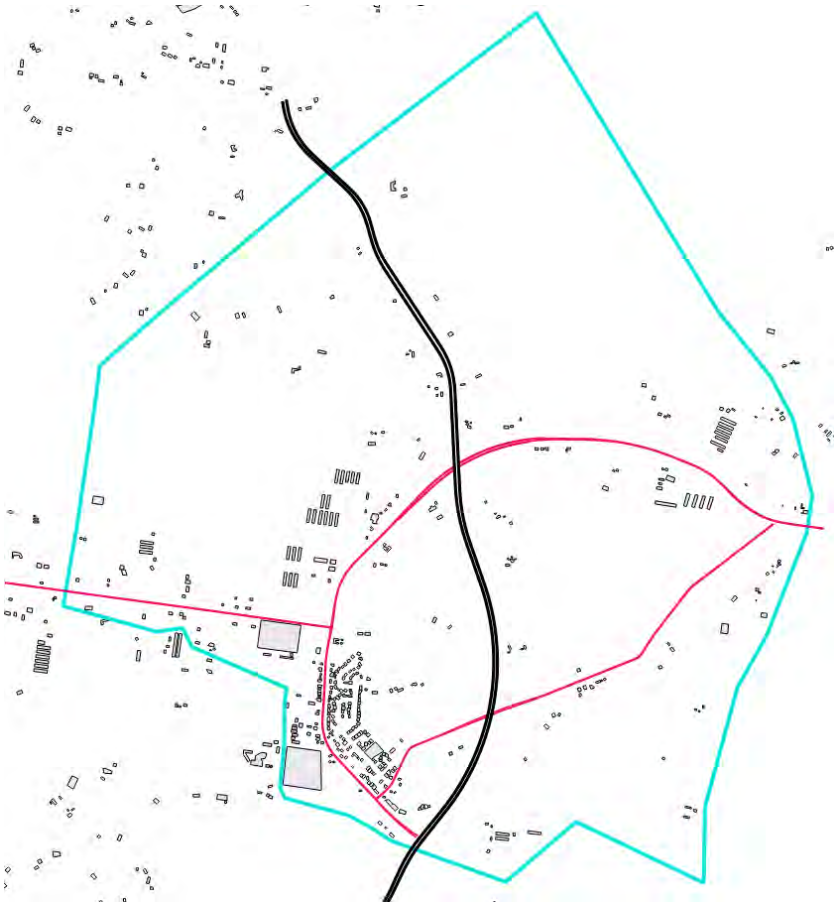
5.6 Assessment Study Area

The typical study area required in the NCG is defined by a 600 m buffer adjacent to either side of the main alignment. At the ends of the alignment a ‘hard’ edge is drawn which extends perpendicularly out to a distance of 600 m. The study area can be manually adjusted to include logical boundaries of houses or streets which are divided at the 600 m interface or hard edge of the alignment.

Figure 2 shows the study area used in this assessment. We note that the study area has been increased to include sensitive receivers at distances greater than 600 m. This expanded study area adjacent to the alignment was done as an additional modelling precaution for the detailed design assessment to capture all potential ‘relative increase criteria’ receivers in the study area. The completed modelling and assessment ultimately found that the increased study area had no impact on the noise study outcomes.

In addition, the study area has been expanded past the hard edge of the southern boundary to include a small number of receivers in the TNR4 study area. This is because the vertical alignment changes that occur between the TNR4 and TNR6 noise models could not be accurately assessed until the TNR6 design was complete. At the time of the TNR4 assessment the TNR6 design was incomplete so the new bypass section of The Northern Road could not be modelled as a continuous section of road. Assessment of TNR6 means the new bypass section of The Northern Road can be modelled as a continuous section of road. Therefore, the TNR6 study area has been expanded to include the potentially affected receivers in the TNR4 study area. Accordingly, the Noise Catchment Areas (NCAs) have been adjusted to extend to the boundaries of the TNR6 study area.

Figure 2. Study Area for the TNR6 Stage



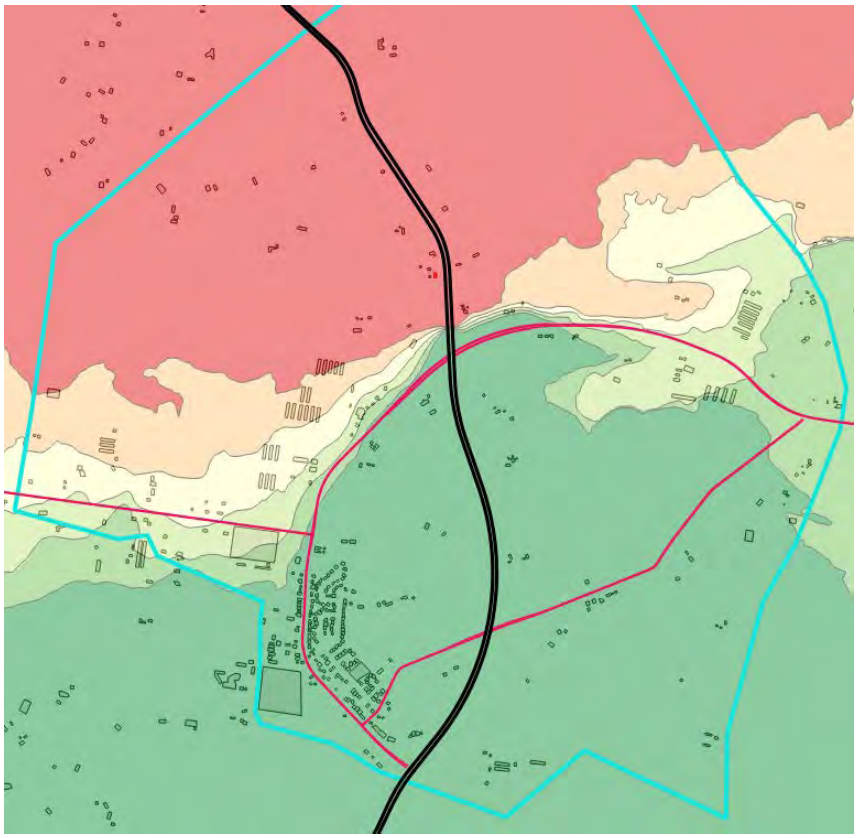
Note: 1. Light blue box highlights the TNR6 study area.
2. Black lines show the TNR6 roads (main alignment)
3. Pink lines show the existing The Northern Road and local road network.
4. Grey boxes show the noise sensitive receivers.
5. Grey outline shows the new NCAs which have been extended to meet the TNR6 study area.

5.7 Assessment Transition Zone

As discussed in Section 3.5 the TNR6 stage study area is predominately affected by a single (1) transition zone. The transition zone is centred at the Elizabeth Drive interchange where the project transitions from a redeveloped section of the road (redevelopment of the existing TNR) into a new section of road (ie the new Luddenham bypass section of road).

Figure 3 shows the transition zones and contribution difference map inside the TNR6 stage study area.

Figure 3. Transition Zone / Contribution Difference Map Inside the TNR6 Study Area



Notes: 1. Red shows a Contribution Difference > 3 dB and therefore New Road Criteria.
2. Dark Green shows a Contribution Difference <3 dB and therefore the Redeveloped Road Criteria.
3. Colours in-between are assigned as per the criteria steps given in Table 2.

North of Elizabeth Drive the residential receivers are classified with redeveloped road criteria. South of Elizabeth Drive the residential receivers are classified with new road criteria. The residential receivers near to the transition zone (at Elizabeth Drive) will have noise criteria that depend on the contribution of the nearby new and redeveloped road sections as per Table 2. The transition zone in the TNR6 assessment is slightly different to that presented in the EIS. This difference is due to the changes to the NO BUILD and BUILD traffic volumes in the Project (The Northern Road) and Non-Project Roads (Elizabeth Drive). The changes have affected the transition zone criteria at a small (< 15) number of receivers.

6 EIS Operational Noise Assessment Outcomes

6.1 NCG Criteria Exceedances (Without Mitigation)

Table 8 below identifies the EIS NCG criteria exceedances without any noise mitigation. The 'without mitigation' noise predictions identify receivers which qualify for consideration of additional noise mitigation. Feasible and reasonable additional noise mitigation is then assessed (by priority) for low noise pavements, noise barriers and architectural treatments as discussed in Section 4.3.

Table 8. EIS NCG Criteria Exceedances (Without Mitigation) in the TNR6 Study Area

Noise Catchment Area	Total Receivers	Qualify for Consideration of Additional Mitigation
NCA02	9	2
NCA03	26	5
NCA04	23	5
NCA05	228	9
Total	**286**	**21**

Note: 1. NCAs adjusted as necessary to include only those inside the TNR6 study area. The NCAs are therefore slightly different to the EIS and respective counts are not directly comparable.

6.2 Low Noise Pavement

The EIS found that there were no groupings of four (4) or more receivers that qualified for consideration of additional noise mitigation. Therefore, low noise pavements were not considered as noise mitigation in the EIS.

The EIS road design was surfaced with Dense Grade Asphalt (AC14) throughout.

6.3 Noise Barriers

The EIS found that there were no groupings of four (4) or more receivers that qualified for consideration of additional noise mitigation. Therefore, noise barriers were not considered as noise mitigation in the EIS.

6.4 Architectural Treatments

Since low noise pavements and noise barriers were not considered reasonable or feasible during the EIS assessment, the receivers which are considered eligible for additional mitigation should be mitigated with architectural treatments.

Table 9 below summarises the number of receivers which qualified for architectural treatment in the EIS assessment.

Table 9. Number of Receivers which Qualified for Architectural Treatments in the EIS

Noise Catchment Area	Total Receivers	Qualify for Consideration of Additional Mitigation
NCA02	9	2
NCA03	26	5
NCA04	23	5
NCA05	228	9
Total	**286**	**21**

Note: 1. NCAs adjusted as necessary to include only those inside the TNR6 study area. The NCAs are therefore slightly different to the EIS and respective counts are not directly comparable.

Appendix D presents a map of the receivers which qualified for architectural treatment as per the EIS assessment.

7 TNR6 Design Compared to EIS Design

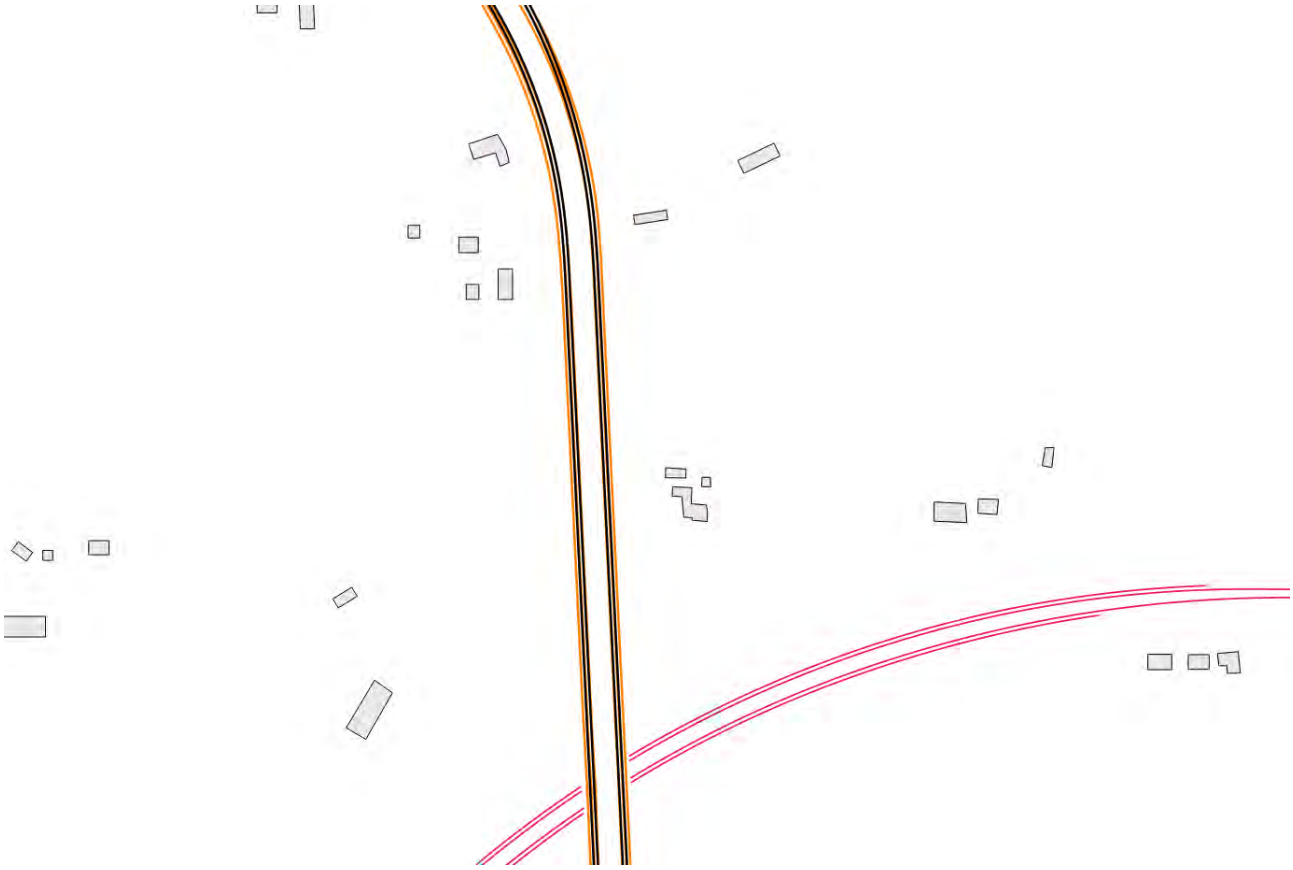
The TNR6 Detailed Design is different to the EIS design. The following sections highlight the physical differences between the designs which are relevant to the assessment of noise impacts.

In the EIS, the road design had three (3) lanes of traffic with lane 1 dedicated as a bus lane. The SPIR revised design removed the dedicated bus lane and redistributed this bus lane traffic onto the remaining two (2) lanes of the SPIR revised design. However, during the SPIR a quantitative noise assessment to account for the bus lane removal was not conducted. The TNR6 design is a progression of the SPIR revised design, so it also has no dedicated bus lane. Since a quantitative noise assessment was not conducted during the SPIR the TNR6 design noise results will be compared with the quantitative noise results from the EIS.

7.1 Overview of the Design Changes

Generally, the TNR6 Detailed Design horizontal alignment either exactly follows the EIS alignment or the lanes have been shifted towards the overall centre line of the design. This is illustrated below in Figure 4.

Figure 4. Typical Horizontal Alignment Changes between the EIS (Bus Lane Not Shown) and TNR6 Detailed Design



Note 1. Orange = EIS alignment (bus lane not shown). Black = TNR6 Detailed Design Alignment
2. Approximate location adjacent to 2843-2857 The Northern Road_4, Luddenham, NSW

The typical horizontal alignment changes show the main lanes of the TNR6 Detailed Design move closer to the overall centre of the design. This means that noise emissions are likely to be (marginally) lower since the offset distances to the noise sensitive receivers will be increased (assuming equivalent elevations).

7.2 Vertical Alignment / Topological Changes

In addition, to the lane changes and horizontal movements of the alignment the TNR6 design changes the vertical alignment of the road design throughout the study area. Figure 5 highlights the vertical alignment differences between the TNR6 and EIS designs with chainage (0 m starts at the southern end of the TNR6 stage).

Figure 5. TNR6 minus EIS Alignment Height Differences with Chainage

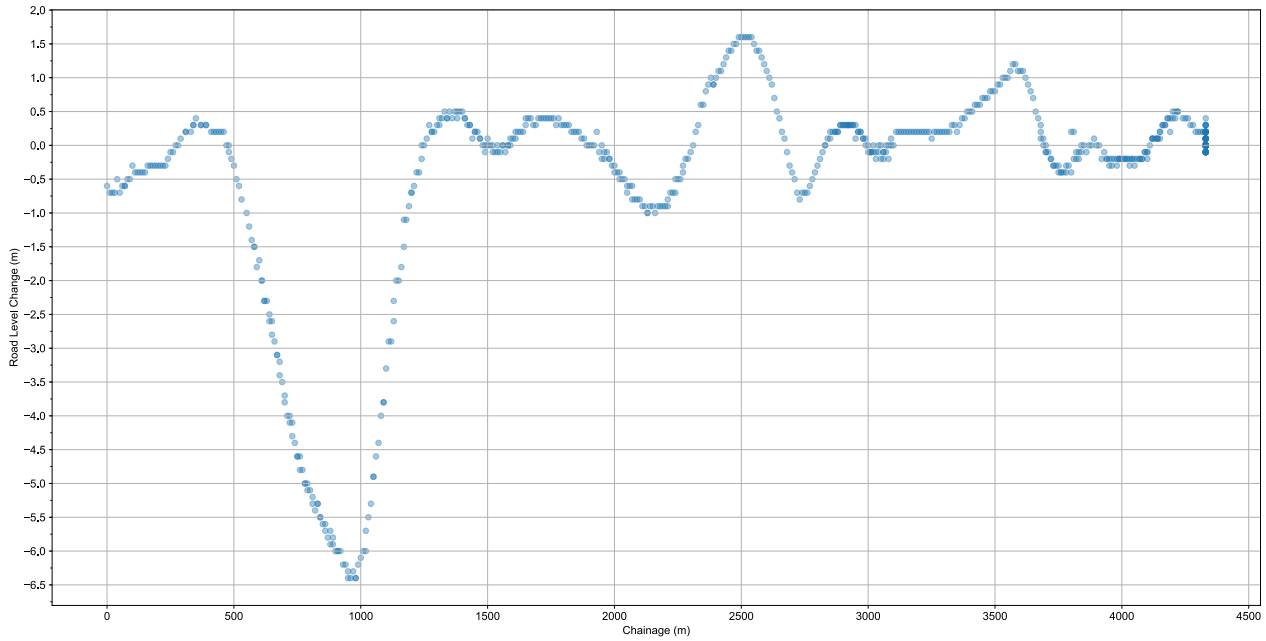


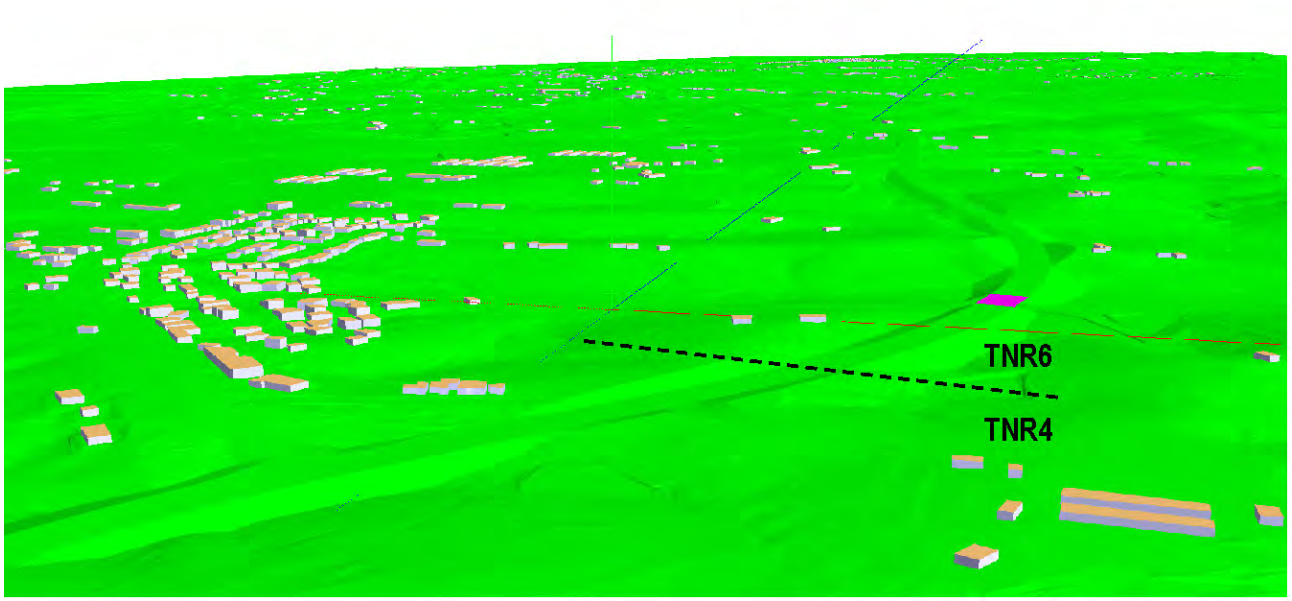
Figure 5 illustrates that there are several locations which have different height reductions (cuts) and height increases (fills) compared to the original EIS design. Vertical changes of alignment can cause changes to propagation distances, shielding and angle-of-view between the source (road) and the receiver, which in turn can affect noise levels.

The TNR6 design has reduced the overall width / footprint of the road alignment by reducing one (1) lane of traffic in each direction compared to the EIS design. This translates to generally steeper cut and fill sections for the TNR6 design due to the narrower alignment footprint.

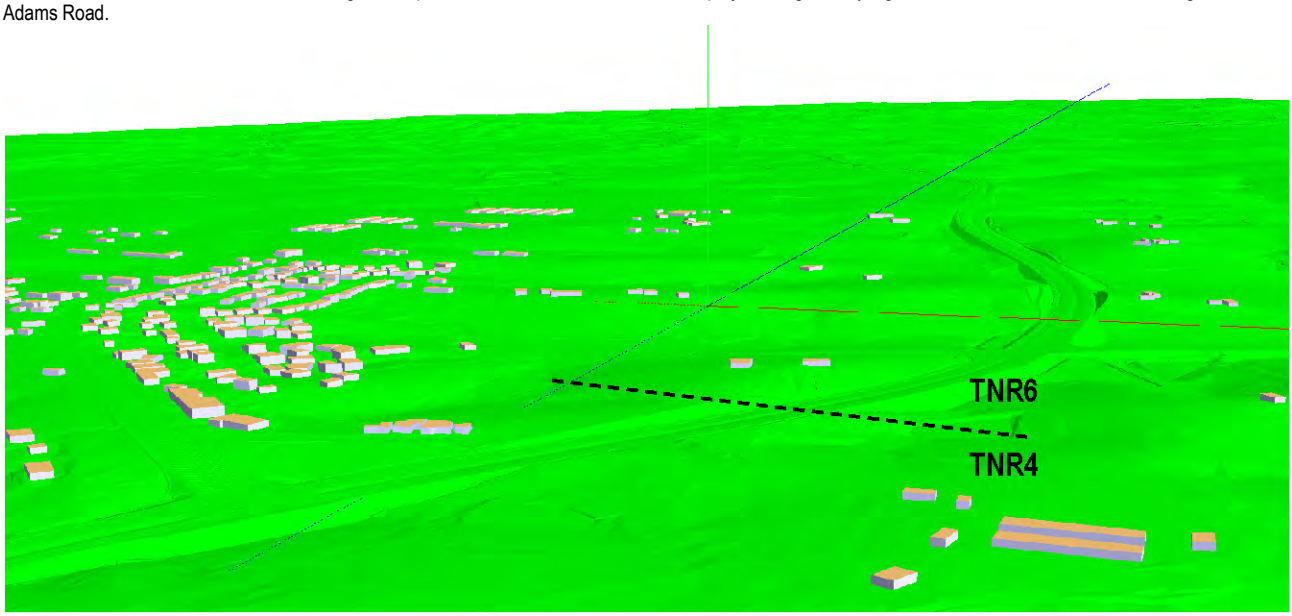
7.2.1 Adams Road Interchange

At its southern end the TNR6 stage merges into the TNR4 stage. The TNR6 stage has significant design changes compared to the EIS alignment at Adams Road, which is now at-grade to form an interchange. Whereas, the EIS design had a bridge over Adams Road. The new Adams Road interchange affects the alignment in TNR6 and TNR4 as the road height is reduced to form the at-grade Adams Road interchange. Figure 6 and Figure 7 show the topographical changes in this area and the vertical road alignment changes in both the TNR4 and TNR6 stages.

Figure 6. 3D Render of the EIS and TNR4 / TNR6 Ground Topography Differences



Note: 1. EIS Model with Adam Road bridge in Purple. TNR4 and TNR 6 sections of the project are generally higher in this location to traverse the bridge over Adams Road.



Note: 1. TNR4 / TNR6 alignment levels with Adam Road. Alignment generally lower in this location to meet new intersection at Adams Road.

Figure 7. Geographic View of the Road Height Reduction Near the Intersection with Adams Road

Note: 1. TNR4 main alignment with height differences between TNR4 and EIS shown in Black.
2. TNR6 main alignment with height differences between TNR6 and EIS shown in Orange.
3. Local roads in Pink.

The information shown in Figure 7 demonstrates the large vertical alignment changes required to create the Adams Road interchange in the TNR6 stage and how the vertical alignment of the design in TNR4 also changes as a result.

The noise models used in this assessment included ground topography and road alignment information from the TNR4 stage at the TNR4/TNR6 interface. Therefore, the assessment accurately captures the noise changes in the TNR6 study area that result from the vertical alignment changes around the Adam Road interchange.

7.3 Lane Changes on Projects Roads (Main Alignment)

In the EIS, the design had three (3) lanes of traffic with lane 1 dedicated as a bus lane. The SPIR revised design and the TNR6 design remove the dedicated bus lane, effectively taking the number of lanes from three (3) down to two (2). However, the amount of traffic predicted on the road (overall) remains unchanged from the EIS. Therefore, the traffic from the EIS bus lane has been redistributed into the remaining lanes in the TNR6 design. The redistribution of traffic is straight forward and shown in Table 10 below.

Table 10. Redistribution of the EIS Traffic into the TNR6 Design

EIS Traffic	TNR6 Traffic
Lane 1 (bus lane)	Lane 1
Lane 2	
Lane 3	Lane 2

7.4 Traffic Volume Changes

As part of the detailed design assessment for the TNR6 stage the traffic consultants (Jacobs) undertook additional traffic monitoring on Adams Road. The new traffic data on Adams Road was used to update the traffic model for the whole project. This was done to refine the traffic models and provide greater accuracy for the new traffic volumes caused by the interchange at Adams Road in the TNR6 stage.

The new traffic monitoring and modelling changed the traffic volumes in the NO BUILD and BUILD scenarios for the Project (main alignment) and Non-Project (local) roads. These traffic changes were incorporated into the noise models for this assessment. Table 11 summarises the traffic volume changes along the main alignment and along Adams Road due to the new interchange.

Table 11. Summary of Traffic Volume Changes in the TNR6 Compared to the EIS

Road	Time Frame 1 (2021)				Time Frame 2 (2031)			
	Cars (15hr)	HGV (15hr)	Cars (9hr)	HGV (9hr)	Cars (15hr)	HGV (15hr)	Cars (9hr)	HGV (9hr)
NO BUILD Project Roads								
TNR6 North Bound	-	-	-	-	-	-	-	-
TNR6 South Bound	-	-	-	-	-	-	-	-
BUILD Project Roads[1]								
TNR6 North Bound	-134	104	-39	14	-349	-3	-68	-7
TNR6 South Bound	-326	115	-59	20	180	79	33	6
NO BUILD Non-Project Roads								
Adams Road East Bound	400	251	-13	13	1000	964	-110	7
Adams Road West Bound	-77	77	-74	-3	-37	424	-156	5
BUILD Non-Project Roads								
Adams Road East Bound	1652	83	285	17	2544	99	486	22
Adams Road West Bound	1099	247	106	12	2356	218	173	13

Note: 1. Median of the traffic volume changes used.

Appendix F provides the detailed traffic volume data used in the noise modelling for this assessment.

8 Condition E36(a) – Operational Noise Model Validation

8.1 EIS Validation

Noise model validation is used to verify that noise predictions fall within the generally accepted tolerance for model accuracy of ± 2 dB. This is done by comparing the difference between the noise model predictions and measured noise levels at specific validation locations.

During the EIS assessment the noise model was validated using measured noise levels and traffic count data at various locations adjacent to the entire EIS alignment. The validation noise modelling and measured noise levels were processed and compared to determine the validation corrections. Table 12 summarises the EIS validation results.

Table 12. EIS Validation Results

	Predicted Noise Levels		Measured Noise Levels		Difference	
ID	$L_{Aeq(15hour)}$	$L_{Aeq(9hour)}$	$L_{Aeq(15hour)}$	$L_{Aeq(9hour)}$	$L_{Aeq(15hour)}$	$L_{Aeq(9hour)}$
N10	62.1	57.2	60.9	57.5	1.2	-0.3
N11	56.2	51.3	54.7	50.3	1.5	1.0
N12	61.4	56.4	60.4	55.8	1.0	0.6
N13	60.8	55.8	60.9	55.8	-0.1	0.0
N14	60.2	55.2	60.8	54.3	-0.6	0.9
N18	59.3	54.8	58.8	54.2	0.5	0.6
				Median	**0.7**	**0.6**
				Standard Deviation	**0.7**	**0.5**

The EIS validation locations were all adjacent to existing residential buildings with complex contributions from facade reflections, local roads, and local screening effects. In general, the EIS validation results were found to slightly over-predict when compared to the measured noise levels.

8.2 Additional Model Validation – E36(a)

To satisfy the requirements of condition E36(a) of the Ministers Conditions additional noise model validation was undertaken for the TNR4 project.

