Transport Roads & Maritime Services

Appendix B3

Noise and Vibration Management Sub-plan

Albion Park Rail bypass (Stage 2 – Princes Motorway between Yallah and Oak Flats)

September 2020

Document control

Approval and authorisation

Title	Noise and Vibration Management Sub-plan Albion Park Rail bypass (Stage 2 – Princes Motorway between Yallah and Oak Flats)
Accepted on behalf of NSW Transport of NSW by	Peter Chudleigh
Signed	[redacted]
Dated	29 September 2020

Endorsement

Endorsed by the Environmental Representative	Toby Hobbs
Signed	[redacted]
Dated	30 September 2020

Document status

Revision	Date	Description	Approval
[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	

		[redacted]	
[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	

Distribution of controlled copies

This NVMP as part of the CEMP is available to all personnel and sub-contractors via the Project document control management system. An electronic copy can be found on the Project website.

The document is uncontrolled when printed. One controlled hard copy of the NVMP as part of the CEMP and supporting documentation will be maintained by the Quality Manager at the Project office and on the project website.

Copy number	Issued to	Version

Contents

Tables

Figures

Appendices

Glossary/ Abbreviations

Abbreviation	Expanded text
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Attenuation	The reduction in the level of sound or vibration.
CEMP	Construction Environmental Management Plan
CNVG	Construction Noise and Vibration Guideline
CoA	Conditions of approval (state or federal). State CoA are the NSW Minister for Planning's conditions of approval. Federal CoA are the federal Conditions of Approval under the EPBC Act.
dBA	Decibels using the A-weighted scale measured according to the frequency of the human ear.
DPIE	NSW Department of Planning, Industry and Environment
EIS	Environmental Impact Statement
EMS	Environmental management system
ENMM	Environmental Noise Management Manual
EPA	NSW Environment Protection Authority
EP&A Act	Environmental Planning and Assessment Act 1979
ER	Environmental Representative
ERG	Environmental Review Group
EWMS	Environmental Work Method Statements
Feasible and reasonable	Consideration of best practice taking into account the benefit of proposed measures and their technological and associated operational application in the NSW and Australian context. Feasible relates to engineering considerations and what is practical to build. Reasonable relates to the application of judgement in arriving at a decision, taking into account mitigation benefits and cost of mitigation versus benefits provided, community views and nature and extent of potential improvements.
ICNG	Interim Construction Noise Guideline
$L_{Aeq(15min)}$	The A-weighted equivalent continuous (energy average) A-weighted sound pressure level of the construction works under consideration over a 15-minute period and excludes other noise sources such as from industry, road, rail and the community.
$L_{A(max)}$	the A-weighted maximum noise level only from the construction works under consideration, measured using the fast time weighting on a sound level meter.

Abbreviation	Expanded text
NCA	Noise Catchment Area
NML	Noise Management Level
NSW Minister, the	NSW Minister for Planning
NVMM	Noise and vibration mitigation measure
NVMP	Noise and Vibration Management Sub-plan
OEH	Office of Environment and Heritage
OOHMM	Out of hours mitigation measure
OOHW	Out of Hours Work
Project, the	Albion Park Rail bypass
RBL	The Rating Background Level for each period is the medium value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period (day, evening and night)
Roads and Maritime	Roads and Maritime Services – All references to Roads and Maritime should be interpreted as Transport for NSW (formerly Roads and Maritime Services)
REMM	Revised Environmental Management Measures
SPIR	Submissions and Preferred Infrastructure Report - A report developed to respond to submissions raised during the exhibition of the EIS and assess changes from the EIS
SWL	Sound Power Level
SPL	Sound Pressure Level
TfNSW	Transport for NSW

1 Introduction

1.1 Context

This Noise and Vibration Management Sub-plan (NVMP or Plan) forms part of the Construction Environmental Management Plan (CEMP) for the Albion Park Rail bypass (Stage 2 – Princes Motorway between Yallah and Oak Flats) (the Project).

This NVMP has been prepared to address the requirements of the Ministers' Conditions of Approval (CoA), the Albion Park Rail Bypass Environmental Impact Statement (EIS), as amended by the Submissions and Preferred Infrastructure Report (SPIR), including the revised environmental management measures (REMM) listed in the SPIR and all applicable legislation.

1.2 Background and project description

Transport for NSW (TfNSW) propose to extend the M1 Princes Motorway between Yallah and Oak Flats to bypass Albion Park Rail. The motorway would complete the 'missing link' for a high standard road between Sydney and Bomaderry. The project is known as the Albion Park Rail bypass.

The Albion Park Rail Bypass Environmental Impact Statement (October 2015) assessed noise and vibration impacts on sensitive receivers and structures from construction of the Project.

As part of EIS development, a detailed construction and operational noise and vibration assessment was prepared to address the Environmental Assessment Requirements issued by the then Department of Planning and Environment. The noise and vibration assessment was included in the EIS in Chapter 12, which is based on the full assessment in Technical Paper 8

1.3 Environmental management systems overview

The overall Environmental Management System for the Project is described in Chapter 3 of the CEMP.

The NVMP is part of Fulton Hogan's environmental management framework for the Project, as described in Chapter 4 of the CEMP. Management measures identified in this Plan will be incorporated into site or activity specific Environmental Work Method Statements (EWMS).

EWMS will be developed and signed off by environment and management representatives prior to associated works and construction personnel will be required to undertake works in accordance with the identified mitigation and management measures.

Used together, the CEMP, strategies, procedures and EWMS form management guides that clearly identify required environmental management actions for reference by Fulton Hogan personnel and contractors.

The review and document control processes for this Plan are described in Section 1.6 the CEMP.

1.4 Consultation for preparation of this NVMP

This NVMP (including the construction noise monitoring program) has been developed in consultation with the EPA.

The EPA made three observations regarding the NVMP, generally related to the minimisation of noise and vibration impacts on sensitive receivers; the implementation of all reasonable and feasible noise and vibration mitigation measures; and the assessment of sleep disturbance for out of hours works. Fulton Hogan responded to the EPA and outlined how each observation is covered within the NVMP. The EPA acknowledged Fulton Hogan's response.

A summary of consultation undertaken during preparation of this Plan, including copies of all correspondence, is provided in Appendix A5 of the CEMP.

2 Purpose and objectives

2.1 Purpose

The purpose of this Plan is to describe how Fulton Hogan proposes to manage potential noise and vibration impacts during construction of the Project.

2.2 Objectives

The key objective of the NVMP is to ensure that project impacts on noise and vibration are minimised and within the scope permitted by the planning approval. To achieve this objective, Fulton Hogan will undertake the following:

- Ensure appropriate controls and procedures are implemented during construction activities to avoid or minimise noise and vibration impacts and potential adverse impacts to sensitive receivers along the Project corridor.
- Ensure appropriate measures are implemented to address the relevant CoA and REMM outlined in Table 3-1 and Table 3-2 respectively.
- Ensure appropriate measures are implemented to comply with all relevant legislation and other requirements as described in Chapter 3 of this Plan.

2.3 Targets

The following targets have been established for the management of noise and vibration impacts during construction of the Project:

- Full compliance with the relevant legislative requirements, CoA and REMM
- That blasting activities are only undertaken at designated times and remain within established/agreed criteria
- Complaints from the community and stakeholders are minimised.

2.4 Environmental performance targets

Table 2-1 identifies the construction-related environmental performance outcomes identified in the EIS as amended by the SPIR and how these will be achieved.

Table 2-1 Environmental performance outcomes

EIS/ SPIR reference	Environmental performance outcome	How achieved
Section 12.3.1 p332	Noise levels would be minimised with the aim of achieving the Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009) noise management levels where feasible and reasonable	Section 8.2 mitigation measures.
Section 12.4.1 p362	Avoid any damage to buildings from vibration.	Section 8.2 mitigation measure ID NVMM36-NVMM49.
Section 12.3.1, p338	Minimise sleep disturbance for any night time construction works that occur for two or more consecutive nights near a sensitive receiver (e.g. a residence).	Section 8.3 mitigation measure ID OOHMM1–OOHMM30.

EIS/ SPIR reference	Environmental performance outcome	How achieved
SPIR, p271	Comply with the airblast overpressure and ground vibration limits outlined in the EIS as amended by the SPIR as amended by the CoA.	Section 5.7 Appendix D Blast Management Strategy mitigation measure ID BMM3-BMM14.
SPIR NV02, p280	Prior to out of hours work being carried out, all affected receivers will be notified of all relevant details of the proposed activities.	Section 8.3 mitigation measure ID OOHMM1.

3 Environmental requirements

3.1 Relevant legislation and guidelines

3.1.1 Legislation

Legislation relevant to noise and vibration management includes:

- *Protection of the Environment Operations Act 1997*
- *Protection of the Environment Operations (Noise Control) Regulation 2008*

Relevant provisions of the above legislation are explained in the register of legal and other requirements included in Appendix A1 of the CEMP.

3.1.2 Guidelines

The main guidelines, specifications and policy documents relevant to this Plan include:

- TfNSW QA Specification G36 – Environmental Protection (Management System)
- TfNSW Construction Noise and Vibration Guidelines (Roads and Maritime 2015)
- NSW Interim Construction Noise Guideline (ICNG), Department of Environment and Climate Change 2009
- NSW Road Noise Policy, Dept. of Environment, Climate Change and Water 2011
- NSW Industrial Noise Policy, Environment Protection Authority 2000
- NSW Assessing Vibration – a technical guideline, Department of Environment and Conservation 2006
- Australian Standard AS/NZS 2107:2000 Acoustics - Recommended design sound levels and reverberation times for building interiors
- Australian Standard 2834-1995 Computer Accommodation, Chapter 2.9 Vibration
- Australian Standard AS 2187.2 Explosives - Storage and use - Part 2 Use of explosives
- Australian Standard AS2436-1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites
- British Standard BS 6472-2008, ‘Evaluation of human exposure to vibration in buildings (1-80Hz)
- British Standard 7385: Part 2-1993 'Evaluation and measurement of vibration in buildings'
- German Standard DIN4150-1999 Structural vibration Part 3: Effects of vibration on Structures
- Construction Noise Strategy 7TP-ST-157/2.0, Transport for NSW 2012
- Environmental Noise Management Manual (ENMM), Roads and Traffic Authority 2001.

3.2 Minister's Conditions of Approval

The CoA relevant to this Plan are listed Table 3-1 below. A cross reference is also included to indicate where the condition is addressed in this Plan or other project management documents.

Table 3-1 Conditions of Approval relevant to the NVMP

<table>
<tr><th>CoA No.</th><th>Condition Requirements</th><th>Document Reference</th></tr>
<tr><td>C4</td><td>The following CEMP Sub-plans must be prepared in consultation with the relevant government agencies identified for each CEMP Sub-plan and be consistent with the CEMP referred to in Condition C1.
Table 3: CEMP Sub-plan Consultation Requirements<table><tr><th></th><th>Required CEMP Sub-plan</th><th>Relevant government agencies to be consulted for each CEMP Sub-plan</th></tr><tr><td>a)</td><td>Traffic and transport</td><td>Relevant Council(s)</td></tr><tr><td>b)</td><td>Noise and vibration</td><td>EPA</td></tr><tr><td>c)</td><td>Fauna and Flora</td><td>OEH and DPI Fisheries</td></tr><tr><td>d)</td><td>Soil and water</td><td>EPA and DPI Water and Fisheries</td></tr><tr><td>e)</td><td>Heritage</td><td>OEH, Relevant Council(s), Registered Aboriginal Parties</td></tr><tr><td>f)</td><td>Flooding and Hydrology</td><td>OEH and Relevant Council(s)</td></tr></table></td><td>Section 1.4</td></tr>
<tr><td>C5</td><td>The CEMP Sub-plans must state how:</td><td></td></tr>
<tr><td>(a)</td><td>The environmental performance outcomes identified in the EIS as amended by the SPIR as modified by these conditions will be achieved</td><td>Section 2.4</td></tr>
<tr><td>(b)</td><td>the mitigation measures identified in the EIS as amended by the SPIR as modified by these conditions will be implemented;</td><td>Through the implementation of this NVMP (in particular refer to Section 3.3 and Chapter 8).</td></tr>
<tr><td>(c)</td><td>the relevant terms of this approval will be complied with (in particular Part E of this approval);</td><td>Through the implementation of this NVMP (in particular refer to Part E condition cross references below).</td></tr>
<tr><td>(d)</td><td>the identification of the relevant environmental specific training and induction processes for construction personnel; and</td><td>Section 9.2</td></tr>
<tr><td>(e)</td><td>issues requiring management during construction, as identified through ongoing environmental risk analysis, will be managed.</td><td>Chapter 6 second paragraph
Chapter 7</td></tr>
<tr><td>C6</td><td>The CEMP Sub-plans must be developed in consultation with relevant government agencies identified in Table 3 of Condition C4 of this approval. Where an agency(ies) request(s) is not included, the Proponent must provide the Secretary justification as to why. Details of all information requested by an agency to be included in a CEMP Sub-plan as a result of consultation, including copies of all correspondence from those agencies, must be provided with the relevant CEMP Sub-Plan.</td><td>Section 1.4</td></tr>
</table>

<table>
<tr><th>CoA No.</th><th>Condition Requirements</th><th>Document Reference</th></tr>
<tr><td>C7</td><td>Any of the CEMP Sub-plans may be submitted to the Secretary for approval along with, or subsequent to, the submission of the CEMP but in any event, no later than one (1) month before commencement of construction.</td><td>CEMP (main section) Section 1.4</td></tr>
<tr><td>C8</td><td>Construction must not commence until the CEMP and all CEMP Sub-plans have been approved by the Secretary. The CEMP and CEMP Sub-plans, as approved by the Secretary, including any minor amendments approved by the ER must be implemented for the duration of construction. Where the SSI is being staged, construction of that stage is not to commence until the relevant CEMP and sub-plans have been approved by the Secretary, unless otherwise agreed by the Secretary.</td><td>CEMP (main section) Section 1.4</td></tr>
<tr><td>C9</td><td>The following Construction Monitoring Programs must be prepared in consultation with the relevant government agencies identified for each Construction Monitoring Program to compare actual performance of construction of the SSI against performance predicted performance:
Table 4: Construction Monitoring Program Consultation Requirements
<table>
<tr><th></th><th>Required Construction Monitoring Programs</th><th>Relevant government agencies to be consulted for each Construction Monitoring Program</th></tr>
<tr><td>a)</td><td>Air Quality</td><td>EPA</td></tr>
<tr><td>b)</td><td>Groundwater</td><td>DPI Water</td></tr>
<tr><td>c)</td><td>Surface Water</td><td>EPA and DPI Fisheries</td></tr>
<tr><td>d)</td><td>Noise</td><td>EPA</td></tr>
</table></td><td>Section 1.4.
In accordance with CoA C16, the construction noise monitoring program requirements have been incorporated into this NVMP. See below.</td></tr>
<tr><td rowspan="9">C10</td><td>Each Construction Monitoring Program must provide:
(a) details of baseline data available</td><td>Section 4.2</td></tr>
<tr><td>(b) details of baseline data to be obtained and when</td><td>Section 9.3.3</td></tr>
<tr><td>(c) details of all monitoring of the project to be undertaken;</td><td>Section 9.3</td></tr>
<tr><td>(d) the parameters of the project to be monitored;</td><td>Table 9-1</td></tr>
<tr><td>(e) the frequency of monitoring to be undertaken;</td><td>Table 9-1</td></tr>
<tr><td>(f) the location of monitoring;</td><td>Section 9.3.3
Table 9-1
Appendix F</td></tr>
<tr><td>(g) the reporting of monitoring results;</td><td>Section 9.7</td></tr>
<tr><td>(h) procedures to identify and implement additional mitigation measures where results of monitoring are unsatisfactory; and</td><td>Section 8
Section 9.3.1
Section 9.3.2</td></tr>
<tr><td>(i) any consultation to be undertaken in relation to the monitoring programs.</td><td>Section 1.4
Section 9.3.3</td></tr>
</table>

CoA No.	Condition Requirements	Document Reference
C11	The Construction Monitoring Programs must be developed in consultation with relevant government agencies as identified in Condition C9 of this approval and must include, to the written satisfaction of the Secretary, information requested by an agency to be included in a Construction Monitoring Programs during such consultation. Details of all information requested by an agency including copies of all correspondence from those agencies, must be provided with the relevant Construction Monitoring Program.	Section 1.4
C12	The Construction Monitoring Programs must be endorsed by the ER and then submitted to the Secretary for approval at least one (1) month prior to the commencement of construction or within another timeframe agreed with the Secretary.	As permitted by CoA C16, the Noise Construction Monitoring Program has been incorporated into this NVMP. The Construction Monitoring Program is therefore, endorsed by the ER by virtue of the endorsement of this NVMP on page 1.
C16	Where a relevant **CEMP Sub-plan** exists, the relevant **Construction Monitoring Program** may be incorporated into the **CEMP Sub-plan.**	Section 9.3
PART E – NOISE AND VIBRATION		
Standard Construction Hours		
E36	Works must only be undertaken during the following construction hours: (a) 7:00am to 7:00pm Mondays to Fridays, inclusive; (b) 8:00am to 5:00pm Saturdays; and (c) at no time on Sundays or public holidays.	Section 7.1 Section 8.2 Chapter 8 mitigation measure ID NVMM1

CoA No.	Condition Requirements	Document Reference
E37	Except as permitted by an EPL, activities resulting in impulsive or tonal noise emissions must only be undertaken: (a) between the hours of 8:00 am to 6:00 pm Monday to Friday; (b) between the hours of 8:00 am to 1:00 pm Saturday; and (c) 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. For the purposes of this condition, '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.	Chapter 8 mitigation measure ID NVMM26
E38	Notwithstanding **Condition E36**, works associated with the SSI may be undertaken outside the specified hours in the following circumstances: (a) for the delivery of materials required by the NSW Police Force or other authority for safety reasons; or (b) where it is required in an emergency to avoid injury or the loss of life, to avoid damage or loss of property or to prevent environmental harm; or (c) where it causes $L_{Aeq(15\ minute)}$ noise levels: i. no more than 5 dB(A) above the rating background level at any residence in accordance with the *Interim Construction Noise Guideline* (DECC, 2009), and ii. no more than the noise management levels specified in Table 3 of the Interim Construction Noise Guideline (DECC, 2009) at other sensitive land uses, and iii. continuous or impulsive vibration values at the most affected residence are no more than those for human exposure to vibration, specified in Table 2.2 of Assessing Vibration: a technical guideline (DEC, 2006), and iv. intermittent vibration values at the most affected residence are no more than those for human exposure to vibration, specified in Table 2.4 of Assessing Vibration: a technical guideline (DEC, 2006), or (d) no more than 15dBA above the night time rating background level at any residence during the night time period, when measured using the $LA_{eq(1\ minute)}$ noise descriptor; or (e) where different hours are permitted or required under an EPL in force in respect of the works, in which case those hours must be complied with.	Appendix C OOHW Approval Procedure Section 8.3
E39	The Proponent must ensure that all works for the delivery of the SSI are coordinated with utility works, including those works undertaken by third parties, to minimise cumulative impacts of noise and vibration and provides maximise respite for affected sensitive receivers.	Chapter 8 mitigation measure ID NVMM2