8.2.1 Additional Traffic Monitoring

Concurrent traffic counting (by Matrix Traffic & Transport Data) and ambient noise monitoring were undertaken during the period 13 February to 23 February 2018. Traffic counting equipment was deployed in both directions of the main carriageway at approximately 100 m south of 2026 The Northern Road, Luddenham. This location was selected in consideration of the following:

- Free flowing traffic conditions.
- No large gradient changes.
- No tight bends / corners.
- No posted speed changes.

The traffic data inputs for the validation modelling are summarised in Table 13 below.

Table 13. Additional Validation Traffic Data – 100 m south 2026 The Northern Road, Luddenham

Time Period	North Bound Traffic			South Bound Traffic		
	Speed (km/h)	Volume Cars	Volume HV	Speed (km/h)	Volume Cars	Volume HV
Daytime (7am-10pm)	75.8	5519	644	73.4	5533	479
Night-time (10pm-7am)	80.3	919	80	77.4	1133	72

Note: 1. HV – Heavy Vehicles (C3 to C12)
2. Speed is the weighted average speed for the periods of concurrent noise monitoring.

8.2.2 Additional Noise Monitoring

Additional noise monitoring was undertaken at three (3) separate locations on the same property. The logging locations were selected in consideration of the following:

- Free field conditions with no buildings or acoustic screening nearby.
- Surrounding topography with no sudden gradient changes.
- Free flowing traffic conditions.
- No tight bends / corners.
- No posted speed changes.
- Consistent ground absorption – soft ground.
- ≥ 150^{o} line-of-sight to the road.
- Loggers can be placed at varying perpendicular distances from the road along a straight line.
- Access and security.

Figure 8 shows the validation noise logger locations selected for the assessment at 1935 The Northern Road, Luddenham.

Figure 8. Validation Logger Locations – 1935 The Northern Road, Luddenham

Note: 1. The buildings shown in grey adjacent to the noise loggers and to the north have been demolished as part of the future airport construction. They were not included in the validation model as a result.
2. The blue dots show the location of the noise loggers used in the TNR4 validation. The distance from the existing The Northern Road (lane edge) for each logger is given in brackets().

All noise measurement instrumentation used in the survey was designed to comply with the requirements of Australian Standard AS IEC 61672.1—2004 - *Electroacoustics—Sound level meters, Part 1: Specification* and carried appropriate and current National Association of Testing Authorities (NATA) calibration certificates.

The equipment was set up with microphones at 1.5 metres above the ground level. All microphones were fitted with wind shields.

The noise monitoring was conducted over two (2) separate survey periods to ensure a full seven (7) days of noise data was captured. The field calibration of the loggers was checked both before and after each measurement survey. The variation (or drift) in calibration at all locations was found to be within the allowable tolerance of ≤ 0.5 dB. Table 14 summarises the survey periods, equipment used and the calibration variation during each survey period.

Table 14. Noise Measurement Equipment and Calibration Verification

Logger	Equipment	Serial Number	Survey 1 13/02/2018 to 20/02/2018 Calibration (dB)			Survey 2 21/02/2018 to 23/02/2018 Calibration (dB)		
			Pre-Survey	Post Survey	Variation	Pre-Survey	Post Survey	Variation
Logger 1	Svan 957	14566	3.0	3.0	0.0	3.0	2.8	-0.2
Logger 2	Svan 959	21293	2.2	2.3	+0.1	2.2	2.1	-0.1
Logger 3	Svan 955	28808	-0.5	-0.6	-0.1	-0.6	-0.7	-0.1

The noise loggers continuously measured 1/3 octave band noise levels in 15-minute sampling periods to determine the existing L_{Aeq}, L_{A90} and other relevant statistical noise levels during the daytime and night-time periods.

The results of the noise monitoring have been analysed in 1/3 octave bands and processed to exclude noise identified as extraneous and / or data affected by adverse weather conditions such as strong wind or rain. The results of the unattended noise logging surveys are summarised in Table 15 as the L_{Aeq} (energy averaged) noise levels for the RNP / NCG daytime and night-time periods.

Table 15. Summary of the Additional Noise Logging

Logger	RNP / NCG Time Periods			
	Daytime $L_{Aeq(15hour)}$	Night-time $L_{Aeq(9hour)}$	Daytime $L_{Aeq(1hour)}$	Night-time $L_{Aeq(1hour)}$
Logger 1	65.3	61.9	67.2	66.0
Logger 2	52.7	49.6	55.4	53.8
Logger 3	44.2	39.8	46.7	42.8

Appendix B provides weekly and daily graphical summaries of the additional noise monitoring data (with exclusions) used in the validation assessment.

8.2.3 Additional Validation Noise Model

The validation noise model used was identical to that used in the EIS except for the following logical changes:

- Changes to the measured traffic volumes and weighted average speeds as per the recent traffic monitoring given in Table 13.
- Free-field noise model receiver locations.
- Buildings close to the monitoring locations, which have been demolished as part of the new airport project, were removed from the noise model.

8.2.4 Additional Validation Results

The validation noise modelling and measured noise levels were processed and compared to determine the additional validation corrections. Table 16 summarises the additional validation results.

Table 16. Additional Validation Results

	Predicted Noise Levels		Measured Noise Levels		Difference	
ID	$L_{Aeq(15hour)}$	$L_{Aeq(9hour)}$	$L_{Aeq(15hour)}$	$L_{Aeq(9hour)}$	$L_{Aeq(15hour)}$	$L_{Aeq(9hour)}$
Logger 1	65.1	60.3	65.3	61.9	-0.2	-1.6
Logger 2	54.1	49.3	52.7	49.6	1.4	-0.3
Logger 3	43.7	38.9	44.2	39.8	-0.5	-0.9
				Median	**-0.2**	**-0.9**
				Standard Deviation	**0.8**	**0.5**

In general, the additional validation results were found to slightly under-predict when compared to the measured noise levels.

8.3 Safety Factor Applied to the TNR6 Stage

When assessing the Detailed Design of a project a safety factor is typically applied to the predicted noise levels to provide a margin of error when determining the noise impacts. In effect, the safety factor causes the noise model of the Detailed Design to slightly over-predict the noise levels and therefore the noise impacts. The safety factor varies between projects; however, generally a safety factor of 1 dB is used to ensure a conservative assessment is achieved.

The latest additional validation factors show a slight under-prediction in the noise models. However, the original EIS validation factors showed a slight over-prediction in the noise models. The difference between the validation factors can be applied as the safety factor. In this case, the safety factor is calculated to be +0.9 dB for the daytime and +1.5 dB for the night-time.

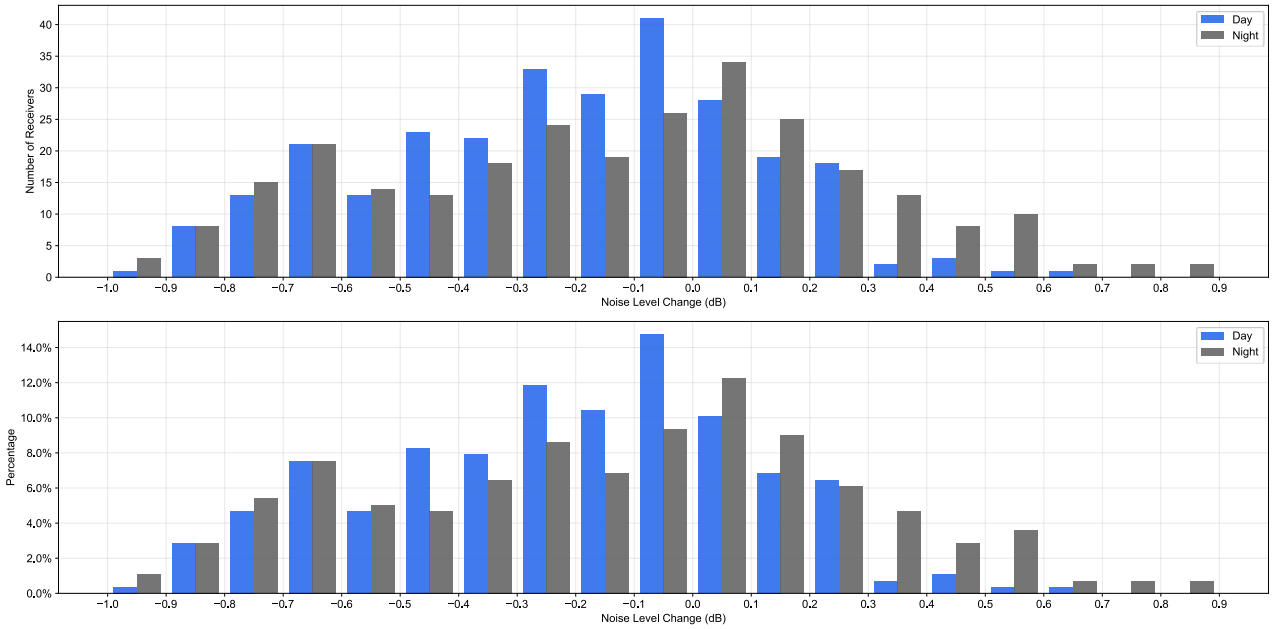
These safety factors were applied to the noise models which were validated using the additional validation results. This approach will provide an assessment which slightly over-predicts the noise levels and therefore noise impacts. This approach applies an appropriate level of conservatism to the assessment.

9 Condition E36(a) – Detailed Design Operational Noise Predictions

The noise predictions for the controlling assessment scenario in the EIS and the TNR6 Detailed Design assessment have been compared and analysed. Figure 9 below shows a histogram of the number of receivers vs predicted noise level change between the TNR6 and EIS alignments.

Figure 9 also shows a histogram of the percentage of receivers (in the study area) vs predicted noise level change between the TNR6 and EIS alignments. The histograms show the results during the day (blue) and night-time (grey) periods for the controlling assessment scenario (2031).

Figure 9. Number of Receivers vs Predicted Noise Level Change (TNR6 minus EIS Noise Levels)

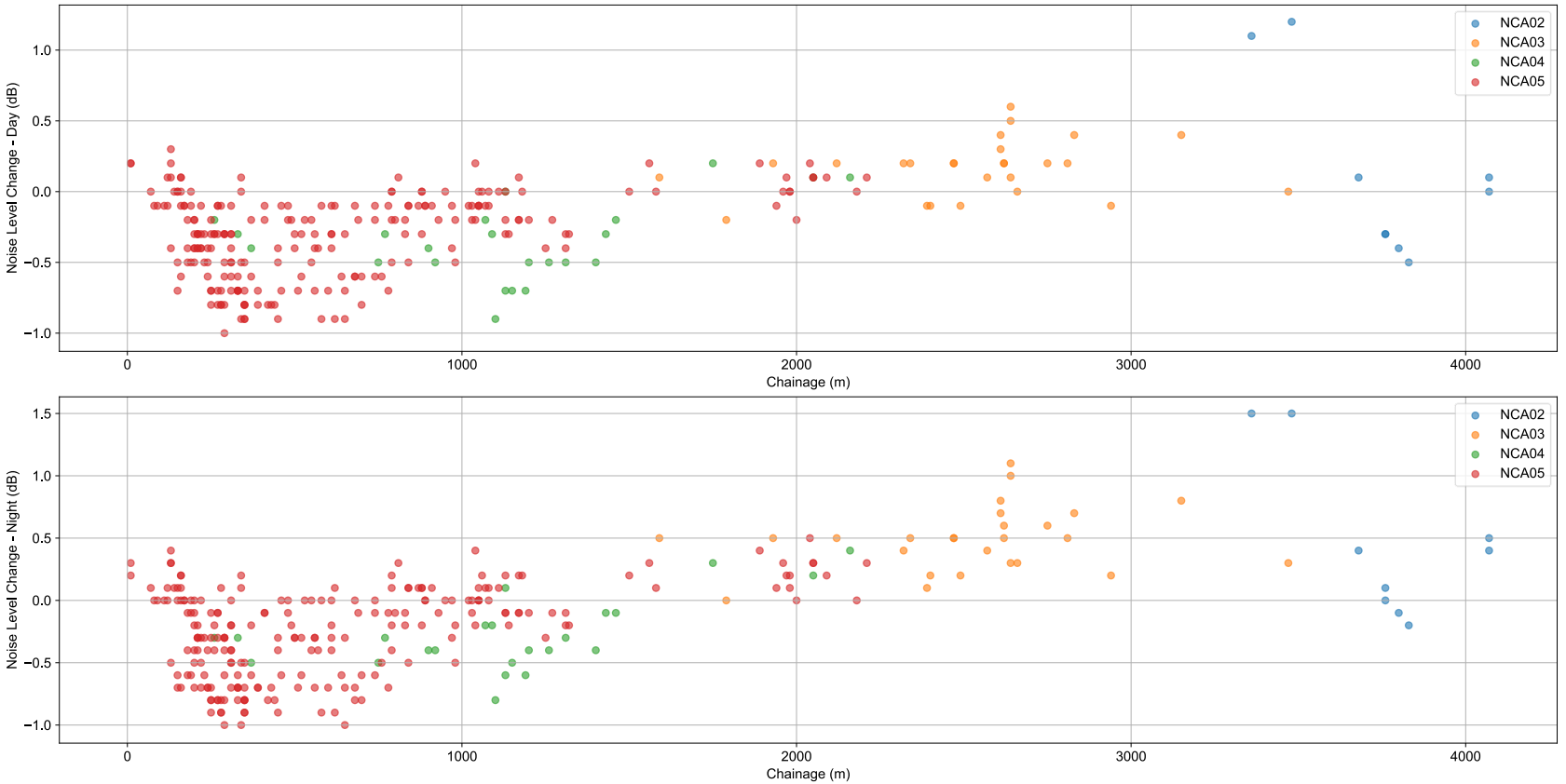


The histogram results in Figure 9 show that the majority of the receivers in both the day and the night-time periods have noise level changes of ≤ 0.2 dB. A small number of receivers have noise levels changes of > 0.2 dB.

9.1 Noise Level Changes with Chainage

Figure 10 graphically presents the predicted change in noise level with chainage (0 m starting at the southern end of the alignment) between the TNR6 and EIS alignments. This shows the predicted noise level changes during the day and night-time periods for the full extent of the study area.

Figure 10. Predicted Noise Level Change (TNR6 minus EIS Noise Levels) vs Chainage



9.2 Noise Level Change Summary

The graphical data presented in Figure 9 and Figure 10 demonstrates the following:

- The trend in the data shows that on average the TNR6 design changes noise levels by -0.1 dB during the day and +0.1 dB during the night compared to the EIS design.
- The majority of the receivers, 96.8% (day) and 85.3% (night) show a noise level change ≤ 0.2 dB.
- Up to 3.2% of the receivers show small noise level increases of between 0.2 and 1.2 dB during the day.
- Up to 14.7% of the receivers show small noise level increases of between 0.2 and 1.5 dB during the night.

Table 17 summarises the average, minimum and maximum noise level changes between the assessments (TNR6 minus EIS) for the each NCA during the day and night-time periods.

Table 17. Summary of the Noise Level Changes (TNR6 minus EIS) for Each NCA

NCA_ID	Day ΔdB (TNR6 minus EIS)			Night ΔdB (TNR6 minus EIS)		
	Average	Minimum	Maximum	Average	Minimum	Maximum
NCA02	0.1	-0.5	1.2	0.5	-0.2	1.5
NCA03	0.2	-0.2	0.6	0.5	0.0	1.1
NCA04	-0.4	-0.9	0.2	-0.3	-0.8	0.4
NCA05	-0.3	-1.0	0.3	-0.3	-1.0	0.5
Overall	**-0.1**	**-1.0**	**1.2**	**0.1**	**-1.0**	**1.5**

Appendix C presents a map of the predicted noise level changes between the alignments (TNR6 minus EIS) in the Timeframe 2, 2031 Daytime scenario for all receivers in the study area.

Overall, the noise level predictions between the TNR6 and EIS alignments are similar. Therefore, it is expected that the noise impact outcomes / mitigation will be comparable as a result.

9.3 Maximum Noise Levels

Maximum noise levels were assessed for the project during the EIS assessment. The approach taken during that assessment was to estimate the likely number of maximum noise events based on noise measurements of the existing environment and estimate the potential for changes in maximum noise levels for receivers adjacent to the alignment.

It was concluded that the majority of residential receivers adjacent to the EIS alignment are subjected to maximum noise level events. Approximately 4% of noise events during the night may exceed the maximum noise level of 65 dB L_{AFmax}. This is a low number of events with a low risk of sleep disturbance impacts.

Table 18 summarises the changes between the EIS and TNR6 designs which may influence maximum noise levels or the number of maximum noise level events.

Table 18. Summary of Design Changes between the EIS and TNR6 which May Impact Maximum Noise Levels

Design Element	Design Change between EIS and TNR6	Potential Maximum Noise Level Impact
Overall Traffic Volumes	Small changes due to new intersection at Adams Road	Nil
Changes in Speed Limits	No change	Nil
Changes in Road Curvature	Small changes with no tight curves	Negligible
Turning Bays	Minor changes	Negligible
Merging Lanes	Increased offset distance due to removal of one (1) lane in the SPIR / TNR6 design	Negligible
Vertical Alignments / Road Gradients	Minor changes to gradients	Negligible
Intersections	New Adams Road Interchange	Minor – See Section 9.4 for discussion

Table 18 highlights that no significant changes between the EIS design and the TNR6 design have been identified with respect to maximum noise level events and sleep disturbance for all design elements except for intersections. Therefore, the assessment of maximum noise levels completed during the EIS is considered sufficient except for the potential impacts at the new Adams Road Interchange.

9.4 Adams Road Interchange – Maximum Noise Level Changes

9.4.1 Decelerating Heavy Vehicles

The new interchange at Adams Road may cause a change to the number of maximum noise level events. Maximum noise events are typically driven by heavy vehicles decelerating at an intersection. To qualify the change to the number of maximum noise level events near to the new interchange the traffic data as per Appendix F and Table 11 was analysed.

The traffic data shows that during the night-time the number of heavy vehicles potentially decelerating at the new interchange is equal to 24 vehicles in any 9-hour period (Timeframe 2, 2031 scenario). From the discussion in Section 9.3 approximately 4% of noise events during the night have maximum noise levels greater than 65 dB L_{AFmax}. Based on this percentage, the analysis of the traffic data shows an additional one (1) event per night with the potential to cause sleep disturbance near to the Adams Road interchange.

The deceleration distance along the main alignment has been estimated using typical truck stopping sight distances (as per the Austroads Guide to Road Design Part 3 – Geometric Design) at the posted speed of 90 km/h. The heavy vehicle deceleration distance along the main alignment is estimated to be 160 m (chainage) either side of the new intersection as Adams Road. Therefore, any additional maximum noise events due to decelerating heavy vehicles are only expected to occur at up to 160 m from the new interchange in each direction along the main alignment.

The potential number of additional sleep disturbance events is low. The area affected by these potential sleep disturbance events is also small. Therefore, the change to the maximum noise levels at the interchange are found to be minor and are not considered a detrimental or significant noise impact.

9.4.2 Traffic Signals

The new interchange will have traffic control signals with audible / tactile units at each pedestrian crossing. The walk / don't walk audible tones are varied between 2 kHz and 500 Hz to provide audible crossing signals and a location signal (for sight impaired persons).

A noise model of the new interchange at Adams Road was constructed to evaluate the maximum noise level events due the traffic control signals. The interchange has eight (8) pedestrian crossings with a total of sixteen (16) audible traffic control signals. Each traffic control signal was assumed to generate a noise level of at least 80 dB L_{AFmax} (at 1 m). The noise from the traffic signals has the potential to contain annoying characteristics due to the tonal nature of the signals. A noise penalty of 5 dB was added to the noise model

predictions in accordance with the latest guidance given in the NSW Noise Policy for Industry (NPI 2017) Fact Sheet C. Figure 11 illustrates the combined L_{AFmax} noise emissions from all the traffic control units at the intersection.

Figure 11. Summary of the L_{AFmax} Noise Emissions from the Signalised Intersection at Adams Road

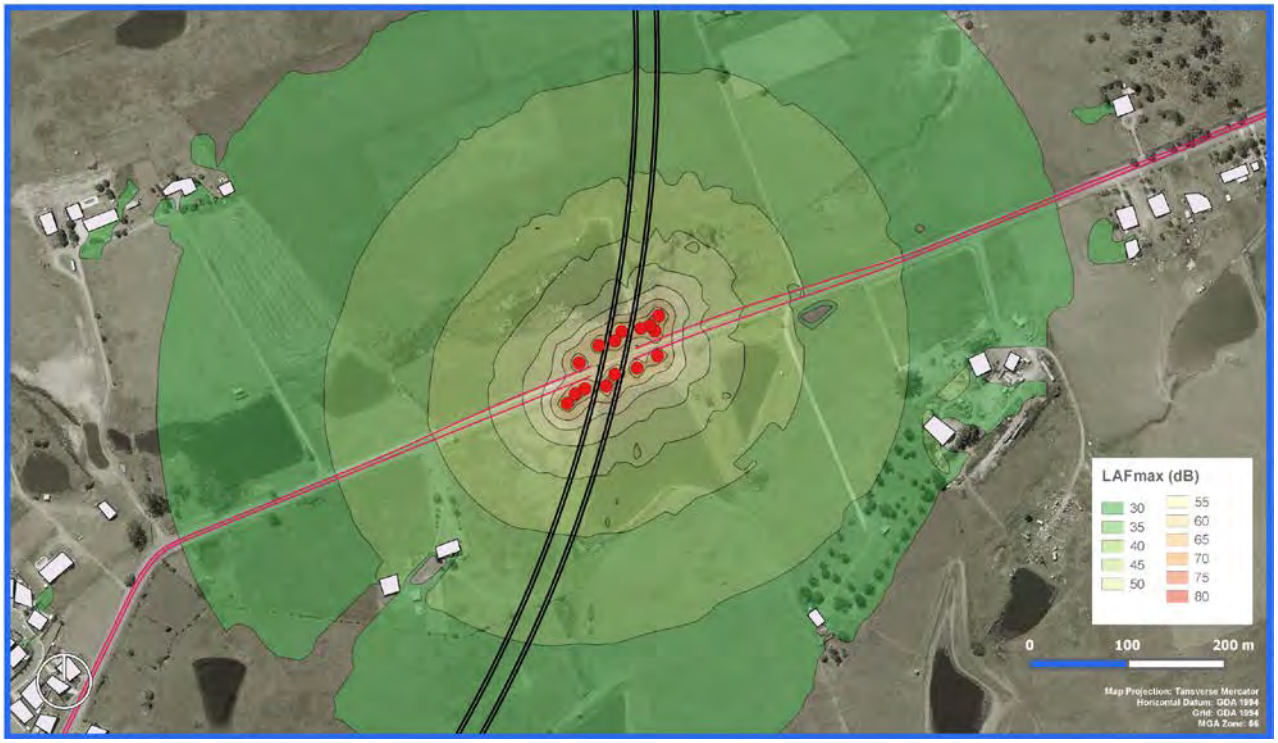


Figure 11 shows that no receivers experience noise emissions > 40 dB L_{AFmax} due to the traffic signals at the intersection. Therefore, the potential for sleep disturbance events is negligible.

10 Condition E36(b) – Detailed Design Operational Noise Mitigation Review

Review of the assessment as summarised in Section 9 shows strong agreement between the noise levels in the TNR6 Detailed Design and the EIS for the majority of receivers. The following discusses the assessment of the noise level predictions against the NCG criteria and any changes to the noise impacts that are identified.

Table 19 below identifies the NCG criteria exceedances for the EIS and the TNR6 stage without noise mitigation. The 'without mitigation' noise predictions identify receivers which qualify for consideration of additional noise mitigation. Feasible and reasonable additional noise mitigation is then assessed (by priority) for low noise pavements, noise barriers and architectural treatments as discussed in Section 4.3.

Any receivers which were identified for consideration of additional mitigation during the EIS must remain as part of this assessment due to the ongoing EIS commitments. Therefore, this assessment includes all receivers identified during the EIS plus any additional receivers identified as part of the TNR6 detailed design assessment.

Table 19. EIS and TNR6 NCG Criteria Exceedances (Without Mitigation)

Noise Catchment Area	Total Receivers	Qualify for Consideration of Additional Mitigation	
		EIS	TNR6
NCA02	9	2	3
NCA03	26	5	5
NCA04	23	5	7
NCA05	228	9	11
Total	**286**	**21**	**26**

The results show architectural treatments increase by a total of five (5) receivers in the TNR6 stage compared to the original EIS. The additional receivers are located in NCA02, NCA04 and NCA05. The reasons for the mitigation changes between the TNR6 and EIS alignments are summarised in Table 20 below.

Table 20. Summary of Mitigation Changes between TNR6 and EIS Alignments

NCA	Address	Qualify for Consideration of Additional Mitigation		Reason
		EIS	TNR6	
NCA02	2778-2828 The Northern Road, Luddenham	N	Y	Vertical alignment changes of +0.5 m to +0.8 m Eastward shift of TNR6 alignment by > 2.0 m
NCA04	2422-2430a The Northern Road, Luddenham[1]	N	Y	Not identified as a residential receiver in the EIS
NCA04	151 Adams Rd_1, Luddenham	N	Y	Changes to the NO BUILD and BUILD traffic volumes along and Adams Road (due to the new intersection) have changed the BUILD minus NO BUILD trigger at this receiver meaning it now qualifies for treatment.
NCA05	2292 The Northern Road_1, Luddenham	N	Y	Changes to the NO BUILD and BUILD traffic volumes on (existing) The Northern Road and the new bypass section of The Northern Road and Elizabeth Drive. These traffic changes have shifted the triggering facade for this receiver. The new facade has criteria driven by the Relative Increase Criteria (RIC) where as in the EIS this receiver was driven by the Redeveloped Criteria. The RIC criteria is slightly lower which means this receivers now triggers.
NCA05	2215a The Northern Road, Luddenham	N	Y	Not identified as a residential receiver in the EIS

Note: 1. Address cannot be verified through on-line mapping services. Precise coordinates and location of receiver provided in Appendix D and E.

Appendix D presents a map of the receivers which qualify for consideration of additional mitigation in the EIS and TNR6 stage for direct comparison.

Overall, the majority of the receivers which require consideration of additional mitigation is consistent between the EIS and TNR6 designs.

11 Condition E36(c) – Detailed Design Additional Operational Noise Mitigation

This assessment has found that there were no groupings of four (4) or more receivers that qualified for consideration of additional noise mitigation due to the TNR6 design. As a result, low noise pavements and noise barriers are not considered feasible and reasonable as additional noise mitigation as per the NCG. This is consistent with the EIS assessment.

Therefore, all of the receivers which qualified for consideration of additional noise mitigation as per Table 19 qualify for architectural treatment.

Table 21 below summarises the number of receivers which qualified for architectural treatment in the EIS and TNR6 assessments.

Table 21. Number of Receivers which Qualify for Architectural Treatments

Noise Catchment Area	Total Receivers	Qualify for Architectural Treatments	
		EIS	TNR6
NCA02	9	2	3
NCA03	26	5	5
NCA04	23	5	7
NCA05	228	9	11
Total	**286**	**21**	**26**

As per the discussion in Section 10 the results show that architectural treatments increase by five (5) receivers in the TNR6 stage compared to the original EIS.

Architectural treatments are committed to all the receivers identified in the EIS assessment. Therefore, the total number of architectural treatments equals the EIS commitment (21 receivers) with an additional five (5) receivers added due to the TNR6 assessment. This means the combined EIS and TNR6 assessments result in a total of 26 receivers which qualify for architectural treatment.

The 26 receivers which qualify for architectural treatment due to the combined EIS and TNR6 assessments are provided in Table 22 below. All the receivers identified in Table 22 should be treated as per the Section 7.3 of the RMS Noise Mitigation Guidelines (NMG).

Table 22. Assessment Details of Receivers which Qualify for Architectural Treatments

NCA	Address	Floor	Noise Level Difference TNR6 vs EIS (dB)		Qualify for Architectural Treatment	
			Daytime	Night-time	TNR6	EIS
NCA02	2751 The Northern Road Luddenham	1	-0.5	-0.2	Y	Y
NCA02	2785-2787 The Northern Road, Luddenham	1	1.2	1.5	Y	Y
NCA03	2825-2841 The Northern Road_5, Luddenham	1	-0.1	0.2	Y	Y
NCA03	2843-2857 The Northern Road_4, Luddenham	1	0.4	0.7	Y	Y
NCA03	2311-2337 Elizabeth Dr_1, Luddenham	1	0.6	1.1	Y	Y
NCA03	2311-2337 Elizabeth Dr_1, Luddenham	2	0.5	1.0	Y	Y
NCA04	2422-2430 The Northern Road_3, Luddenham	1	0.1	0.2	Y	Y
NCA04	2420 The Northern Road_2, Luddenham	1	0.2	0.3	Y	Y
NCA04	140 Adams Rd_1, Luddenham	1	-0.5	-0.3	Y	Y
NCA04	125 Adams Rd_3, Luddenham	1	-0.5	-0.4	Y	Y
NCA04	105-115 Adams Rd, Luddenham	1	-0.5	-0.5	Y	Y
NCA05	2320-2390 The Northern Road_2, Luddenham	1	0.0	0.0	Y	Y
NCA05	45 Adams Rd_1, Luddenham	1	-0.6	-0.8	Y	Y
NCA05	18 Eaton Road Luddenham	1	-0.4	-0.7	Y	Y
NCA05	16 Eaton Rd, Luddenham	1	-0.4	-0.7	Y	Y
NCA05	Luddenham Public School_2	1	-0.6	-0.6	Y	Y
NCA05	14 Eaton Rd, Luddenham	1	-0.4	-0.7	Y	Y
NCA05	2215 The Northern Road_1, Luddenham	1	0.2	0.2	Y	Y
NCA02	2778-2828 The Northern Road, Luddenham	1	1.1	1.5	Y	N
NCA04	2422-2430a The Northern Road, Luddenham[1]	1	0.1	0.4	Y	N
NCA04	151 Adams Rd_1, Luddenham	1	-0.9	-0.8	Y	N
NCA05	2292 The Northern Road_1, Luddenham	1	0.2	0.3	Y	N
NCA05	2215a The Northern Road, Luddenham	1	0.2	0.3	Y	N
NCA03	2859 The Northern Road_1, Luddenham	1	-0.1	0.2	N	Y
NCA05	Luddenham Public School_3	1	-0.6	-0.6	N	Y
NCA05	Luddenham Public School_1	1	-0.7	-0.6	N	Y

Note: 1. Address cannot be verified through on-line mapping services. Precise coordinates and location of receiver provided in Appendix D and E.

The detailed noise assessment results for all receivers in the study area are tabulated in Appendix E.

Since the noise impacts and mitigation requirements are typically comparable between the EIS and the TNR6 design, no further consideration of additional noise mitigation is required.

12 Construction Noise Criteria

The potential for construction noise impacts are assessed using the Roads and Maritime Construction Noise and Vibration Guideline (CNVG) which is the RMS application of the Interim Construction Noise Guideline (ICNG). The CNVG provides a consistent approach to identifying construction noise management levels and noise impacts for Roads and Maritime projects.

12.1 Construction Periods

Construction noise impacts must be assessed during specific construction periods which have different criteria depending on the time of day the construction activities occur. The CNVG's Standard and Out of Hours (OOH) construction periods are given in Table 23.

Table 23. Standard and Out of Hours (OOH) Construction Periods

Construction Hours	Monday to Friday	Saturday	Sunday / Public Holiday
Standard hours			
Standard construction hours	7:00 to 18:00	8:00 to 13:00	No work
Activities with impulsive or tonal noise emissions	8:00 to 17:00	9:00 to 13:00	No work
Blasting	9:00 to 17:00	9:00 to 13:00	No blasting
Out of Hours			
Out of Hours (Day)	N/A	07:00 to 8:00, 13:00 to 18:00	08:00 to 18:00
Out of Hours (Evening)	18:00 to 22:00	18:00 to 22:00	18:00 to 22:00
Out of Hours (Night)	22:00 to 07:00	22:00 to 08:00	22:00 to 07:00

Note: 1 Works may be carried out in continuous blocks not exceeding three hours each with a minimum respite from those activities and works of not less than one hour between each block. 'Continuous' includes any period during which there is less than a one hour respite between ceasing and recommencing any of the work the subject of this condition.

12.2 Construction Noise Management Levels (NMLs)

The CNVG specifies that each sensitive receiver potentially impacted by construction noise is assigned a Noise Management Level (NML). The NMLs are based on the ICNGs construction noise goals. The NML for each residential receiver is defined as an allowable exceedance above the background noise levels depending on the time of the day the works occur. Non-residential receivers are assigned fixed-value NMLs. The CNVG requires that all *feasible and reasonable* mitigation measures be applied where construction noise is predicted to exceed the NMLs.

12.3 Noise Management Levels for Residential Receivers

Table 24 outlines how NMLs are determined for residential receivers potentially impacted by construction noise. Table 24 also illustrates how receivers that are *highly noise affected* may be identified. In such instances, restrictions to construction hours may apply to minimise the impacts.

Table 24. Construction Noise Management Levels for Residential Receivers

Time of Day	Noise Management Level (NML) $L_{Aeq(15min)}$	How to Apply
Recommended standard hours Monday to Friday 7.00am to 6.00pm Saturday 8.00am to 1.00pm	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq(15min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and the duration, as well as contact details.
No work on Sundays or public holidays	Highly noise affected 75 dB	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences 2. If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours The proponent should apply all feasible and reasonable work practices to meet the noise affected level Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community For guidance on negotiating agreements see Section 7.2.2 of the ICNG (DECC, 2009).

12.4 Noise Management Levels for Non-Residential Receivers

The following NMLs are applicable for non-residential receivers:

- Industrial premises (external): 75 dB $L_{Aeq(15min)}$.
- Offices, retail outlets (external): 70 dB $L_{Aeq(15min)}$.
- Classrooms: (internal): 45 dB $L_{Aeq(15min)}$.
- Places of worship: (internal): 45 dB $L_{Aeq(15min)}$.
- Active recreational areas (external): 65 dB $L_{Aeq(15min)}$.

Internal noise criteria have been converted to external noise criteria for the purposes of consistent noise modelling and analysis by using the conversation factors as discussed in Section 3.3.

12.5 Sleep Disturbance Screening Criterion

The assessment for potential sleep disturbance at residences from night-time construction works is taken from the Interim Construction Noise Guideline (ICNG), which prescribes the following sleep disturbance *screening criterion*:

$L_{AFmax} \leq L_{A90(15min)} + 15$ dB

The screening criterion indicates that sleep disturbance is possible where the L_{AFmax} maximum noise level (from construction exceeds) the background noise level by more than 15 dB. Where this screening criterion is not satisfied more detailed analysis is required.

12.6 Project Specific NMLs for Residential Receivers

The construction Noise Management Levels (NMLs) and residential sleep disturbance screening criteria adopted in this assessment are summarised in Table 25. The NMLs are derived as an allowable emergence above the Rating Background Level (RBL). The NMLs and RBLs are derived directly from the EIS assessment.

Table 25. Construction NMLs & Sleep Disturbance Screening Criteria at Residences

NCA	Rating Background Level (RBL)				Noise Management Level (NML) $L_{Aeq(15min)}$				Sleep disturbance screening criterion L_{Amax} (RBL + 15 dB)
					Standard hours (RBL + 10 dB)	Out Of Hours (OOH) (RBL + 5dB)			
	Standard hours	OOH Day	OOH Evening	OOH Night	Day	Day	Evening	Night	
NCA04	37	38	38	37	47	43	43	42	52
NCA05	42	44	43	34	52	49	48	39	49

Note: 1. Only the NCAs affected by the changes in the TNR6 stage are shown.

12.7 Project Specific NMLs for Non-Residential Receivers

The NML for each non-residential receiver within the study area is detailed in Table 26 below.

Table 26. Construction NMLs for Non-Residential Receivers

NCA	Non-Residential Receiver	Land Use	No. of Buildings	NML $L_{Aeq(15min)}$ dB
NCA05	Luddenham Public School	Educational	5	55
NCA05	St James Anglican Church	Place of Worship	1	55
NCA05	Luddenham Uniting Church	Place of Worship	2	55
NCA05	Sales Park	Active Recreation	N/A	65
NCA05	Willmington Reserve	Active Recreation	N/A	65
NCA05	Luddenham Showground	Active Recreation	N/A	65
NCA05	Caltex Service Station	Commercial	2	70
NCA05	Quality Meats Butcher	Commercial	1	70
NCA05	2903 The Northern Road, Luddenham	Commercial	1	70
NCA05	Luddenham Auto Repairs	Commercial	1	70
NCA05	Ali's Bakery	Commercial	1	70
NCA05	Shell Service Station	Commercial	1	70
NCA05	IGA	Commercial	3	70
NCA05	David's Stall Fruit and Veg	Commercial	1	70
NCA05	Luddenham Progress Hall	Commercial	1	70

12.8 Construction Traffic Noise Criteria

The assessment of noise impacts arising from construction vehicles on public roads (not when they operate within a construction site) are assessed in accordance with the CNVG. The CNVG requires that where construction traffic increases the existing traffic noise levels by more than 2 dB, then further assessment using the NCG is required. Construction traffic increases of less than 2 dB are considered acceptable and are not subject to further mitigation measures.

13 Construction Noise Mitigation

13.1 Principles for Managing Construction Noise

The CNVG outlines the following principles which are to be applied when reviewing and assessing construction noise, vibration and construction traffic:

- Construction noise and vibration levels at sensitive receivers will be minimised where feasible and reasonable.
- Feasible and reasonable mitigation will reflect the time of day, and the degree and duration of the impact.
- Minimising construction noise and vibration will be viewed as a continuous improvement exercise that is inclusive of stakeholders where no idea is too small to be considered.
- Good engagement with the community will be maintained to facilitate effective project delivery with consideration of community impact, including procedures for notifying residents, business owners and other sensitive receivers, of any noise- or vibration-intensive construction activities likely to affect their amenity.
- The community will be informed of the dates for the intended works, sequencing and timing of noisy events. Where possible this will include an indicative schedule over a 24-hour period.
- Staff and community will be informed of the effort and methods undertaken to reduce noise and vibration for the works.

The CNVG enforces these principles by outlining how Noise Management Levels (NMLs) are determined for a construction project and identifying feasible and reasonable noise mitigation measures where NMLs are exceeded.

13.2 Standard Noise Mitigation Measures

The CNVG outlines standard mitigation measures that should be incorporated by default in all construction projects. Those most relevant to the construction of the TNR6 stage are listed below.

- Restricting works to standard construction hours as far as practicable, considering safety and traffic management requirements.
- Regularly maintaining and monitoring plant and equipment to ensure that their noise emissions are not excessive.
- Selecting quieter plant and equipment.
- Maximising offset distances between receivers and noisy plant or activities.
- Reducing throttle settings and switching off equipment when it's not being used.
- Erecting temporary acoustic hoarding to reduce noise form works within a confined area such as long-term drainage works.
- Deploying mobile hoardings (eg, acoustic screen curtains mounted on a wheeled trailer) to track moving, but tightly-contained processes.
- Orientating plant and processes away from residences.
- Scheduling works for times outside of heightened sensitivity for the impacted receiver, eg, outside of school hours, or at least outside of HSC and exam periods specifically.
- Minimising the number of consecutive evenings / nights of works near any particular receiver(s).
- Necessarily instigating respite periods where feasible and reasonable to do so for any receiver identified as highly affected (for which construction noise levels will be greater than 75 dB).
- Optionally scheduling respite periods for noise-intensive processes undertaken near receivers eg. limiting operation of pavement sawing to three hours at a time.
- Planning any out of hours (OOH) works so that noisier works are carried out in the earlier part of the evening or night time.
- Restricting heavy vehicle movements, heavy deliveries and loading and unloading processes to daytime periods and to areas well away from receivers.

- Minimising the annoyance from reversing alarms by either fitting closed circuit monitors or non-tonal reversing alarms on vehicles or deploying spotters to oversee reversing movements. Sites should be designed to minimise or remove the need for plant to undertake reversing manoeuvres.

The feasibility of applying these measures would be assessed as part of the CNVMP once the detailed construction program is known.

13.3 CNVG Additional Mitigation Measures

Where exceedances of the NMLs are found after the implementation of the standard mitigation measures then the project should consider additional mitigation measures as detailed in Appendix C of the CNVG (where feasible and reasonable). Table 27 below summarises the additional mitigation measures applicable under the CNVG.

Table 27. Additional Mitigation Measures (from CNVG Appendix C)

Predicted Airborne $L_{Aeq(15min)}$ Noise Level at Receiver			Additional Mitigation Measures	
Perception[1]	dB above RBL	dB above NML	Type[2]	Mitigation level[3]
All hours				
75 dB or greater	-	-	N, V, PC, RO	HA
Standard Hours: Mon-Fri (7am – 6pm), Sat (8am-1pm)				
Noticeable	5 to 10	0	-	NML
Clearly Audible	10 to 20	< 10	-	NML
Moderately Intrusive	20 to 30	10 to 20	N, V	NML + 10
Highly Intrusive	> 30	> 20	N, V	NML + 20
Out of Hours Works Period 1: Mon-Fri (6pm-10pm), Sat (7am-8am & 1pm-10pm), Sun / Public Holiday (8am-6pm)				
Noticeable	5 to 10	< 5	-	NML
Clearly Audible	10 to 20	5 to 15	N, R1, DR	NML + 5
Moderately Intrusive	20 to 30	15 to 25	V, N, R1, DR	NML + 15
Highly Intrusive	> 30	> 25	V, IB, N, R1, DR, PC, SN	NML + 25
Out of Hours Works Period 1: Mon-Fri (10pm-7am), Sat (10pm-8am), Sun / Public Holiday (6pm-7am)				
Noticeable	5 to 10	< 5	N	NML
Clearly Audible	10 to 20	5 to 15	V, N, R2, DR	NML + 5
Moderately Intrusive	20 to 30	15 to 25	V, IB, N, PC, SN, R2, DR	NML + 15
Highly Intrusive	> 30	> 25	AA, V, IB, N, PC, SN, R2, DR	NML + 25

Notes: 1 Perception relates to the level above the RBL

2

AA	=	Alternative Accommodation	R1	=	Respite Period 1
V	=	Verification	R2	=	Respite Period 2
IB	=	Individual Briefing	DR	=	Duration Respite
N	=	Notification	PC	=	Phone Calls
RO	=	Respite offers	SN	=	Specific Notifications

3 HA = Highly Affected (>75dBA – applies to residences only)

The detailed description of each additional mitigation measure is provided in Appendix C of the CNVG.

14 Construction Noise Methodology

14.1 Noise Model Prediction Algorithm

Construction noise modelling of the study area was carried out using the ISO9613 prediction algorithms provided by SoundPLAN V7.1. The modelling allows for noise source and receiver locations, ground and air absorption as well as any acoustic shielding provided by intervening topography and barriers. Construction modelling parameters were held consistent with those used for the EIS assessment and the TNR6 operational noise assessment (where applicable).

14.2 Noise Model Calculation Parameters

A summary of the noise model calculation parameters used in this assessment are provided in Table 28 below.

Table 28. Summary of Noise Model Calculation Parameters

Calculation Parameter	Assigned Attribute	
Proportion of Absorbing Ground	0.50 (residential areas) 0.75 (rural areas)	
Sensitive Receiver Points	All sensitive receiver buildings, all facades and all floors, excluding facades shorter than 3.0 meters. Facade assessment point located at the centre of the facade.	
Receiver Location (@ 1m from facade)	Ground floor First floor	1.5 m 4.5 m
Facade Correction	+2.5 dB	

14.3 Noise Model Input Data

A summary of the new and existing input data used to generate the noise models is provided in Table 29 below.

Table 29. Summary of the Noise Model Input Data

Input Data	Source of Data
Ground Topography of the Surrounding Environment	As per the EIS and provided by Jacobs (December 2016): The TNR terrain data was derived from NSW Land Property Information (LPI) 1m resolution bare earth Digital Elevation Model (DEM). The DEM was produced from a standard LiDAR survey conducted by LPI. *Reference: NSW Land Property Information (LPI) LiDAR Product Specifications, Version 3.0, March 2013.*
Receiver Locations	As per the EIS and provided by Jacobs (December 2016) and updated in January & July 2018: Footprints taken from aerial photography. Building heights determined from site inspections and Google Streetview.
Construction Stages	Only changes to Earthworks and Bridge construction stages considered for the new Adams Road Interchange as discussed in Section 16.
Construction Durations	Mainline Earthworks as per the EIS and SPIR submission reports. Earthworks duration of the new Adams Road Interchange as discussed in Section 16.
Construction Traffic	As per the EIS and SPIR submission reports.

14.4 Construction Stages – Proposed Plant & Equipment

The sound power levels adopted for each item of plant and equipment for each construction stage is given in Table 30 below. These sound power levels are equivalent to those used in the EIS to maintain a comparable like-for-like assessment.

Table 30. Plant Sound Power Levels Used in the Modelling of Construction Noise

Construction Stage	Typical Plant / Equipment	Sound Power Level dB L_{WA}
Earthworks	Excavator	109
	Dump trucks	114
	Vibratory roller (20-30T)[1]	110
	Light vehicles	88
	Bulldozer	112
	Grader	112
	Water cart	107
	Bobcat	104
Bridge Construction	Excavators	109
	Light vehicles	88
	Generator	101
	Rock breaker[1]	126
	Concrete trucks and pump	108
	Welding equipment	105
	Mobile crane	104
	Impact piling[1]	121
	Oxy-cutting equipment	98

Note: 1. Sound power level includes a 5 dB penalty for annoying noise characteristics

15 EIS Construction Noise Assessment Outcomes

15.1 Construction Noise Impacts - Standard Hours

An overview of the predicted construction noise impacts in the EIS assessment during standard hours works are presented in Table 31**.** This table illustrates a range of construction noise levels predicted for the affected residences and shows counts of residences which exceed the NMLs as per the banding in the CNVG. Counts are accumulated per building storey to ensure all tenancies of a single building are represented.

Table 31. Predicted Construction Noise Impacts at All Sensitive Receivers During Standard Hours

NCA	NML	Assessment Parameter		Construction Stage EIS	
				Earthworks	Bridge work
NCA04	47	Range of predicted noise levels (dB)		50-68	52-65
		Number of Residences	Complying	0	0
			0-10 dB above NML	9	6
			10-20 dB above NML	8	10
			20+ dB above NML	0	0
		Highly noise affected	≥75 dB	0	0
NCA05	52	Range of predicted noise levels (dB)		43-88	45-72
		Number of Residences	Complying	183	23
			0-10 dB above NML	44	199
			10-20 dB above NML	17	1
			20+ dB above NML	5	1
		Highly noise affected	≥ 75dB	8	0

15.2 Construction Noise Impacts – Out of Hours (OOH)

An overview of the predicted construction noise impacts in the EIS assessment during out of hours (OOH) works are presented in Table 32**.** This table illustrates a range construction noise levels predicted for the affected residences and shows counts of residences which exceed the NMLs as per the banding in the CNVG. Counts are accumulated per building storey to ensure all tenancies of a single building are represented.

Table 32. Predicted Construction Noise Impacts at Residential Receivers Out of Hours (OOH)

NCA	NML	Assessment Parameter		OOH Work Stage EIS Bridge Work	Sleep Disturbance	OOH Work Stage EIS Bridge Work
NCA04	42	Range of predicted noise levels (dB)		46-60	52	49-63
		Number of Residences	Complying	-		1
			0 - 5 dB above NML	1		11
			5 - 15 dB above NML	14		4
			15 - 25 dB above NML	1		-
		Highly noise affected	≥ 25 dB above NML	-		-
NCA05	39	Range of predicted noise levels (dB)		38-69	49	41-72
		Number of Residences	Complying	1		125
			0-10 dB above NML	-60		84
			10-20 dB above NML	151		14
			20+ dB above NML	11		1
		Highly noise affected	≥75dB	1		-

15.3 Predicted Impacts at Non-Residential Receivers

Exceedances of the NML from standard hours works were predicted during the EIS at the following non-residential receivers within the TNR6 study area:

- IGA Luddenham – moderate exceedances of up to 12 dB.
- Luddenham Public School - minor exceedances of up to 4 dB.
- St James Anglican Church - moderate exceedances of up to 11 dB.
- Luddenham Uniting Church – minor exceedances of up to 2 dB.

16 TNR6 Construction Compared to the EIS Construction

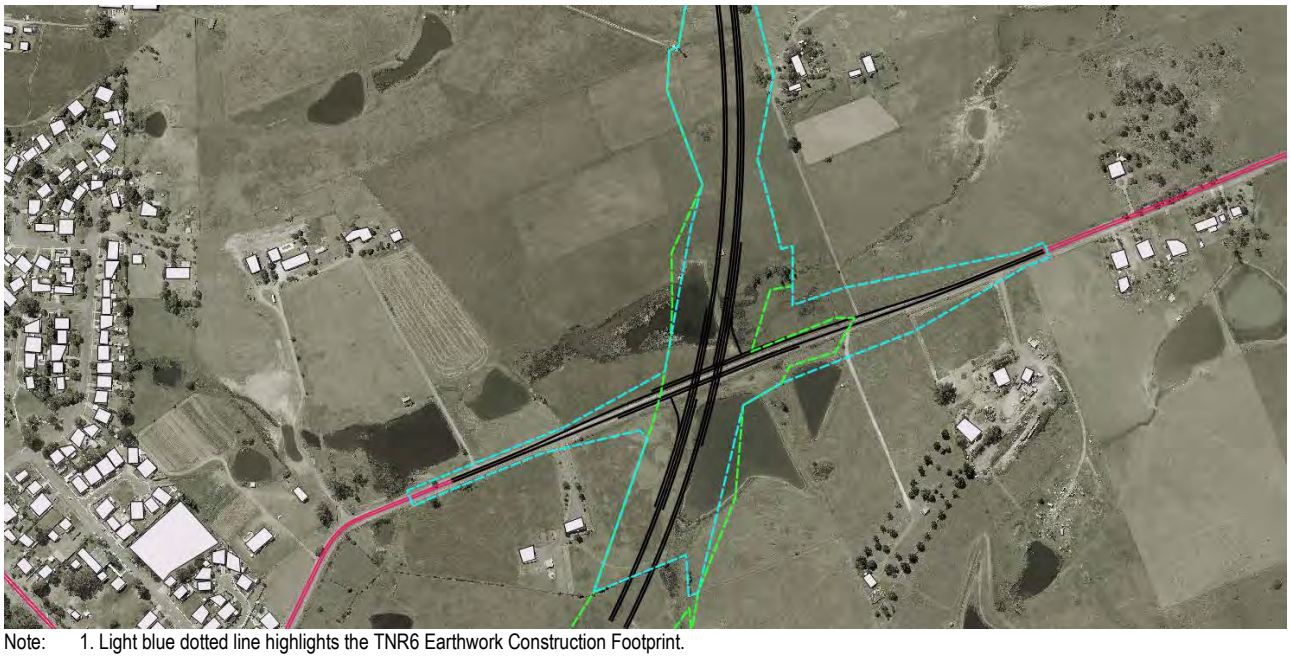
16.1 Overview of Changes

At its southern end the TNR6 stage merges into the TNR4 stage. The TNR6 stage has significant design changes compared to the EIS alignment at Adams Road, which is now at-grade to form an interchange. Whereas, the EIS design had a bridge over Adams Road. The new Adams Road interchange affects the alignment in TNR6 and TNR4 as the road height is reduced to form the at-grade Adams Road interchange. Section 7.2.1 shows the topographical changes in this area and the vertical road alignment changes in both the TNR4 and TNR6 stages.

16.2 Adams Road Interchange Construction Footprints

Figure 12 illustrates the differences between the TNR6 and EIS construction footprints during earthworks. The TNR6 earthworks footprint is generally the same as the EIS footprint except for the region around the new interchange at Adams Road.

Figure 12. Plan of the TNR6 and EIS Construction Footprints During Earthworks at Adams Road Interchange



Note: 1. Light blue dotted line highlights the TNR6 Earthwork Construction Footprint.
2. Light green dotted line highlights the EIS Earthwork Construction Footprint.
3. Black lines show the TNR6 roads.
4. Pink lines show the existing The Northern Road and local road network.
4. Grey boxes show the noise sensitive receivers.

As shown above the TNR6 construction footprint is larger than the EIS footprint. To create the new at-grade interchange the TNR6 footprint extends along Adams Road in both the East and West directions for a distance of approximately 400 m.

16.3 Construction Stages Changes

Table 33 summarises the construction stage changes which occur in proximity to the new Adams Road interchange.

Table 33. Summary of Construction Stage Changes Near to the Adams Road Interchange

NCAs Affected	Construction Stage	Construction Hours	EIS		TNR6	
			Location	Duration	Location	Duration
NCA04 NCA05	Earthworks	Standard hours	Main alignment only.	4 -16 weeks	Main alignment	4 -16 weeks
					New interchange at Adams Road	4 – 8 weeks
	Bridgeworks	Standard hours	Adams Road bridge.	0 – 26 weeks	No longer required.	-
		OOH				

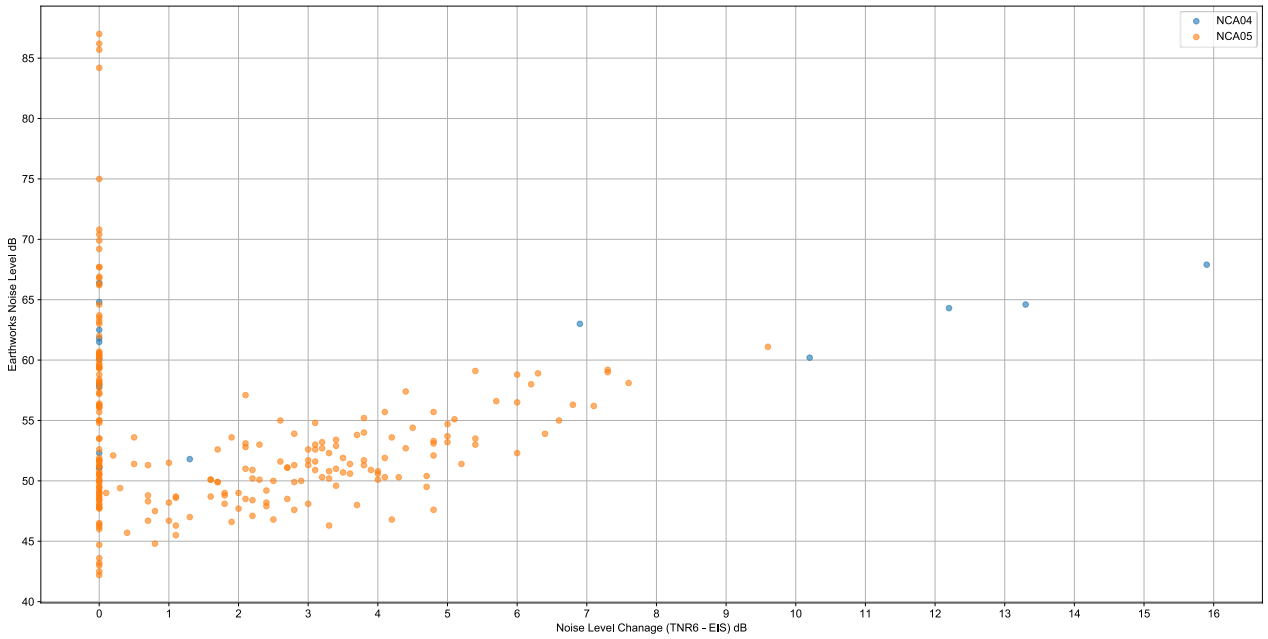
The TNR6 design increases the earthworks construction footprint at the new Adams Road interchange. In addition, the new interchange extends the duration of the earthworks affecting the receivers in NCA04 and NCA05. However, the TNR6 design does not require the construction of a bridge in this area which means standard hours and OOH works in this area will be reduced as a result.

17 TNR6 Detailed Design Construction Noise Predictions

17.1 Earthworks

The construction noise levels for the new earthworks footprints associated with the TNR6 project have been predicted using the detailed 3D noise model. The earthworks construction stage will only take place during standard construction hours as per Table 33 above. Figure 13 below shows the predicted construction noise levels (standard hours) vs the change in construction noise levels when compared to the EIS (ie TNR6 minus EIS).

Figure 13. Predicted Construction Noise Levels vs the Change in Noise Levels (TNR6 minus EIS)



This graph shows a significant number of the affected receivers only experience small changes (< 2 dB) in construction noise levels. It also shows a small number of receivers experience noise levels changes greater than 4 dB. The distribution of the noise levels changes is summarised in Table 34 below.

Table 34. Summary of Noise Level Changes Between TRN6 and EIS Earthworks Construction

NCA NCA	Noise Level Change (TNR6 minus EIS)								
	0 dB	0 – 2 dB	2 – 4 dB	4-6 dB	6 – 8 dB	8 – 10 dB	10 – 12 dB	12 – 14 dB	14 – 16 dB
Number of Receivers									
NCA04	11	1	0	0	1	0	1	2	1
NCA05	111	35	62	30	10	1	0	0	0
Total	**122**	**36**	**62**	**30**	**11**	**1**	**1**	**2**	**1**
Percentage (%) of Receivers									
NCA04	64.7%	5.9%	0.0%	0.0%	5.9%	0.0%	5.9%	11.8%	5.9%
NCA05	44.6%	14.1%	24.9%	12.0%	4.0%	0.4%	0.0%	0.0%	0.0%
Total	**45.9%**	**13.5%**	**23.3%**	**11.3%**	**4.1%**	**0.4%**	**0.4%**	**0.8%**	**0.4%**
Cumulative Total	**45.9%**	**59.4%**	**82.7%**	**94.0%**	**98.1%**	**98.5%**	**98.9%**	**99.6%**	**100.0%**

The data presented in Table 34 and Figure 13 demonstrates the following:

- NCA04 has only six (6) receivers with noise level changes > 0 dB.
- The average noise level increase in NCA04 is 3.5 dB.
- 70.6% of receivers in NCA04 have noise levels increase of < 6 dB.
- NCA05 has 138 receivers with noise level changes > 0 dB.
- The average noise level increase in NCA05 is 1.9 dB.
- 83.5% of receivers in NCA05 have noise levels increase of < 4 dB.
- The average noise level increase for both NCAs is 2.7 dB.
- 94.0% of all receivers have noise level changes of < 6 dB.