CoA No.	Condition Requirements	Document Reference
E40	On becoming aware of the need for emergency works in accordance with Condition E38 the Proponent must notify the ER and the EPA (if an EPL applies) of the need for those works. The Proponent must also use its best endeavours to notify all affected sensitive receivers of the likely impact and duration of those works.	Appendix C OOHW Approval Procedure Section 8.3
Construction Vibration		
E41	The SSI must be delivered with the aim of achieving the following vibration goals: (a) for structural damage to heritage structures, the vibration limits set out in the German Standard DIN 4150-3: Structural Vibration – Part 3 Effects of vibration on structures; (b) for damage to other buildings and/or structures, the vibration limits set out in the British Standard BS 7385-1:1990 – Evaluation and measurement of vibration in buildings—Guide for measurement of vibration and evaluation of their effects on buildings (and referenced in Australian Standard 2187.2 – 2006 Explosives – Storage and use – Use of explosives); and (c) for human exposure, the acceptable vibration values set out in Assessing Vibration: A Technical Guideline (Department of Environment and Conservation, 2006).	Section 5.5 Section 7.5
E42	Blasting associated with the SSI must only be undertaken during the following hours: (a) 9:00am to 5:00pm, Monday to Friday, inclusive; (b) 9:00am to 1:00pm on Saturday; and (c) at no time on Sunday or public holidays. This condition does not apply in the event of a direction from the NSW Police Force or other relevant authority for safety or emergency reasons to avoid loss of life, property loss and/or to prevent environmental harm. Blasting may be undertaken outside the above hours where: (a) no sensitive receivers would be impacted by blasting; or (b) an agreement has been made with potentially affected receivers.	Appendix D Blast Management Strategy

<table>
<tr><th>CoA No.</th><th>Condition Requirements</th><th>Document Reference</th></tr>
<tr><td>E43</td><td>Airblast overpressure generated by blasting associated with the SSI must not exceed the criteria specified in Table 6 when measured at the most affected residence or other sensitive receiver.

Table 6: Airblast overpressure limits for human comfort
<table><tr><th>Receiver</th><th>Type of blasting operations</th><th>Airblast Overpressure Limit</th></tr><tr><td>Sensitive site</td><td>Blasting operations lasting more than 12 months or more than 20 blasts</td><td>115 dBL for 95% of blasts per year
120 dBL maximum limit</td></tr><tr><td>Sensitive site</td><td>Blasting operations lasting less than 12 months or less than 20 blasts in total</td><td>120 dBL for 95% of blasts per year
125 dBL maximum limit</td></tr><tr><td>Occupied non-sensitive sites, such as factories and commercial premises</td><td>All blasting</td><td>125 dBL maximum limit.
For sites containing equipment sensitive to vibration, the vibration level should be kept below manufacturer's specifications or levels that can be shown to adversely affect the equipment operation</td></tr></table>
Source – Table J5.4(A) – AS 2187.2 – 2006
Note: a sensitive site includes houses and low rise residential buildings, theatres, schools and other similar buildings occupied by people</td><td>Section 5.7

Appendix D Blast Management Strategy</td></tr>
</table>

<table>
<tr><th>CoA No.</th><th>Condition Requirements</th><th>Document Reference</th></tr>
<tr><td>E44</td><td>
Ground vibration generated by blasting associated with the SSI must not exceed the criteria specified in Table 7 and Table 8 when measured at the most affected residence or other sensitive receiver.

Table 7: Ground vibration limits for human comfort
<table>
<tr><th>Receiver</th><th>Type of blasting operations</th><th>Peak component particle velocity (mm/s)</th></tr>
<tr><td>Sensitive site</td><td>Blasting operations lasting more than 12 months or more than 20 blasts</td><td>5 mm/s for 95% of blasts per year
10 mm/s maximum limit</td></tr>
<tr><td>Sensitive site</td><td>Blasting operations lasting less than 12 months or less than 20 blasts in total</td><td>10 mm/s maximum limit</td></tr>
</table>
<table>
<tr><th>Receiver</th><th>Type of blasting operations</th><th>Peak component particle velocity (mm/s)</th></tr>
<tr><td>Occupied non-sensitive sites, such as factories and commercial premises</td><td>All blasting</td><td>25 mm/s maximum limit.
For sites containing equipment sensitive to vibration, the vibration level should be kept below manufacturer's specifications or levels that can be shown to adversely affect the equipment operation</td></tr>
</table>
Source – Table J4.5(A) – AS 2187.2 – 2006
Note: a sensitive site includes houses and low rise residential buildings, theatres, schools and other similar buildings occupied by people

Table 8: Ground vibration limits for control of damage to structures
<table>
<tr><th>Receiver</th><th>Type of blasting operations</th><th colspan="2">Peak component particle velocity (mm/s)</th></tr>
<tr><td>Other structures or architectural elements that include masonry, plaster and plasterboard in their construction [1]</td><td></td><td>15 mm/s 4 Hz to 15 Hz, except for heritage structures where a frequency dependent vibration criteria would be determined in accordance with AS 2187.2 – 2006.</td><td>20 mm/s 15 Hz and above</td></tr>
<tr><td>Reinforced or framed structures. Industrial and heavy commercial buildings [2]</td><td>All blasting</td><td>50 mm/s at 4 Hz and above</td><td></td></tr>
<tr><td>Unreinforced or light framed structure. Residential or light commercial type building [2]</td><td>All blasting</td><td>15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz</td><td>20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above</td></tr>
<tr><td>Unoccupied structures of reinforced concrete or steel construction</td><td>All blasting</td><td colspan="2">100 mm/s maximum, where agreed with the structure owner.</td></tr>
<tr><td>Infrastructure service structures, such as pipelines, powerlines, cables and reservoirs.</td><td>All blasting</td><td colspan="2">Limits to be determined by structural design methodology in consultation with the infrastructure service provider.</td></tr>
</table>
Source: Table J4.5(B) – AS 2187.2 – 2006 and Table J4.4.2.1 – AS 2187.2 – 2006 (BS 7385-2)
</td><td>Section 5.7

Appendix D Blast Management Strategy</td></tr>
</table>

CoA No.	Condition Requirements	Document Reference
E45	The blasting criteria specified in the tables in Conditions E43 and E44 may be exceeded where the Proponent has obtained the written agreement of the landowner to increase the relevant criteria. In obtaining the agreement, the Proponent must make available to the landowner: (a) details of the proposed blasting program and justification for the proposed increase in blasting criteria including alternatives considered (where relevant); (b) an assessment of the environmental impacts of the increased blasting criteria on the surrounding environment and most affected residences or other sensitive receivers including, but not limited to noise, vibration and air quality and any risk to surrounding utilities, services or other structures; and (c) details of the blast management, mitigation and monitoring procedures to be implemented. The Proponent must provide a copy of the landowner written agreement to the Secretary and the EPA, including details of the consultation undertaken (with clear identification of proposed blast limits and potential property impacts, prior to commencing blasting at the higher limits. Unless otherwise agreed by the Secretary, the following exclusions apply: (a) The landowner may terminate at any time an agreement made with the Proponent to increase the blasting criteria, should concerns made by the landowner about the blasting criteria be unresolved. Where an agreement is terminated, the Proponent must not exceed the criteria specified in the tables in Conditions E43 and E44 for future blasting that affects the property; and (b) the blasting limit agreed to under any agreement must not exceed a maximum Peak Particle Velocity vibration level of 25 mm/s or maximum Airblast Overpressure level of 125 dBL.	Appendix D Blast Management Strategy
Operational Noise Mitigation Report		

CoA No.	Condition Requirements	Document Reference
E46	The Proponent must undertake a review of the operational noise mitigation measures proposed to be implemented for the SSI. The review must be prepared in consultation with the EPA and submitted to the Secretary for approval prior to construction commencing, except for the Croom Regional Sporting Complex works, unless otherwise agreed by the Secretary. The review must: (a) confirm the operational noise predictions of the SSI 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); (b) review the suitability of the operational noise mitigation measures identified in the EIS as amended by the SPIR. The review must take into account the detailed design of the SSI 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 SSI predicted under (a) above; (c) where necessary, investigate additional noise mitigation measures to achieve the criteria outlined in the *NSW Road Noise Policy* (DECCW, 2011); and (d) investigate noise mitigation measures to achieve the criteria outlined in the *Industrial Noise Policy* (DECCW 2011) for the Croom Regional Sporting Complex. Note: noise barriers that may penetrate the OLS must comply with the requirements of **Condition E7**.	Condition E46 will be addressed in a separate operational noise assessment (Operational Noise Mitigation Report). The mitigation measures specified by the review in E46 are considered in this NVMP under Condition E47.
E47	Operational noise mitigation measures identified in **Condition E46** (such as at-property architectural treatments) that will not be affected by construction works, must be implemented within six (6) months of the commencement of construction, except for the Croom Regional Sporting Complex works, or at other times during construction to minimise construction noise impacts. These measures must be detailed in the **Construction Noise and Vibration Management Plan** for the SSI, unless otherwise agreed by the Secretary. Where early implementation of noise mitigation measures are not proposed, the Proponent must submit to the Secretary a report providing justification as to why, along with details of temporary measures that would be implemented to reduce construction noise impacts, until such time that the operational noise mitigation measures identified in **Condition E46** are implemented. The report must be provided to the Secretary for approval prior to the commencement of construction which would affect the identified receivers.	Section 7.4 Chapter 8 mitigation measure ID NVMM27
Building and Structure Condition Survey		

CoA No.	Condition Requirements	Document Reference
E51	Prior to commencement of any works, a suitably qualified person must undertake building and structure condition surveys of all building and structures identified in the EIS as amended by the SPIR as being at risk of damage. The results of the surveys must be documented in a Building and Structure Condition Survey Report for each building structure surveyed. Copies of Building and Structure Condition Survey Reports must be provided to the landowners of the building and structures surveyed, and if agreed by the landowner, the Relevant Council(s), within three weeks of completing the surveys and no later than one month prior to the commencement of works.	Building and Structure Condition Survey Report - to be completed separately to this NVMP.
E52	After completion of the works, condition surveys of all building and structures for which pre-construction condition surveys were undertaken in accordance with Condition E51 must be undertaken by a suitably qualified person. The results of the surveys must be documented in a Building and Structure Condition Survey Report for each building and structure surveyed. Copies of Building and Structure Condition Survey Reports must be provided to the landowners of the buildings and structures surveyed, and if agreed by the landowner, the Relevant Council(s), within three weeks of completing the surveys and no later than three (3) months following the completion of the works.	Building and Structure Condition Survey Report - to be completed separately to this NVMP.
E53	Any damage caused to property as a result of the SSI must be rectified or the landowner compensated, within a reasonable timeframe, with the costs borne by the Proponent. This condition does not limit any claims that the landowner may have against the Proponent.	Chapter 5

3.3 Revised Environmental Management Measures

Relevant REMM from the SPIR are listed in Table 3-2 below. This includes a cross reference as to where the measure is addressed in this Plan or other Project management documents.

Table 3-2 Environmental management measures relevant to the NVMP

ID No.	Environmental management measure	How mitigation measure will be implemented
NV01	A Construction Noise and Vibration Management Plan will be prepared for the project. The Plan will provide details of noise and vibration management measures and procedures to be carried out during construction to minimise and manage noise impacts on sensitive receivers, including:	This NVMP
	• Noise and vibration monitoring and reporting requirements	Section 9.3
	• Map showing the location of all sensitive receivers	Appendix E Project Map
	• Specific mitigation treatments, management methods and procedures to be implemented to control noise and vibration during construction	Chapter 8
	• Construction timetabling to minimise noise impacts including time and duration restrictions, respite periods and frequency	Chapter 8
	• Procedures for notifying residents, business owners, and other sensitive receivers of construction activities likely to affect their amenity through noise and vibration	Community Communication Strategy (CCS)
	• Contingency procedures to be implemented in the event of non-compliances and / or noise complaints.	Chapter 8 Section 9.3 CCS
	The type of noise mitigation measures that may be adopted in the Plan include: • Carrying out only low noise activities during the weekday morning (6am to 7am) period	Chapter 8 mitigation measure ID NVMM1
	• Selection of less noisy plant and equipment, where feasible	Chapter 8 mitigation measure ID NVMM12
	• Avoiding simultaneous operation of noisy plant, where feasible	Chapter 8 mitigation measure ID NVMM21
	• Avoiding queueing and idling of construction vehicles outside of the project standard construction hours	Chapter 8 mitigation measure ID NVMM23
	• Maintaining plant and equipment so as to ensure optimum operating conditions	Chapter 8 mitigation measure ID NVMM15

ID No.	Environmental management measure	How mitigation measure will be implemented
	• Planning construction traffic flow to minimise reversing and noise from reversing alarms.	Chapter 8 mitigation measure ID NVMM7
	The type of vibration mitigation measures that may be adopted in the Plan include: • Undertaking building dilapidation surveys for buildings that could be impacted by vibration	Chapter 8 mitigation measure ID NVMM47, NVMM48.
	• Consideration of feasible alternative construction methodologies or equipment where vibration intensive equipment is expected to exceed the criteria.	Chapter 8 mitigation measure ID NVMM39
NV02	Work will be carried out generally in accordance with the Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009). Prior to out of hours work being carried out, all affected receivers will be notified of relevant details of the proposed activities.	This NVMP Section 5 Section 7 Section 8 Appendix C OOHW Approval Procedure
NV03	If blasting is required, the Construction Noise and Vibration Management Plan will incorporate a Blast Management Strategy. The Strategy will be prepared in consultation with the Environment Protection Agency, will aim to demonstrate that all blasting and associated activities will be undertaken in a manner that will not generate unacceptable noise and vibration impacts or pose a significant risk impact to residences and sensitive receivers. The Blast Management Strategy will address: • Details of blasting to be performed, including location, method and justification of the need to blast • Identification of any potentially affected noise and vibration sensitive sites including heritage buildings and utilities • Establishment of appropriate criteria for blast overpressure and ground vibration levels at each category of noise sensitive site • Details of the storage and handling arrangements for explosive materials and the proposed transport of those materials to the construction site • Identification of hazardous situations that may arise from the storage and handling of explosives, the blasting process and recovery of the blast site after detonation of the explosives • Determination of potential noise and vibration and risk impacts from blasting and appropriate best management practices • Community consultation procedures.	Appendix D Blast Management Strategy

ID No.	Environmental management measure	How mitigation measure will be implemented
NV04	The need for operational phase noise mitigation measures, including low noise pavement, noise barriers or architectural treatments, will be confirmed during detailed design. The final noise barrier design will be selected following investigations into the OLS and engineering feasibility of the proposed mitigation measures and community consultation with residents from properties identified as exceeding, without mitigation, the Noise Criteria Guideline (Roads and Maritime, 2015a) in the adjoining noise catchment area. The mitigation measures will be provided as early as practicable in the construction program to reduce potential noise impacts associated with construction.	Operational measure addressed in Operational Noise Mitigation Report

4 Existing environment

The following sections summarise what is known about factors influencing noise and vibration within and adjacent to the Project corridor.

The key reference document is chapter 12 of the EIS.

4.1 Sensitive receivers

There are a range of noise-sensitive receivers in the study area. All residences are considered to be sensitive receivers with respect to construction noise and vibration, and operational noise. Other receivers considered to be sensitive to noise and vibration include commercial receivers, educational institutions, child care centres, places of worship, and areas of open space.

A summary of the noise catchment areas is provided in Table 4-1 with a brief description of the key characteristics of each area.

The location of the noise catchment areas is shown in Figure 4-1.

Table 4-1 Summary of noise catchment areas

Noise catchment area	Description of area
NCA01	Residential receivers south-east of the Oak Flats Interchange and New Lake Entrance Road
NCA02	Agricultural land to the south of the East West Link, near the Green Meadows detention basin
NCA03	Residential receivers in Albion Park Rail north of the East West Link
NCA04	Rural residential receivers near Croome Road south of the entrance to Croom Regional Sporting Complex
NCA05	Residential receivers east of Terry Street and part of the Croom Regional Sporting Complex
NCA06	Residential receivers and agricultural land south of Tongarra Road and east of Terry Street
NCA07	Residential receivers to the north of Tongarra Road and east of Station Road
NCA08	Residential receivers north of Tongarra Road
NCA09	Commercial area and Albion Park Showground east of the Illawarra Highway and north of Tongarra Road
NCA10	Commercial / industrial area, residential receivers and agricultural land west and north of the Illawarra Highway
NCA11	Illawarra Regional Airport industrial precinct
NCA12	Residential receivers east of the Princes Highway in Haywards Bay
NCA13	Rural residential and commercial receivers west of the Princes Highway and south of Yallah Road

Noise catchment area	Description of area
NCA14	Agricultural land and vegetated parts of the TransGrid site located east of the Princes Highway and south of the Princes Highway
NCA15	Residential receivers west of the existing Princes Highway to the north of the project northern extent
NCA16	Residential receivers east of the existing Princes Highway to the north of the project northern extent

Figure 4-1 Noise catchment areas and noise monitoring programs

4.2 Ambient noise

Noise monitoring was conducted as part of the EIS for the Albion Park Rail Bypass Project in February and July 2015. The results of the monitoring of existing noise levels, referred to as rating background levels (RBL) are presented in Table 4-2. The RBL is a measure of the typical background ambient noise level in the environment.