Appendix G presents a map of the predicted construction noise level changes between the assessments (TNR6 minus EIS) during the earthworks construction stage for all receivers in the study area.

Overall, the earthworks construction noise level between the TNR6 and EIS are dissimilar. Therefore, it is expected that the noise impact outcomes / mitigation will be different as a result.

17.2 Bridgeworks

Since bridgeworks are no longer necessary due to the new interchange at Adams Road there are no bridgeworks noise predictions for the construction stage in this region (ie affecting NCA04 & NCA05). Therefore, the standard hours and OOH noise impacts at all receivers will be nil for this construction stage in this region.

17.3 Construction Traffic Noise Impacts

The TNR6 construction traffic will access construction sites using only designated heavy vehicle routes such as the M4 Motorway, Elizabeth Drive and The Northern Road. No construction traffic access is proposed for Adams Road.

Table 35 summarises the increase in traffic noise levels at receivers adjacent to the TNR6 stage due to the addition of construction traffic.

Table 35. Summary of TN6 Construction Traffic Volumes and Noise Increases

Route	Existing Traffic Volumes				Proposed Additional Construction Traffic Volumes				Change in Traffic Noise Levels	
	Day (7am-10pm)		Night (10pm-7am)		Day (7am-10pm)		Night (10pm-7am)		Day	Night
	Cars	HGV	Cars	HGV	Cars	HGV	Cars	HGV	ΔdB	ΔdB
The Northern Road Sections										
Littlefields Rd and Elizabeth Drive	11,859	1,357	1,667	319	197	176	10	49	0.3	0.4
Elizabeth Drive and Park Road	12,052	1,519	1,810	351	197	176	10	49	0.3	0.4
Park Rd and Blaxland Avenue	10,139	1,301	1,469	310	197	176	10	49	0.3	0.4
Elizabeth Drive										
East of The Northern Road	6,160	887	1,093	197	22	20	10	5	0.1	0.1

Table 35 illustrates that construction traffic will not increase existing traffic noise levels by more than 2 dB at any location in the TNR6 study area. Therefore, construction traffic noise mitigation measures are not necessary as per the RMS CNVG. This means the TNR6 construction traffic noise impact outcomes are equivalent and comparable to the EIS assessment.

18 TNR6 Detailed Design Construction Noise Mitigation Review

18.1 Earthworks

Review of the assessment from Section 17 shows dissimilar results between the noise levels in the TNR6 and the EIS during the earthworks construction stage. The following discusses the assessment of the noise level predictions against the NMLs and any changes to the noise impacts that are identified.

Table 36 below identifies the NML exceedances for the EIS and the TNR6 earthwork construction stages. The level of the NML exceedances identify receivers which qualify for consideration of additional noise mitigation as per the bandings given in the CNVG (during standard hours). Feasible and reasonable additional noise mitigation measures are then assessed as per Appendix C of the CNVG.

Table 36. NML Exceedances Comparing the EIS and TNR6 Earthwork Construction Stages

NCA	NML Exceedance				
	Complies	0 to 10 dB	10 to 20 dB	+20 dB	Highly Noise Affected
EIS					
NCA04	0	9	8	0	0
NCA05	183	44	17	5	8
Total	183	53	25	5	8
TNR6					
NCA04	0	4	12	1	0
NCA05	138	89	17	5	8
Total	138	93	29	6	8
Difference (TNR6 minus EIS)					
NCA04	0	-5	4	1	0
NCA05	-45	45	0	0	0
Total	**-45**	**40**	**4**	**1**	**0**

Any receivers which shift between NML exceedance bands will require different noise mitigation as per Appendix C of the CNVG. The data in Table 36 can be summarised as follows:

- NCA04. The noise level increases in TNR6 mean that five (5) receivers are shifted from the 0 to 10 dB exceedance band when compared to the EIS assessment. Of these receivers four (4) are shifted into the 10 to 20 dB exceedance band and one (1) is shifted into the +20 dB exceedance band. There are no changes to the number of highly noise affected receivers between the assessments.
- NCA05. The noise level increases in TNR6 mean that 45 receivers are shifted from the 0 dB exceedance band (compliance) when compared to the EIS assessment. All of these receivers are shifted into the 0 to 10 dB exceedance band. There are no changes to the number of receivers in the +20 dB exceedance band or highly noise affected receivers between the assessments.
- Overall 50 receivers in the study area have shifted between NML exceedance bands and therefore require different mitigation measures as per the CNVG.

Appendix H presents a map of the predicted NML exceedances for TNR6 during the earthworks construction stage for all receivers in the study area.

19 TNR6 Detailed Design Additional Construction Noise Mitigation

19.1 Earthworks

Based on the assessment given in Section 18.1, Table 37 below identifies the additional mitigation measures for the EIS and the TNR6 earthwork construction stages in each banding as per the CNVG (during standard hours).

Table 37. CNVG Additional Mitigation Measures Comparing the EIS and TNR6 Earthwork Construction Stages

NCA	CNVG Additional Mitigation Measures				
	Noticeable (No Mitigation)	Clearly Audible (No Mitigation)	Moderate Intrusive (N, V)	Highly Intrusive (N, V)	Highly Noise Affected (N, V, PC, RO)
EIS					
NCA04	0	9	8	0	0
NCA05	183	44	17	5	8
Total	183	53	25	5	8
TNR6					
NCA04	0	4	12	1	0
NCA05	138	89	17	5	8
Total	138	93	29	6	8
Difference (TNR6 minus EIS)					
NCA04	0	-5	4	1	0
NCA05	-45	45	0	0	0
Total	**-45**	**40**	**4**	**1**	**0**

Notes: 1 Perception relates to the level above the RBL

2

AA	=	Alternative Accommodation	R1	=	Respite Period 1
V	=	Verification	R2	=	Respite Period 2
IB	=	Individual Briefing	DR	=	Duration Respite
N	=	Notification	PC	=	Phone Calls
RO	=	Respite offers	SN	=	Specific Notifications

3 HA = Highly Affected (>75dBA – applies to residences only)

Table 37 shows that overall there are only five (5) receivers which have changes to the required mitigation measures since the Noticeable and Clearly Audible mitigation bandings do not require any specific mitigation measures. This is a low number of receivers and indicates that the changes to the construction noise impacts are also low.

All the affected receivers are all located in NCA04 and require the following additional mitigation measures:

- N – Notification (ie letters during construction).
- V – Verification (ie measurements during construction).

The five (5) receivers which require additional mitigation measures due to the TNR6 earthworks construction stage are provided below:

- 151 Adams Rd, Luddenham
- 180 Adams Rd, Luddenham
- 145 Adams Rd, Luddenham
- 161 Adams Rd, Luddenham
- 125 Adams Rd, Luddenham

19.2 Earthwork Duration

The additional mitigation measures are only required during the TNR6 earthworks construction stage associated with the new Adams Road interchange. These construction activities are predicted to occur for between 4 to 8 weeks.

The noise impacts associated with the main alignment earthworks are effectively unchanged between the EIS and TNR6.

19.3 Bridgeworks

The additional mitigation measures required for the earthworks of the new Adams Road interchange should be offset against the changes to bridgeworks construction stage. Since the bridgeworks are no longer necessary the standard hours and OOH noise impacts from the bridgeworks are effectively nil. The change to OOH impacts should be considered a significant positive change to the construction noise impacts in this area.

19.4 Overall Mitigation Impacts

Combining the low number of additional receivers which require treatment with the short duration of construction works and the reduction of OOH bridgework in the area, this assessment concludes that the overall change to construction noise impacts are minor. Therefore, the construction noise results between the EIS and TNR6 construction stages are comparable with no significant modifications.

20 Conclusion

20.1 Operational Noise

Operational noise levels have been predicted and assessed for the Detailed Design of The Northern Road Stage 6 (TNR6) in accordance with the Ministers Conditions of Approval, Condition E36.

The TNR6 Detailed Design operational noise predictions have been compared against the acoustic assessment undertaken for the EIS. As discussed in Section 9 an average change in noise of -0.1 dB (day) and +0.1(night) was observed for the TNR6 alignment when compared to the EIS. A small percentage of receivers (3.2% day and 14.7% night) experience small noise increases ≥ 0.2 dB. Overall, the noise modelling showed a strong agreement between the noise predictions for the TNR6 and EIS assessments.

The operational noise impact outcomes from Section 10 and Section 11 show architectural treatments increase by five (5) receivers in the TNR6 stage compared to the original EIS. The reasons for the mitigation changes between the TNR6 and EIS alignments are summarised in Table 20 above.

Architectural treatments are committed to all the receivers identified in the EIS assessment. Therefore, the total number of architectural treatments equals the EIS commitment (21 receivers) with an additional five (5) receivers added due to the TNR6 assessment. This means the combined EIS and TNR6 assessments result in a total of 26 receivers which qualify for architectural treatment.

The assessment shows that there is no requirement to consider additional noise mitigation measures such as low noise pavements or barriers for the TNR6 stage, which is comparable with the EIS.

Overall, the noise level predictions and noise impact outcomes (mitigation) between the EIS and TNR6 alignments are considered to be virtually equivalent and comparable. The project satisfies the requirement of Condition E36 of the NSW Ministers Conditions of Approval as a result.

20.2 Construction Noise

Construction noise levels have been predicted and assessed for the Detailed Design of The Northern Road Stage 6 (TNR6) in accordance with the Roads and Maritime Construction Noise and Vibration Guideline (CNVG) which is the RMS application of the Interim Construction Noise Guideline (ICNG).

The TNR6 Detailed Design construction noise predictions have been compared against the assessment undertaken for the EIS. As discussed in Section 17 an average increase in noise of 2.7 dB was observed for the TNR6 earthworks construction stage when compared to the EIS. Within the assessment study area 94.0% of all receivers have noise level changes of < 6 dB.

The construction noise impact outcomes from Section 18 and Section 19 show an increase of five (5) receivers in the TNR6 assessment compared to the original EIS which require additional mitigation measures as per the CNVG. Combining the low number of additional receivers which require treatment with the short duration of construction works and the reduction of OOH bridgework in the area, this assessment concludes that the overall change to construction noise impacts are minor.

Therefore, the construction noise results between the EIS and TNR6 construction stages are comparable with no significant modifications. TNR6 satisfies the requirements of the Roads and Maritime Construction Noise and Vibration Guideline (CNVG) as a result.

APPENDIX A: TERMINOLOGY

1 Sound Level or Noise Level

The terms “sound” and “noise” are almost interchangeable, except that in common usage “noise” is often used to refer to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure capable of evoking the sense of hearing. The human ear responds to changes in sound pressure over a very wide range. The loudest sound pressure to which the human ear responds is ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or L_P are commonly used to represent Sound Pressure Level. The symbol L_A represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels (dB) is 20 µPa.

2 “A” Weighted Sound Pressure Level

The overall level of a sound is often expressed in terms of dBA, which is measured using a sound level meter with an “A-weighting” filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People’s hearing is most sensitive to sounds at mid frequencies (500 Hz to 4000 Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dBA is a good measure of the loudness of that sound. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dBA or 2 dBA in the level of a sound is difficult for most people to detect, whilst a 3 dBA to 5 dBA change corresponds to a small but noticeable change in loudness. A 10 dBA change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120 110	Heavy rock concert Grinding on steel	Extremely noisy
100 90	Loud car horn at 3 m Construction site with pneumatic hammering	Very noisy
80 70	Kerbside of busy street Loud radio or television	Loud
60 50	Department store General Office	Moderate to quiet
40 30	Inside private office Inside bedroom	Quiet to very quiet
20	Unoccupied recording studio	Almost silent

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as “linear”, and the units are expressed as dB(Lin) or dB.

3 Sound Power Level

The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or L_W, or by the reference unit 1 pW.

The relationship between Sound Power and Sound Pressure may be likened to an electric radiator, which is characterised by a power rating, but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4 Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels L_{AN}, where L_{AN} is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the L_{A1} is the noise level exceeded for 1% of the time, L_{A10} the noise exceeded for 10% of the time, and so on.

Of particular relevance, are:

- L_{A1} - The noise level exceeded for 1% of the 15-minute interval.
- L_{A10} - The noise level exceeded for 10% of the 15-minute interval. This is commonly referred to as the average maximum noise level.
- L_{A90} - The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.
- L_{Aeq} - The A-weighted equivalent noise level (basically the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

When dealing with numerous days of statistical noise data, it is sometimes necessary to define the typical noise levels at a given monitoring location for a particular time of day. A standardised method is available for determining these representative levels.

This method produces a level representing the “repeatable minimum” L_{A90} noise level over the daytime and night-time measurement periods, as required by the EPA. In addition, the method produces mean or “average” levels representative of the other descriptors (L_{Aeq}, L_{A10}, etc).

5 Tonality

Tonal noise contains one or more prominent tones (ie distinct frequency components), and is normally regarded as more offensive than “broad band” noise.

6 Impulsiveness

An impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.

7 Frequency Analysis

Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal. This analysis was traditionally carried out using analogue electronic filters, but is now normally carried out using Fast Fourier Transform (FFT) analysers.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (3 bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

8 Vibration

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of “peak” velocity or “rms” velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as “peak particle velocity”, or PPV. The latter incorporates “root mean squared” averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements. Where triaxial measurements are used, the axes are commonly designated vertical, longitudinal (aligned toward the source) and transverse.

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V, expressed in mm/s can be converted to decibels by the formula 20 log (V/V_o), where V_o is the reference level (1E-6 mm/s). Care is required in this regard, as other reference levels are used by some countries.

9 Human Perception of Vibration

People are able to “feel” vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as “normal” in a car, bus or train is considerably higher than what is perceived as “normal” in a shop, office or dwelling.

10 Over-Pressure

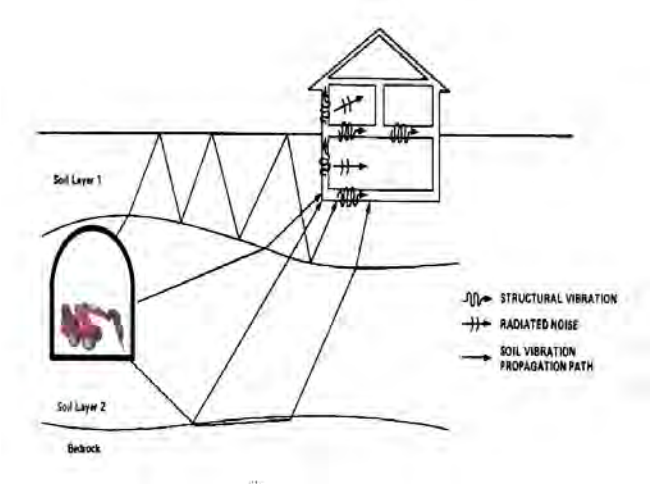
The term “over-pressure” is used to describe the air pressure pulse emitted during blasting or similar events. The peak level of an event is normally measured using a microphone in the same manner as linear noise (ie unweighted), at frequencies both in and below the audible range.

11 Regenerated Noise

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed “regenerated noise”, “structure-borne noise”, or sometimes “ground-borne noise”. Regenerated noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

Typical sources of regenerated noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

The following figure presents the various paths by which vibration and regenerated noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.

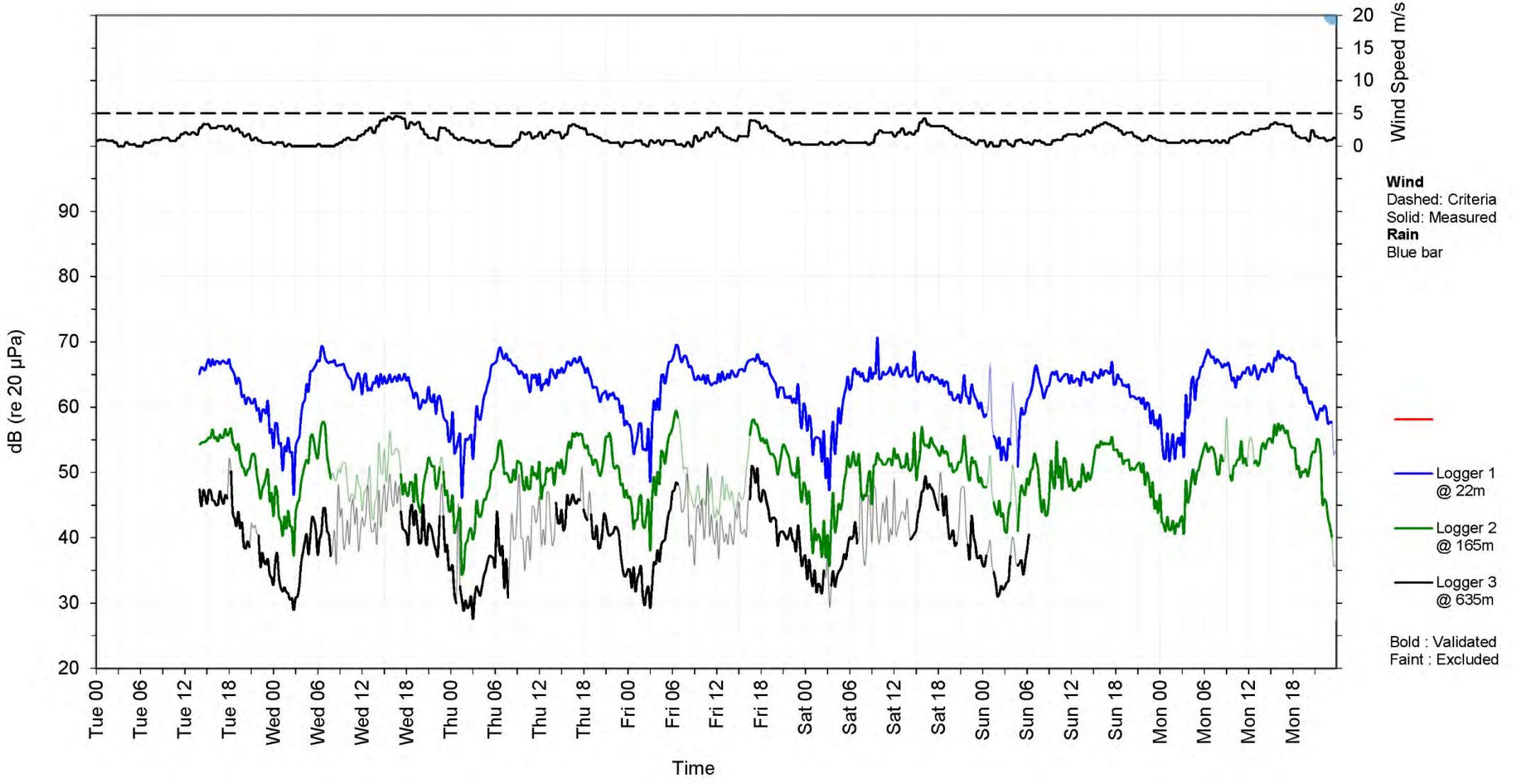


The term “regenerated noise” is also used to describe other types of noise that are emitted from the primary source as a different form of energy. One example would be a fan with a silencer, where the fan is the energy source and primary noise source. The silencer may effectively reduce the fan noise, but some additional noise may be created by the aerodynamic effect of the silencer in the airstream. This “secondary” noise may be referred to as regenerated noise.

APPENDIX B:
ADDITIONAL VALIDATION NOISE LOGGERS

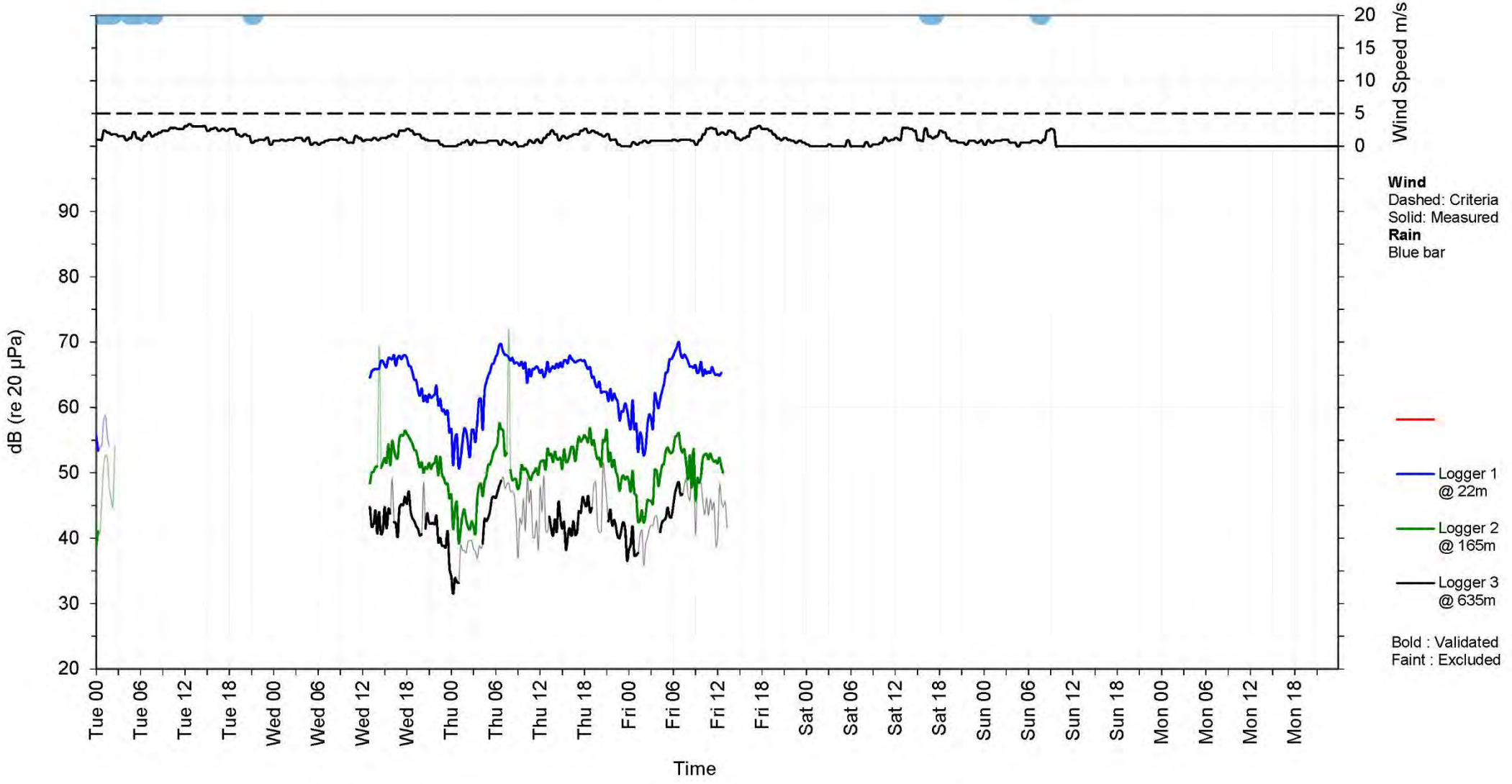
TNR4 - Supplementary Noise Logging
Logger LAeq Comparison
60.00750.01

Tuesday 13 February 2018
to
Monday 19 February 2018



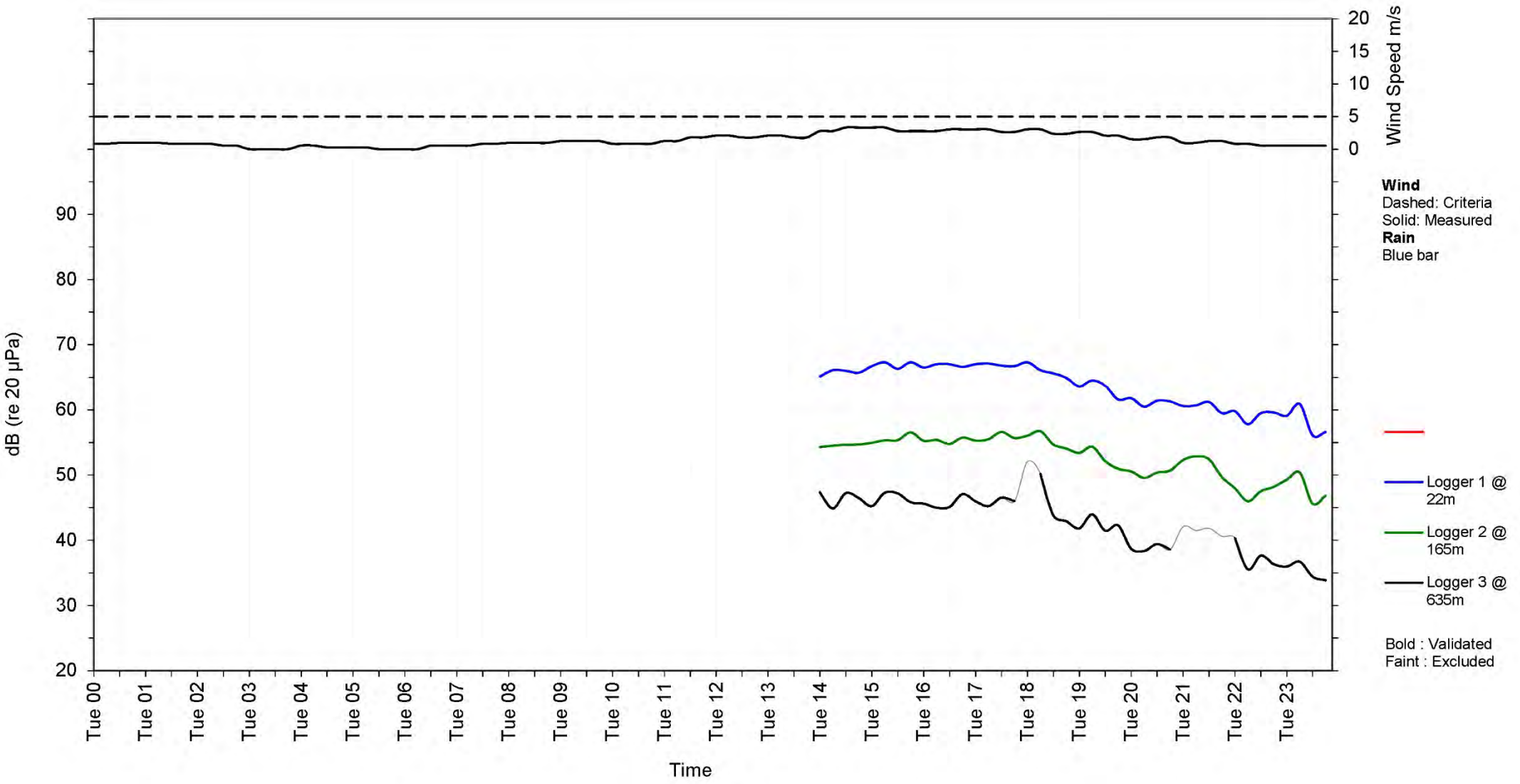
TNR4 - Supplementary Noise Logging
Logger LAeq Comparison
60.00750.01

Tuesday 20 February 2018
to
Monday 26 February 2018



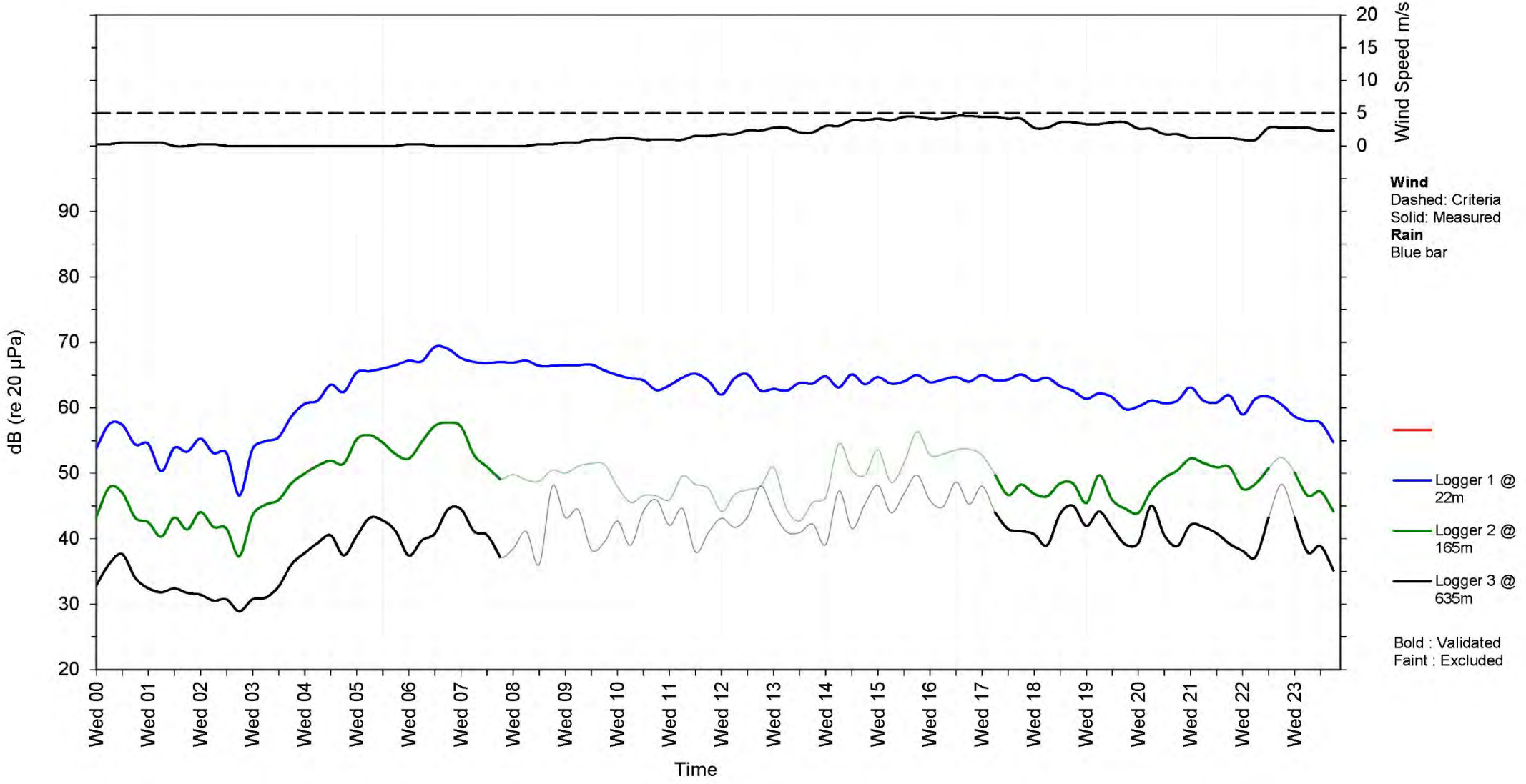
TNR4 - Supplementary Noise Logging
Logger LAeq Comparison
60.00750.01