Table 4-2 Ambient noise monitoring results (EIS Noise and Vibration Assessment Table 4 and 5)

Logger number	Noise catchment area(s)	Location	Rating background level, dB			Measured traffic noise levels, dB	
			Day 7am - 6pm	Evening 6pm - 10pm	Night 10pm - 7am	$L_{Aeq\ (15\ hr)}$ 7am – 10pm	$L_{Aeq\ (9\ hr)}$ 10pm – 7am
February 2015							
8	NCA1	20 Westwood Drive, Blackbutt	48	46	44	59	59
7	NCA2	78 Jarrah Way, Albion Park	45	47	47	56	55
5	NCA3	54 Oak Street, Albion Park Rail	43	43	38	58	52
6	NCA4	152 Croome Road, Albion Park	45	44	36	71	65
4	NCA8	52 Tongarra Road, Albion Park Rail	52	48	39	70	63
3	NCA10	24 Terry Street, Albion Park	47	43	39	67	64
2	NCA13	42 Larkins Lane, Yallah	48	46	46	59	59
11	NCA13	Yallah Road, Yallah	46	42	38	61	55
1	NCA15	4 Semillon Place, Mount Brown	54	53	52	61	58
9	-	216 Princes Highway, Albion	58	49	39	69	64
10	-	305 Princes Highway, Albion	59	49	39	68	65
July 2015							
12	NCA4	152 Croome Road, Albion Park	44	37	29	72	65
13	NCA5	59 Burdekin Drive, Albion Park	35	33	29	51	45
14	NCA5	25 Fraser Crescent, Albion Park	39	38	30	50	44

The measured ambient traffic noise levels (Table 4-2) show that levels of road traffic noise are already above the Road Noise Policy base criteria of 60 dB $L_{Aeq\ (15\ hr)}$ and 55 dB $L_{Aeq\ (9\ hr)}$ in many locations. This is generally the case for locations adjacent to the Princes Highway, although lower ambient noise levels were observed in areas with less exposure to road traffic noise, such as locations 13 and 14 in NCA5.

The monitoring was undertaken to provide background noise levels and, among other purposes, to establish appropriate construction noise assessment criteria. Locations were selected to be representative of receivers that would experience a potential noise impact from the existing highway or from the Project (see Appendix A6 of the CEMP for monitoring locations). It is noted that no monitoring was conducted in a number of NCAs but:

- There are only two sensitive receivers in NCA6 and the background noise environment is expected to be equivalent to that in NCA8 on the opposite side of Tongarra Road.
- NCA7 is well removed from the construction area and the background noise environment is expected to be equivalent to that in NCA8 on the same stretch of Tongarra Road.
- NCA9 is expected to have an equivalent background noise environment to that of NCA8 on the same stretch of Tongarra Road.
- The background noise levels in NCA11 and NCA12 have conservatively been assumed to be equivalent to those in NCA13, despite being closer to the existing Princes Highway than NCA13.
- There are only two sensitive receivers in NCA14 and the background noise environment is expected to be similar to that in NCA15.
- NCA16 is expected to have an equivalent background noise environment to that of NCA15 on the opposite side of the Princes Motorway.

Figure 4-1 shows the location at which existing noise levels were monitored, as well as the noise catchment areas. The rating background levels identified were determined in accordance with the Industrial Noise Policy (INP).

Noise levels display a typical diurnal trend, with lower levels during the night-time than the daytime and evening periods. This is characteristic of urban and suburban areas where the ambient noise is dominated by road traffic. This is consistent with observed traffic flows on existing roads throughout the study area that have a relatively small decrease in traffic volumes in the evening compared to the daytime period, and a more substantial reduction in volumes during night-time.

5 Noise and vibration criteria for NSW

The EPA recommends management levels and goals when assessing construction noise and vibration. These are outlined in:

- The Interim Construction Noise Guideline (ICNG)
- The TfNSW Construction Noise and Vibration Guideline (CNVG)
- Assessing Vibration: A technical guideline
- The ANZECC, Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration.

Relevant elements of these documents are summarised and discussed in this Chapter.

Note that the noise and vibration criteria change during different time periods, with more stringent criteria generally applying in the more sensitive time periods (evening and night time).

Any damage caused to property as a result of the project will be rectified or the landowner compensated, within a reasonable timeframe.

5.1 Construction noise and assessment objectives

The DECC ICNG provides guidelines for the assessment and management of construction noise. The ICNG focuses on applying a range of work practices to minimise construction noise impacts rather than focusing on achieving numeric noise levels.

The main objectives of the ICNG are to:

- Identify and minimise noise from construction works
- Focus on applying all ‘feasible’ and ‘reasonable’ work practices to minimise construction noise impacts
- Encourage construction during the recommended standard hours only, unless approval is given for works that cannot be undertaken during these hours
- Reduce time spent dealing with complaints at the project implementation stage
- Provide flexibility in selecting site-specific feasible and reasonable work practices to minimise noise impacts.

5.2 Quantitative noise assessment criteria

The ICNG prescribes noise management levels (NMLs) depending on the type of land use and the time that construction work is to be carried out. The ICNG states that all feasible and reasonable work practices should be applied to meet the NML.

5.2.1 Residential Premises

Table 5-1 sets out management levels for noise at residences and how they are to be applied as prescribed by the ICNG.

In Table 5-1 the RBL is used when determining the management level. The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours). The term RBL is described in detail in the NSW INP, with the measured RBLs for the Project area shown in Table 4-2.

As a guide, the difference between the internal noise level and the external noise level is typically 10 dB with windows open for adequate ventilation.

Table 5-1 Noise Management Levels at residences using quantitative assessment

Time of day	Management Level $L_{Aeq\ (15\ min)}$ *	How to apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	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 $L_{Aeq\ (15\ min)}$ 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 duration, as well as contact details.
	Highly noise affected 75 dB(A)	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: ○ 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 ○ 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(A) above the noise affected level, the proponent should negotiate with the community.

* Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5m above ground level. If the property boundary is more than 30m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

5.2.2 Additional night time construction noise criterion

Item (d) of CoA E38 adds an additional requirement for night time work near residences, namely that the construction noise level, assessed as an $L_{Aeq,1min}$ level, must not exceed the night time RBL by more than 15 dB.

5.2.3 Other land uses

Other sensitive land uses, such as schools, typically find noise from construction to be disruptive when the properties are being used (such as during school times). Table 5-2 presents management levels for noise at other sensitive land uses based on the principle that the characteristic activities for each of these land uses should not be unduly disturbed. Consultation should be undertaken with noise sensitive land use occupants likely to be affected by noise from the works to schedule the project's work hours to achieve a reasonable noise outcome.

Table 5-2 Noise Management Levels at non-residential sensitive land uses

Land use	Noise assessment location	Noise management level ($L_{Aeq,15min}$)
Classrooms at schools and other educational institutions	Internal	45
Hospitals and operating theatres		
Places of worship		
Active recreation areas[1]	External	65
Passive recreation areas[2]	External	60
Community centres	Dependent on intended use	Maximum internal levels recommended in AS2107 for specific use
Industrial premises	External	75
Office, retail outlets	External	70
Other noise sensitive businesses	Investigation to determine suitable noise levels on project-by-project basis	

Notes:

1. Active recreation areas are characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion.
2. Passive recreation areas are characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion (e.g. reading, meditation).

The management levels in Table 5-2 are 5 dB above the corresponding road traffic noise levels in the Environmental Criteria for Road Traffic Noise (EPA 1999) (and the 'maximum' levels in the NSW INP for commercial and industrial uses) to account for the variable and short-term nature of construction noise.

Internal noise levels presented in Table 5-2 are assessed at the centre of the occupied, and sensitive, room. External noise levels are assessed at the most affected point within 50 metres of the area boundary. Where internal noise levels cannot be measured, external noise levels may be used. A conservative estimate of the difference between internal and external noise levels is 10 dB for buildings, which allows for windows being kept partially open for ventilation. Where

windows can be kept closed (e.g. due to mechanical ventilation), the difference will generally improve to at least 20 dB.

Whilst present in the study area, there are no noise management levels in the guidelines for child care centres. Child care centres generally have internal and external play areas, and internal sleep areas. For the purposes of this Project, the following Noise Management Levels have been adopted which are consistent with those adopted in the EIS:

- Sleeping areas – 35 dB $L_{Aeq(1hr)}$
- Indoor play areas – 40 dB $L_{Aeq(1hr)}$
- Outdoor play areas – 55 dB $L_{Aeq(1hr)}$.

Table 5-3 lists the non-residential sensitive receivers that have been identified within 400 metres of the Project area.

Table 5-3 Nearest non-residential sensitive receivers to the Project

Land use	NCA	Details	Approx. distance to nearest works
Educational facility	NCA1	Echidna Children's Centre, 30 Pioneer Drive, Blackbutt	330 m
	NCA9	World of Learning Child Care, 108 Tongarra Road, Albion Park	400 m
	NCA10	Albion Public School, Tongarra Road, Albion Park	300 m
Place of Worship	-	Lighthouse Church, 4/9 Durgadin Drive, Albion Park Rail	30 m
Active Recreation	-	Croom Regional Sporting Complex	Alongside
	NCA9	Albion Park Showground / Des King Oval / Keith Grey Oval, Albion Park	30-300 m
Commercial	NCA8	Ravensthorpe Guesthouse and Restaurant, 56 Tongarra Rd, Albion Park	120 m
	NCA10	Commercial premises on Tongarra Road, Albion Park	6-10 m
Industrial	-	Industrial premises in Durgadin Drive	25 m
	NCA11	Airport Precinct	50 m
	NCA12	Yallah Road industrial premises	15-60 m
Heritage sites	NCA3	Albion Park Rail Cemetery, Croome Road, Albion Park Rail	60 m
	NCA4	Swansea Dairy site, 149 Croome Road, Albion Park	100 m
	NCA4	Swansea Farmhouse, 152 Croome Road, Albion Park	10-20 m

Land use	NCA	Details	Approx. distance to nearest works
	NCA8	Ravensthorpe grounds and workers cottages	175 m
	NCA8 / 11	Illawarra Regional Airport	70-400 m
	NCA14	House, Princes Hwy, Yallah	80 m

5.3 Sleep disturbance

The EIS also recommends an $L_{A1(1min)}$ sleep disturbance screening criterion of 15 dB above the RBL, or 10 dB above the night time NML. The sleep disturbance screening criterion is only relevant to any night time construction works.

Where the screening criterion is exceeded, additional consideration should be given to potential sleep disturbance impacts. From the research on sleep disturbance to date, it can be concluded that:

- Maximum internal noise levels below 50-55 dB L_{Amax} are unlikely to awaken people from sleep.
- One or two noise events per night, with maximum internal noise levels of 65-70 dB L_{Amax} are not likely to affect health and wellbeing.

On the basis of the above and a 10 dB reduction from outdoors to indoors across a partially open window, as per the guidance given in the Road Noise Policy, it is proposed that sleep disturbance from night time construction works will be assessed against an acceptability level of 60-65 dB L_{Amax} from a single event where the screening criterion is exceeded.

5.4 Adopted project noise management levels

Based on the NCAs and measured noise levels described in Chapter 4, the project-specific construction noise objectives (NMLs) for residential land uses represented by each representative monitoring location have been determined and are presented in Table 5-4. NMLs for non-residential sensitive land uses are summarised in Table 5-2.

Note that NMLs for residential land uses are specified for the following times:

- ICNG standard hours (RBL + 10 dB): these are the standard working hours as defined by the ICNG.
- Additional hours allowed under CoA E36 that extended beyond the ICNG standard hours (RBL + 5 dB): these are still approved hours but have more stringent NMLs than the ICNG standard hours. These hours are 6 pm to 7 pm Monday to Friday, and 1 pm to 5 pm Saturdays.

Considering the possibility of works outside the construction hours allowed under CoA E36, additional NMLs for Out of Hours Work (OOHW) are also included in the construction noise objectives.

Table 5-4 Construction noise management levels at residential receivers (consistent with EIS Table 12-6)

Noise catchment area	Logger location	Rating Background Level, dB L_{A90}					Noise Management Level (NML), dB $L_{Aeq,15min}$						Additional requirements (RBL + 15 dB)	
							ICNG Standard Hours[6], RBL + 10 dB	Additional CoA E36 Hours[7], RBL + 5 dB	Out of Hours Work, RBL + 5 dB				CoA E38, dB $L_{Aeq,1min}$	Sleep disturbance dB $L_{A1(1min)}$
		Shoulder, N – D[1]	Day[2]	Shoulder, D – E[3]	Evening[4]	Night[5]	Day	Shoulder, D – E[3]	Shoulder, N – D[1]	Day[2]	Evening[4]	Night[5]	10 pm – 7 am	10 pm – 7 am
NCA1	8	48	48	47	46	44	58	52	53	53	51	49	59	59
NCA2	7	45	45	45	47	47	55	50	50	50	52	52	62	62
NCA3	7	45	45	45	47	47	55	50	50	50	52	52	62	62
NCA4	12	39	44	44	37	30	54	49	44	49	42	35	45	45
NCA5	13	34	35	35	33	30	45	40	39	40	38	35	45	45
NCA6	4	49	52	52	48	39	62	57	54	57	53	44	54	54
NCA7	4	49	52	52	48	39	62	57	54	57	53	44	54	54
NCA8	4	49	52	52	48	39	62	57	54	57	53	44	54	54
NCA9	4	49	52	52	48	39	62	57	54	57	53	44	54	54
NCA10	3	47	47	47	43	39	57	52	52	52	48	44	54	54
NCA11	2	48	48	48	46	46	58	53	53	53	51	51	61	61
NCA12	2	48	48	48	46	46	58	53	53	53	51	51	61	61

Noise category	Logger	Rating Background Level, dB L_{A90}					Noise Management Level (NML), dB $L_{Aeq,15min}$						Additional requirements (RBL + 15 dB)	
NCA13	2	48	48	48	46	46	58	53	53	53	51	51	61	61
NCA14	1	54	54	53	53	52	64	58	59	59	58	57	67	67
NCA15	1	54	54	53	53	52	64	58	59	59	58	57	67	67
NCA16	1	54	54	53	53	52	64	58	59	59	58	57	67	67

Note:

1. *The Shoulder Night – Day period is defined as 6 am – 7 am Monday to Friday*
2. *The Day period is defined as 7 am – 6 pm any day*
3. *The Shoulder Day – Evening period is defined as 6 pm – 7 pm Monday to Friday and 1 pm to 5 pm Saturdays*
4. *The Evening period is defined as 7 pm – 10 pm Mondays to Fridays, and 6 pm to 10 pm Saturdays, Sundays and Public Holidays*
5. *The Night period is defined as 10 pm – 6 am Monday to Friday, and 10 pm – 7 am on Saturdays, Sundays and Public Holidays.*
6. *ICNG Standard Hours of 7 am to 6 pm Monday to Friday, and 8 am to 1 pm Saturday*
7. *CoA E36 extended hours of 6 pm to 7 pm Monday to Friday and 1 pm to 5 pm Saturday*

5.5 Vibration criteria

Effects of ground vibration on buildings resulting from construction may be segregated into the following three categories:

- Human exposure – disturbance to building occupants: vibration in which the occupants or users of the building are inconvenienced or possibly disturbed
- Effects on building contents – vibration where the building contents may be affected
- Effects on building structures – vibration in which the integrity of the building or structure itself may be prejudiced.

Vibration criteria relating to human comfort that are applicable to this project are taken from the DEC (2006) document Assessing Vibration – A Technical Guideline and include the following.

- Continuous vibration – from uninterrupted sources (see Table 5-5)
- Impulsive vibration – up to three instances of sudden impact per monitoring period, e.g. occasional dropping of heavy items (see Table 5-6)
- Intermittent vibration – such as from drilling, compacting or activities that would result in continuous vibration if operated continuously (see Table 5-7).

With respect to construction works, from which vibration is regular but rarely continuous in nature, intermittent vibration is the most common form of vibration which requires assessment.

Two standards by which building damage from construction-induced vibration are commonly assessed include:

- British Standard 7385: Part 2-1993 Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration (BSI 1993)
- German DIN 4150: Part 3 – 1999 Effects of Vibration on Structure (DIN 1999).

The German standard provides the most stringent criteria and will be used in this NVMP. This approach is more stringent than that required under the CoA, which allow for the use of BS 7385-2 criteria for non-heritage-listed buildings.

The DIN guideline values for peak particle velocity (mm/s) measured at the foundation of the building are summarised in Table 5-8. The criteria are frequency dependent and specific to particular categories of structure.

Table 5-5 Continuous vibration acceleration criteria (m/s^2) 1-80Hz

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day or night-time	0.020	0.014	0.040	0.028
		0.04	0.029	0.080	0.058
Workshops	Day or night-time	0.04	0.029	0.080	0.058

Table 5-6 Impulsive vibration acceleration criteria (m/s^2) 1-80Hz

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day or night-time	0.64	0.46	1.28	0.92
Workshops	Day or night-time	0.64	0.46	1.28	0.92

Table 5-7 Intermittent vibration impacts criteria (Vibration Dose Value, m/s$^{1.75}$) 1-80Hz

Location	Daytime		Night-time	
	Preferred Values	Maximum Values	Preferred Values	Maximum Values
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Table 5-8 Structural damage criteria

Type of Structure	Peak Component Particle Velocity, mm/s			
	Vibration at the foundation at a frequency of			Vibration of horizontal plane of highest floor at all frequencies
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz*	
Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15

Type of Structure	Peak Component Particle Velocity, mm/s			
Structures that, because of their sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

* For frequencies above 100Hz, at least the values specified in this column shall be applied.

5.6 Construction Noise and Vibration Guideline

In considering the potential noise and vibration impact from construction works, and the appropriate approach to address them, the TfNSW CNVG defines additional noise mitigation measures that should be applied depending on the times at which works are occurring and the predicted exceedance of the NMLs.

The CNVG does not provide specific noise and vibration criteria, rather referencing the criteria detailed in this Chapter from the ICNG and vibration guidelines but provides guidance on how to manage exceedances of the criteria. The CNVG has been adopted for this NVMP as it documents the latest Roads and Maritime requirements for construction noise and vibration management. It supersedes the ENMM, referenced by G36, for the management of construction noise and vibration.

The requirements of the CNVG for the management of construction noise and vibration are discussed further in Chapter 7.

5.7 Blast criteria

The ANZECC "Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration" has been used to establish goals for assessing blast air-blast overpressure and ground vibration. These are in accordance with Roads and Maritime QA Specification G36 and are either equivalent to or more stringent than CoA E43 and E44.

Controlled blasting is likely where deep cuts are required, and where cuttings cannot be excavated economically using mechanical equipment. It is anticipated that blasting will be required at Cut 5, which is the cut in the eastern extent of the East West Link at the Oak Flats Interchange.

Air-blast overpressure generated by blasting associated with the SSI must not exceed the criteria specified in Table 5-9 when measured at the most affected residence or another sensitive receiver.

Table 5-10 summarises applicable vibration limits for human comfort from blasting ground vibration in line with the Project Approval and ANZECC Guidelines, including for occupied non-sensitive sites, including commercial and industrial uses. Further information on negotiated agreements for blasting is provided in Appendix D.

Table 5-11 details the ground vibration limits that apply to structures to prevent damage due to blasting. These limits apply even where structures are unoccupied.

For assessment of air-blast overpressure the DECC/ANZECC guidelines recommend measurement at any sensitive receiver at least 3.5 metres from building or structure, and ground vibration measured at any point on the noise sensitive site at least the longest dimension of the foundations of a building or structure away from the building or structure.

The blasting criteria may be exceeded where written agreement has been obtained from the landowner to increase the relevant criteria in accordance with the requirements of CoA E45.

Table 5-9 Airblast overpressure criteria for blasting

Category	Airblast overpressure, $dB_{(Lin\ Peak)}$	Allowable exceedance
Sensitive site*	115	5% of total number of blasts over a 12 month period
Sensitive site*	120	0%
Occupied non- sensitive sites, such as factories and commercial premises	125	0%

Note:

**A sensitive site includes houses and low rise residential buildings, theatres, schools, and other similar buildings occupied by people.*

Table 5-10 Ground vibration limits for human comfort from blasting

Category	Type of blasting operation	Peak component particle velocity, mm/s
Sensitive site*	Operations lasting longer than 12 months or more than 20 blasts	5 mm/s for 95% blasts per year 10 mm/s maximum unless agreement is reached with the occupier that a higher limit may apply
Sensitive site*	Operations lasting for less than 12 months or less than 20 blasts	10 mm/s maximum unless agreement is reached with occupier that a higher limit may apply
Occupied non-sensitive sites, such as factories and commercial premises	All blasting	25 mm/s maximum unless agreement is reached with occupier that a higher limit may apply. For sites containing equipment sensitive to vibration, the vibration should be kept below manufacturer's specifications or levels that can be shown to adversely

Note:

**A sensitive site includes houses and low rise residential buildings, theatres, schools, and other similar buildings occupied by people.*

The recommendations in Table J4.5(A) of the guidelines are intended to be informative and do not override statutory requirements with respect to human comfort limits set by various authorities. They should be read in conjunction with any such statutory requirements and with regard to their respective jurisdictions.

Table 5-11 Ground vibration limits for control of damage to structures for all blasting

Category	Peak component particle velocity, mm/s	
Other structures or architectural elements that include masonry, plaster and plasterboard in their construction	15 mm/s 4 Hz to 15 Hz, except for heritage structures where a frequency dependent vibration criteria would be determined in accordance with AS 2187.2 - 2006	20 mm/s, 15 Hz and above

Category	Peak component particle velocity, mm/s	
Reinforced or framed structures. Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above.	
Unreinforced or light framed structure. Residential or light commercial type building.	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz.	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above.
Unoccupied structures of reinforced concrete or steel construction.	100 mm/s maximum, where agreed with the structure owner.	
Infrastructure service structures, such as pipelines, powerlines, cables and reservoirs.	Limits to be determined by structural design methodology in consultation with the infrastructure service provider.	

6 Environmental aspects and impacts

The key construction activities and the associated potential sources of noise and vibration impact are identified through a risk management approach. The consequence and likelihood of each activity's impact on the environment has been assessed to prioritise its significance. The results of this risk assessment are included in Appendix A2 of the CEMP.

Ongoing environmental risk analysis during construction will be undertaken through regular monitoring, inspections and auditing as described in Chapter 9.

6.1 Environmental aspects

Construction activities generate noise and vibration of varying levels depending on the activities being carried out and the proximity to sensitive receivers such as residential areas. The type of work carried out during construction often involves the use of large plant and machinery, sometimes moving along the project alignment and sometimes working in a fixed location, which can cause varying noise and vibration at nearby receivers. These aspects of construction can exacerbate noise levels from the works and their effects, causing annoyance to those affected.

Section 12.4.1 of the environmental impact statement provides an outline of the key noise and vibration-generating activities that will be carried out to complete the project, and their potential impact on receivers in the project area.

In order to assess the level of potential impact on noise and vibration sensitive receivers, the broad categories of construction activity likely to interact with these receivers are identified below.

- Site establishment
- Clearing and grubbing
- Demolition
- Earthworks and drainage
- Drilling and blasting
- Quarrying – crushing and screening and rock hammering
- Concrete batching (batch plant)
- Bridgeworks (piling)
- Paving and concrete saw cutting
- Road furnishing
- Establishment and operation of ancillary facilities.

6.2 Environmental impacts

The potential for noise and vibration impacts on sensitive receivers or structures will depend on a number of factors. Typically, these might include:

- The type of equipment in use
- The number of equipment simultaneously in use
- Ground condition
- Topography and other physical barriers
- Proximity to sensitive receivers
- The condition of sensitive receivers
- Hours/duration of construction works
- Proximity of heavy traffic areas such as the highway.

Relevant aspects and the potential for related impacts have been considered in a risk assessment at Appendix A2 of the CEMP.

Noise and vibration impacts attributable to the Project are anticipated and summarised in Chapter 7. Chapter 8 provides a suite of mitigation measures that will be implemented to avoid or minimise impacts on the receiving community and/or built environment.

7 Construction noise and vibration assessment

A range of plant and equipment will be required to undertake activities associated with the Project. A summary of anticipated construction scenarios and predicted noise levels are provided below. This information will be used to determine potential impacts on the receiving community. An adaptive management approach will be applied to the implementation of mitigation measures to minimise impacts on the community.

7.1 Construction hours

The following construction hours apply to the Project:

Standard and extended construction hours

Standard construction hours are as per those defined in the ICNG:

- 7 am to 6 pm Mondays to Fridays
- 8 am to 1 pm Saturdays.

The ICNG provides guidance on managing noise from construction work in NSW. The guidelines state that, public infrastructure works are one of the five categories of works that may need to be undertaken outside the recommended standard hours. This need is typically based on a requirement to sustain the operational integrity of public infrastructure, as work to restore operation of the infrastructure provides a benefit to the greater community (that is, more broadly, rather than just local residents).

Reflecting this, CoA E36 for the Project has also allowed standard construction work to occur during the following hours outside of the standard hours defined in the ICNG:

- 6 pm to 7 pm Mondays to Fridays
- 1 pm to 5 pm Saturdays.

These hours are described in this NVMP as extended hours.

Extended hours work during the times defined above will be assessed and managed in accordance with this NVMP and do not require an Out of Hours Work Assessment.

Out of Hours Work

Work outside of the standard construction hours would also be required at times – this is called Out of Hours Work (OOHW). OOHW would occur in accordance with the Project Approval (Condition E38) and relevant requirements of the Environment Protection Licence (EPL) for construction of the project.

OOHW that may be required could include:

- delivery of materials required to occur outside of standard hours by the NSW Police Force or another authority for safety reasons;
- emergency work to avoid injury or the loss of life, to avoid damage or loss of property to prevent environmental harm;
- where it is low noise and vibration work that complies with the relevant noise and vibration level requirements of CoA E38 for out of hours construction work; and/or
- where permitted under an EPL.

Generally, OOHW would be undertaken at less sensitive times where reasonable and feasible, e.g. in the morning period between 6 am and 7 am prior to the commencement of main works.

All OOHW will be assessed in accordance with the OOHW Approval Procedure in Appendix C of this NVMP to ensure compliance with requirements of CoA E38 of the approval.

7.2 Construction activities

Table 7-1 provides a summary of construction scenarios, and associated plant and equipment required for the works. Plant and equipment may be used in isolation or simultaneously. Appendix A provides a list of equipment and a correlating sound power level. A typical overall sound power level for each scenario is also provided which is a typical upper estimate of the sound power level for the noisier activities that may occur during each phase over a 15-minute period.

Table 7-1: Construction scenarios and associated plant and equipment

Scenario	Description of typical activities	Typical plant and equipment required
A1: Mobilisation and site establishment	Property acquisition and associated works including property access changes. Detailed geotechnical investigations and surveys. General site clearance, site establishment work, fencing and signage Establishment of temporary construction facilities and ancillary facilities. Temporary traffic management arrangements. Progressive installation of environmental controls including fencing, erosion and sediment control measures. Construction of temporary drainage controls. Clearing and removal of vegetation. Diversion of utilities.	• Trucks • Generators • Light vehicles • Excavators • Chainsaws • Mulchers • Water carts • Drilling rigs • Cranes Overall SWL: 115 dB L_{Aeq}
A2: Road work and road surfacing	Vegetation and topsoil removal. Temporary local traffic diversion measures. Placement / compaction of earthworks. Road widening. Signalling works and road markings. Construction of retaining walls and surface drainage. Paving works. Landscaping and tree planting.	• Chainsaws • Graders • Backhoes • Front end loaders • Trucks • Water carts • Vibratory rollers • Excavators • Pavers Overall SWL: 113 dB L_{Aeq}
A3: Drainage	Construction of drainage, including kerb and gutter. Installation of culverts. Installation of longitudinal and vertical drainage in cuttings and embankments. Construction of drainage and catch drains along the formation and sedimentation control basins or swales (where required).	• Trucks • Bulldozers • Excavators • Concrete pumps • Concrete trucks Overall SWL: 112 dB L_{Aeq}

Scenario	Description of typical activities	Typical plant and equipment required
A4: Bulk earthwork	Stripping of topsoil and stockpiling for reuse. Materials haulage. Soft soils treatment. Construction of embankments. Stockpiling.	• Trucks • Bulldozers • Excavators • Front end loaders • Vibratory rollers Overall SWL: 115 dB L_{Aeq}
A5: Bridgework	Establishment of batching plant. Preparation of bridge work areas including temporary piling pads and access platforms. Installation of bridge foundations, bored piling method. Construction of new bridge and piers.	• Batching plant • Bored piling rig • Concrete pumps • Concrete trucks • Cranes • Excavators • Trucks Overall SWL: 116 dB L_{Aeq}
A6: Finishing work	Remove temporary works and restoration works. General site clean-up. Removal of temporary environmental controls.	• Trucks • Generators • Light vehicles • Cranes Overall SWL: 108 dB L_{Aeq}
A7: Ancillary sites and compounds	Site compound, stockpile site	• Trucks • Excavators • Front end loaders • Compressors • Cranes • Vibratory rollers • Generators Overall SWL: 114 dB L_{Aeq}
A8: Material Processing including crushing and screening	Crushing and screening of rock material for reuse on-site	• Rock crusher/screener • Bulldozer D9 • Excavator • Truck Overall SWL: 115 dB L_{Aeq}

7.3 Construction noise impacts

Based on the sound power levels for each construction scenario presented in Table 7-1 above, construction noise levels at noise-sensitive land uses have been predicted using a three-dimensional model of the site and surrounds developed in SoundPlan version 7.4 environmental noise prediction software. The noise model was based on:

- predictions conducted using the ISO 9613-2 prediction algorithm, which predicts noise levels typical of light downwind conditions or a moderate ground-based temperature inversion
- construction noise sources being in the worst case position for each sensitive land use (i.e. the position at which the highest construction noise levels were predicted)
- typical source heights for construction noise sources
- topography, considering both the existing and/or altered topography of the road corridor dependent on the construction scenario
- sensitive receiver locations based on information supplied by TfNSW
- ground absorption factor of 0% (completely reflective) for road surfaces and 75% for other areas as defined in information supplied by TfNSW.

Typical construction noise contours for the various phases of work are included in Appendix B. A discussion is provided in the following sections regarding the typical construction noise impact that may occur for each time period and each NCA.

Material Processing including crushing and screening is initially proposed to occur in Cut 1, Green Meadows Basin and Cut 5/Fill 14 however, the construction noise contours for Material Processing in Appendix B (Figure 8A and 8B) assess the worst-case noise levels of crushing and screening occurring across the whole alignment as part of normal construction activities. Tables 7.3, 7.4 and 7.5 indicate the maximum predicted noise level and the number of exceedances for each NCA which is consistent with Table 33 - Predicted construction noise levels of the EIS.

Construction noise mitigation and management measures are provided in Chapter 8 that will be implemented to assist in reducing construction noise impacts to receivers.

7.3.1 CNVG noise management approach

The TfNSW CNVG provides additional context to the management of construction noise as shown in Table 7-2, which summarises the CNVG management approach to noise based on the Predicted Noise Level (PNL) and the time for which works are occurring. The CNVG has been adopted as it documents the latest TfNSW requirements for construction noise and vibration management.

Separate additional noise mitigation measures are defined for the following periods:

- Standard hours: works carried out between 7 am and 7 pm Monday to Friday, and 8 am to 5 pm on Saturdays as defined by the CoA;
- OOHW Period 1: works carried out between 7 pm and 10 pm Monday to Friday, 7 am to 8 am and 5 pm to 10 pm on Saturdays, and 7 am to 6 pm on Sundays and Public Holidays; and
- OOHW Period 2: works carried out between 10 pm and 7 am Monday to Friday, 10 pm and 8 am on Saturdays, and 6 pm and 8 am on Sundays and Public Holidays.

Further details on the project-specific application of the CNVG construction noise mitigation measures as detailed in Table 7-2 are provided in Chapter 8 of this NVMP.

Table 7-2 CNVG noise management approach

Predicted noise level at sensitive land use	Additional mitigation measures to be applied to affected sensitive receivers (refer Chapter 8 for detail)	
ANY TIME		
Highly affected: PNL > 75 dB $L_{Aeq,15min}$	• Notification[1] • Verification	• Phone calls • Respite offer
STANDARD WORKING HOURS: Mon – Fri 7 am – 7 pm, Sat 8 am – 5 pm		
Noticeable: PNL ≤ NML	• Standard mitigation measures only	
Clearly audible: PNL ≤ NML+10 dB	• Standard mitigation measures only	
Moderately intrusive: NML+10 dB < PNL ≤ NML+20 dB	• Notification[1] • Verification	
Highly intrusive: PNL > NML+20 dB	• Notification[1] • Verification	
OOHW PERIOD 1: Mon – Fri 7 pm – 10 pm, Sat 7 am – 8 am & 5 pm – 10 pm, Sun/Pub Hol, 7 am – 6 pm		
Noticeable: PNL ≤ NML+5 dB	• Standard OOHW mitigation measures only	
Clearly audible: NML+5 dB < PNL ≤ NML+15 dB	• Notification[1] • Respite Period 1	• Duration Respite
Moderately intrusive: NML+15 dB < PNL ≤ NML + 25 dB	• Verification • Notification[1]	• Duration Respite • Respite Period 1
Highly intrusive: PNL > NML+25 dB	• Verification • Individual briefings • Notification[1] • Respite Period 1	• Duration Respite • Phone calls • Specific notifications[2]
OOHW PERIOD 2: Mon – Sat 10 pm – 7 am, Sun/Pub Hol, 6 pm – 7 am		
Noticeable: PNL ≤ NML+5 dB	• Standard OOHW mitigation measures only	
Clearly audible: NML+5 dB < PNL ≤ NML+15 dB	• Verification • Notification[1]	• Duration Respite • Respite Period 2
Moderately intrusive: NML+15 dB < PNL ≤ NML + 25 dB	• Verification • Individual briefings • Notification[1] • Respite Period 2	• Duration Respite • Phone calls • Specific notifications[2]

Predicted noise level at sensitive land use	Additional mitigation measures to be applied to affected sensitive receivers (refer Chapter 8 for detail)	
Highly intrusive: PNL > NML+25 dB	• Consideration of alternative accommodation • Verification • Individual briefings • Notification[1]	• Respite Period 2 • Duration Respite • Phone calls • Specific notifications[2]

[1] Notifications will occur 5-14 working days prior to noisy works commencing.
[2] Specific notifications will occur 7-14 working days prior to noisy works commencing.

7.3.2 General construction during standard construction hours

A summary of predicted construction noise levels for each NCA and each phase of works is included as Table 7-3 for residential receivers and Table 7-4 for non-residential sensitive receivers.

Table 7-3 presents the maximum predicted construction noise level for each NCA as well as the number of receivers where predicted noise levels exceed the daytime NML at some point during each phase of works. Note that these are based on the works occurring in the worst case location for each sensitive receiver and the duration of the exceedance will depend upon the duration of the works in front of those receivers.

Table 7-4 presents predicted construction noise levels for key non-residential sensitive receivers against the relevant NMLs for those land uses.

Based on the assumed construction scenarios and predicted construction noise levels shown in both the Tables and noise contour maps in Appendix B, it can be concluded that:

- Most construction activities are likely to comply with the standard hours NMLs in NCAs 2, 6, 7, 8, 9, 12 and 14 given the existing noise levels and distances to works, although some receivers in these NCAs may be noise affected at times during corridor clearing and bulk earthworks.
- Exceedances of the NMLs are predicted at times in NCAs 1, 11 and 13, although these exceedances are less than 10 dB above the daytime NML.
- A larger number of receivers in NCAs 3 and 5 will be exposed to higher, potentially moderately intrusive noise levels during construction, particularly when corridor clearing and bulk earthwork is occurring in relatively close proximity to them.
- A small number of receivers in NCAs 4, 9 and 10 may be highly noise affected during construction, likely to be caused by utilities relocation, corridor clearing and bulk earthworks.

In line with the predictions, mitigation measures for construction noise that will be implemented throughout the works are provided in Chapter 8 of this NVMP. The implementation of these measures will ensure consistency with the environmental performance outcomes identified in the EIS and SPIR.

Standard mitigation measures will be implemented at all times, with increased mitigation measures applied where predicted noise levels exceed the predicted NML by more than 10 dB and with further measures applied where receivers are expected to be highly noise affected. These increased mitigation measures will apply in:

- NCA 3
- NCA 4
- NCA 5
- NCA 9

- NCA 10
- NCA 12.