Tuesday 13 February 2018



TNR4 - Supplementary Noise Logging
Logger LAeq Comparison
60.00750.01

Wednesday 14 February 2018

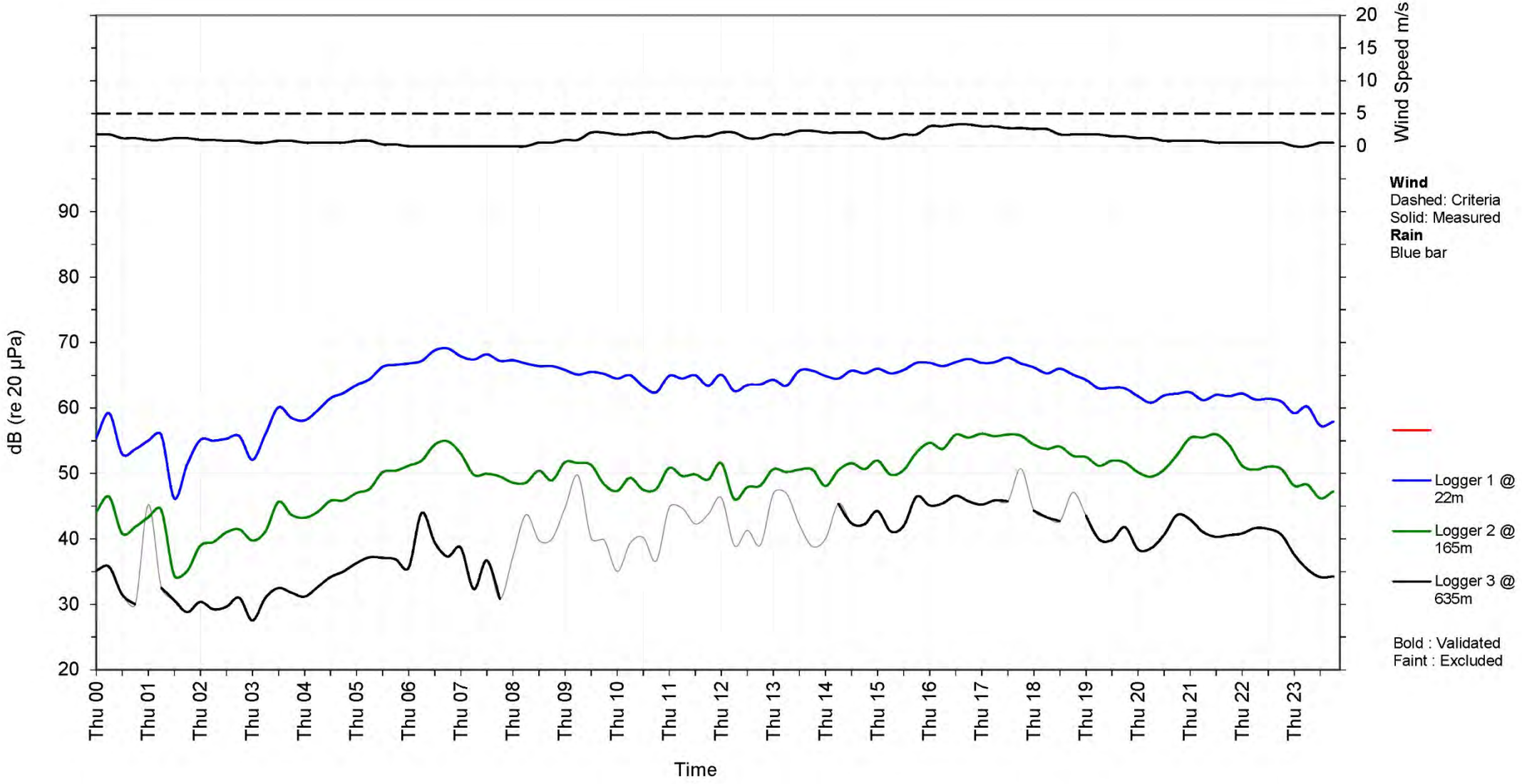


TNR4 - Supplementary Noise Logging

Logger LAeq Comparison

60.00750.01

Thursday 15 February 2018

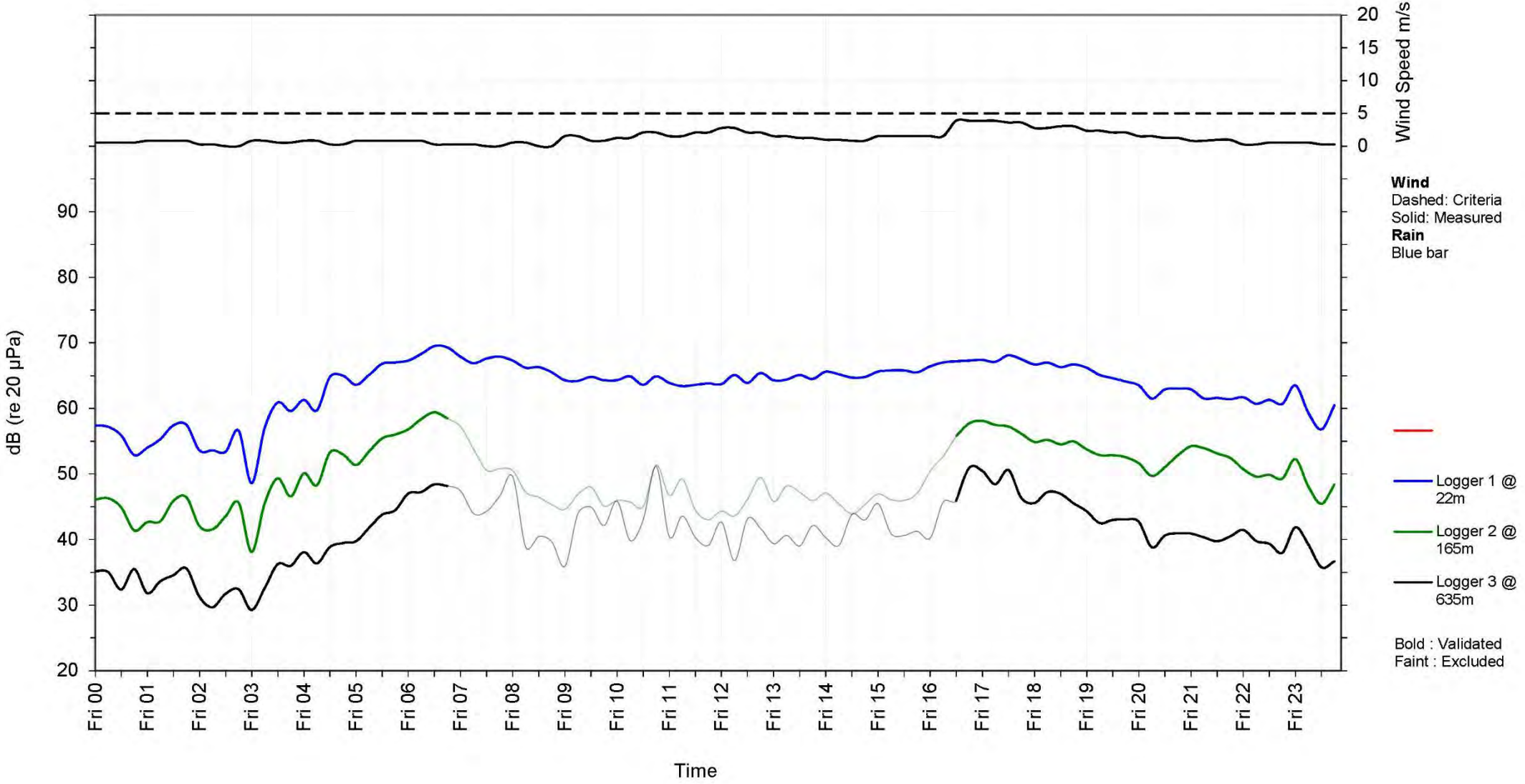


TNR4 - Supplementary Noise Logging

Logger LAeq Comparison

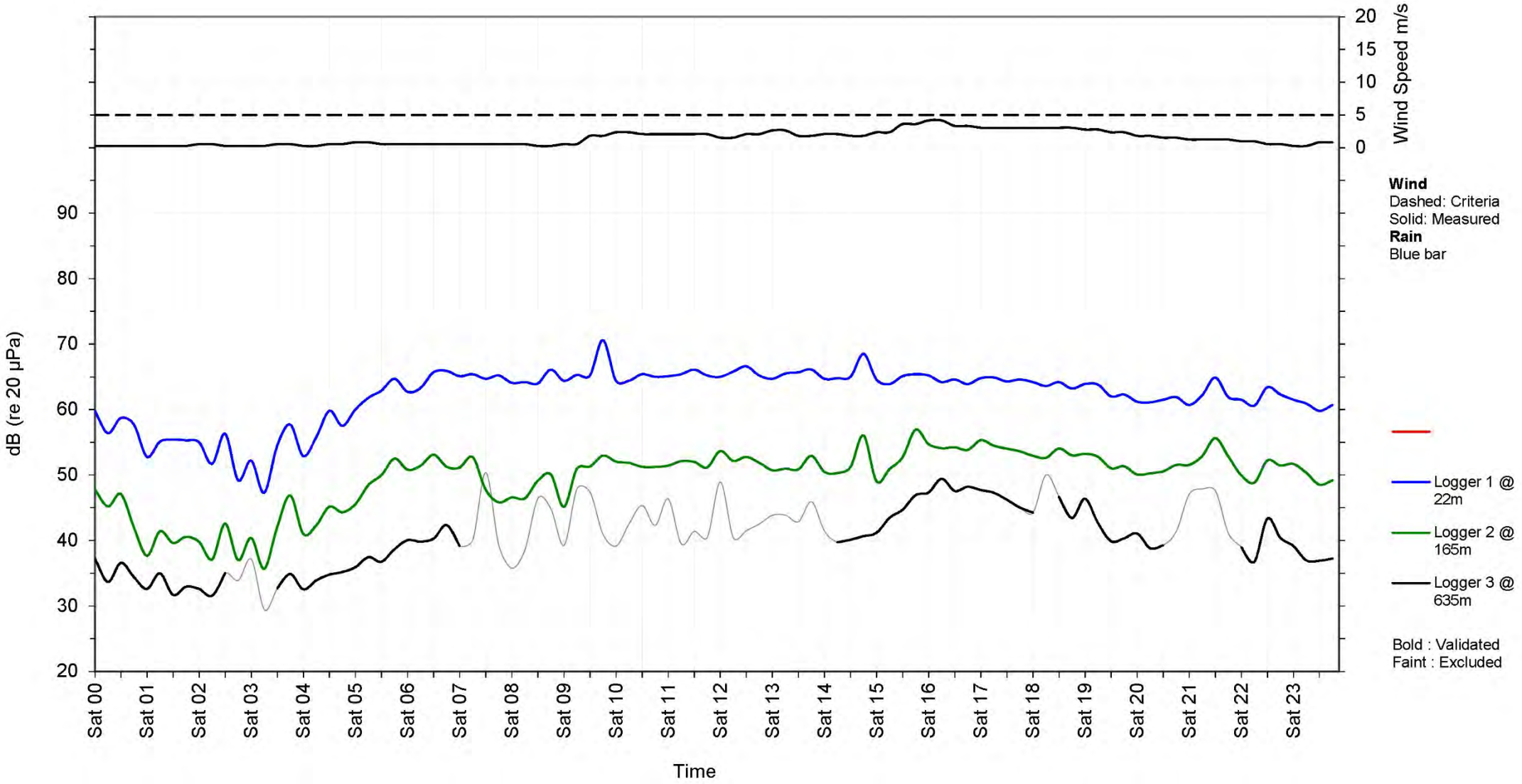
60.00750.01

Friday 16 February 2018



TNR4 - Supplementary Noise Logging
Logger LAeq Comparison
60.00750.01

Saturday 17 February 2018

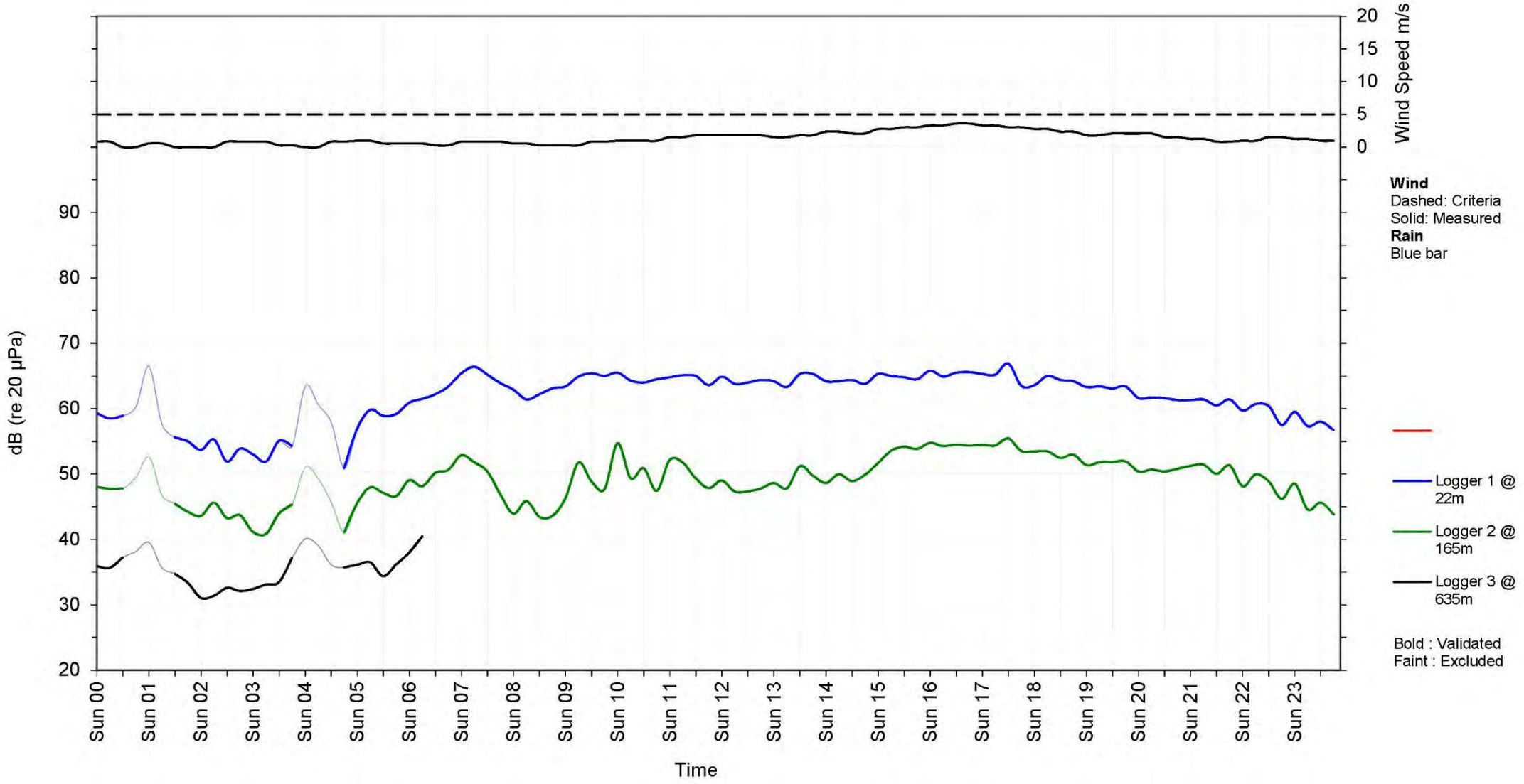


TNR4 - Supplementary Noise Logging

Logger LAeq Comparison

60.00750.01

Sunday 18 February 2018

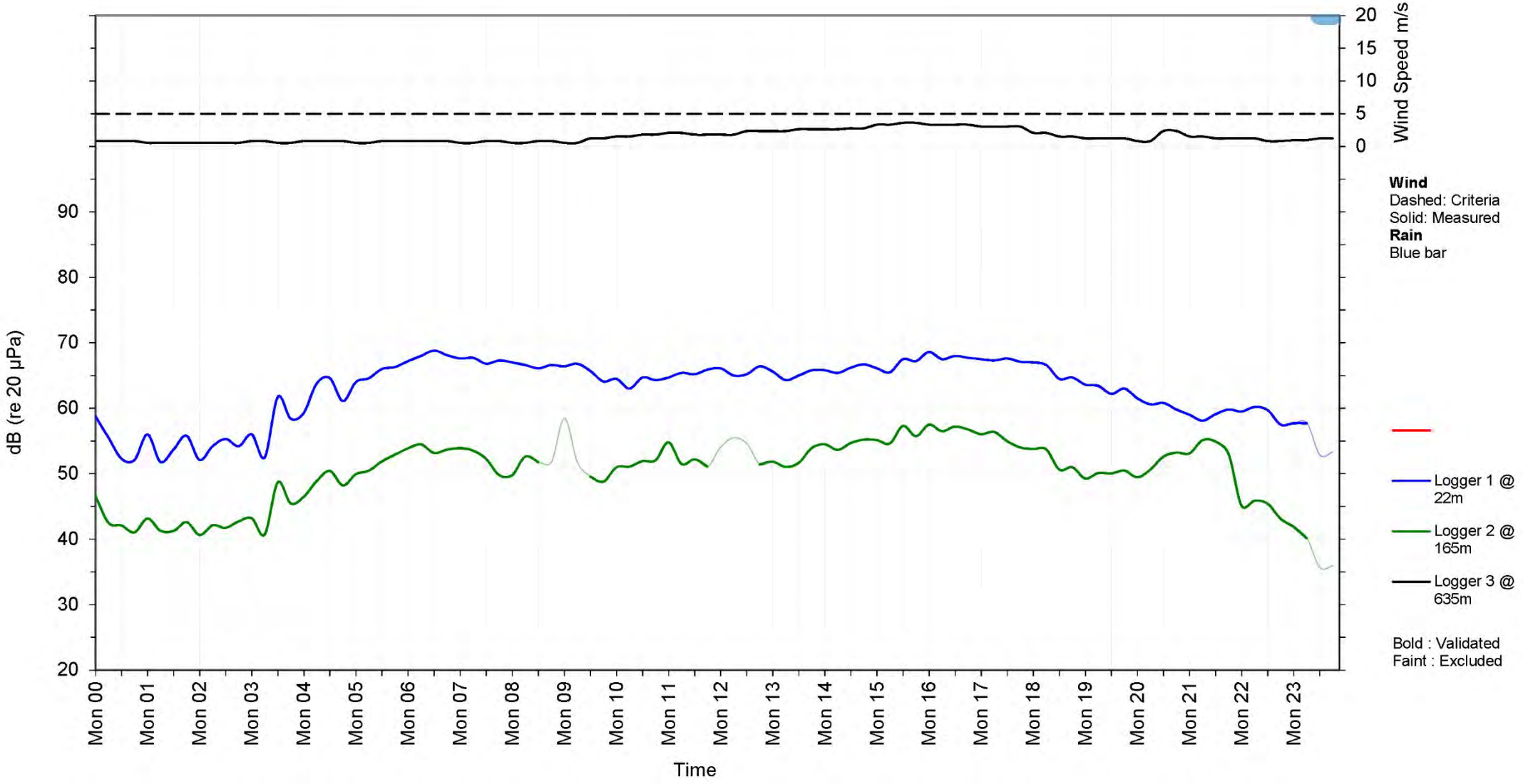


TNR4 - Supplementary Noise Logging

Logger LAeq Comparison

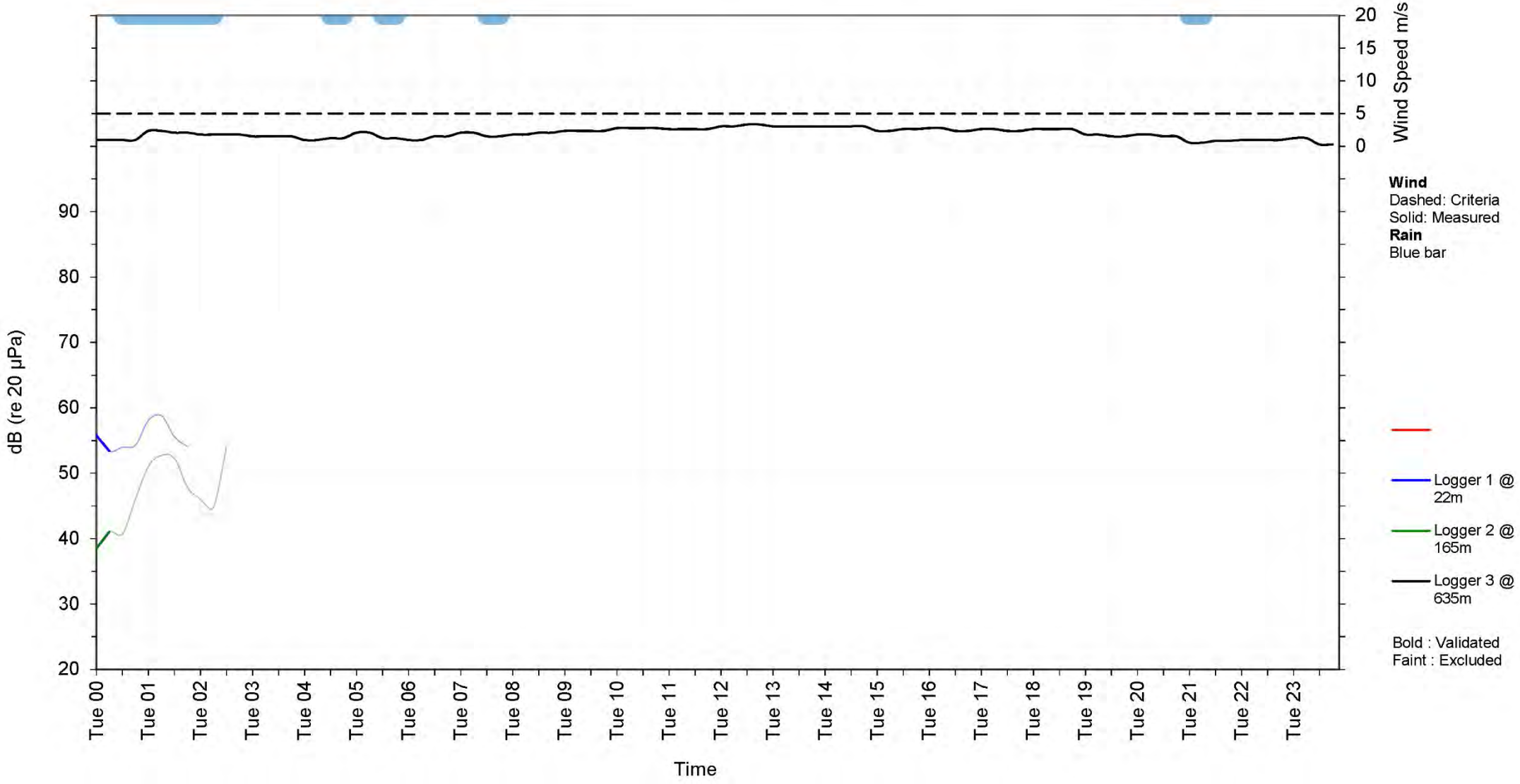
60.00750.01

Monday 19 February 2018



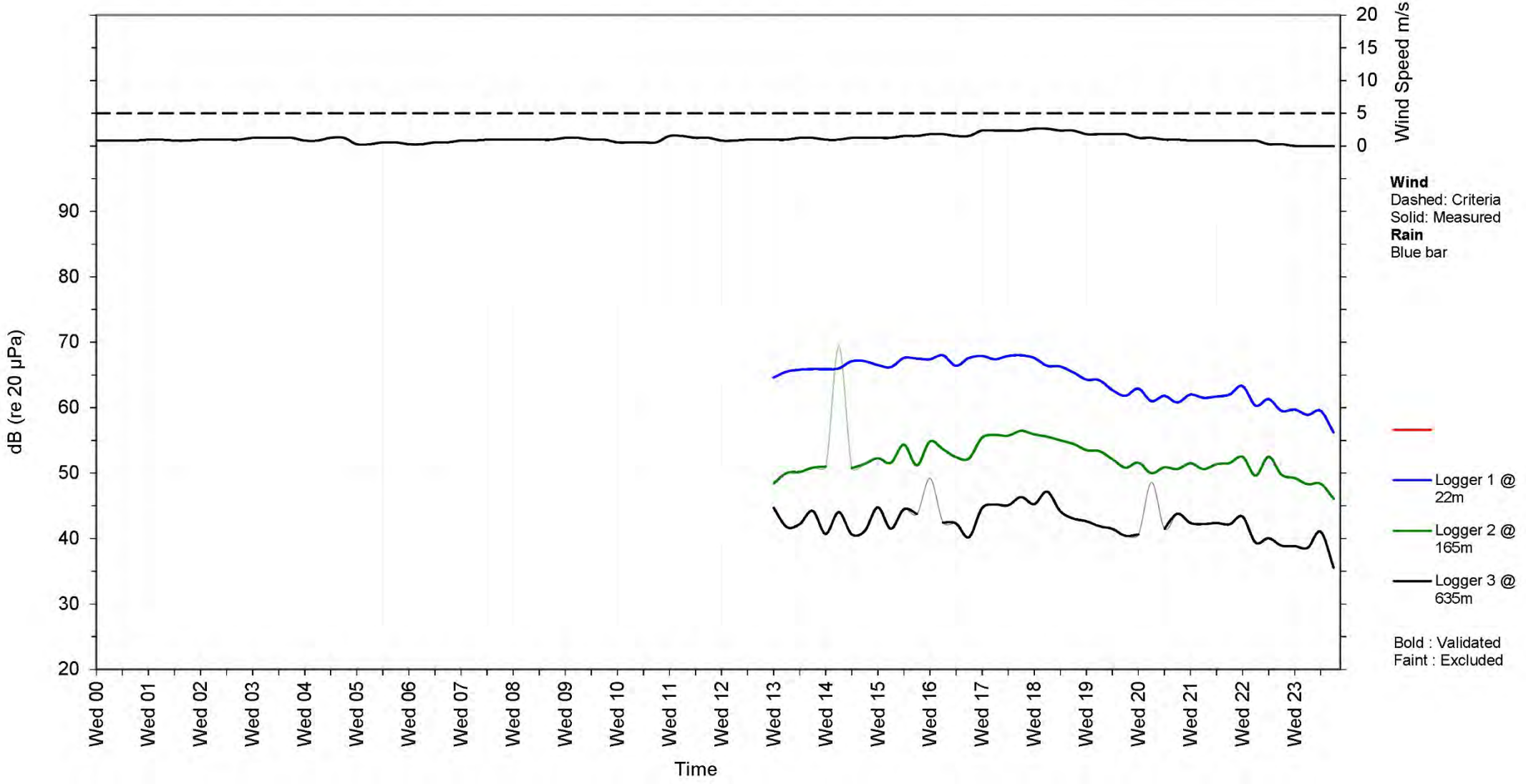
TNR4 - Supplementary Noise Logging
Logger LAeq Comparison
60.00750.01

Tuesday 20 February 2018



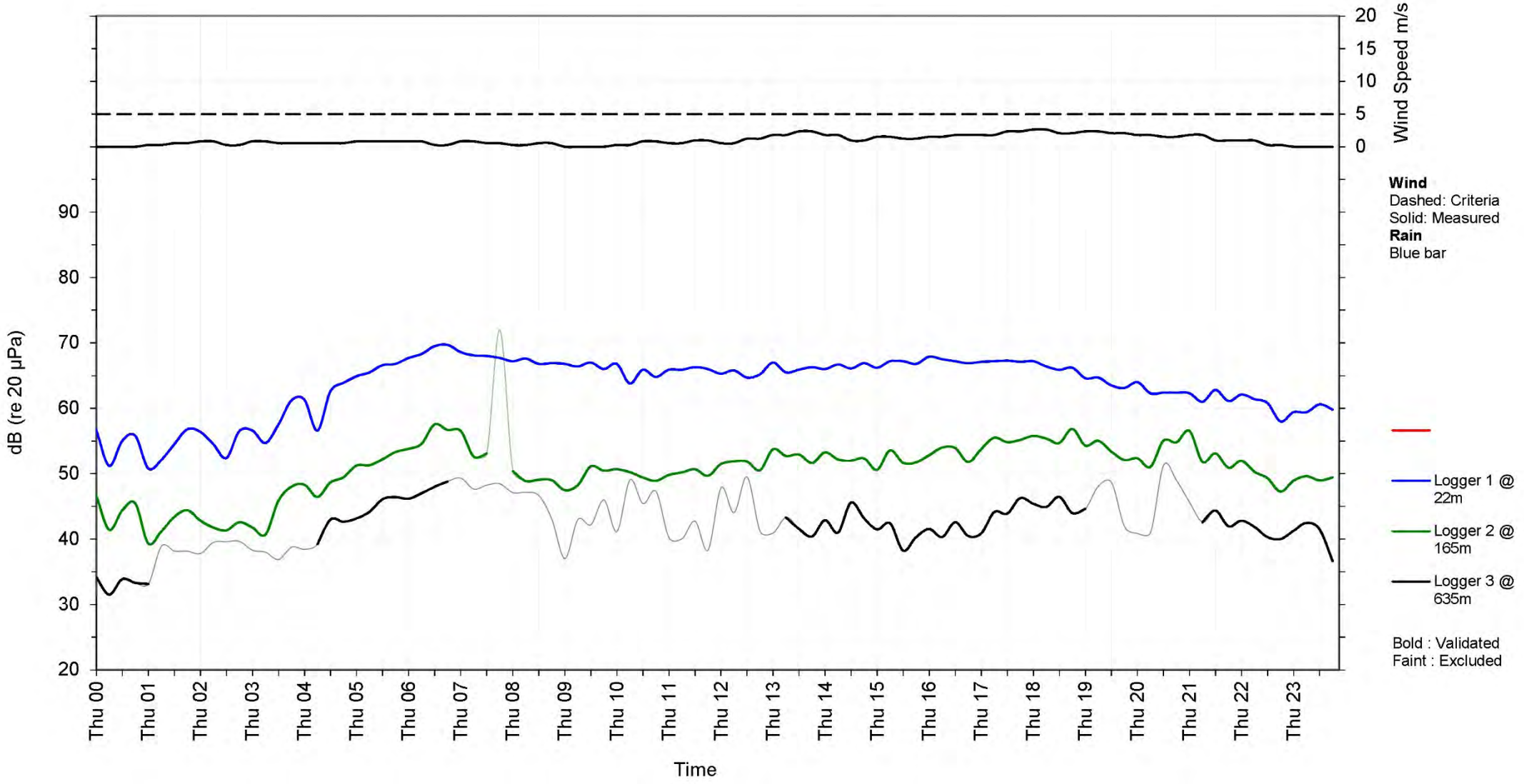
TNR4 - Supplementary Noise Logging
Logger LAeq Comparison
60.00750.01

Wednesday 21 February 2018



TNR4 - Supplementary Noise Logging
Logger LAeq Comparison
60.00750.01

Thursday 22 February 2018

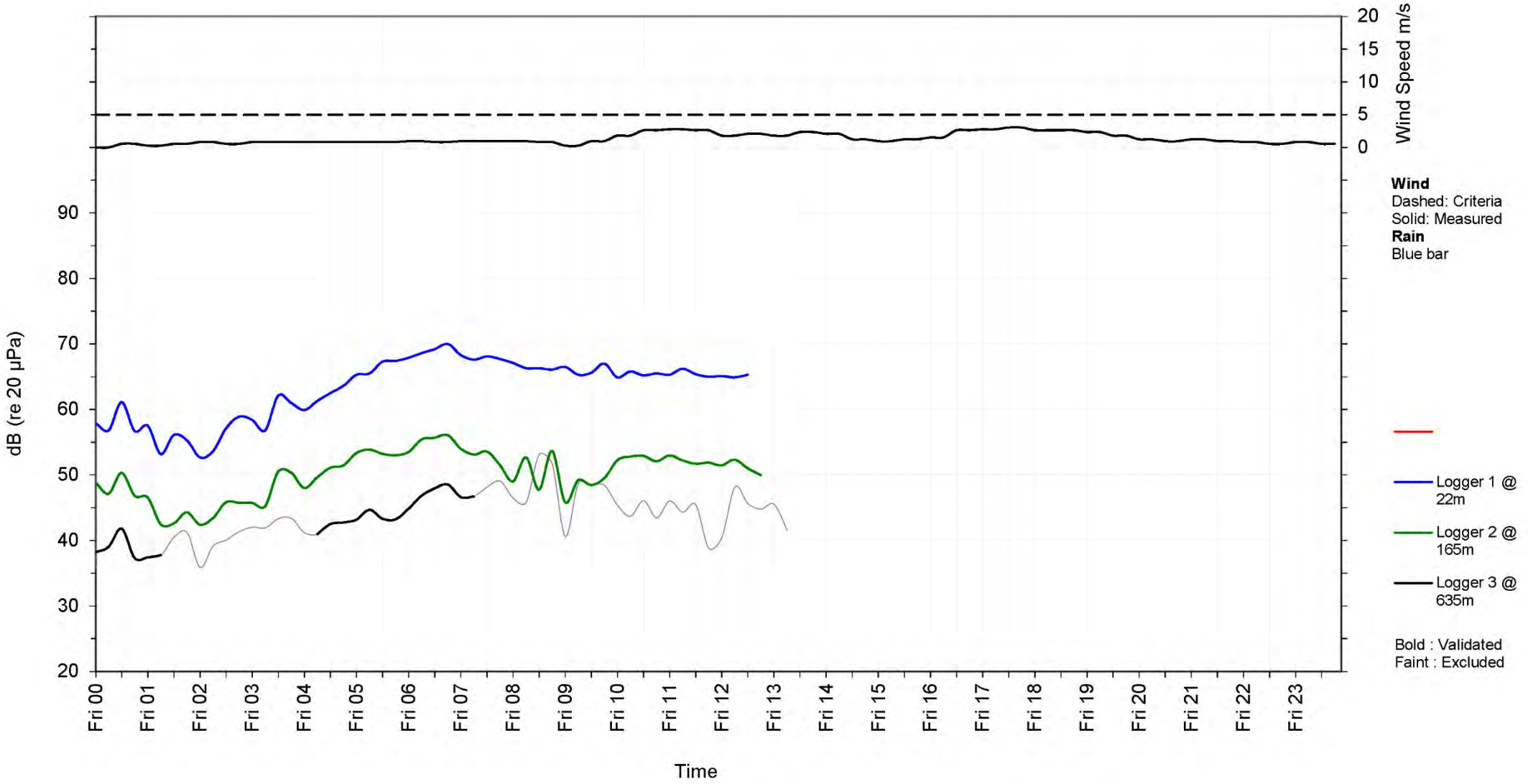


TNR4 - Supplementary Noise Logging

Logger LAeq Comparison

60.00750.01

Friday 23 February 2018



APPENDIX C:
NOISE LEVEL CHANGES – TNR6 vs EIS ALIGNMENTS

Noise Level Change (TNR6 - EIS) dB

- < 1.0
- -1.00 to -0.50
- -0.50 to 0.00
- 0.00 to 0.50
- 0.50 to 1.00
- > 1.0

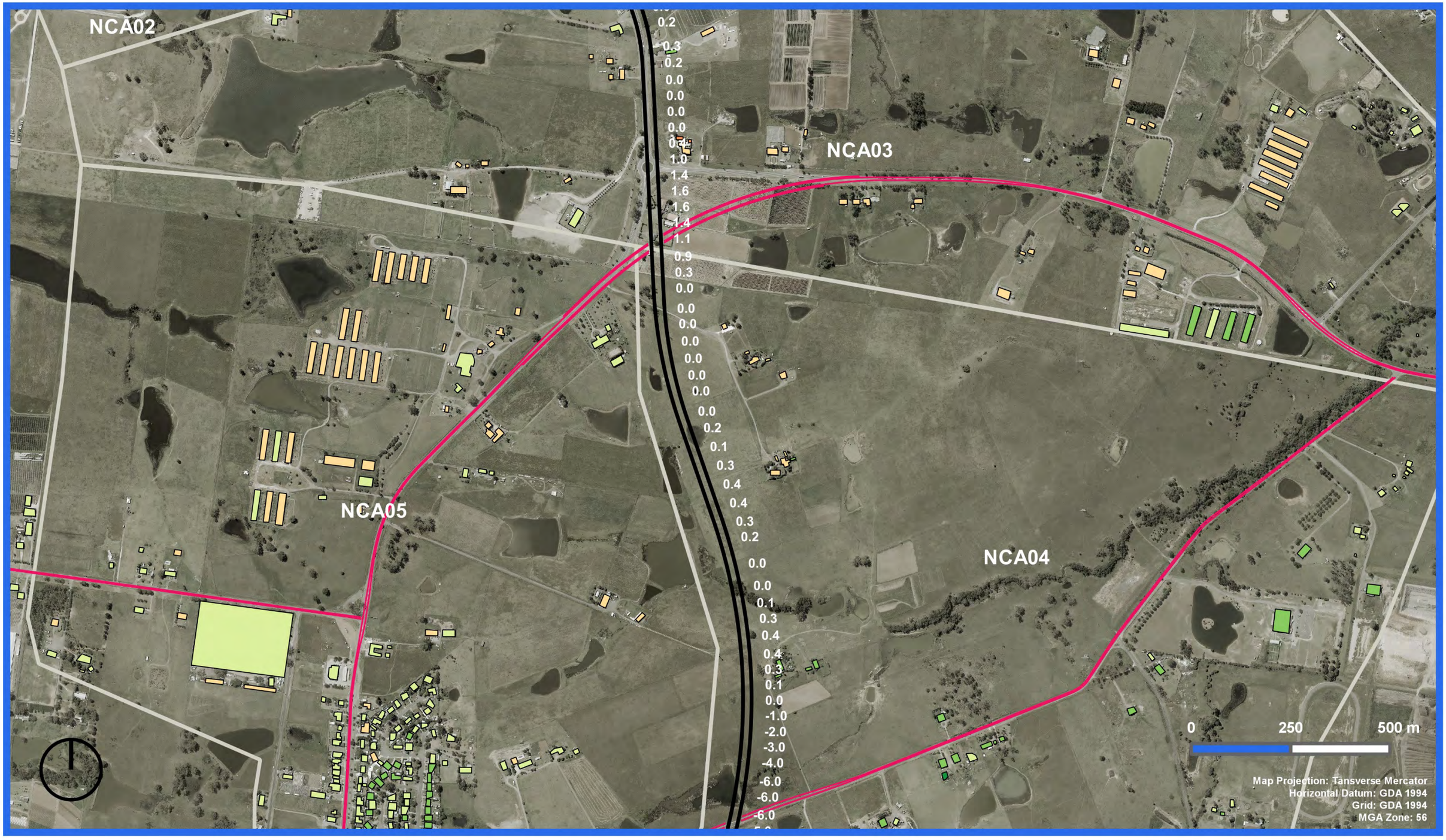
- TNR6 Projects Roads - height difference EIS (m)
- Local Roads
- NCAs

Predicted Noise Level Change (TNR6 - EIS)
Daytime Controlling Scenario 2031

OPERATIONAL NOISE MODIFICATION ASSESSMENT

Waves CONSULTING

Project Number: 60.00758.01
Date: 13 September 2018
Revision: 02
Prepared by: TC



Noise Level Change (TNR6 - EIS) dB

- < 1.0
- -1.00 to -0.50
- -0.50 to 0.00
- 0.00 to 0.50
- 0.50 to 1.00
- > 1.0

- TNR6 Projects Roads - height difference EIS (m)
- Local Roads
- NCAs

Predicted Noise Level Change (TNR6 - EIS)
Daytime Controlling Scenario 2031

OPERATIONAL NOISE MODIFICATION ASSESSMENT

Waves CONSULTING

Project Number: 60.00758.01
Date: 13 September 2018
Revision: 02
Prepared by: TC

Noise Level Change (TNR6 - EIS) dB

- < 1.0
- -1.00 to -0.50
- -0.50 to 0.00
- 0.00 to 0.50
- 0.50 to 1.00
- > 1.0

- TNR6 Projects Roads - height difference EIS (m)
- Local Roads
- NCAs

Predicted Noise Level Change (TNR6 - EIS)
Daytime Controlling Scenario 2031

OPERATIONAL NOISE MODIFICATION ASSESSMENT

Waves CONSULTING

Project Number: 60.00758.01
Date: 13 September 2018
Revision: 02
Prepared by: TC

APPENDIX D:
ARCHITECTURAL TREATMENTS – TNR6 vs EIS ALIGNMENTS

Qualify for Architectural Treatments

- No TNR6, Yes EIS
- Yes TNR6, No EIS
- No TNR6 & EIS
- Yes TNR6 & EIS
- Not Sensitive

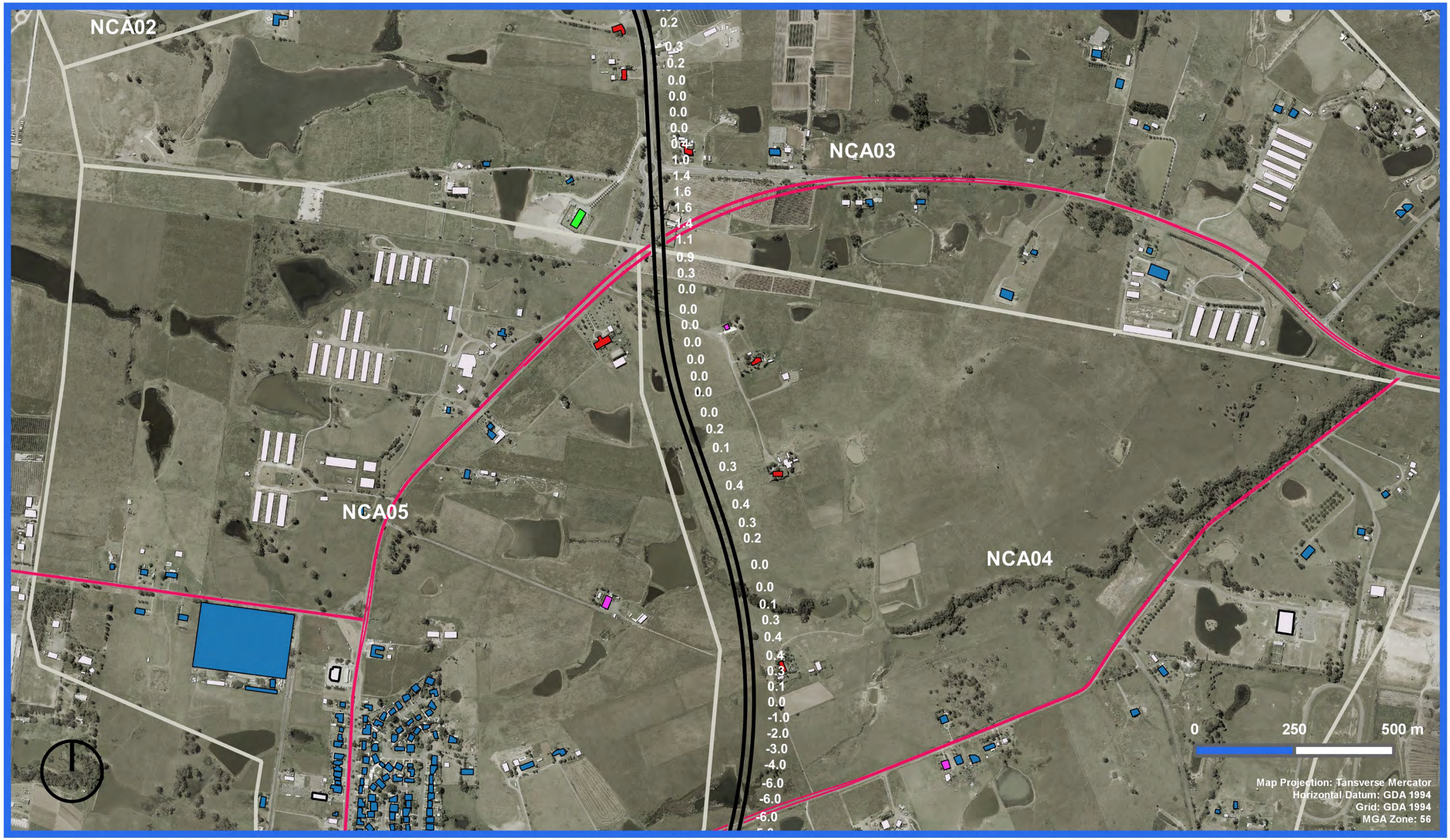
- TNR6 Projects Roads - height difference EIS (m)
- Local Roads
- NCAs

Architectural Treatments
TNR6 vs EIS Alignments

OPERATIONAL NOISE MODIFICATION ASSESSMENT

Waves CONSULTING

Project Number: 60.00758.01
Date: 13 September 2018
Revision: 02
Prepared by: TC



Qualify for Architectural Treatments

- No TNR6, Yes EIS
- Yes TNR6, No EIS
- No TNR6 & EIS
- Yes TNR6 & EIS
- Not Sensitive

- TNR6 Projects Roads - height difference EIS (m)
- Local Roads
- NCAs

Architectural Treatments
TNR6 vs EIS Alignments

OPERATIONAL NOISE MODIFICATION ASSESSMENT

Waves CONSULTING

Project Number: 60.00758.01
Date: 13 September 2018
Revision: 02
Prepared by: TC

Qualify for Architectural Treatments

- No TNR6, Yes EIS
- Yes TNR6, No EIS
- No TNR6 & EIS
- Yes TNR6 & EIS
- Not Sensitive

- TNR6 Projects Roads - height difference EIS (m)
- Local Roads
- NCAs

Architectural Treatments
TNR6 vs EIS Alignments

OPERATIONAL NOISE MODIFICATION ASSESSMENT

Waves CONSULTING

Project Number: 60.00758.01
Date: 13 September 2018
Revision: 02
Prepared by: TC

APPENDIX E:
TABULATED NOISE ASSESSMENT RESULTS

NCA	Address	Floor	Location (MGA 56)		Receiver Type	Criteria Type	Day Criteria	Night Criteria	Noise Level Difference TNR6 minus EIS (dB)		Qualify for Architectural Treatment		TNR6 Mitigation Trigger			TNR6 Predicted Noise Levels in 2021 (dB L_{Aeq} rounded)		TNR6 Predicted Noise Levels in 2031 (dB L_{Aeq} rounded)	
			Easting	Northing					Day	Night	TNR6	EIS	Trigger 1	Trigger 2	Trigger 3	Day	Night	Day	Night
NCA02	2751 The Northern Road Luddenham	1	286504.3862	6251618.993	RES	P	60	55	-0.5	-0.2	Y	Y	Y	N	N	60	53	62	55
NCA02	2785-2787 The Northern Road, Luddenham	1	286718.3813	6251311.432	RES	P	60	55	1.2	1.5	Y	Y	Y	Y	Y	64	57	66	59
NCA03	2825-2841 The Northern Road_5, Luddenham	1	286982.2772	6250878.622	RES	P	60	55	-0.1	0.2	Y	Y	Y	Y	Y	65	58	67	60
NCA03	2843-2857 The Northern Road_4, Luddenham	1	286995.2521	6250763.98	RES	P	60	55	0.4	0.7	Y	Y	Y	Y	Y	64	57	66	56
NCA03	2311-2337 Elizabeth Dr_1, Luddenham	1	287152.8979	6250576.6	RES	P	60	55	0.6	1.1	Y	Y	Y	N	N	62	55	64	57
NCA03	2311-2337 Elizabeth Dr_1, Luddenham	2	287152.8979	6250576.6	RES	P	60	55	0.5	1	Y	Y	Y	Y	Y	64	57	66	59
NCA04	2422-2430 The Northern Road_3, Luddenham	1	287327.5176	6250044.651	RES	P	55	50	0.1	0.2	Y	Y	Y	N	N	56	49	57	50
NCA04	2420 The Northern Road_2, Luddenham	1	287381.0142	6249761.792	RES	P	55	50	0.2	0.3	Y	Y	Y	N	N	57	51	58	52
NCA04	140 Adams Rd_1, Luddenham	1	287392.8513	6249278.213	RES	P	55	50	-0.5	-0.3	Y	Y	Y	Y	N	59	52	60	53
NCA04	125 Adams Rd_3, Luddenham	1	287609.967	6248813.944	RES	P	55	50	-0.5	-0.4	Y	Y	Y	N	N	55	49	56	50
NCA04	105-115 Adams Rd, Luddenham	1	287484.358	6248622.184	RES	P	55	50	-0.5	-0.5	Y	Y	Y	N	N	55	49	56	50
NCA05	2320-2390 The Northern Road_2, Luddenham	1	286940.5391	6250092.763	RES	P	55	50	0	0	Y	Y	Y	N	N	58	52	59	52
NCA05	45 Adams Rd_1, Luddenham	1	287106.87	6248692.696	RES	P	55	50	-0.6	-0.8	Y	Y	Y	Y	N	61	54	62	55
NCA05	18 Eaton Road Luddenham	1	286921.4616	6248346.477	RES	P	55	50	-0.4	-0.7	Y	Y	Y	Y	N	61	52	62	55
NCA05	16 Eaton Rd, Luddenham	1	286902.3269	6248344.895	RES	P	55	50	-0.4	-0.7	Y	Y	N	Y	N	60	53	61	54
NCA05	Luddenham Public School_2	1	286489.2319	6248647.41	OED	H	50	-	-0.6	-0.6	Y	Y	Y	N	N	53*	45*	51*	49*
NCA05	14 Eaton Rd, Luddenham	1	286881.1193	6248343.561	RES	P	55	50	-0.4	-0.7	Y	Y	N	Y	N	59	52	60	53
NCA05	2215 The Northern Road_1, Luddenham	1	286631.8429	6248248.14	RES	P	55	50	0.2	0.2	Y	Y	Y	N	N	54	47	56	50
NCA02	2778-2828 The Northern Road, Luddenham	1	286961.6341	6251330.184	RES	P	60	55	1.1	1.5	Y	N	Y	N	N	59	52	61	54
NCA04	2422-2430a The Northern Road, Luddenham	1	287252.9036	6250130.302	RES	P	55	50	0.1	0.4	Y	N	Y	N	N	57	51	59	52
NCA04	151 Adams Rd_1, Luddenham	1	287802.8028	6249031.227	RES	P	55	50	-0.9	-0.8	Y	N	Y	N	N	55	51	57	53
NCA05	2292 The Northern Road_1, Luddenham	1	286952.0644	6249439.214	RES	P	52	46	0.2	0.3	Y	N	Y	N	N	53	47	53	47
NCA05	2215a The Northern Road, Luddenham	1	286666.3859	6248220.379	RES	P	55	50	0.2	0.3	Y	N	Y	N	N	55	48	56	50
NCA03	2859 The Northern Road_1, Luddenham	1	286879.7954	6250402.266	RES	P	58	53	-0.1	0.2	N	Y	N	N	N	55	48	57	50
NCA05	Luddenham Public School_3	1	286505.1567	6248627.717	OED	H	50	-	-0.6	-0.6	N	Y	N	N	N	53*	46*	54*	49*
NCA05	Luddenham Public School_1	1	286525.2372	6248618.256	OED	H	50	-	-0.7	-0.6	N	Y	N	N	N	53*	45*	54*	49*
NCA02	2594-2776 The Northern Road_4, Luddenham	1	286707.8121	6251983.272	RES	P	60	55	0	0.4	N	N	N	N	N	56	49	59	52
NCA02	2594-2776 The Northern Road_4, Luddenham	2	286707.8121	6251983.272	RES	P	60	55	0.1	0.5	N	N	N	N	N	57	50	59	53
NCA02	114 Galaxy Rd, Mulgoa	1	285547.2462	6251221.324	RES	P	56	49	-0.4	-0.1	N	N	N	N	N	44	37	46	40
NCA02	89 Galaxy Rd_1, Mulgoa	1	285611.4377	6251113.875	RES	P	56	49	-0.3	0.1	N	N	N	N	N	44	38	47	40
NCA02	44 galaxy Rd_2, Luddenham	1	285794.2384	6251224.224	RES	P	57	51	-0.3	0	N	N	N	N	N	46	39	48	41
NCA02	2761-2783 The Northern Road, Luddenham	1	286352.1274	6251334.061	RES	P	60	55	0.1	0.4	N	N	N	N	N	52	45	54	48
NCA03	44 Galaxy Rd_2, Luddenham	1	286127.818	6250903.684	RES	P	57	51	0	0.3	N	N	N	N	N	46	39	48	41
NCA03	2825-2841 The Northern Road_4, Luddenham	1	286826.2296	6250997.169	RES	P	60	55	0.4	0.8	N	N	N	N	N	58	51	60	53

Note:
1. * denotes calculated $L_{Aeq(1hour)}$ for comparison against hourly criteria.
2. Criteria Type P = 15 hour and 9 hour assessment periods for the day and night respectively. Criteria Type H = 1 hour assessment period. As per the definitions in the NCG.
3. Receiver Type: RES = Residential, OED = Educational, OOA = Outdoor Active Area, OPW = Place of Worship.
4. Educational buildings and Places of Worship have been assessed against external criteria which have been derived from the NCG internal criteria via the conversion factors discussed in Section 3.3 and Table 5.