In addition, noise mitigation measures for highly noise affected residences will be applied as per Chapter 8 of this NVMP for any residence within 40 m of construction works, unless it can be demonstrated through monitoring that construction noise levels are below the highly noise affected level of 75 dB(A). This requirement will apply to NCA 4, NCA 9 and NCA 10 where noise levels in excess of 75 dB(A) have been predicted.

Predicted construction noise levels for other (non-residential) sensitive receivers are provided in Table 7-4. Construction noise levels at these sensitive receivers are generally predicted to comply with the noise management levels, with the exception of Albion Park Rail Public School and exceedances by up to 4 dB of the noise management level at the nearest industrial premises in NCA3 during vegetation clearing, roadwork and bulk earthworks.

Higher construction noise levels, up to 11 dB above the noise management level during clearing and bulk earthworks, are predicted at Albion Park Rail Public School. All reasonable and feasible noise mitigation measures will apply during works in these areas.

7.3.3 General construction during extended construction hours

Table 7-5 presents a summary of predicted noise levels for each NCA and each phase of works, compared against the NMLs for the extended construction hours approved under CoA E36. These are the shoulder periods from day to evening, namely 6 – 7 pm Monday to Friday, and 1 – 5 pm on Saturdays.

The number of exceedances of the NMLs increase during these time periods due to the reduced NMLs. Application of the standard mitigation measures, and the increased mitigation measures for certain NCAs as described above for standard construction hours, will assist in mitigating construction noise impacts during these approved extended working times, and will ensure consistency with the environmental performance outcomes identified in the EIS and SPIR.

Table 7-3 Predicted construction noise levels at residences from standard hours works

NCA	NML, dB(A)	Site establishment		Roadwork and road surfacing		Drainage		Bulk earthwork		Bridgework		Finishing work		Material Processing	
	Day	Maximum PNL, dB $L_{Aeq(15min)}$	No of receivers exceeding NML	Maximum PNL, dB $L_{Aeq(15min)}$	No of receivers exceeding NML	Maximum PNL, dB $L_{Aeq(15min)}$	No of receivers exceeding NML	Maximum PNL, dB $L_{Aeq(15min)}$	No of receivers exceeding NML	Maximum PNL, dB $L_{Aeq(15min)}$	No of receivers exceeding NML	Maximum PNL, dB $L_{Aeq(15min)}$	No of receivers exceeding NML	Maximum PNL, dB $L_{Aeq(15min)}$	No of receivers exceeding NML
NCA1	58	63	26	61	13	60	6	63	26	57	0	56	0	63	26
NCA2	55	53	0	51	0	50	0	53	0	41	0	46	0	53	0
NCA3	55	73	179	71	34	70	96	73	179	55	0	66	15	73	179
NCA4	54	83	2	81	2	80	2	83	2	44	0	76	2	83	2
NCA5	45	67	124	65	105	64	97	67	127	54	33	60	48	67	127
NCA6	62	62	0	59	0	59	0	62	0	48	0	54	0	62	0
NCA7	62	<35	0	<35	0	<35	0	<35	0	<35	0	<35	0	<35	0
NCA8	62	59	0	57	0	56	0	59	0	48	0	52	0	59	0
NCA9	62	81	3	79	3	78	3	81	3	60	0	74	2	81	3
NCA10	57	82	24	80	18	79	17	82	24	51	0	75	13	82	24
NCA11	58	67	4	65	4	64	4	67	4	<35	0	60	3	67	4
NCA12	58	69	1	67	1	66	1	69	1	53	0	62	1	69	1

NCA	NML, dB(A)	Site establishment		Roadwork and road surfacing		Drainage		Bulk earthwork		Bridgework		Finishing work		Material Processing	
NCA13	58	67	7	64	4	64	5	67	7	39	0	59	1	67	7
NCA14	64	68	1	63	0	65	0	68	1	59	0	58	0	68	1
NCA15	64	59	0	57	0	56	0	59	0	<35	0	52	0	59	0
NCA16	64	50	0	47	0	47	0	50	0	<35	0	42	0	50	0

Table 7-4 Predicted construction noise levels at non-residential sensitive uses residences from standard hours works

NCA	Receiver	NML, dB(A)	Site establishment		Roadwork and road surfacing		Drainage		Bulk earthwork		Bridgework		Finishing work		Material Processing	
		Day	Maximum PNL, dB $L_{Aeq(15min)}$	No of receivers exceeding NML	Maximum PNL, dB $L_{Aeq(15min)}$	No of receivers exceeding NML	Maximum PNL, dB $L_{Aeq(15min)}$	No of receivers exceeding NML	Maximum PNL, dB $L_{Aeq(15min)}$	No of receivers exceeding NML	Maximum PNL, dB $L_{Aeq(15min)}$	No of receivers exceeding NML	Maximum PNL, dB $L_{Aeq(15min)}$	No of receivers exceeding NML	Maximum PNL, dB $L_{Aeq(15min)}$	No of receivers exceeding NML
NCA1	Echidna Children's Centre	55	50	0	47	0	47	0	50	0	43	0	42	0	50	0
NCA3	Commercial / Industrial	70	74	7	72	5	71	4	73	7	50	0	66	0	73	7
NCA9	World of Learning Child Care	55	55	0	53	0	53	0	55	0	45	0	48	0	55	0
NCA10	Albion Public School	55	65	7	63	7	62	5	66	7	< 35	0	59	2	66	7
NCA12	Commercial / Industrial	70	68	0	66	0	65	0	68	0	< 35	0	61	0	68	0
N/A	Croom Regional Sporting Complex	65	77	1	75	1	74	1	77	1	45	0	70	1	77	1

Table 7-5 Predicted construction noise levels at residences from shoulder works (Day – Evening)

NCA	NML, dB $L_{Aeq(15min)}$	Site establishment		Roadwork and road surfacing		Drainage		Bulk earthwork		Bridgework		Finishing work		Material Processing	
	Shoulder, Day – Evening	Maximum PNL, dB $L_{Aeq(15min)}$	No of receivers exceeding NML	Maximum PNL, dB $L_{Aeq(15min)}$	No of receivers exceeding NML	Maximum PNL, dB $L_{Aeq(15min)}$	No of receivers exceeding NML	Maximum PNL, dB $L_{Aeq(15min)}$	No of receivers exceeding NML	Maximum PNL, dB $L_{Aeq(15min)}$	No of receivers exceeding NML	Maximum PNL, dB $L_{Aeq(15min)}$	No of receivers exceeding NML	Maximum PNL, dB $L_{Aeq(15min)}$	No of receivers exceeding NML
NCA1	52	63	97	61	68	60	61	63	97	57	19	56	15	63	97
NCA2	50	53	1	51	1	50	0	53	1	41	0	46	0	53	1
NCA3	50	73	373	71	96	70	242	73	373	55	9	66	34	73	373
NCA4	49	83	2	81	2	80	2	83	2	44	0	76	2	83	2
NCA5	40	67	158	65	161	64	149	67	169	54	77	60	105	67	169
NCA6	57	62	1	59	1	59	1	62	1	48	0	54	0	62	1
NCA7	57	<35	0	<35	0	<35	0	<35	0	<35	0	-2	0	<35	0
NCA8	57	59	1	57	0	56	0	59	1	48	0	52	0	59	1
NCA9	57	81	8	79	5	78	4	81	8	60	1	74	3	81	8
NCA10	52	82	40	80	33	79	29	82	40	51	0	75	18	82	40
NCA11	53	67	4	65	4	64	4	67	4	<35	0	60	4	67	4
NCA12	53	69	2	67	1	66	1	69	2	53	0	62	1	69	2

NCA	NML, dB $L_{Aeq(15min)}$	Site establishment		Roadwork and road surfacing		Drainage		Bulk earthwork		Bridgework		Finishing work		Material Processing	
NCA13	53	67	13	64	8	64	9	67	14	39	0	59	4	67	14
NCA14	58	68	1	63	1	65	1	68	1	59	1	58	0	68	1
NCA15	58	59	3	57	0	56	0	59	3	<35	0	52	0	59	3
NCA16	58	50	0	47	0	47	0	50	0	<35	0	42	0	50	0

7.3.4 Out of Hours Work

At times during the Project, OOHW will be required due to restrictions around works near major roads, intersections and rail lines during standard hours. At this stage, it is anticipated that the OOHW listed in Table 7-6 will be required during the Project works. Expected sound power levels for each OOHW activity are also listed.

Table 7-6: Anticipated OOHW

Description of OOHW	Locations	Typical plant and equipment required, and overall SWL
Installation and removal of main site office buildings	Ancillary Site AS06	• Truck • Crane • Generator Overall SWL: 112 dB L_{Aeq}
Temporary barrier installation / adjustment / removal	Princes Highway, CH14900 – 17500 Yallah Road Illawarra Highway Tongarra Road Croome Road East West Link Road Princes Highway – Oak Flats I/C Woolybutt Dr – Princes Highway I/C	• Trucks • Franna crane • Scissor lift Overall SWL: 110 dB L_{Aeq}
Earthworks and embankment construction	Oak Flats Interchange ramp works	• Excavator • Truck • Vibratory roller • Dump truck • Grader Overall SWL: 115 dB L_{Aeq}
Service Relocations	Yallah Road Tongarra Road Illawarra Road Croome Road	• Excavator • Dump truck • Concrete saw • Backhoe • Generator Overall SWL: 116 dB L_{Aeq}
Pavement construction and asphalting	Princes Highway, CH14900 – 17500 Yallah Road Illawarra Highway Tongarra Road Croome Road	• Paver • Dump truck • Vibratory rollers • Concrete truck • Trucks

Description of OOHW	Locations	Typical plant and equipment required, and overall SWL
	East West Link Road Princes Highway – Oak Flats I/C Woolybutt Dr – Princes Highway I/C	• Generator Overall SWL: 114 dB L_{Aeq}
Profiling of existing pavements		• Profiler • Dump truck • Truck • Front end loader Overall SWL: 116 dB L_{Aeq}
Asphalt line-marking		• Truck • Line marking truck Overall SWL: 110 dB L_{Aeq}
Drainage works	Princes Motorway CH14900 – 17500 Princes Motorway CH25600 – 17500 Oak Flats Interchange ramp works	• Truck • Bulldozer • Excavator • Backhoe Overall SWL: 115 dB L_{Aeq}
Traffic switch works	Site wide	• Trucks • Franna crane • Scissor lift Overall SWL: 110 dB L_{Aeq}
Bridge pre-cast girder delivery and dressing	All bridge locations	• Truck • Crane • Generator Overall SWL: 112 dB L_{Aeq}
Bridge pre-cast girder and parapet installation	CH 17400 South Coast Railway CH 21500 Tongarra Road CH 23100 Croome Road	• Truck • Crane • Welding equipment • Generator Overall SWL: 113 dB L_{Aeq}

At this stage, the precise nature of each of the proposed OOHW has not been confirmed. However, as a screening assessment, Table 7-7 summarises predicted noise levels for the various

NCAs, compared against the NMLs for OOHW during different periods of time and for each of the areas in which OOHW are currently being considered.

It should be noted that this assessment is preliminary in nature as it assumes that relatively noisy elements of the works would be undertaken out of hours, which would be avoided where possible.

It demonstrates that noise-sensitive receivers in most NCAs may be exposed to construction noise levels above the relevant OOHW NMLs at times. Works in some NCAs, in particular 12, 13 and 14, are expected to have relatively minor impacts on noise-sensitive receivers. However, OOHW near NCA5 may impact a larger number of uses.

Typically, exceedances of the OOHW NMLs could be a concern for any works within 500 m of sensitive receivers, although this distance would be decreased for those NCAs with higher OOHW NMLs, in particular NCAs 14, 15 and 16.

To manage potential construction noise impacts of any OOHW, the works will be assessed in accordance with the Approval Procedure in Appendix C of this NVMP. Specific OOHW mitigation measures will be applied in accordance with Chapter 8 of this NVMP.

It is noted that CoA E38 (d) imposes an additional noise management level, stating that the short-term $L_{Aeq(1min)}$ noise level should not exceed the NML by more than 15 dB. In the context of the preliminary assessment below, this is not a relevant concern as Appendix A shows that the maximum noise levels from typical works are not expected to exceed the $L_{Aeq(15min)}$ level by more than approximately 5 – 10 dB. However, this may require consideration for works with high level but short-term noise events if these are proposed out of hours and has been included in the OOHW Approval Procedure in Appendix C of this NVMP.

Table 7-7 Predicted construction noise levels at residences from potential OOHW

Area	Works	Receivers	NML, dB $L_{Aeq(15min)}$				Maximum PNL	Number of receivers with PNL exceeding NML			
			Shoulder N–D	Day	Evening	Night	dB $L_{Aeq(15min)}$	Shoulder N–D	Day	Evening	Night
Princes Highway CH14900-17500	Temporary barriers	NCA 14	59	59	58	57	61	1	1	1	1
	Pavement construction		59	59	58	57	65	2	2	2	2
	Pavement profiling		59	59	58	57	67	2	2	2	2
	Line-marking		59	59	58	57	61	1	1	1	1
	Drainage works		59	59	58	57	66	2	2	2	2
Yallah Road	Temporary barriers	NCA 12 & 13	53	53	51	51	47	0	0	0	0
	Service relocations		53	53	51	51	53	0	0	1	1
	Pavement construction		53	53	51	51	51	0	0	0	0
	Pavement profiling		53	53	51	51	53	0	0	1	1
	Line-marking		53	53	51	51	47	0	0	0	0
Illawarra Highway	Temporary barriers	NCA10	52	52	48	44	74	26	26	41	64
	Service relocations		52	52	48	44	80	50	50	77	135
	Pavement construction		52	52	48	44	78	41	41	64	96

Area	Works	Receivers	NML, dB $L_{Aeq(15min)}$				Maximum PNL	Number of receivers with PNL exceeding NML			
	Pavement profiling		52	52	48	44	80	50	50	77	135
	Line-marking		52	52	48	44	74	26	26	41	64
Tongarra Road	Temporary barriers	NCA5	39	40	38	35	56	69	61	78	103
	Service relocations		39	40	38	35	62	122	118	126	142
	Pavement construction		39	40	38	35	60	103	89	118	131
	Pavement profiling		39	40	38	35	62	122	118	126	142
	Line-marking		39	40	38	35	56	69	61	78	103
	Temporary barriers	NCA8	54	57	53	44	51	0	0	0	4
	Service relocations		54	57	53	44	57	2	0	2	6
	Pavement construction		54	57	53	44	55	1	0	1	6
	Pavement profiling		54	57	53	44	57	2	0	2	6
	Line-marking		54	57	53	44	51	0	0	0	4
Croome Road	Temporary barriers	NCA3	50	50	52	52	75	29	29	18	18
	Service relocations		50	50	52	52	81	56	56	44	44
	Pavement construction		50	50	52	52	79	44	44	35	35
	Pavement profiling		50	50	52	52	81	56	56	44	44
	Line-marking		50	50	52	52	75	29	29	18	18

Area	Works	Receivers	NML, dB $L_{Aeq(15min)}$				Maximum PNL	Number of receivers with PNL exceeding NML			
East West Link Road	Temporary barriers	NCA3	50	50	52	52	48	0	0	0	0
	Pavement construction		50	50	52	52	52	6	6	0	0
	Pavement profiling		50	50	52	52	54	29	29	6	6
	Line-marking		50	50	52	52	48	0	0	0	0
Oak Flats Interchange & Woolybutt Drive	Temporary barriers	NCA1	53	53	51	49	55	6	6	15	37
	Earthworks + embankments		53	53	51	49	60	51	51	69	93
	Pavement construction		53	53	51	49	59	37	37	60	77
	Pavement profiling		53	53	51	49	61	60	60	77	102
	Line-marking		53	53	51	49	55	6	6	15	37
	Drainage works		53	53	51	49	60	51	51	69	93
Bridge sites	Girder delivery and dressing	Various	–	–	–	–	59	53	44	71	110
	Girder + parapet installation	Various	–	–	–	–	60	68	54	79	128
Site wide	Traffic switch	Various	–	–	–	–	57	211	202	238	329

7.3.5 Sleep disturbance

Sleep disturbance is a relevant consideration for OOHW that occurs at night time near residential receivers. In accordance with the ICNG, sleep disturbance should be assessed for any works which occur for two consecutive nights or more near a sensitive receiver (e.g. residence).

The most likely source of potential sleep disturbance from the night construction works will be from the use of saw cutting during services relocation and/or road pavement works or from truck movement on site, in particular the application of air brakes during other out of hours activities. Indicative maximum noise levels were predicted in the EIS to the nearest affected residential receivers to allow a review of the potential for sleep disturbance from OOHW. The results are summarised in Table 7-8.

Table 7-8 Preliminary sleep disturbance assessment for night works (EIS Table 12-21)

NCA	Sleep noise management level dB $L_{A1(1min)}$	Predicted L_{Amax} noise levels at worst affected receivers	
		Services / road pavement	Finishing / compounds
NCA1	59	51-58	48-55
NCA2	62	56	53
NCA3	62	48-66	45-63
NCA4	45	79	76
NCA5	45	44-60	41-57
NCA6	54	45-53	42-50
NCA7	54	38-43	35-40
NCA8	54	51-56	48-53
NCA9	54	56-63	53-60
NCA10	54	37-72	34-69
NCA11	61	45-70	42-67
NCA12	61	45-56	42-53
NCA13	61	49-75	46-72
NCA14	67	65	62
NCA15	67	< 60	< 60
NCA16	67	< 60	< 60

The predictions indicate that sleep disturbance is a potential concern for noisy works in some NCAs, mainly NCA3, NCA4, NCA5, NCA8, NCA9, NCA10, NCA11 and NCA13. Sleep disturbance will be assessed in accordance with the OOHW Approval Procedure in Appendix C. Specific noise mitigation measures to be implemented where sleep disturbance is a risk are outlined in Chapter 8.

7.3.6 Construction related road traffic noise

Construction-related traffic movements, including haulage routes and the expected number of truck movements, were discussed in Section 5.20.10 of the EIS. Light vehicle movements associated with construction were not considered to be substantial and have not been included in this traffic assessment.

Fulton Hogan expects that construction-related traffic will involve approximately 150 – 200 heavy vehicles per day on the following roads:

- East West Link
- Tongarra Road
- Illawarra Highway.

For the purpose of this assessment, it has been assumed that all movements occur during standard construction hours. Where construction activities are required outside recommended standard hours, this will be assessed as required as part of an OOHW assessment submitted in accordance with the procedure in Appendix C.

To determine the increase in traffic noise as a result of 200 additional heavy vehicle movements, traffic data from the concurrent traffic counts conducted in February 2015 (Appendix C of the EIS Noise and Vibration Assessment) were used in the relevant locations and then adjusted for the increase of construction traffic. Table 7-9 presents the predicted increase in road traffic noise from additional construction traffic. Note that the Princes Motorway and Princes Highway have also been included to provide information on these major access routes.

Table 7-9 Predicted impact of Fulton Hogan construction traffic on existing traffic noise levels

Road	Without construction traffic		With construction traffic		Change in $L_{Aeq(15\ hour)}$ traffic noise level dB
	Total	HV%	Total	HV %	
Princes Motorway	46773	7.4	46973	7.8	<1
Princes Highway	54623	6.1	54823	6.5	<1
Illawarra Highway	13669	4.4	13869	5.8	<1
Tongarra Road	11583	4.0	11783	5.6	<1
Princes Highway	42062	10.9	42262	11.4	<1
East-West Link	12741	3.2	12941	4.7	<1
Princes Motorway	31593	7.2	31793	7.8	<1

From Table 7-9, it is apparent that the noise impact of construction-related traffic is expected to be relatively minor in nature. To minimise the impact of construction-related traffic noise:

- Construction traffic will access the site compounds via defined routes on major arterial roads.
- Site access routes will be planned to avoid residential streets where reasonable and feasible.

It is expected that construction traffic will need to use local roads from time-to-time but this will be limited wherever possible and off road haulage will be prioritised. Where local roads are used, the number of movements would be significantly smaller than assumed above such that construction-related road traffic noise increases of greater than 2 dB above the existing road traffic noise level

are not expected when assessed across a daytime period. Noise impacts from any occasional movements on local roads will be managed in accordance with Chapter 8 of this NVMP.

7.3.7 Ancillary site operation (including access)

The Project will require a main site compound, and a number of ancillary facilities and stockpile sites. These compound and ancillary facilities will accommodate a range of activities, plant and equipment including, but not limited to:

- Office accommodation
- Staff amenities
- Light vehicle parking and access
- A plant and equipment maintenance workshop
- Material and chemical storage
- Equipment storage
- Material storage.

The ancillary facility sites shown in the EIS are shown on the noise contour maps in Appendix B of this NVMP. At this stage it is not confirmed which sites will be used and for what purpose and, therefore, an assessment has been undertaken on the basis of the activities listed in Table 7-1 occurring at each site.

The Ancillary Facilities Management Plan required under CoA A17 provides an assessment of all ancillary facilities on the Project.

Table 7-10 provides the predicted noise levels for ancillary sites within different NCAs, as well as the number of residences where the predicted noise levels exceed the NMLs for different periods of day. It can be seen that the majority of affected sensitive receivers by potential operations at ancillary facilities are located in NCA 5, partly due to the location of the sites and partly due to the lower background noise levels in this area. Small numbers of residential land uses are also predicted to be exposed to compound noise levels above the NMLs in other NCAs but typically no more than ten residences per NCA.

Generally:

- During standard work hours, including the shoulder period, predicted noise levels from ancillary sites are generally less than 10 dB above the NML with the exception of residences in NCA 5.
- Any OOHW at ancillary sites in NCA 3, 4, 5, 9, 10, 11, 15 and 16 have the potential to produce noise levels in excess of the OOHW NMLs at residential land uses. Any such works will be assessed in accordance with the OOHW Procedure in Appendix C.

All reasonable and feasible mitigation measures will be implemented for the ancillary sites in accordance with the procedures detailed in Chapter 8. This will include the use of site access routes for the ancillary sites that use major roads and avoid residential streets.

Vibration impacts from the operation of compound and ancillary facilities are not anticipated given the distance of the sites to sensitive land uses and the typical activities that will occur at each site.

Table 7-10 Predicted construction noise levels from ancillary sites at residences during different time periods

NCA	Daytime during standard hours			Shoulder (D-E) during standard hours			OOHW Shoulder (N-D)			OOHW Day			OOHW Evening			OOHW Night		
	NML, dB(A)	Maximum PNL, dB(A)	No of receivers exceeding NML	NML, dB(A)	Maximum PNL, dB(A)	No of receivers exceeding NML	NML, dB(A)	Maximum PNL, dB(A)	No of receivers exceeding NML	NML, dB(A)	Maximum PNL, dB(A)	No of receivers exceeding NML	NML, dB(A)	Maximum PNL, dB(A)	No of receivers exceeding NML	NML, dB(A)	Maximum PNL, dB(A)	No of receivers exceeding NML
NCA1	58	<35	0	52	<35	0	53	<35	0	53	<35	0	51	<35	0	49	<35	0
NCA2	55	<35	0	50	<35	0	50	<35	0	50	<35	0	52	<35	0	52	<35	0
NCA3	55	53	0	50	53	10	50	53	10	50	53	10	52	53	2	52	53	2
NCA4	54	61	2	49	61	2	44	61	2	49	61	2	42	61	2	35	61	2
NCA5	45	57	281	40	57	380	39	57	393	40	57	380	38	57	404	35	57	412
NCA6	62	44	0	57	44	0	54	44	0	57	44	0	53	44	0	44	44	0
NCA7	62	<35	0	57	<35	0	54	<35	0	57	<35	0	53	<35	0	44	<35	0
NCA8	62	42	0	57	42	0	54	42	0	57	42	0	53	42	0	44	42	0
NCA9	62	69	1	57	69	1	54	69	1	57	69	1	53	69	1	44	69	6
NCA10	57	54	0	52	54	1	52	54	1	52	54	1	48	54	1	44	54	2
NCA11	58	62	2	53	62	3	53	62	3	53	62	3	51	62	3	51	62	3
NCA12	58	49	0	53	49	0	53	49	0	53	49	0	51	49	0	51	49	0

NCA	Daytime during standard hours			Shoulder (D-E) during standard hours			OOHW Shoulder (N-D)			OOHW Day			OOHW Evening			OOHW Night		
NCA13	58	52	0	53	52	0	53	52	0	53	52	0	51	52	1	51	52	1
NCA14	64	54	0	58	54	0	59	54	0	59	54	0	58	54	0	57	54	0
NCA15	64	63	0	58	63	18	59	63	13	59	63	13	58	63	18	57	63	21
NCA16	64	63	0	58	63	2	59	63	2	59	63	2	58	63	2	57	63	3

7.4 Early mitigation measures as per Condition E47

Condition E47 of the CoA for the Project identifies a requirement for operational noise mitigation measures to be implemented early for residences that may be impacted by construction noise. CoA E47 also requires the early implementation measures to be detailed in the NVMP and justification for the measures to be implemented early to be provided in a report to the Secretary of DPIE.

This NVMP fulfils the requirement for the report to the Secretary, with justification for the approach to CoA E47 provided below.

7.4.1 Summary of operational noise mitigation measures

The operational noise mitigation measures referred to in CoA E47 primarily refer to at-property architectural treatments, which are proposed for up to 183 properties, including 172 residences.

Additional operational noise mitigation measures proposed for the project include the noise mound to the north of East-West Link, a noise barrier to the west of the elevated road near Albion Park and a low noise road surface. As these measures will be affected by construction works and are restricted as to when they can be installed by the overall construction program, they are not considered relevant to CoA E47.

For example, the noise mound requires significant excavation works to occur prior to it being constructed, and the barrier on the elevated road requires the bridge structure to be in place. It is also noted that the low noise road surface and low height noise barrier on the elevated road would not be expected to provide any noticeable benefit to construction noise levels at residences. Therefore, the primary form of early treatment will be the provision of at-property treatments.

7.4.2 Early implementation of operational noise mitigation measures

The intention of CoA E47 is to ensure that the operational noise mitigation measures not affected by construction works also provide control of construction noise.

It is intended to provide all at-property treatments as early in the construction process as possible. However, it is noted that it may not be reasonable and feasible to implement at-property treatments to all 183 properties within six months of construction commencing, as the at-property treatments will require approval from each individual property owner, which may cause delays outside of Fulton Hogan control.

Therefore, the following approach will be undertaken to address Condition E47 most effectively by prioritising treatments for those residences expected to be most impacted by construction noise as part of the Project works:

- To address those properties most potentially affected by construction noise, early treatment will be provided to any residence where at-property treatment is proposed for operational road traffic noise and where the predicted typical worst-case construction noise level exceeds the daytime NML by more than 10 dB for any construction phase. Therefore, CoA E47 will be addressed through the provision of early at-property treatments at the 26 residential properties listed in Table 7-11.
- These priority early treatments will be provided within six months of construction works commencing within 150 – 200 m of the nominated residence (or as per CoA E47 at other times during construction). At these distances, predicted construction noise levels remain below the standard hours NML and therefore the treatments would be installed no later than six months after the commencement of works with the potential to create noise levels above the NML for the residence.
- Other at-property treatments (at the remaining 157 properties) will be installed as early as is practical in the construction process, noting that consultation with the property owners needs to occur and property treatment agreements need to be in place. Where possible, this will also be carried out within six months of commencing construction near the residence.

- The East-West Link noise mound will be installed as early as practical in the construction process.
- Works will proceed with the application of all reasonable and feasible temporary mitigation and management measures as per Chapter 8 of this NVMP to minimise impacts as much as is feasible both prior to and following the at-property treatments.

Table 7-11 identifies those residences where the highest NML exceedances are predicted and where early at-property treatment will be provided where reasonable and feasible and an indication of the timing for the treatment. The locations of the properties are also shown on the Project Map in Appendix E of this NVMP.

Table 7-11 Residences where early at-property treatment required

NCA	Properties nominated for at-property treatment where construction noise PNL exceeds daytime NML by more than 10 dB	Timing
NCA1	None	n/a
NCA2	None	n/a
NCA3	3_0204, 3_0205, 3_0224, 3_0235	Within 6 months of works commencing within 150 m of the residence.
NCA4	4_0001, 4_0002	
NCA5	5_0011, 5_0014, 5_0017, 5_0018, 5_0019, 5_0020, 5_0021, 5_0022, 5_0030, 5_0031, 5_0032, 5_0033, 5_0034, 5_0035, 5_0038, 5_0039	Within 6 months of works commencing within 200 m of the residence.
	5_0223	Within 6 months of activities at an ancillary site within 200 m of residence.
NCA6	None	n/a
NCA7	None	n/a
NCA8	None	n/a
NCA9	9_0014	Within 6 months of works commencing within 100 m of the residence.
NCA10	10_0001	
NCA11	None	n/a
NCA12	12_0246	Within 6 months of works commencing within 100 m of the residence.
NCA13	None	n/a
NCA14	None	n/a

7.5 Construction vibration and blasting impacts

7.5.1 CNVG vibration management approach

The Roads and Maritime CNVG provides additional context to the management of construction vibration as shown in Table 7-12, with additional mitigation measures to be applied where the predicted or measured vibration level exceeds the “Maximum” level for human comfort.

Table 7-12 CNVG vibration management approach

Predicted vibration level at sensitive land use	Additional mitigation measures to be applied to affected sensitive receivers (refer Chapter 8 for detail)
STANDARD WORKING HOURS: Mon – Fri 7 am – 7 pm, Sat 8 am – 5 pm	
Exceeds “Maximum” human comfort criteria from Assessing Vibration: A Technical Guideline	• Validation of predicted vibration levels • Notification drops • Respite period
OOHW PERIOD 1: Mon – Fri 7 pm – 10 pm, Sat 7 am – 8 am & 5 pm – 10 pm, Sun/Pub Hol, 7 am – 6 pm	
Exceeds “Maximum” human comfort criteria from Assessing Vibration: A Technical Guideline	• Validation of predicted vibration levels • Individual briefings • Notification drops • Project-specific respite offer • Phone calls • Respite period • Specific notifications
OOHW PERIOD 2: Mon – Sat 10 pm – 7 am, Sun/Pub Hol, 6 pm – 7 am	
Exceeds “Maximum” human comfort criteria from Assessing Vibration: A Technical Guideline	• Consideration of alternative accommodation options • Validation of predicted vibration levels • Individual briefings • Notification drops • Phone calls • Respite period • Specific notifications

Further details on the project-specific application of construction vibration mitigation measures are provided in Chapter 8 of this NVMP.

7.5.2 Vibration assessment

The propagation of vibration emitted from a source is site-specific with the level of vibration potentially experienced at a receiver dependent on the vibration energy generated by the source, the main frequencies of vibration, the localised geotechnical conditions and the interaction of structures and features which can dampen vibration. The recommended safe working distances for

construction plant provided in Table 7-13 are referenced from the CNVG and from in-house measurement data from Resonate.

Table 7-13 Vibration safe working distances

Plant item	Rating / Description	Safe working distance, m					
		Cosmetic damage			Human response		
		Heritage structure	Residential structure	Commercial / industrial	Residence – night	Residence – day	Educational
Vibratory roller	<50 kN (typically 1-2t)	7	5	2	25	15	10
	<50 kN (typically 2-4t)	9	6	2	35	20	13
	<50 kN (typically 4-6t)	18	12	5	65	40	25
	<50 kN (typically 7-13t)	22	15	6	140	100	65
	<50 kN (typically 13-18t)	28	20	8	150	100	70
	<50 kN (typically >18t)	35	25	10	150	100	75
Handheld compactor	Up to 300 kg	7	5	2	30	20	12
Small hydraulic hammer	300 kg – 18-34t excavator	3	2	–	10	7	5
Medium hydraulic hammer	1600 kg – 5-12t excavator	12	7	3	35	23	15
Large hydraulic hammer	1600 kg – 12-18t excavator	30	22	9	100	73	45
Bored piling	< 800 mm	3	2	–	7	4	2
Excavation works	12-18t excavator	3	2	–	15	10	7
Jackhammer	Handheld	2	1	–	5	–*	–*

Notes:

** Avoid contact with structure*

The safe working distances are generally conservative, developed with reference to the more stringent objectives for continuous vibration for typical residential building constructions and the lowest applicable criterion for potential cosmetic building damage. It follows that work within the safe working distance does not necessarily mean that an impact will occur, but rather that further consideration may be required.

Based on the vibration data presented above, vibration generated by construction plant was estimated and potential vibration impacts are summarised in Table 7-14. The assessment is relevant to residential and commercial use buildings, and other similar type structures in the project area. The risk of human disturbance is described with respect to the potential for an adverse comment from an affected receiver.

Table 7-14 Potential vibration impacts (based on EIS Table 12-24)

Noise catchment area	Approx. distance of nearest buildings from the works	Type of building	Assessment of risk of vibration impact		
			Structural damage risk	Risk of human disturbance	Vibration monitoring
NCA1	100-130 m	Residential	Negligible	Very low	Not required
NCA2	120 m	Residential	Negligible	Very low	Not required
NCA3	40-130	Residential	Negligible	Low risk	Not required
	60 m (Park Rail Cemetery)	Heritage	Negligible	Very low	Not required
NCA4	20 m	Residential	Very low	Medium	May be required
	10-20 m (Swansea Farmhouse / Dairy)	Heritage	Medium	Medium	Required
NCA5	120-200 m	Residential	Negligible	Very low	Not required
NCA6	100 m	Residential	Negligible	Very low	Not required
NCA7	600 m	Residential	Negligible	Negligible	Not required
NCA8	130 m	Residential	Negligible	Very low	Not required
	175 m (Ravensthorpe grounds)	Heritage	Negligible	Negligible	Not required
NCA9	6-10 m	Commercial	Medium	High risk	Required
	80-100 m	Residential	Negligible	Low risk	Not required
NCA10	10-12 m	Residential	Low risk	High risk	May be required
NCA11	40-60 m	Residential	Negligible	Low risk	Not required
	70-400 m (Illawarra Regional Airport)	Heritage	Very low	Low risk	Not required
NCA12	10 m	Industrial	Negligible	Low risk	Not required
	200 m	Residential	Very low	High risk	May be required
NCA13	30-40 m	Residential	Very low	Medium	May be required
NCA14	25-60 m	Residential	Very low	Medium	May be required

Noise catchment area	Approx. distance of	Type of building	Assessment of risk of vibration impact		
	80 m (House, Princes Hwy, Yallah)	Heritage	Very low	Low risk	Not required
NCA15	20-50 m	Residential	Low risk	High risk	May be required
NCA16	25-40 m	Residential	Low risk	High risk	May be required

Generally, there is low risk of damage to building structures from construction vibration, although care will be required where works are occurring in close proximity to the heritage-listed Swansea Farmhouse and Dairy in NCA4 and if heavy compaction works are required in very close proximity to commercial structures in NCA9.

There is the potential for human disturbance from vibration where works are occurring within 50 m of residential and other sensitive land uses but, for those NCAs where residences are located further than this from the works, the risk of vibration disturbance to building occupants is considered low to negligible.

Vibration management procedures are discussed further in Chapter 8, with monitoring procedures discussed further in Chapter 8.

7.5.3 Blasting assessment

Blasting may be required to excavate the lower benches of the cut at the eastern extent of East-West Link.

Overpressure and ground vibration are the two main impacts to take into consideration from blasting. Overpressure and ground vibration both have the potential to cause discomfort or annoyance to sensitive receivers near to the blast area. At high levels, overpressure and ground vibration have the potential to cause cosmetic or structural damage.

A separate Blast Management Strategy has been prepared for this NVMP and is attached as Appendix D.

7.5.4 Potential impact on equestrian activities

The noise associated with the construction works, including that associated with ancillary sites, construction traffic and construction activities, has potential to impact on users of the Croom Regional Sporting Complex. In particular, construction noise has the potential to adversely impact horses and their riders. The extent to which any individual horse will be impacted by noise during construction is dependent on the degree to which it is habituated to noise, and is not possible to predict.

The main way in which this impact would be managed is via consultation with the equestrian groups using the Croom Regional Sporting Complex, to advise them of upcoming construction activities in proximity to the Complex. These groups would be included in the consultation with affected residents during the construction period.

8 Environmental mitigation measures

Specific mitigation measures to address impacts from construction noise and vibration are outlined in Table 8-1 for Standard Hours work and in Table 8-2 for any OOHW. The application of these mitigation measures will ensure that construction noise and vibration impacts from the Project are managed in accordance with the outcomes specified in the EIS and SPIR.