NCA	Address	Floor	Location (MGA 56)		Receiver Type	Criteria Type	Day Criteria	Night Criteria	Noise Level Difference TNR6 minus EIS (dB)		Qualify for Architectural Treatment		TNR6 Mitigation Trigger			TNR6 Predicted Noise Levels in 2021 (dB L_{Aeq} rounded)		TNR6 Predicted Noise Levels in 2031 (dB L_{Aeq} rounded)	
			Easting	Northing					Day	Night	TNR6	EIS	Trigger 1	Trigger 2	Trigger 3	Day	Night	Day	Night
NCA03	2225-2239 Elizabeth Dr_1, Luddenham	1	288181.736	6250816.645	RES	P	58	53	0.2	0.5	N	N	N	N	N	52	45	52	46
NCA03	2225-2239 Elizabeth Dr_2, Luddenham	1	288239.2626	6250741.769	RES	P	58	53	0.2	0.6	N	N	N	N	N	52	45	52	46
NCA03	2179 Elizabeth Dr_1, Luddenham	1	288636.6973	6250678.137	RES	P	57	52	0	0.3	N	N	N	N	N	50	43	50	44
NCA03	2179 Elizabeth Dr_2, Luddenham	1	288675.6041	6250667.39	RES	P	57	52	0.1	0.3	N	N	N	N	N	49	42	49	43
NCA03	2859 The Northern Road_3, Luddenham	1	286649.5253	6250540.217	RES	P	60	55	0.2	0.6	N	N	N	N	N	51	45	54	47
NCA03	2207-2223 Elizabeth Dr_1, Luddenham	1	288307.0754	6250631.158	RES	P	59	54	0.2	0.5	N	N	N	N	N	53	47	53	47
NCA03	2289-2309 Elizabeth Dr_1, Luddenham	1	287373.5577	6250570.209	RES	P	56	51	0.4	0.8	N	N	N	N	N	56	50	56	50
NCA03	2289-2309 Elizabeth Dr_1, Luddenham	2	287373.5577	6250570.209	RES	P	56	51	0.3	0.7	N	N	N	N	N	58	52	58	52
NCA03	2859 The Northern Road_2, Luddenham	1	286858.8606	6250497.864	RES	P	60	55	0.1	0.4	N	N	N	N	N	55	48	57	50
NCA03	2650 Elizabeth Dr_3. Luddenham	1	287611.5946	6250443.313	RES	P	55	50	0.2	0.5	N	N	N	N	N	60	53	60	53
NCA03	2650 Elizabeth Dr_5, Luddenham	1	287740.5696	6250445.029	RES	P	55	50	0.2	0.5	N	N	N	N	N	60	53	60	53
NCA03	2161_2 Luddenham Rd, Luddenham	1	288962.0088	6250431.448	RES	P	56	51	-0.1	0.2	N	N	N	N	N	47	40	47	41
NCA03	2161 Luddenham Rd_3, Luddenham	1	288944.9462	6250416.869	RES	P	56	51	-0.1	0.1	N	N	N	N	N	50	43	50	44
NCA03	2620 Elizabeth Dr_1, Luddenham	1	288024.5488	6250317.918	RES	P	56	51	0.2	0.5	N	N	N	N	N	55	48	55	48
NCA03	2550 Elizabeth Dr_1, Luddenham	1	288314.3894	6250322.047	RES	P	57	52	0.2	0.4	N	N	N	N	N	58	52	58	52
NCA03	2620 Elizabeth Dr_3, Luddenham	1	287955.9356	6250212.288	RES	P	57	52	0.2	0.5	N	N	N	N	N	52	46	53	46
NCA03	2550 Elizabeth Dr_3, Luddenham	1	288336.7481	6250267.883	RES	P	57	52	0.2	0.5	N	N	N	N	N	55	48	54	48
NCA03	892 Luddenham Rd, Luddenham	1	289070.2347	6250404.521	RES	P	56	51	-0.2	0	N	N	N	N	N	48	42	49	43
NCA03	2111-2141 Elizabeth Dr_1, Luddenham	1	289131.4965	6250071.908	RES	P	56	51	0.1	0.5	N	N	N	N	N	57	50	57	50
NCA04	285 Adams Rd_1, Luddenham	1	288906.5017	6249710.613	RES	P	56	51	-0.2	-0.1	N	N	N	N	N	49	43	50	45
NCA04	275 Elizabeth Dr_1, Luddenham	1	288845.8271	6249616.713	RES	P	55	50	-0.3	-0.1	N	N	N	N	N	47	41	48	43
NCA04	265 Elizabeth Dr, Luddenham	1	288711.6701	6249564.714	RES	P	55	50	-0.5	-0.4	N	N	N	N	N	48	42	49	44
NCA04	1 Anton Rd_1, Luddenham	1	288348.0979	6249266.529	RES	P	55	50	-0.5	-0.4	N	N	N	N	N	47	43	49	45
NCA04	185 Adams Rd, Luddenham	1	288277.6457	6249162.605	RES	P	55	50	-0.5	-0.4	N	N	N	N	N	48	43	50	45
NCA04	180 Adams Rd, Luddenham	1	287798.2581	6249145.451	RES	P	55	50	-0.7	-0.6	N	N	N	N	N	52	48	54	51
NCA04	161 Adams Rd_1, Luddenham	1	287912.6838	6249076.054	RES	P	55	50	-0.7	-0.5	N	N	N	N	N	54	50	56	53
NCA04	145 Adams Rd_1, Luddenham	1	287835.169	6249043.776	RES	P	55	50	-0.7	-0.6	N	N	N	N	N	55	50	57	53
NCA04	145 Adams Rd_2, Luddenham	1	287875.1828	6249046.379	RES	P	55	50	0	0.1	N	N	N	N	N	52	48	54	51
NCA04	10 Jackson Rd_1, Luddenham	1	288530.5042	6248929.871	RES	P	53	47	-0.3	-0.2	N	N	N	N	N	43	37	44	39
NCA04	10 Jackson Rd_3, Luddenham	1	288485.1969	6248913.853	RES	P	54	47	-0.2	-0.2	N	N	N	N	N	42	37	44	38
NCA04	30 Anton Rd, Luddenham	1	288296.7662	6248627.153	RES	P	52	46	-0.4	-0.4	N	N	N	N	N	40	34	41	35
NCA04	50 Anton Rd_1, Luddenham	1	288481.5292	6248320.974	RES	P	54	46	-0.3	-0.3	N	N	N	N	N	42	36	43	37
NCA04	70 Eaton Rd_1, Luddenham	1	287259.0526	6248243.483	RES	P	55	50	-0.4	-0.5	N	N	N	N	N	55	48	56	49
NCA04	68 Eaton Rd_1, Luddenham	1	287284.1179	6248155.75	RES	P	55	50	-0.3	-0.3	N	N	N	N	N	52	45	53	47
NCA04	96 Eaton Rd, Luddenham	1	287268.0368	6248082.71	RES	P	55	50	-0.2	-0.3	N	N	N	N	N	51	45	53	46
NCA05	2903 The Northern Road_22, Luddenham	1	286689.0628	6250115.731	RES	P	57	52	0.1	0.3	N	N	N	N	N	54	48	57	51
NCA05	2903 The Northern Road_28, Luddenham	1	286554.5042	6249921.985	RES	P	57	52	0.1	0.2	N	N	N	N	N	55	48	59	52
NCA05	2392-2398 The Northern Road_1, Luddenham	1	286659.2033	6249881.124	RES	P	55	50	0.1	0.3	N	N	N	N	N	57	49	60	53

Note:
1. * denotes calculated $L_{Aeq(1hour)}$ for comparison against hourly criteria.
2. Criteria Type P = 15 hour and 9 hour assessment periods for the day and night respectively. Criteria Type H = 1 hour assessment period. As per the definitions in the NCG.
3. Receiver Type: RES = Residential, OED = Educational, OOA = Outdoor Active Area, OPW = Place of Worship.
4. Educational buildings and Places of Worship have been assessed against external criteria which have been derived from the NCG internal criteria via the conversion factors discussed in Section 3.3 and Table 5.

NCA	Address	Floor	Location (MGA 56)		Receiver Type	Criteria Type	Day Criteria	Night Criteria	Noise Level Difference TNR6 minus EIS (dB)		Qualify for Architectural Treatment		TNR6 Mitigation Trigger			TNR6 Predicted Noise Levels in 2021 (dB L_{Aeq} rounded)		TNR6 Predicted Noise Levels in 2031 (dB L_{Aeq} rounded)	
			Easting	Northing					Day	Night	TNR6	EIS	Trigger 1	Trigger 2	Trigger 3	Day	Night	Day	Night
NCA05	2392-2398 The Northern Road_1, Luddenham	2	286659.2033	6249881.124	RES	P	55	50	0.1	0.3	N	N	N	N	N	58	51	62	55
NCA05	2392-2398 The Northern Road_3, Luddenham	1	286662.0604	6249860.343	RES	P	55	50	0.2	0.5	N	N	N	N	N	53	46	57	50
NCA05	385 Park Rd, Luddenham	1	285710.05	6249528.687	RES	P	58	53	-0.2	0	N	N	N	N	N	60	53	64	58
NCA05	2300 The Northern Road_1, Luddenham	1	286601.158	6249760.954	RES	P	55	50	0	0.1	N	N	N	N	N	51	44	55	48
NCA05	417 Park Rd_1, Luddenham	1	285790.5653	6249514.757	RES	P	58	53	0	0.2	N	N	N	N	N	60	53	64	58
NCA05	2903 The Northern Road_34, Luddenham	1	286334.9843	6249668.992	RES	P	56	51	0.1	0.2	N	N	N	N	N	55	48	58	51
NCA05	429 Park Rd_1, Luddenham	1	285858.7075	6249507.856	RES	P	58	53	0	0.3	N	N	N	N	N	59	53	63	57
NCA05	406 Park Rd_1, Luddenham	1	285779.9827	6249416.251	RES	P	57	52	-0.1	0.1	N	N	N	N	N	58	51	62	56
NCA05	406 Park Rd_2, Luddenham	1	285888.4255	6249401.054	RES	P	57	52	0.2	0.4	N	N	N	N	N	58	51	62	56
NCA05	Luddenham Showground, Park Road,	1	286039.7511	6249342.979	OOA	P	60	-	0	0.2	N	N	N	N	N	61	54	65	58
NCA05	2230 The Northern Road_1, Luddenham	1	286373.6449	6249315.725	RES	P	55	50	0	0.1	N	N	N	N	N	60	52	62	55
NCA05	Lot1/DP931631	1	286112.95	6249235.588	RES	P	56	51	0.0	0.2	N	N	N	N	N	51	44	54	48
NCA05	28 Hawkins Ave, Luddenham	1	286507.8391	6249241.69	RES	P	55	49	-0.3	-0.2	N	N	N	N	N	47	40	48	42
NCA05	26 Hawkins Ave, Luddenham	1	286471.8962	6249223.76	RES	P	55	50	-0.4	-0.2	N	N	N	N	N	46	39	48	42
NCA05	26 Hawkins Ave, Luddenham	2	286471.8962	6249223.76	RES	P	55	50	-0.3	-0.1	N	N	N	N	N	49	41	51	44
NCA05	17 Hawkins Ave, Luddenham	1	286518.6015	6249212.798	RES	P	55	49	-0.2	-0.1	N	N	N	N	N	46	39	47	41
NCA05	24 Hawkins Ave, Luddenham	1	286448.5707	6249199.554	RES	P	55	50	-0.4	-0.3	N	N	N	N	N	47	39	49	42
NCA05	22 Hawkins Ave, Luddenham	1	286430.0127	6249180.441	RES	P	55	50	-0.2	-0.1	N	N	N	N	N	48	40	50	43
NCA05	3037 The Northern Road_1, Luddenham	1	286288.8541	6249182.435	RES	P	55	50	0	0.2	N	N	N	N	N	62	53	64	57
NCA05	2210 The Northern Road, Luddenham	1	286354.5742	6249176.027	RES	P	55	50	0.1	0.2	N	N	N	N	N	59	50	60	54
NCA05	15 Hawkins Ave, Luddenham	1	286513.484	6249180.268	RES	P	54	48	-0.2	-0.1	N	N	N	N	N	46	40	47	41
NCA05	20 Hawkins Ave, Luddenham	1	286413.4929	6249165.073	RES	P	55	50	-0.2	-0.1	N	N	N	N	N	49	41	51	45
NCA05	13 Hawkins Ave, Luddenham	1	286505.875	6249162.132	RES	P	54	48	-0.3	-0.2	N	N	N	N	N	45	39	46	40
NCA05	11 Hawkins Ave, Luddenham	1	286478.9321	6249149.845	RES	P	55	50	-0.3	-0.1	N	N	N	N	N	46	39	48	41
NCA05	11 Hawkins Ave, Luddenham	2	286478.9321	6249149.845	RES	P	55	50	-0.2	-0.1	N	N	N	N	N	48	42	50	44
NCA05	18 Hawkins Ave, Luddenham	1	286390.5065	6249152.769	RES	P	55	50	0	0.2	N	N	N	N	N	50	42	52	46
NCA05	9 Hawkins Ave, Luddenham	1	286457.2116	6249138.466	RES	P	55	50	0.0	0.1	N	N	N	N	N	46	39	48	42
NCA05	2208 The Northern Road, Luddenham	1	286345.7298	6249146.482	RES	P	55	50	0	0.1	N	N	N	N	N	60	51	61	54
NCA05	2208 The Northern Road, Luddenham	2	286345.7298	6249146.482	RES	P	55	50	-0.1	0	N	N	N	N	N	61	52	62	56
NCA05	45 Blaxland Ave, Luddenham	1	286497.7801	6249126.285	RES	P	55	50	-0.1	0.1	N	N	N	N	N	48	41	49	43
NCA05	3039 The Northern Road, Luddenham	1	286281.7284	6249149.852	RES	P	55	50	0	0.2	N	N	N	N	N	61	52	63	56
NCA05	30 Blaxland Ave, Luddenham	1	286475.2694	6249116.252	RES	P	55	50	-0.1	0	N	N	N	N	N	47	40	48	42
NCA05	7 Hawkins Ave, Luddenham	1	286431.0904	6249118.613	RES	P	55	50	-0.1	0	N	N	N	N	N	47	40	49	42
NCA05	7 Hawkins Ave, Luddenham	2	286431.0904	6249118.613	RES	P	55	50	-0.1	0	N	N	N	N	N	49	42	51	45
NCA05	16 Hawkins Ave, Luddenham	1	286377.6954	6249135.614	RES	P	55	50	0	0.1	N	N	N	N	N	49	41	51	44
NCA05	50-80 Adams Rd_1, Luddenham	1	286833.2258	6249062.278	RES	P	55	50	-0.2	-0.2	N	N	N	N	N	51	44	52	46
NCA05	2206 The Northern Road, Luddenham	1	286350.1522	6249118.734	RES	P	55	50	0.2	0.4	N	N	N	N	N	60	51	61	54
NCA05	43 Blaxland Ave, Luddenham	1	286521.5814	6249106.757	RES	P	55	50	-0.1	0	N	N	N	N	N	48	41	49	43

Note:
1. * denotes calculated $L_{Aeq(1hour)}$ for comparison against hourly criteria.
2. Criteria Type P = 15 hour and 9 hour assessment periods for the day and night respectively. Criteria Type H = 1 hour assessment period. As per the definitions in the NCG.
3. Receiver Type: RES = Residential, OED = Educational, OOA = Outdoor Active Area, OPW = Place of Worship.
4. Educational buildings and Places of Worship have been assessed against external criteria which have been derived from the NCG internal criteria via the conversion factors discussed in Section 3.3 and Table 5.

NCA	Address	Floor	Location (MGA 56)		Receiver Type	Criteria Type	Day Criteria	Night Criteria	Noise Level Difference TNR6 minus EIS (dB)		Qualify for Architectural Treatment		TNR6 Mitigation Trigger			TNR6 Predicted Noise Levels in 2021 (dB L_{Aeq} rounded)		TNR6 Predicted Noise Levels in 2031 (dB L_{Aeq} rounded)	
			Easting	Northing					Day	Night	TNR6	EIS	Trigger 1	Trigger 2	Trigger 3	Day	Night	Day	Night
NCA05	43 Blaxland Ave, Luddenham	2	286521.5814	6249106.757	RES	P	55	50	-0.2	-0.1	N	N	N	N	N	49	42	50	44
NCA05	41 Blaxland Ave, Luddenham	1	286564.0144	6249093.98	RES	P	55	50	-0.1	0	N	N	N	N	N	48	42	50	43
NCA05	28 Blaxland Ave, Luddenham	1	286460.5322	6249099.542	RES	P	55	49	-0.5	-0.5	N	N	N	N	N	46	39	47	41
NCA05	5 Hawkins Ave, Luddenham	1	286418.4116	6249098.293	RES	P	55	48	-0.2	-0.2	N	N	N	N	N	45	38	47	41
NCA05	50-80 Adams Rd_2, Luddenham	1	286751.6425	6249028.541	RES	P	55	50	-0.4	-0.3	N	N	N	N	N	51	44	52	46
NCA05	14 Hawkins Ave_1, Luddenham	1	286368.5354	6249105.498	RES	P	55	50	-0.1	0	N	N	N	N	N	50	41	51	45
NCA05	3043 The Northern Road, Luddenham	1	286285.4687	6249119.673	RES	P	55	50	0	0	N	N	N	N	N	62	53	63	57
NCA05	1 Hawkins Ave, Luddenham	1	286459.1048	6249072.423	RES	P	55	50	-0.2	-0.1	N	N	N	N	N	46	40	48	41
NCA05	3 Hawkins Ave, Luddenham	1	286431.5085	6249071.742	RES	P	55	50	-0.1	0.1	N	N	N	N	N	46	38	47	41
NCA05	37 Blaxland Ave, Luddenham	1	286518.9417	6249042.589	RES	P	55	50	-0.1	0	N	N	N	N	N	48	41	49	43
NCA05	12 Hawkins Ave, Luddenham	1	286369.8386	6249074.29	RES	P	55	50	-0.1	0	N	N	N	N	N	50	42	52	45
NCA05	2204 The Northern Road, Luddenham	1	286342.1713	6249079.867	RES	P	55	50	0	0.1	N	N	N	N	N	60	51	61	55
NCA05	2204 The Northern Road, Luddenham	2	286342.1713	6249079.867	RES	P	55	50	0	0.1	N	N	N	N	N	61	52	62	56
NCA05	39 Blaxland Ave_1, Luddenham	1	286601.492	6249013.514	RES	P	55	50	-0.3	-0.2	N	N	N	N	N	49	43	50	44
NCA05	3045 The Northern Road, Luddenham	1	286282.2137	6249099.618	RES	P	55	50	-0.1	0.1	N	N	N	N	N	61	52	63	56
NCA05	3047 The Northern Road, Luddenham	1	286277.1904	6249083.251	RES	P	55	50	-0.1	0.1	N	N	N	N	N	62	53	63	57
NCA05	3047 The Northern Road, Luddenham	2	286277.1904	6249083.251	RES	P	55	50	-0.1	0.1	N	N	N	N	N	63	54	64	58
NCA05	35 Blaxland Ave, Luddenham	1	286516.1205	6249019.873	RES	P	55	50	-0.5	-0.5	N	N	N	N	N	47	40	48	42
NCA05	2 Hawkins Ave, Luddenham	1	286457.9108	6249029.549	RES	P	55	50	-0.2	-0.1	N	N	N	N	N	46	39	47	41
NCA05	2 Hawkins Ave, Luddenham	2	286457.9108	6249029.549	RES	P	55	50	-0.3	-0.2	N	N	N	N	N	48	42	50	43
NCA05	10 Hawkins Ave, Luddenham	1	286371.5213	6249046.379	RES	P	55	50	0.1	0.3	N	N	N	N	N	49	41	51	44
NCA05	22 Blaxland Ave, Luddenham	1	286462.0026	6249012.88	RES	P	55	50	-0.2	-0.1	N	N	N	N	N	46	39	48	41
NCA05	8 Hawkins Ave, Luddenham	1	286387.6481	6249031.922	RES	P	55	50	0	0.2	N	N	N	N	N	47	38	48	41
NCA05	8 Hawkins Ave, Luddenham	2	286387.6481	6249031.922	RES	P	55	50	0	0.1	N	N	N	N	N	49	40	50	44
NCA05	4 Hawkins Ave, Luddenham	1	286429.8322	6249026.615	RES	P	55	49	-0.2	-0.2	N	N	N	N	N	44	37	46	39
NCA05	4 Hawkins Ave, Luddenham	2	286429.8322	6249026.615	RES	P	55	50	-0.5	-0.4	N	N	N	N	N	47	40	49	42
NCA05	2202 The Northern Road, Luddenham	1	286347.5716	6249043.488	RES	P	55	50	-0.1	-0.1	N	N	N	N	N	59	50	60	54
NCA05	33 Blaxland Ave, Luddenham	1	286510.641	6248994.153	RES	P	55	50	-0.7	-0.7	N	N	N	N	N	46	40	48	42
NCA05	6 Hawkins Ave, Luddenham	1	286405.0685	6249024.606	RES	P	55	50	-0.6	-0.5	N	N	N	N	N	46	38	47	41
NCA05	3051 The Northern Road, Luddenham	1	286278.9209	6249052.385	RES	P	55	50	-0.1	0	N	N	N	N	N	63	54	65	58
NCA05	31 Blaxland Ave, Luddenham	1	286510.432	6248971.464	RES	P	55	50	-0.6	-0.6	N	N	N	N	N	47	40	48	42
NCA05	20 Blaxland Ave, Luddenham	1	286455.707	6248992.225	RES	P	55	50	-0.2	-0.1	N	N	N	N	N	45	38	47	40
NCA05	29 Blaxland Ave, Luddenham	1	286510.1661	6248952.033	RES	P	55	50	-0.8	-0.8	N	N	N	N	N	46	40	48	42
NCA05	3 Michael Ave, Luddenham	1	286425.3043	6248996.276	RES	P	55	50	-0.6	-0.6	N	N	N	N	N	45	38	46	40
NCA05	2200 The Northern Road, Luddenham	1	286343.7137	6249015.481	RES	P	55	50	-0.2	-0.1	N	N	N	N	N	60	50	60	54
NCA05	3053 The Northern Road, Luddenham	1	286276.6992	6249036.405	RES	P	55	50	-0.1	0	N	N	N	N	N	62	53	63	57
NCA05	5 Michael Ave, Luddenham	1	286396.7757	6248999.242	RES	P	55	50	-0.6	-0.7	N	N	N	N	N	46	37	47	40
NCA05	27 Blaxland Ave, Luddenham	1	286507.7682	6248931.862	RES	P	55	48	-0.9	-1	N	N	N	N	N	46	39	47	41

Note:
1. * denotes calculated $L_{Aeq(1hour)}$ for comparison against hourly criteria.
2. Criteria Type P = 15 hour and 9 hour assessment periods for the day and night respectively. Criteria Type H = 1 hour assessment period. As per the definitions in the NCG.
3. Receiver Type: RES = Residential, OED = Educational, OOA = Outdoor Active Area, OPW = Place of Worship.
4. Educational buildings and Places of Worship have been assessed against external criteria which have been derived from the NCG internal criteria via the conversion factors discussed in Section 3.3 and Table 5.

NCA	Address	Floor	Location (MGA 56)		Receiver Type	Criteria Type	Day Criteria	Night Criteria	Noise Level Difference TNR6 minus EIS (dB)		Qualify for Architectural Treatment		TNR6 Mitigation Trigger			TNR6 Predicted Noise Levels in 2021 (dB L_{Aeq} rounded)		TNR6 Predicted Noise Levels in 2031 (dB L_{Aeq} rounded)	
			Easting	Northing					Day	Night	TNR6	EIS	Trigger 1	Trigger 2	Trigger 3	Day	Night	Day	Night
NCA05	27 Blaxland Ave, Luddenham	2	286507.7682	6248931.862	RES	P	55	50	-0.7	-0.7	N	N	N	N	N	47	41	48	43
NCA05	18 Blaxland Ave, Luddenham	1	286453.948	6248949.454	RES	P	55	49	-0.3	-0.3	N	N	N	N	N	44	37	46	39
NCA05	7 Michael Ave, Luddenham	1	286383.9197	6248983.71	RES	P	55	50	-0.6	-0.6	N	N	N	N	N	47	39	48	41
NCA05	3055 The Northern Road, Luddenham	1	286276.4961	6249021.489	RES	P	55	50	-0.1	0.1	N	N	N	N	N	62	53	63	56
NCA05	25 Blaxland Ave, Luddenham	1	286506.9635	6248912.235	RES	P	55	49	-0.9	-0.9	N	N	N	N	N	46	40	47	42
NCA05	2198 The Northern Road_1, Luddenham	1	286337.193	6248988.709	RES	P	55	50	-0.1	0	N	N	N	N	N	60	51	61	55
NCA05	2198 The Northern Road_1, Luddenham	2	286337.193	6248988.709	RES	P	55	50	-0.3	-0.2	N	N	N	N	N	61	52	62	56
NCA05	4 Michael Ave, Luddenham	1	286416.8438	6248944.411	RES	P	55	50	-0.4	-0.4	N	N	N	N	N	45	38	46	40
NCA05	16 Blaxland Ave, Luddenham	1	286453.942	6248932.361	RES	P	55	49	-0.3	-0.3	N	N	N	N	N	44	37	46	39
NCA05	9 Michael Ave, Luddenham	1	286365.6399	6248975.475	RES	P	55	50	-0.7	-0.7	N	N	N	N	N	47	39	48	42
NCA05	3057 The Northern Road, Luddenham	1	286276.3906	6249007.417	RES	P	55	50	-0.1	0	N	N	N	N	N	62	53	63	57
NCA05	23 Blaxland Ave, Luddenham	1	286508.1861	6248893.014	RES	P	55	50	-0.9	-0.9	N	N	N	N	N	46	40	48	42
NCA05	14 Blaxland Ave, Luddenham	1	286447.9632	6248913.104	RES	P	55	49	-0.4	-0.4	N	N	N	N	N	45	38	46	40
NCA05	2196 The Northern Road, Luddenham	1	286333.8908	6248969.083	RES	P	55	50	-0.4	-0.3	N	N	N	N	N	61	52	62	55
NCA05	6 Michael Ave, Luddenham	1	286417.4353	6248922.487	RES	P	55	50	-0.3	-0.3	N	N	N	N	N	45	38	46	40
NCA05	21 Blaxland Ave, Luddenham	1	286507.7876	6248875.131	RES	P	55	50	-0.7	-0.7	N	N	N	N	N	47	40	48	42
NCA05	3059 The Northern Road_2, Luddenham	1	286275.5247	6248995.566	RES	P	55	50	-0.2	0	N	N	N	N	N	61	52	63	56
NCA05	11 Michael Ave, Luddenham	1	286362.1061	6248947.958	RES	P	55	50	-0.5	-0.4	N	N	N	N	N	50	41	51	45
NCA05	3059 The Northern Road_1, Luddenham	1	286276.987	6248986.115	RES	P	55	50	-0.2	0	N	N	N	N	N	62	53	63	56
NCA05	12 Blaxland Ave, Luddenham	1	286448.8005	6248893.498	RES	P	54	48	-0.3	-0.3	N	N	N	N	N	44	37	45	39
NCA05	12 Blaxland Ave, Luddenham	2	286448.8005	6248893.498	RES	P	55	50	-0.6	-0.6	N	N	N	N	N	46	40	48	42
NCA05	19 Blaxland Ave, Luddenham	1	286504.0039	6248855.959	RES	P	55	50	-0.7	-0.7	N	N	N	N	N	47	41	48	43
NCA05	8 Michael Ave, Luddenham	1	286412.9836	6248902.398	RES	P	55	50	-0.3	-0.3	N	N	N	N	N	44	37	46	39
NCA05	13 Michael Ave, Luddenham	1	286367.099	6248926.385	RES	P	55	50	-0.4	-0.3	N	N	N	N	N	46	39	47	41
NCA05	10 Blaxland Ave, Luddenham	1	286452.1811	6248873.232	RES	P	55	49	-0.2	-0.2	N	N	N	N	N	45	38	46	39
NCA05	3061-3063 The Northern Road_1, Luddenham	1	286273.9274	6248971.2	RES	P	55	50	-0.1	0	N	N	N	N	N	63	54	65	58
NCA05	3061-3063 The Northern Road_1, Luddenham	2	286273.9274	6248971.2	RES	P	55	50	-0.2	-0.1	N	N	N	N	N	64	55	65	59
NCA05	2194 The Northern Road, Luddenham	1	286334.7915	6248935.108	RES	P	55	50	-0.1	0	N	N	N	N	N	61	52	62	55
NCA05	17 Blaxland Ave, Luddenham	1	286505.8502	6248831.628	RES	P	55	50	-0.7	-0.6	N	N	N	N	N	47	41	49	43
NCA05	10 Michael Ave, Luddenham	1	286413.2382	6248874.069	RES	P	55	50	-0.4	-0.3	N	N	N	N	N	45	38	46	40
NCA05	15 Michael Ave, Luddenham	1	286359.6575	6248906.762	RES	P	55	50	-0.5	-0.4	N	N	N	N	N	46	39	47	41
NCA05	1 Adams Rd_1, Luddenham	1	286705.4546	6248673.71	RES	P	55	50	-0.9	-0.9	N	N	N	N	N	51	46	53	49
NCA05	12 Ethan Cl, Luddenham	1	286561.7978	6248765.173	RES	P	55	50	-0.8	-0.8	N	N	N	N	N	47	41	48	43
NCA05	10 Ethan Cl, Luddenham	1	286544.4151	6248781.431	RES	P	55	50	-0.8	-0.7	N	N	N	N	N	47	41	48	43
NCA05	15 Blaxland Ave, Luddenham	1	286491.3345	6248813.674	RES	P	55	50	-0.8	-0.8	N	N	N	N	N	47	40	48	43
NCA05	2192 The Northern Road, Luddenham	1	286333.8807	6248909.05	RES	P	55	50	-0.2	-0.1	N	N	N	N	N	60	51	61	55
NCA05	8 Ethan Cl, Luddenham	1	286521.7469	6248778.602	RES	P	55	49	-0.1	-0.1	N	N	N	N	N	45	38	46	40
NCA05	16 Ethan Cl, Luddenham	1	286581.2865	6248729.758	RES	P	55	50	-0.8	-0.7	N	N	N	N	N	47	41	48	43

Note:
1. * denotes calculated $L_{Aeq(1hour)}$ for comparison against hourly criteria.
2. Criteria Type P = 15 hour and 9 hour assessment periods for the day and night respectively. Criteria Type H = 1 hour assessment period. As per the definitions in the NCG.
3. Receiver Type: RES = Residential, OED = Educational, OOA = Outdoor Active Area, OPW = Place of Worship.
4. Educational buildings and Places of Worship have been assessed against external criteria which have been derived from the conversion factors discussed in Section 3.3 and Table 5.