The mitigation measures are provided in various stages, depending on the predicted noise levels relative to the NMLs or vibration management levels, in general accordance with the CNVG. The standard feasible and reasonable mitigation measures will be implemented at all times on site, with additional mitigation measures applied depending on the predicted exceedance of the relevant NMLs and the times of the works.

Noise mitigation measures for OOHW are also provided, which are applied in accordance with the OOHW Approval Procedure in Appendix C.

The vibration mitigation measures are to be implemented where works are occurring within the safe working distances from residences for human response identified in Section 7.5.2 and in accordance with the CNVG.

8.1 Feasibility and reasonableness

Mitigation measures are applied where feasible and reasonable. This requires judgment in accordance with the definitions in the CNVG.

It also requires consideration of any requirements of the CoA. For example, OOHW may require compliance with noise criteria established in the CoA and EPL regardless of feasibility and reasonableness.

Feasibility relates to engineering considerations (what can be practically built). These engineering considerations may include:

- The inherent limitations of different techniques to reduce noise emissions from construction works;
- Safety issues such as restrictions on road vision;
- Worksite constraints such as space limitations;
- Floodway and stormwater flow obstruction;
- Access requirements; and/or
- Maintenance requirements.

The CNVG advises that selecting reasonable measures from those that are feasible involves judging whether the overall noise benefits provide significant social, economic or environmental benefits. The factors to be considered are:

- The noise reduction provided and the overall number of people that benefit from the mitigation;
- The duration of the construction noise impact on the sensitive land uses;
- Existing noise levels at the residence in the absence of construction works;
- The cost of mitigation, including the cost of noise mitigation measures as a percentage of the total project cost and the ongoing maintenance and operational costs;
- The impact a mitigation measure may have on the duration of the construction works, noting that a higher noise level for a shorter duration may be preferable;
- The impact a mitigation measure may have on the wider community, e.g. by extending traffic management controls on a major road; and
- Community views and preferences regarding the above (typically gathered during community consultation processes).

8.2 Mitigation measures for Standard Working Hours

Specific mitigation measures to address construction noise and vibration impacts during Standard Working Hours are outlined in Table 8-1.

Table 8-1 Standard hours noise and vibration mitigation measures

ID	Mitigation Measure	Responsibility
NOISE: Standard Working Hours and Extended Working Hours measures applied at all times		
NVMM1	Undertake works during Standard Hours or Approved Extended Working Hours. Where works must occur outside of these hours, assess Out of Hours works in accordance with the Out of Hours Work Approval Procedure provided in Appendix C, and ensuring compliance with Condition E38.	Construction Manager
NVMM2	Maintain communication with third parties providing utility works to ensure that cumulative noise and vibration impacts on sensitive land uses are assessed and considered in accordance with this NVMP prior to works commencing.	Construction Manager
NVMM3	Prioritise noisier works to occur during Standard Hours rather than Out of Hours Work, including deliveries.	Construction Manager
NVMM4	Operate the hotline and complaints management system as detailed in the CCS.	Community Relations Manager
NVMM5	Include noise and vibration management practice information in site induction training for staff and contractors. A one-page summary will be provided regarding noise and vibration management practices during all inductions	Construction Manager, Foreman
NVMM6	Ensure all mobile construction equipment on site for longer than two months have non-tonal reversing alarms.	Foreman, Operators
NVMM7	Plan and conduct works in a manner to minimise the reversing of vehicles with audible reversing alarms.	Construction Manager, Foreman
NVMM8	Trucks will travel via internal haul roads and major roads where practicable to minimise use of local roads.	Foreman
NVMM9	Site compounds, access points and roads will be positioned as far as practicable away from residential receivers. Equipment within site compounds will be oriented as positioned as far as possible from sensitive receivers, to take advantage of natural shielding and shielding provided by buildings. Enclose stationary noisy sources at compounds where practicable.	Foreman
NVMM10	Ensure that truck tailgates are cleared and locked at the point of unloading.	Foreman, Operators
NVMM11	Use two way radios at the minimum effective volume. Avoid slamming of doors, shouting and whistling. Reinforce behavioural practices such as no swearing and no unnecessary shouting.	Foreman, Operators

ID	Mitigation Measure	Responsibility
NVMM12	Utilise quieter work methods and equipment, including the use of mufflers and silencers, or hydraulic and electric-controlled units where practicable.	Construction Manager
NVMM13	Noise levels generated by plant and equipment will be considered in rental decisions, with noise levels to be compliant with Appendix B and Table 2 of the CNVG.	Construction Manager
NVMM14	Vehicle warning devices, such as horns, are not to be used as signaling devices.	Foreman, Operators
NVMM15	Undertake regular maintenance of plant and equipment, including silencers, to ensure that noise emissions do not increase over time. Servicing, refueling and warm-up to be undertaken during standard construction hours.	Foreman, Operators
NVMM16	Throttle down equipment where practicable and turn vehicles and machinery off when not in use.	Foreman, Operators
NVMM17	Only necessary equipment, of an appropriate size and power, will be on site.	Construction Manager
NVMM18	The use of engine compression brakes near residential areas will be limited.	Foreman, Operators
NVMM19	Orient plant and equipment known to emit noise strongly in one direction so that noise is directed away from noise sensitive areas.	Foreman, Operators
NVMM20	Maximise the offset distance between noisy items of plant and sensitive receivers for each task and activity.	Foreman, Operators
NVMM21	Where possible, the occurrence of consecutive works within the same locality, and coincidence of noisy plant/equipment working close together (and adjacent to sensitive receivers) will be avoided or otherwise minimised.	Construction Manager, Foreman
NVMM22	Locate plant and equipment to take advantage of barriers provided by existing site features and structures.	Foreman, Operators
NVMM23	Use traffic controllers to minimise occurrences of vehicles queuing, idling or reversing near noise sensitive receivers as much as is practical.	Construction Manager, Foreman
NVMM24	Avoid metal-to-metal contact on equipment where feasible.	Foreman, Operators
NVMM25	Avoid dropping material from a height into unlined metal trays (line trays with soil or similar to reduce noise).	Foreman, Operators
NVMM26	Undertake high noise impact activities (including activities with impulsive or tonal noise emissions) only: • Between hours of 8 am to 6 pm Mondays to Fridays; • Between hours of 8 am to 1 pm Saturdays; and • In continuous blocks not exceeding three hours each with a minimum respite from those activities and works of not less than one hour between each block.	Construction Manager, Foreman

ID	Mitigation Measure	Responsibility
NVMM27	Early Treatment: Subject to agreement from landowners, provide early at-property treatments to residences nominated to receive at-property treatments for operational noise. Refer to Section 7.4 of this NVMP for process for early treatments.	Construction Manager
NOISE: Standard Working Hours and Extended Working Hours where Predicted Noise Level exceeds NML by more than 10 dB		
	Implement all feasible and reasonable measures NVMM1 to NVMM27 inclusive	As noted above.
NVMM28	Verification: Measure noise levels from noise intensive plant prior to use and check against manufacturer's specifications and/or the sound power levels listed in Appendix A.	Construction Manager
NVMM29	Notification: Sensitive receivers will be notified of construction activities to be undertaken through letterbox drops five to fourteen working days prior to commencement.	Community Relations Manager, Construction Manager
NVMM30	Stockpiles of excavated material will be positioned to provide shielding to noise-sensitive land uses where possible.	Construction Manager, Foreman, Operators
NVMM31	Use noise screens/shields where possible.	Construction Manager, Foreman
NVMM32	Plant and machinery will not be permitted to warm up before the nominated construction hours.	Construction Manager, Foreman
NVMM33	Loading and unloading will be carried out as far as practical away from sensitive receivers.	Construction Manager, Foreman
NOISE: Standard Working Hours and Extended Working Hours where Predicted Noise Level are greater than 75 dB(A) at residences (Highly Noise Affected)		
	Implement all feasible and reasonable measures NVMM1 to NVMM33 inclusive	As noted above.
NVMM34	Phone calls: Phone calls detailing relevant information will be made to identified residences within seven calendar days of proposed work. Phone calls will provide affected residences with specific contact details and advice regarding noise management measures to be implemented. If the resident is not able to be reached via phone, door knocking and/or personalised letterbox drops will be used.	Community Relations Manager

ID	Mitigation Measure	Responsibility
NVMM35	Respite offers: Consultation with highly noise affected residences will involve discussion of specific respite periods. If specific respite periods are not agreed, then NVMM36 will be followed.	Community Relations Manager, Construction Manager, Foreman
VIBRATION: Standard Hours Work and Extended Hours Work occurring within safe working distances for human comfort		
NVMM36	Undertake works during Standard Working Hours. Where works must occur outside of these hours, assess Out of Hours works in accordance with the Out of Hours Work Approval Procedure provided in Appendix C	Construction Manager
NVMM37	Prioritise vibration-intensive works to occur during Standard Hours.	Construction Manager
NVMM38	Implement a hot line and complaints handling procedure for vibration and other construction related complaints.	Community Relations Manager
NVMM39	Avoid vibration intensive works within the safe working distances unless necessary and consider feasible alternatives if works must occur within the distance. Ensure Hold Point is released prior to commencement of any piling, hammering, ripping, demolition operations or any other activities which may cause damage through vibration.	Foreman Construction Manager
NVMM40	Restrict construction traffic speed to 20 km/h across the site, or 40 km/h for haul roads. Signpost the speed limit.	Foreman
NVMM41	Restrict construction traffic to designated roadways.	Foreman
NVMM42	Run plant that has high and low vibration operating settings on the lowest effective vibration setting, including static rolling where feasible.	Foreman
NVMM43	Notification: Sensitive receivers will be notified of construction activities to be undertaken through letterbox drops five to fourteen working days prior to the works.	Community Relations Manager, Construction Manager
NVMM44	Respite offers: Consultation with highly affected residences will involve discussion of specific respite periods. If specific respite periods are not agreed, then works will not be carried out for continuous blocks of more than three hours without a minimum respite period of one hour.	Community Relations Manager, Construction Manager, Foreman
VIBRATION: Standard Hours Work and Extended Hours Work occurring within safe working distances for cosmetic damage to buildings		
	Implement all feasible and reasonable measures NVMM36 to NVMM44 inclusive	As noted above.

ID	Mitigation Measure	Responsibility
NVMM45	If vibration intensive plant is to be used within the safe working distance for cosmetic damage (as per Table 7-13), works would not proceed until attended vibration measurements are undertaken.	Foreman, Environment Officer
NVMM46	Where vibration intensive works are occurring for a continuous period of time within the safe working distance for cosmetic damage (as per Table 7-13), install a permanent vibration monitoring system to warn operators (via flashing light, audible alarm, SMS etc.) when vibration levels are approaching the cosmetic damage objective.	Environment Officer Operators
NVMM47	Undertake pre-construction dilapidation surveys of buildings and structures where construction works will occur within safe working distances for cosmetic damage, at such a time that the report can be provided to the landowner at least one month prior to that work being undertaken.	Environment Officer
NVMM48	Undertake post-construction dilapidation surveys of buildings and structures where construction works has occurred within safe working distances for cosmetic damage.	Environment Officer, Environment Manager
NVMM49	Undertake surveys of buildings and structures immediately following a monitored exceedance of the relevant vibration criteria.	Environment Officer, Environment Manager

8.3 Mitigation measures for Out of Hours Work

Specific mitigation measures to address construction noise and vibration impacts during Out of Hours Work are outlined in Table 8-2.

Table 8-2 Out of Hours Work noise and vibration mitigation measures

ID	Mitigation Measure	Responsibility
OOHW STAGE 1 NOISE ANY TIME: • NML EXCEEDANCE ≤ 5 dB & NO EXCEEDANCE OF SLEEP DISTURBANCE CRITERIA		
OOOHM1	Assess Out of Hours works in accordance with the Out of Hours Work Approval Procedure in Appendix C, including: • Justification for Out of Hours work. • Noise assessment. • Notification to and consultation with the EPA, Roads and Maritime, and with the affected community. • Implementation of reasonable and feasible mitigation measures for receivers where night time NMLs are predicted to be exceeded.	Environment Manager, Community Relations Manager
OOHMM2	Implement a hot line and complaints handling procedure for noise and other construction related complaints.	Community Relations Manager
OOHMM3	Ensure all mobile construction equipment have non-tonal reversing alarms.	Foreman, Operators
OOHMM4	Plan and conduct works in a manner to minimise the reversing of vehicles with audible reversing alarms.	Construction Manager, Foreman
OOHMM5	Trucks will travel via internal haul roads and major roads where practicable to minimise use of local roads.	Foreman
OOHMM6	Site access points and roads will be positioned as far as practicable away from residential receivers.	Foreman
OOHMM7	Ensure that truck tailgates are cleared and locked at the point of unloading.	Foreman, Operators
OOHMM8	Use two way radios at the minimum effective volume.	Foreman, Operators
OOHMM9	Utilise quieter work methods and equipment, including the use of mufflers and silencers where practicable.	Construction Manager
OOHMM10	Noise levels generated by plant and equipment will be considered in rental decisions, with noise levels to be compliant with Appendix A and Table 2 of the CNVG.	Construction Manager
OOHMM11	Vehicle warning devices, such as horns, are not to be used as signalling devices.	Foreman, Operators

ID	Mitigation Measure	Responsibility
OOHMM12	Undertake regular maintenance of plant and equipment, including silencers, to ensure that noise emissions do not increase over time. Servicing, refueling and warm-up to be undertaken during standard construction hours.	Foreman, Operators
OOHMM13	Turn vehicles and machinery off when not in use.	Foreman, Operators
OOHMM14	Only necessary equipment, of an appropriate size and power, will be on site.	Construction Manager
OOHMM15	The use of engine compression brakes near residential areas will be limited.	Foreman, Operators
OOHW STAGE 2 NOISE OOHW TIME PERIOD 1 Mon–Fri 7 pm–10 pm, Sat 7 am–8 am & 5 pm–10 pm, Sun / Pub Hol 7 am–6 pm • NML EXCEEDANCE > 5 dB & ≤ 25 dB OOHW TIME PERIOD 2 Mon–Fri 10 pm–7 am, Sat 10 pm–7 am, Sun / Pub Hol 6 pm–7 am • NML EXCEEDANCE > 5 dB & ≤ 15 dB, & NO EXCEEDANCE OF SLEEP DISTURBANCE CRITERIA		
	Implement all feasible and reasonable measures OOHMM1 to OHMM15 inclusive	As noted above.
OOHMM16	Verification: Measure noise levels from noise intensive plant prior to use and check against manufacturer's specifications and/or the sound power levels listed in Appendix D.	Construction Manager
OOHMM17	Notification: Sensitive receivers will be notified of construction activities to be undertaken through letterbox drops at least two weeks prior to works commencing.	Community Relations Manager, Construction Manager
OOHMM18	Respite Period 1 (OOHW Period 1 only): Out of hours construction noise will be limited to no more than three consecutive periods per week impacting particular sensitive receivers except where there is a Duration Respite (OOHMM21). For the purposes of this measure, a separation distance of 300 m is considered sufficient to provide respite.	Community Relations Manager, Construction Manager
OOHMM19	Respite Period 2 (OOHW Period 2 only): Out of hours construction noise will be limited to no more than two consecutive periods per week impacting particular sensitive receivers except where there is a Duration Respite (OOHMM21). For the purposes of this measure, a separation distance of 500 m is considered sufficient to provide respite.	Community Relations Manager, Construction Manager

ID	Mitigation Measure	Responsibility
OOHMM20	Duration Respite: Engagement will be undertaken with the affected community to offer limiting respite periods to ensure works are completed more quickly.	Community Relations Manager, Construction Manager
OOHMM21	Maximise the offset distance between noisy items of plant and sensitive receivers for each task and activity.	Foreman, Operators
OOHMM22	Locate plant and equipment to take advantage of barriers provided by existing site features and structures.	Foreman, Operators
OOHMM23	Orient plant and equipment known to emit noise strongly in one direction so that noise is directed away from noise sensitive areas.	Foreman, Operators
OOHMM24	Use traffic controllers to minimise occurrences of vehicles queuing, idling or reversing near noise sensitive receivers as much as is practical.	Construction Manager, Foreman
OOHMM25	Position site access points and roads as far as practicable away from residential receivers.	Foreman, Operators
OOHMM26	Avoid metal-to-metal contact on equipment where feasible.	Foreman, Operators
OOHMM27	Avoid dropping material from a height into unlined metal trays (line trays with soil or similar to reduce noise).	Foreman, Operators
OOHW STAGE 3 NOISE **OOHW TIME PERIOD 1 Mon–Fri 7 pm–10 pm, Sat 7 am–8 am & 5 pm–10 pm, Sun / Pub Hol 7 am–6 pm** • NML EXCEEDANCE > 25 dB **OOHW TIME PERIOD 2 Mon–Fri 10 pm–7 am, Sat 10 pm–7 am, Sun / Pub Hol 6 pm–7 am** • NML EXCEEDANCE > 15 dB & ≤ 25 dB, AND/OR EXCEEDANCE OF SLEEP DISTURBANCE CRITERIA		
	Implement all feasible and reasonable measures OOHMM1 to OHMM27 inclusive	As noted above.
OOHMM28	Individual briefings: Where possible with agreement, individual visits made with identified stakeholders at least 48 hours ahead of potentially disturbing construction activities.	Community Relations Manager
OOHMM29	Phone calls: Phone calls detailing relevant information will be made to identified residences within seven calendar days of proposed work. Phone calls will provide affected residences with specific contact details and advice regarding noise management measures to be implemented. If the resident is not able to be reached via phone, door knocking and/or personalised letterbox drops will be used.	Community Relations Manager