NCA	Address	Floor	Location (MGA 56)		Receiver Type	Criteria Type	Day Criteria	Night Criteria	Noise Level Difference TNR6 minus EIS (dB)		Qualify for Architectural Treatment		TNR6 Mitigation Trigger			TNR6 Predicted Noise Levels in 2021 (dB L_{Aeq} rounded)		TNR6 Predicted Noise Levels in 2031 (dB L_{Aeq} rounded)	
			Easting	Northing					Day	Night	TNR6	EIS	Trigger 1	Trigger 2	Trigger 3	Day	Night	Day	Night
NCA05	13 Blaxland Ave, Luddenham	1	286474.4928	6248804.099	RES	P	55	50	-0.7	-0.7	N	N	N	N	N	46	40	48	42
NCA05	Willmington Reserve, Luddenham	1	286595.7527	6248671.663	OOA	P	60	-	-0.8	-0.8	N	N	N	N	N	46	40	48	43
NCA05	2190 The Northern Road, Luddenham	1	286331.6158	6248887.426	RES	P	55	50	-0.2	-0.2	N	N	N	N	N	60	51	61	55
NCA05	7 Ethan Cl, Luddenham	2	286568.3153	6248717.971	RES	P	55	50	-0.6	-0.6	N	N	N	N	N	48	41	49	44
NCA05	17 Michael Ave, Luddenham	1	286356.4262	6248872.623	RES	P	55	50	-0.7	-0.7	N	N	N	N	N	48	39	49	42
NCA05	7 Wade Cl, Luddenham	2	286686.4294	6248619.688	RES	P	55	50	-0.8	-0.8	N	N	N	N	N	52	46	54	50
NCA05	9 Wade Cl, Luddenham	1	286672.0484	6248645.128	RES	P	55	50	-0.8	-0.8	N	N	N	N	N	50	45	52	48
NCA05	11 Wade Cl, Luddenham	1	286654.2669	6248651.931	RES	P	55	50	-0.5	-0.5	N	N	N	N	N	46	40	48	42
NCA05	7 Ethan Cl, Luddenham	1	286568.3153	6248717.971	RES	P	55	50	-0.9	-0.9	N	N	N	N	N	47	40	48	43
NCA05	6 Ethan Cl, Luddenham	1	286509.1916	6248767.202	RES	P	55	50	-0.9	-0.9	N	N	N	N	N	45	39	46	41
NCA05	6 Ethan Cl, Luddenham	2	286509.1916	6248767.202	RES	P	55	50	-0.8	-0.8	N	N	N	N	N	47	41	49	43
NCA05	7 Wade Cl, Luddenham	1	286686.4294	6248619.688	RES	P	55	50	-0.9	-1	N	N	N	N	N	51	45	53	49
NCA05	5 Ethan Cl, Luddenham	1	286549.6445	6248711.315	RES	P	54	48	0	0.1	N	N	N	N	N	44	37	45	39
NCA05	5 Ethan Cl, Luddenham	2	286549.6445	6248711.315	RES	P	55	50	0.1	0.2	N	N	N	N	N	46	40	48	41
NCA05	11 Blaxland Ave, Luddenham	1	286461.4402	6248787.95	RES	P	55	50	-0.5	-0.5	N	N	N	N	N	47	40	48	42
NCA05	19 Michael Ave, Luddenham	1	286356.11	6248845.963	RES	P	55	50	-0.6	-0.6	N	N	N	N	N	46	39	47	41
NCA05	18 Adams Rd, Luddenham	1	286718.7244	6248569.68	RES	P	55	50	-0.7	-0.7	N	N	N	N	N	56	51	59	56
NCA05	18 Adams Rd, Luddenham	2	286718.7244	6248569.68	RES	P	55	50	-0.7	-0.7	N	N	N	N	N	59	55	62	59
NCA05	4 Ethan Cl, Luddenham	1	286493.0645	6248755.83	RES	P	55	50	-0.7	-0.7	N	N	N	N	N	46	39	47	41
NCA05	4 Ethan Cl, Luddenham	2	286493.0645	6248755.83	RES	P	55	50	-0.7	-0.8	N	N	N	N	N	47	41	49	43
NCA05	2188 The Northern Road, Luddenham	1	286331.0436	6248855.942	RES	P	55	50	-0.3	-0.2	N	N	N	N	N	60	51	61	55
NCA05	3065-3067 The Northern Road, Luddenham	1	286271.0017	6248907.432	RES	P	55	50	-0.1	0	N	N	N	N	N	62	53	63	56
NCA05	10 Wade Cl_1, Luddenham	1	286635.5698	6248630.387	RES	P	55	49	-0.4	-0.4	N	N	N	N	N	45	39	47	41
NCA05	10 Wade Cl_1, Luddenham	2	286635.5698	6248630.387	RES	P	55	50	-0.7	-0.7	N	N	N	N	N	49	42	50	44
NCA05	25 Jamison St, Luddenham	1	286508.6926	6248713.383	RES	P	55	49	-0.3	-0.2	N	N	N	N	N	47	40	48	42
NCA05	25 Jamison St, Luddenham	2	286508.6926	6248713.383	RES	P	55	50	-0.5	-0.5	N	N	N	N	N	48	41	49	43
NCA05	9 Blaxland Ave, Luddenham	1	286447.4702	6248779.523	RES	P	55	50	-0.5	-0.4	N	N	N	N	N	46	39	47	41
NCA05	9 Blaxland Ave, Luddenham	2	286447.4702	6248779.523	RES	P	55	50	-0.6	-0.5	N	N	N	N	N	48	41	49	43
NCA05	21 Michael Ave, Luddenham	1	286368.7639	6248829.352	RES	P	55	50	-0.5	-0.4	N	N	N	N	N	46	39	48	41
NCA05	4 Wade Cl, Luddenham	1	286663.6992	6248582.798	RES	P	55	50	-1	-1	N	N	N	N	N	49	44	51	47
NCA05	6 Wade Cl, Luddenham	1	286653.5168	6248597.306	RES	P	55	50	-0.3	-0.3	N	N	N	N	N	46	41	49	44
NCA05	8 Wade Cl, Luddenham	1	286635.5807	6248615.23	RES	P	55	50	-0.3	-0.3	N	N	N	N	N	47	41	49	45
NCA05	8 Wade Cl, Luddenham	2	286635.5807	6248615.23	RES	P	55	50	-0.3	-0.3	N	N	N	N	N	49	43	51	46
NCA05	21 Jamison St, Luddenham	2	286535.2793	6248684.884	RES	P	55	50	-0.6	-0.6	N	N	N	N	N	48	42	50	44
NCA05	2 Ethan Cl, Luddenham	1	286476.6386	6248744.293	RES	P	55	50	-0.8	-0.8	N	N	N	N	N	46	40	48	42
NCA05	16 Adams Rd, Luddenham	1	286706.6746	6248553.767	RES	P	55	50	-0.8	-0.9	N	N	N	N	N	55	51	58	55
NCA05	16 Adams Rd, Luddenham	2	286706.6746	6248553.767	RES	P	55	50	-0.8	-0.9	N	N	N	N	N	58	53	61	58
NCA05	6 Wade Cl, Luddenham	2	286653.5168	6248597.306	RES	P	55	50	-0.7	-0.8	N	N	N	N	N	48	42	50	45

Note:
1. * denotes calculated $L_{Aeq(1hour)}$ for comparison against hourly criteria.
2. Criteria Type P = 15 hour and 9 hour assessment periods for the day and night respectively. Criteria Type H = 1 hour assessment period. As per the definitions in the NCG.
3. Receiver Type: RES = Residential, OED = Educational, OOA = Outdoor Active Area, OPW = Place of Worship.
4. Educational buildings and Places of Worship have been assessed against external criteria which have been derived from the NCG internal criteria via the conversion factors discussed in Section 3.3 and Table 5.

NCA	Address	Floor	Location (MGA 56)		Receiver Type	Criteria Type	Day Criteria	Night Criteria	Noise Level Difference TNR6 minus EIS (dB)		Qualify for Architectural Treatment		TNR6 Mitigation Trigger			TNR6 Predicted Noise Levels in 2021 (dB L_{Aeq} rounded)		TNR6 Predicted Noise Levels in 2031 (dB L_{Aeq} rounded)	
			Easting	Northing					Day	Night	TNR6	EIS	Trigger 1	Trigger 2	Trigger 3	Day	Night	Day	Night
NCA05	23 Jamison St, Luddenham	1	286519.5683	6248694.733	RES	P	55	49	-0.1	0.1	N	N	N	N	N	44	38	46	40
NCA05	15 Adams Rd_1, Luddenham	1	286746.7271	6248505.117	RES	H	55	50	-0.7	-0.8	N	N	N	N	N	57	52	60	57
NCA05	3 Wade Cl, Luddenham	1	286682.8506	6248544.383	RES	P	55	50	-0.3	-0.3	N	N	N	N	N	51	46	53	50
NCA05	11 Jamison St, Luddenham	1	286604.9197	6248607.149	RES	P	55	50	-0.1	-0.1	N	N	N	N	N	47	39	48	42
NCA05	11 Jamison St, Luddenham	2	286604.9197	6248607.149	RES	P	55	50	-0.1	-0.1	N	N	N	N	N	48	40	49	44
NCA05	21 Jamison St, Luddenham	1	286535.2793	6248684.884	RES	P	55	50	-0.8	-0.8	N	N	N	N	N	47	41	49	43
NCA05	2186 The Northern Road, Luddenham	1	286329.5694	6248828.836	RES	P	55	50	-0.3	-0.2	N	N	N	N	N	60	51	61	54
NCA05	7 Jamison St, Luddenham	1	286631.0005	6248579.055	RES	P	55	50	-0.3	-0.4	N	N	N	N	N	45	38	46	41
NCA05	10 Adams Rd, Luddenham	1	286695.3877	6248514.876	RES	P	55	50	-0.8	-0.9	N	N	N	N	N	59	55	62	59
NCA05	5 Jamison St, Luddenham	1	286644.7261	6248563.793	RES	P	55	50	-0.7	-0.8	N	N	N	N	N	49	43	50	46
NCA05	5 Jamison St, Luddenham	2	286644.7261	6248563.793	RES	P	55	50	-0.7	-0.8	N	N	N	N	N	50	44	52	48
NCA05	40 Jamison St, Luddenham	1	286418.9277	6248740.591	RES	P	55	50	-0.3	-0.3	N	N	N	N	N	45	38	47	40
NCA05	42 Jamison St, Luddenham	1	286402.4345	6248755.329	RES	H	55	50	-0.2	-0.1	N	N	N	N	N	47	39	48	42
NCA05	2184 The Northern Road, Luddenham	1	286331.2584	6248802.414	RES	P	55	50	-0.5	-0.4	N	N	N	N	N	60	51	61	55
NCA05	38 Jamison St, Luddenham	1	286426.8546	6248718.81	RES	P	55	50	-0.6	-0.7	N	N	N	N	N	46	39	48	42
NCA05	1 Wade Cl, Luddenham	1	286669.9587	6248526.598	RES	P	55	50	-0.5	-0.6	N	N	N	N	N	50	45	53	49
NCA05	34 Jamison St_1, Luddenham	1	286458.3572	6248693.601	RES	P	55	50	-0.3	-0.3	N	N	N	N	N	48	41	49	43
NCA05	3075 The Northern Road, Luddenham	1	286258.6136	6248830.004	RES	P	55	50	-0.1	0	N	N	N	N	N	60	51	61	54
NCA05	18 Jamison St, Luddenham	1	286562.7344	6248570.462	RES	P	55	50	-0.3	-0.3	N	N	N	N	N	50	42	52	45
NCA05	18 Jamison St, Luddenham	2	286562.7344	6248570.462	RES	P	55	50	-0.4	-0.5	N	N	N	N	N	51	43	53	46
NCA05	12 Jamison St, Luddenham	2	286595.7933	6248536.644	RES	P	55	50	-0.4	-0.4	N	N	N	N	N	50	44	52	47
NCA05	14 Jamison St, Luddenham	1	286583.548	6248547.567	RES	P	55	50	-0.3	-0.3	N	N	N	N	N	47	40	49	43
NCA05	14 Jamison St, Luddenham	2	286583.548	6248547.567	RES	P	55	50	-0.3	-0.3	N	N	N	N	N	49	43	51	45
NCA05	16 Jamison St, Luddenham	1	286572.1811	6248556.655	RES	P	55	50	-0.3	-0.2	N	N	N	N	N	50	41	51	45
NCA05	2176 The Northern Road, Luddenham	1	286365.8914	6248730.831	RES	P	55	50	-0.4	-0.3	N	N	N	N	N	56	47	57	51
NCA05	Luddenham Public School_4	1	286471.1435	6248642.961	OED	P	50	-	-0.2	-0.2	N	N	N	N	N	55*	48*	56*	51*
NCA05	3077 The Northern Road_1, Luddenham	1	286253.162	6248804.058	RES	H	55	50	-0.2	0	N	N	N	N	N	59	50	60	54
NCA05	3077 The Northern Road_1, Luddenham	2	286253.162	6248804.058	RES	P	55	50	-0.2	-0.1	N	N	N	N	N	60	51	61	55
NCA05	12 Eaton Rd, Luddenham	1	286864.683	6248331.858	RES	P	55	50	-0.4	-0.7	N	N	N	N	N	58	51	59	52
NCA05	6 Jamison St, Luddenham	1	286639.1	6248492.16	RES	P	55	50	-0.4	-0.4	N	N	N	N	N	51	46	53	50
NCA05	12 Jamison St, Luddenham	1	286595.7933	6248536.644	RES	P	55	50	-0.5	-0.5	N	N	N	N	N	48	42	50	45
NCA05	2180 The Northern Road_1, Luddenham	1	286330.6859	6248752.031	RES	P	55	50	-0.3	-0.2	N	N	N	N	N	63	54	64	58
NCA05	21-55 Campbell St, Luddenham	1	286088.6978	6248937.29	RES	P	55	50	-0.1	0	N	N	N	N	N	46	39	49	42
NCA05	2 Jamison St, Luddenham	1	286663.7681	6248463.382	RES	P	55	50	-0.5	-0.6	N	N	N	N	N	60	55	63	60
NCA05	2170 The Northern Road, Luddenham	1	286408.2333	6248672.847	RES	P	55	50	0	-0.1	N	N	N	N	N	54	45	55	48
NCA05	7 Adams Rd_1, Luddenham	1	286697.9156	6248432.354	RES	P	55	50	-0.4	-0.4	N	N	N	N	N	57	52	59	56
NCA05	7 Adams Rd_1, Luddenham	2	286697.9156	6248432.354	RES	P	55	50	-0.5	-0.6	N	N	N	N	N	58	53	60	57
NCA05	2172 The Northern Road, Luddenham	1	286386.9304	6248679.573	RES	P	55	50	-0.2	-0.1	N	N	N	N	N	58	49	59	53

Note:
1. * denotes calculated $L_{Aeq(1hour)}$ for comparison against hourly criteria.
2. Criteria Type P = 15 hour and 9 hour assessment periods for the day and night respectively. Criteria Type H = 1 hour assessment period. As per the definitions in the NCG.
3. Receiver Type: RES = Residential, OED = Educational, OOA = Outdoor Active Area, OPW = Place of Worship.
4. Educational buildings and Places of Worship have been assessed against external criteria which have been derived from the conversion factors discussed in Section 3.3 and Table 5.

NCA	Address	Floor	Location (MGA 56)		Receiver Type	Criteria Type	Day Criteria	Night Criteria	Noise Level Difference TNR6 minus EIS (dB)		Qualify for Architectural Treatment		TNR6 Mitigation Trigger			TNR6 Predicted Noise Levels in 2021 (dB L_{Aeq} rounded)		TNR6 Predicted Noise Levels in 2031 (dB L_{Aeq} rounded)	
			Easting	Northing					Day	Night	TNR6	EIS	Trigger 1	Trigger 2	Trigger 3	Day	Night	Day	Night
NCA05	3081 The Northern Road_1, Luddenham	1	286267.283	6248759.749	RES	P	55	50	-0.1	0	N	N	N	N	N	60	51	61	55
NCA05	2166 The Northern Road, Luddenham	1	286432.6958	6248633.265	RES	P	55	50	-0.1	0	N	N	N	N	N	58	49	59	53
NCA05	56 Campbell St, Luddenham	1	286142.1432	6248850.987	RES	P	55	50	0.1	0.2	N	N	N	N	N	47	39	49	43
NCA05	3083 The Northern Road, Luddenham	1	286268.3475	6248740.659	RES	H	55	50	0	0.1	N	N	N	N	N	59	50	60	53
NCA05	3083 The Northern Road, Luddenham	2	286268.3475	6248740.659	RES	P	55	50	-0.1	0	N	N	N	N	N	60	51	61	55
NCA05	2150 The Northern Road, Luddenham	1	286559.0123	6248511.593	RES	H	55	50	-0.6	-0.7	N	N	N	N	N	55	46	56	50
NCA05	2168 The Northern Road, Luddenham	1	286406.3595	6248640.766	RES	P	55	50	0.1	0.2	N	N	N	N	N	62	53	63	56
NCA05	Luddenham Public School 5	1	286471.0449	6248578.208	OED	H	50	-	-0.2	-0.2	N	N	N	N	N	62*	55*	63*	58*
NCA05	Lot4/DP1655	1	286293.7149	6248719.475	RES	P	55	50	0	0.1	N	N	N	N	N	63	54	64	57
NCA05	2144 The Northern Road, Luddenham	1	286597.5585	6248457.63	RES	P	55	50	-0.5	-0.6	N	N	N	N	N	60	51	61	54
NCA05	2146 The Northern Road, Luddenham	1	286583.2668	6248474.025	RES	P	55	50	-0.7	-0.7	N	N	N	N	N	60	51	61	54
NCA05	2154 The Northern Road, Luddenham	2	286536.2536	6248520.498	RES	P	55	50	0	0	N	N	N	N	N	61	52	62	55
NCA05	2154 The Northern Road, Luddenham	1	286536.2536	6248520.498	RES	P	55	50	0	0.1	N	N	N	N	N	60	51	61	54
NCA05	58 Campbell St_1, Luddenham	1	286131.0967	6248820.024	RES	P	55	50	0.1	0.3	N	N	N	N	N	44	37	46	39
NCA05	5 Adams Rd, Luddenham	1	286655.5822	6248400.846	RES	P	55	50	-0.4	-0.5	N	N	N	N	N	60	54	63	59
NCA05	2156 The Northern Road, Luddenham	1	286523.441	6248527.494	RES	P	55	50	0.2	0.3	N	N	N	N	N	60	51	61	55
NCA05	2148 The Northern Road, Luddenham	1	286567.1098	6248484.775	RES	P	55	50	0.3	0.4	N	N	N	N	N	60	51	61	55
NCA05	60 Campbell St, Luddenham	1	286129.5495	6248805.125	RES	P	55	50	-0.1	0	N	N	N	N	N	44	37	46	40
NCA05	2142 The Northern Road, Luddenham	1	286610.3676	6248432.817	RES	P	55	50	0.1	0.1	N	N	N	N	N	60	54	62	58
NCA05	Luddenham Uniting Church_1	1	286361.8397	6248606.137	OPW	H	50	50	0	0.1	N	N	N	N	N	62*	55*	63*	58*
NCA05	64 Campbell St, Luddenham	1	286127.4625	6248786.801	RES	P	55	50	-0.1	0	N	N	N	N	N	44	37	46	39
NCA05	Luddenham Uniting Church_2	1	286338.3941	6248607.665	OPW	H	50	50	0.2	0.2	N	N	N	N	N	56*	48*	57*	52*
NCA05	66 Campbell St, Luddenham	1	286131.9208	6248764.74	RES	P	55	50	-0.1	0	N	N	N	N	N	44	37	45	39
NCA05	68 Campbell St, Luddenham	1	286121.7515	6248745.815	RES	P	52	46	-0.1	0	N	N	N	N	N	42	35	44	38
NCA05	St James Anglican Church	1	286517.1898	6248438.379	OPW	H	50	50	0.2	0.3	N	N	N	N	N	62*	55*	64*	59*
NCA05	70 Campbell St, Luddenham	1	286137.8463	6248722.495	RES	P	55	50	0	0.1	N	N	N	N	N	46	39	48	41
NCA05	Sales Park, Luddenham	1	286180.044	6248567.559	OOA	P	60	-	0.2	0.3	N	N	N	N	N	50	42	51	45

Note:
1. * denotes calculated $L_{Aeq(1hour)}$ for comparison against hourly criteria.
2. Criteria Type P = 15 hour and 9 hour assessment periods for the day and night respectively. Criteria Type H = 1 hour assessment period. As per the definitions in the NCG.
3. Receiver Type: RES = Residential, OED = Educational, OOA = Outdoor Active Area, OPW = Place of Worship.
4. Educational buildings and Places of Worship have been assessed against external criteria which have been derived from the NCG internal criteria via the conversion factors discussed in Section 3.3 and Table 5.

APPENDIX F:
TRAFFIC DATA USED IN NOISE MODELLING

Traffic Data - NO BUILD Scenario 2021

Location	Direction	Daytime (hourly average)					Night time (hourly average)				
		LV	HV	Total	Posted Speed (km/h)	% HV	LV	HV	Total	Posted Speed (km/h)	% HV
The Northern Road											
Littlefields Rd to Elizabeth Dr	NB	787	59	846	90	7%	130	9	139	90	6%
	SB	480	41	521	90	8%	114	8	122	90	7%
Elizabeth Dr to Park Rd	NB	629	48	677	90	7%	129	8	137	90	6%
	SB	559	47	606	90	8%	97	8	105	90	8%
Park Rd to Adams Rd	NB	612	48	660	90	7%	111	7	118	90	6%
	SB	437	35	472	90	7%	85	8	93	90	9%
Adams Rd to end of project design south	NB	543	44	587	90	7%	101	6	107	90	6%
	SB	467	28	495	90	6%	84	6	90	90	7%
Local Roads											
Elizabeth Dr	WB	1124	31	1155	80	3%	66	5	71	80	7%
	EB	667	57	724	80	8%	193	13	206	80	6%
Park Rd	WB	247	25	272	80	9%	33	4	37	80	11%
	EB	118	12	130	80	9%	33	3	36	80	8%
Adams Rd	WB	48	0	48	70	0%	19	0	19	70	0%
	EB	82	0	82	70	0%	14	0	14	70	0%

Traffic Data - NO BUILD Scenario 2031

Location	Direction	Daytime (hourly average)					Night time (hourly average)				
		LV	HV	Total	Posted Speed (km/h)	% HV	LV	HV	Total	Posted Speed (km/h)	% HV
The Northern Road											
Littlefields Rd to Elizabeth Dr	NB	698	52	750	90	7%	131	12	143	90	8%
	SB	640	66	706	90	9%	146	13	159	90	8%
Elizabeth Dr to Park Rd	NB	432	34	466	90	7%	89	7	96	90	7%
	SB	257	29	286	90	10%	51	8	59	90	14%
Park Rd to Adams Rd	NB	552	45	597	90	8%	109	10	119	90	8%
	SB	156	15	171	90	9%	31	4	35	90	11%
Adams Rd to end of project design south	NB	633	51	684	90	7%	148	10	158	90	6%
	SB	314	13	327	90	4%	57	5	62	90	8%
Local Roads											
Elizabeth Dr	WB	513	31	544	80	6%	1	0	1	80	0%
	EB	849	55	904	80	6%	0	0	0	80	0%
Park Rd	WB	490	60	550	80	11%	64	8	72	80	11%
	EB	356	39	395	80	10%	87	11	98	80	11%
Adams Rd	WB	139	0	139	70	0%	70	0	70	70	0%
	EB	127	0	127	70	0%	39	0	39	70	0%

Traffic Data - BUILD Scenario 2021

Location	Direction	Daytime (hourly average)					Night time (hourly average)				
		LV	HV	Total	Posted Speed (km/h)	% HV	LV	HV	Total	Posted Speed (km/h)	% HV
The Northern Road											
Littlefields Rd to Elizabeth Dr	NB	813	69	882	90	8%	133	10	142	90	7%
	SB	548	53	601	90	9%	117	11	129	90	9%
Elizabeth Dr to Adams Rd	NB	508	67	575	90	12%	95	12	107	90	11%
	SB	449	51	500	90	10%	83	11	94	90	12%
Adams Rd to Eaton Rd	NB	554	59	613	90	10%	105	8	112	90	7%
	SB	481	39	520	90	7%	85	8	93	90	9%
Eaton Rd to Old TNR	NB	554	59	613	90	10%	105	8	112	90	7%
	SB	500	38	538	90	7%	88	8	95	90	8%
Old TNR to end of project design south	NB	627	65	691	90	9%	116	8	124	90	7%
	SB	541	47	588	90	8%	96	9	106	90	9%
Local Roads											
Elizabeth Dr	WB	477	32	509	80	6%	52	5	57	80	8%
	EB	189	24	213	80	11%	62	7	69	80	10%
Park Rd	WB	242	24	266	80	9%	29	2	32	80	8%
	EB	125	15	140	80	11%	35	4	39	80	10%
Adams Rd: Old TNR to new TNR	WB	104	0	104	70	0%	30	0	30	70	0%
	EB	42	2	44	70	5%	19	2	20	70	8%
Adams Rd: new TNR to Elizabeth Dr	WB	30	7	37	70	19%	7	1	7	70	7%
	EB	122	0	122	70	0%	56	0	56	70	0%
Old TNR: new TNR to Adams Rd	WB	114	9	123	50	8%	19	2	21	50	8%
	EB	89	14	102	50	13%	17	3	20	50	16%
Old TNR: Adams Rd to Park Rd	WB	51	6	56	50	10%	8	0	9	50	6%
	EB	29	49	78	50	63%	6	5	11	50	44%
Old TNR: Park Rd to Elizabeth Dr	WB	225	22	247	50	9%	27	2	29	50	7%
	EB	141	9	151	50	6%	40	3	43	50	6%

Traffic Data - BUILD Scenario 2031

Location	Direction	Daytime (hourly average)					Night time (hourly average)				
		LV	HV	Total	Posted Speed (km/h)	% HV	LV	HV	Total	Posted Speed (km/h)	% HV
The Northern Road											
Littlefields Rd to Elizabeth Dr	NB	1283	82	1365	90	6%	214	15	229	90	7%
	SB	1129	113	1242	90	9%	233	17	250	90	7%
Elizabeth Dr to Adams Rd	NB	570	57	628	90	9%	124	13	137	90	9%
	SB	673	62	736	90	8%	107	11	118	90	9%
Adams Rd to Eaton Rd	NB	670	49	719	90	7%	152	8	161	90	5%
	SB	757	48	805	90	6%	116	7	123	90	5%
Eaton Rd to Old TNR	NB	670	49	719	90	7%	152	8	161	90	5%
	SB	746	50	796	90	6%	116	6	122	90	5%
Old TNR to end of project design south	NB	831	72	903	90	8%	190	13	203	90	7%
	SB	884	67	951	90	7%	137	13	150	90	8%
Local Roads											
Elizabeth Dr	WB	386	29	415	80	7%	43	5	49	80	11%
	EB	226	24	249	80	10%	70	6	76	80	8%
Park Rd	WB	510	62	573	80	11%	64	8	72	80	11%
	EB	378	44	422	80	10%	100	13	113	80	12%
Adams Rd: Old TNR to new TNR	WB	186	0	186	70	0%	52	0	52	70	0%
	EB	80	6	86	70	7%	41	4	46	70	9%
Adams Rd: new TNR to Elizabeth Dr	WB	79	9	88	70	11%	22	3	25	70	11%
	EB	201	0	201	70	0%	106	0	106	70	0%
Old TNR: new TNR to Adams Rd	WB	290	31	321	50	10%	63	6	69	50	9%
	EB	259	23	283	50	8%	47	7	54	50	14%
Old TNR: Adams Rd to Park Rd	WB	182	22	204	50	11%	31	3	34	50	8%
	EB	141	32	173	50	18%	27	8	35	50	22%
Old TNR: Park Rd to Elizabeth Dr	WB	453	51	504	50	10%	62	6	68	50	9%
	EB	355	26	382	50	7%	89	7	97	50	8%

APPENDIX G:
CONSTRUCTION NOISE LEVEL DIFFERENCE MAPS – TNR6 vs EIS ALIGNMENTS

0 250 500 m

Map Projection: Tansverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994
MGA Zone: 56

Noise Level Change dB (TNR6- EIS)

- 0 to 2
- 2 to 4
- 4 to 6
- 6 to 8
- 8 to 10
- 10 to 12
- 12 to 14
- 14 to 16

- TNR6 Projects Roads - height difference EIS (m)
- Local Roads
- NCAs
- TNR6 Earthworks Footprint

TNR6 Earthworks Construction Standard Hours

CONSTRUCTION NOISE MODIFICATION ASSESSMENT

Waves CONSULTING

Project Number: 60.00758.01
Date: 13 September 2018
Revision: 01
Prepared by: TC

0 250 500 m

Map Projection: Tansverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994
MGA Zone: 56

Noise Level Change dB (TNR6- EIS)

- 0 to 2
- 2 to 4
- 4 to 6
- 6 to 8
- 8 to 10
- 10 to 12
- 12 to 14
- 14 to 16

- TNR6 Projects Roads - height difference EIS (m)
- Local Roads
- NCAs
- TNR6 Earthworks Footprint

TNR6 Earthworks Construction Standard Hours

CONSTRUCTION NOISE MODIFICATION ASSESSMENT

Waves CONSULTING

Project Number: 60.00758.01
Date: 13 September 2018
Revision: 01
Prepared by: TC

APPENDIX H:
CONSTRUCTION NML EXCEEDANCE MAPS

0 250 500 m

Map Projection: Tansverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994
MGA Zone: 56

NML Exceedance dB

- Not Sensitive
- <= 0 dB
- 0 < dB <= 10
- 10 < dB <= 20
- > 20 dB

- TNR6 Projects Roads - height difference EIS (m)
- Local Roads
- TNR6 Earthworks Footprint

TNR6 Earthworks Construction Standard Hours

CONSTRUCTION NOISE MODIFICATION ASSESSMENT

Waves CONSULTING

Project Number: 60.00758.01
Date: 13 September 2018
Revision: 01
Prepared by: TC

0 250 500 m

Map Projection: Tansverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994
MGA Zone: 56

NML Exceedance dB

- Not Sensitive
- <= 0 dB
- 0 < dB <= 10
- 10 < dB <= 20
- > 20 dB

- TNR6 Projects Roads - height difference EIS (m)
- Local Roads
- TNR6 Earthworks Footprint

TNR6 Earthworks Construction Standard Hours

CONSTRUCTION NOISE MODIFICATION ASSESSMENT

Waves CONSULTING

Project Number: 60.00758.01
Date: 13 September 2018
Revision: 01
Prepared by: TC

rms.nsw.gov.au/projects/sydney-west/the-northern-road

13 22 13

Customer feedback
Roads and Maritime
Locked Bag 928,
North Sydney NSW 2059

December 2018
RMS.18.1138