ID	Mitigation Measure	Responsibility
OOHMM30	Specific notification: Personalised letterbox drops made to identified residences seven to fourteen calendar days ahead of works with specific details on works and management measurements in place.	Community Relations Manager
OOHW STAGE 4 NOISE **OOHW TIME PERIOD 2 Mon–Fri 10 pm–7 am, Sat 10 pm–7 am, Sun / Pub Hol 6 pm–7 am** **NML EXCEEDANCE > 25 dB**		
	Implement all feasible and reasonable mitigation measures OOHMM1 to OOHMM30 inclusive.	As noted above
OOHMM31	Install temporary hoarding where feasible to shield noise to affected sensitive receivers.	Construction Manager
OOHMM32	Alternative Accommodation Consider temporary relocation of receivers where the construction noise level exceeds the night time NML by more than 25 dB(A) for an extended period of time. As per the CNVG, the specifics of any offer will be considered on a case-by-case basis.	Community Relations Manager
OOHW VIBRATION **Work occurring within safe working distances for human comfort**		
OOHMM33	Assess OOHW in accordance with the OOHW Approval Procedure in Appendix C, including: • Justification for Out of Hours work. • Vibration assessment. • Notification to and consultation with Roads and Maritime and with the affected community. • Implementation of reasonable and feasible mitigation measures for receivers where night time human comfort 'Maximum' criteria are predicted to be exceeded.	Construction Manager
OOHMM34	Implement a hot line and complaints handling procedure for vibration and other construction related complaints.	Community Relations Manager
OOHMM35	Avoid vibration intensive works within the safe working distances unless necessary. Ensure a Hold Point is released prior to commencement of any impact piling, hammering or ripping, demolition operations or any other activities which may cause damage through vibration.	Foreman Construction Manager
OOHMM36	Restrict construction traffic speed to 20 km/h across the site, or 40 km/h for haul roads. Signpost the speed limit.	Foreman
OOHMM37	Restrict construction traffic to designated roadways.	Foreman

ID	Mitigation Measure	Responsibility
OOHMM38	Run plant that has high and low vibration operating settings on the lowest effective vibration setting, including static rolling where feasible.	Foreman
OOHMM39	Notification: Sensitive receivers will be notified of construction activities to be undertaken through letterbox drops five to fourteen working days prior to the works.	Community Relations Manager, Construction Manager
OOHMM40	Respite offers: Consultation with highly affected residences will involve discussion of specific respite periods. If specific respite periods are not agreed, then: • works will not be carried out for continuous blocks of more than three hours without a minimum respite period of one hour • works will not affect an individual residence for more than two consecutive nights and not more than six nights in each calendar month.	Community Relations Manager, Construction Manager, Foreman
OOHMM41	Individual briefings: Where possible with agreement, individual visits made with identified stakeholders at least 48 hours ahead of potentially disturbing construction activities.	Community Relations Manager
OOHMM42	Phone calls: Phone calls detailing relevant information will be made to identified residences within seven calendar days of proposed work. Phone calls will provide affected residences with specific contact details and advice regarding noise management measures to be implemented. If the resident is not able to be reached via phone, door knocking and/or personalised letterbox drops will be used.	Community Relations Manager
OOHMM43	Specific notification: Personalised letterbox drops made to identified residences seven to fourteen calendar days ahead of works with specific details on works and management measurements in place.	Community Relations Manager
OOHMM44	Alternative Accommodation (Night Work Only) Consider temporary relocation of receivers where the vibration levels will considerably exceed the night time human comfort criteria for extended periods of time and where respite periods may not be feasible. As per the CNVG, the specifics of any offer will be considered on a case-by-case basis.	Community Relations Manager
OOHW VIBRATION **Work occurring within safe working distances for cosmetic damage to buildings**		

ID	Mitigation Measure	Responsibility
	Implement all feasible and reasonable mitigation measures OOHMM33 to OOHMM44 inclusive.	As noted above
OOHMM45	If vibration intensive plant is to be used within the safe working distance for cosmetic damage (as per Table 7-13), works would not proceed until attended vibration measurements are undertaken.	Foreman, Environment Officer
OOHMM46	Where vibration intensive works are occurring for a continuous period of time within the safe working distance for cosmetic damage (as per Table 7-13), install a permanent vibration monitoring system to warn operators (via flashing light, audible alarm, SMS etc.) when vibration levels are approaching the cosmetic damage objective.	Environment Officer Operators
OOHMM47	Undertake pre-construction dilapidation surveys of buildings and structures where construction works will occur within safe working distances for cosmetic damage, at such a time that the report can be provided to the landowner at least one month prior to that work being undertaken.	Environment Officer
OOHMM48	Undertake post-construction dilapidation surveys of buildings and structures where construction works has occurred within safe working distances for cosmetic damage.	Environment Officer, Environment Manager
OOHMM49	Undertake surveys of buildings and structures immediately following a monitored exceedance of the relevant vibration criteria.	Environment Officer, Environment Manager

9 Compliance management

9.1 Roles and responsibilities

The Fulton Hogan Project Team's organisational structure and overall roles and responsibilities are outlined in Section 3.2 of the CEMP. Specific responsibilities for the implementation of environmental mitigation measures are detailed in Chapter 6 of this Plan.

9.2 Training

All employees, sub-contractors and utility staff working on site will undergo site induction training relating to noise and vibration management issues, including:

- Existence and requirements of this sub-plan
- Relevant legislation
- Standard, extended and out of hours construction hours
- The process for seeking approval for out of hours works, including consultation
- Location of noise sensitive areas and receivers
- General noise and vibration management measures
- Complaints reporting.

Further details regarding staff induction and training are outlined in Section 3.4 of the CEMP.

9.3 Monitoring and inspections

Weekly and other routine inspections by Environmental Officers, TfNSW, and ER will occur throughout construction. Details on the nature and frequency of these inspections are documented in Sections 3.7.1 and 3.7.2 of the CEMP.

Noise and vibration monitoring will also occur routinely for the duration of the Project. Monitoring will be undertaken by an Acoustic Consultant or the Environmental Officer during the construction phase of the Project. The Noise and Vibration Monitoring Plan for the Project is provided in the following sections with the monthly noise monitoring locations shown in Appendix F of this NVMP.

9.3.1 Noise monitoring

The following noise monitoring will be undertaken:

- Monthly noise monitoring at nominated sensitive receiver locations to determine the effectiveness of mitigation measures against predicted impacts;
- Where complaints are received, additional noise monitoring may be undertaken at sensitive receivers to determine if the actual construction noise generated exceeds the predicted 'worst case' construction noise levels identified in Section 7.3 and Appendix A of this NVMP;
- Noise monitoring may be carried out for the purpose of refining construction methods or techniques to minimise noise; and
- Ongoing spot checks of noise intensive plant and equipment will be undertaken throughout construction to ensure compliance with manufacturer's specifications.

Where actual noise levels are found to exceed the predicted worst case levels (i.e. an exceedance of more than 3 dB), the source of excessive noise generations will be identified, and any additional feasible and reasonable measures available will be implemented to either reduce noise emissions or reduce the impacts on receivers. At a minimum, the noise mitigation measures detailed in Section 8.2 for the measured exceedance of the relevant NML will be applied.

Details of site activity and equipment usage will be noted during construction noise monitoring.

Acoustic instrumentation employed in the noise monitoring surveys will comply with the requirements of AS1259.2-1990 Acoustics – Sound Level Meters, Part 2: Integrating – Averaging and carry appropriate NATA (or manufacturer) calibration certificates.

9.3.2 Vibration monitoring

The following vibration monitoring will be undertaken:

- For the protection of buildings, monitoring will be carried out at the commencement of vibratory compaction work and any rock-breaking within 50 metres of buildings to ensure that safe vibration working distances specified in Table 7-13 are not exceeded and to confirm safe working distances
- When vibration intensive activities are required, vibration monitoring will be carried out within the established buffer zones, or where there is considered to be a risk that levels may exceed the relevant structural damage goals
- Vibration monitoring may be carried out in response to complaints, exceedances, or for the purpose of refining construction methods or techniques to minimise vibrations
- Vibration monitoring will continue throughout construction, where appropriate, at nominated sensitive receiver locations to determine the effectiveness of mitigation strategies.

Where vibration is found to exceed safe levels, impacts will be avoided by changing work methods and/or equipment, or through the provision of building protection measures where possible. In the event a complaint relating to property damage is received, an inspection of the property would be undertaken and an interim building condition survey prepared.

Vibration monitoring will be carried out in accordance with:

- For structural damage vibration – German Standard DIN 4150 and BS 7385: Part 2 – 1993
- For human exposure to vibration – the evaluation criteria presented in the Environmental Noise Management Assessing Vibration: A Technical Guideline (DECC 2006).

9.3.3 Monitoring program summary

A monitoring (and inspection) program summary is included as Table 9-1.

The nominated monthly attended noise monitoring locations are shown in Appendix F and are:

1. [redacted] (NCA1)
2. [redacted] (NCA3)
3. [redacted] (NCA3)
4. [redacted] (NCA4)
5. [redacted] (NCA5)
6. [redacted] (NCA5)
7. [redacted] (NCA8)
8. [redacted] (NCA10)
9. [redacted] (NCA13)
10. [redacted] (NCA15)

These locations have been selected, where possible, to coincide with locations where previous baseline monitoring occurred during the EIS. For these locations, the EIS baseline noise monitoring data will be used as the baseline data for the construction noise monitoring.

Where monitoring locations do not have previous baseline data (e.g. L3 and L11) then monthly attended monitoring will commence at those locations prior to the commencement of major construction works within 500 m to provide an indication of typical ambient noise levels during the

daytime (supplementary baseline monitoring). The supplementary baseline monitoring at L3 and L11 will be conducted in accordance with the noise monitoring procedures detailed in Table 9-1.

The monthly monitoring locations exclude a small number of NCAs for the following reasons:

- NCA2: this NCA consists of a single receiver. Noise monitoring conducted at nominated location L2 is expected to be adequately representative of general construction noise levels at the receiver in NCA2.
- NCA6: this NCA consists of two receivers. Noise monitoring conducted at nominated location L7 is expected to be adequately representative of general construction noise levels at the receivers in NCA6.
- NCA7: this NCA is separated from the works by NCA8. Therefore monitoring of construction noise levels at NCA8 will adequately address construction noise levels at NCA7.
- NCA9: this NCA is adequately represented by L7 and L8.
- NCA11 and NCA12: These NCAs are typically removed from the works and will be adequately represented by L9.
- NCA14: this NCA consists of two receivers. Noise monitoring conducted at nominated location L10 is expected to be adequately representative of general construction noise levels at NCA14.

It is noted that monitoring will still be conducted in the NCAs above if required for other reasons in accordance with Table 9-1.

Table 9-1 Noise and vibration monitoring implementation

Monitoring details	Record	Frequency	Responsibility	Test procedures
INSPECTIONS				
Inspection of works to ensure that noise & vibration mitigation measures are being implemented on site.	Environmental Inspection Checklist	Weekly	Environmental Manager	Nil
NOISE MONITORING				
Noise monitoring at monitoring locations identified at locations listed above and shown in Appendix F. This includes supplementary baseline monitoring at L3 and L11.	Noise Monitoring Record	Monthly	Environmental Manager	If monitoring cannot be undertaken at the nearest relevant sensitive receiver, a suitable representative location will be selected. The testing method includes: • SLM set to “Fast” time weighting and “A” frequency weighting. • Test environment free from reflecting objects where possible. Where noise monitoring is conducted within 3.5metres of large walls or a building facade, then a reflection correction of up to -2.5dB(A) will be applied to remove of increased noise due to sound reflections. • Tests will not be carried out during rain or when wind speed > 5m/s. • Conditions such as wind velocity and direction, temperature, relative humidity and cloud cover will be recorded from the nearest
Where Verification is required in accordance with CNVG and mitigation measures in Chapter 8.	Noise Monitoring Record	Monthly	Environmental Manager	

Monitoring details	Record	Frequency	Responsibility	Test procedures
Where complaint is received and monitoring is considered an appropriate response to determine if noise levels exceed predicted construction noise levels documented in this NVMP.	Noise Monitoring Record	As required	Environmental Manager	Bureau of Meteorology station or on-site weather station/observations. • The monitoring period should be sufficient such that measured noise levels are representative of noise over a 15-minute period. • At a minimum L_{eq}, L_{max}, L_{10} and L_{90} levels will be reported. The observations of the person undertaking the measurements will be reported including audibility of construction noise, other noise in the environment and any discernible construction activities contributing to the noise at the receiver.
Spot checks of noise intensive plant where it is required to check noise emission against manufacturer's specifications.	Noise Monitoring Record	Monthly for construction activities with PNL>60 dB $L_{Aeq(15min)}$	Environmental Manager	Stationary test procedures according to AS 2012.1 Acoustics – Measurement of airborne noise emitted by earth-moving machinery and agricultural tractors – Stationary test condition. The testing method includes: • Sound level meter configured for "Fast" time weighting and "A" frequency weighting. • The test environment will be free from reflecting objects. • Tests will not be carried out during rain or when wind speed exceeds 5m/s. • In accordance with AS 2012.1, a minimum of three (3) measurement points will be defined at locations on the hemispherical surface around the plant with the radius determined by the basic length of the machine. • The A-weighted L_{eq} background noise at the measurement locations will be at least 6 dB and preferably 10 dB below the level with the plant operating. • Both L_{eq} and L_{10} levels will be measured and reported.
Spot checks for worst-case noise impact scenarios or when new predicted high noise impact activities commence	Noise Monitoring Record	As required	Environmental Manager	
Where required for the purposes of refining construction methods or techniques to reduce noise levels.	Noise Monitoring Record	As required	Environmental Manager	
VIBRATION MONITORING				

Monitoring details	Record	Frequency	Responsibility	Test procedures
At start of vibratory compaction work or rock-breaking within 50m of residential buildings.	Vibration Monitoring Record	As required	Environmental Manager	Attended vibration monitoring will be undertaken when checking the safe working distances from construction plant (e.g. compaction plant) or in response to a complaint. The testing method includes: • Monitoring to be conducted for at least three distances from the plant, including a representative distance for the nearest sensitive structures and/or receivers. • The testing will be conducted at each location to obtain a suitable representation of the range of vibration levels that would occur from the tested plant. • The plant will be tested in the settings in which it is expected to operate. For vibratory rollers this may include both “High” and “Low” settings. Peak (PPV) vibration levels and the dominant frequency of the vibration will be recorded for assessment against the structural and cosmetic damage criteria. In situations in which human comfort is also of concern then the rms vibration level should also be recorded.
Where Verification is required in accordance with CNVG and mitigation measures in Chapter 8.				
Where a complaint is received and monitoring is considered an appropriate response.				
Where an activity may occur within safe working distances for cosmetic damage for no more than one day continuously.				

Monitoring details	Record	Frequency	Responsibility	Test procedures
During construction to confirm minimum safe working distances in Section 7.5.2 and refine construction methods if vibration levels exceed guideline values.				
Where an activity may occur within safe working distances for cosmetic damage for a period of more than one day continuously.	Vibration Monitoring Record	As required	Environmental Manager	Continuous vibration monitoring will be undertaken where vibration from a construction activity may exceed cosmetic damage criteria at a sensitive structure, where activities may occur within safe working distances for cosmetic damage. The testing method includes: • Vibration logger to continuously measure vibration while relevant works are occurring within the safe working distance for cosmetic damage. • Measurement to be conducted as close as possible to the sensitive structure. • A warning system will be implemented including one or both of an audible and/or visual warning alarm, and/or SMS and/or email alerts to site staff.

Monitoring details	Record	Frequency	Responsibility	Test procedures
Dilapidation surveys of buildings and structures where construction works occurs within the safe working distance for cosmetic damage. At a minimum, this will include all buildings within 25 m of areas where vibratory compaction and/or rock-breaking will occur.	Dilapidation Report	At least 3 weeks prior to that work being undertaken and post-construction	Construction Manager	At a minimum, dilapidation surveys and reports will comprise: • Inspector's qualifications and expertise • A visual inspection of the structure, including all internal and external walls, ground level floors and external pavements, all connections of other structures above ground level and their connection at ground level and any exposed foundations. • Full written report outlining condition of internal and external components of each property. • A series of photographs of each identified defect/crack. • A sketched floor plan showing exact locations of defect and measurements of crack width/defect size. • Identification of any condition changes relative to pre-construction and the likely cause of the change (post-construction only). • Sign-off of property the owner

9.4 Non-conformances

Non-conformances in general will be dealt with and documented in accordance with Section 3.8 of the CEMP.

9.5 Complaints

Complaints will be recorded in accordance with Section 3.5.4 of the CEMP and the Community Communication Strategy (CCS).

Information to be recorded will include location of complainant, time/s of occurrence of alleged noise or vibration impacts (including nature of impact particularly with respect to vibration), perceived source, prevailing weather conditions and similar details that could be utilised to assist in the investigation of the complaint. All resident complaints will be responded to in a timely manner and action taken recorded in accordance with the CCS.

9.6 Auditing

Audits (both internal and external) will be undertaken to assess the effectiveness of environmental controls, compliance with this sub-plan, CoA and other relevant approvals, licenses and guidelines.

Audit requirements are detailed in Section 3.7.3 of the CEMP.

9.7 Reporting

Reporting requirements and responsibilities (including for the Construction Monitoring Report) are documented in Section 3.7.5 of the CEMP.

10 Review and improvement

10.1 Continuous improvement

Continuous improvement of this Plan will be achieved by the ongoing evaluation of environmental management performance against environmental policies, objectives and targets for the purpose of identifying opportunities for improvement.

The continuous improvement process will be designed to:

- Identify areas of opportunity for improvement of environmental management and performance
- Determine the cause or causes of non-conformances and deficiencies
- Develop and implement a plan of corrective and preventative action to address any non-conformances and deficiencies
- Verify the effectiveness of the corrective and preventative actions
- Document any changes in procedures resulting from process improvement
- Make comparisons with objectives and targets.

10.2 NVMP update and amendment

The processes described in Section 3.7 of the CEMP may result in the need to update or revise this Plan. This will occur as needed.

Any revisions to this Plan will be in accordance with the process outlined in Section 1.6 of the CEMP and as required, be provided to TfNSW, ER and other relevant stakeholders for review and comment and forwarded to the Secretary of DPIE for approval.

A copy of the updated plan and changes will be distributed to all relevant stakeholders in accordance with the approved document control procedure – refer to Section 1.5 of the CEMP.

Appendix A Indicative Plant and Equipment Sound Power Levels

Maximum sound power levels for the typical operation of construction plant and equipment applied in noise modelling are listed in Table A-1.

The sound power levels are based on previous measurements of similar construction equipment conducted by Resonate, as well as reference to the CNVG where required. The overall activity sound power levels are based on the typical loudest combination of equipment likely occurring for each activity. Note that the overall sound power levels have not generally been obtained by combining predicted noise levels for all items of equipment listed as this is not a typical operating scenario.

Table A-1: Construction scenarios and associated plant and equipment

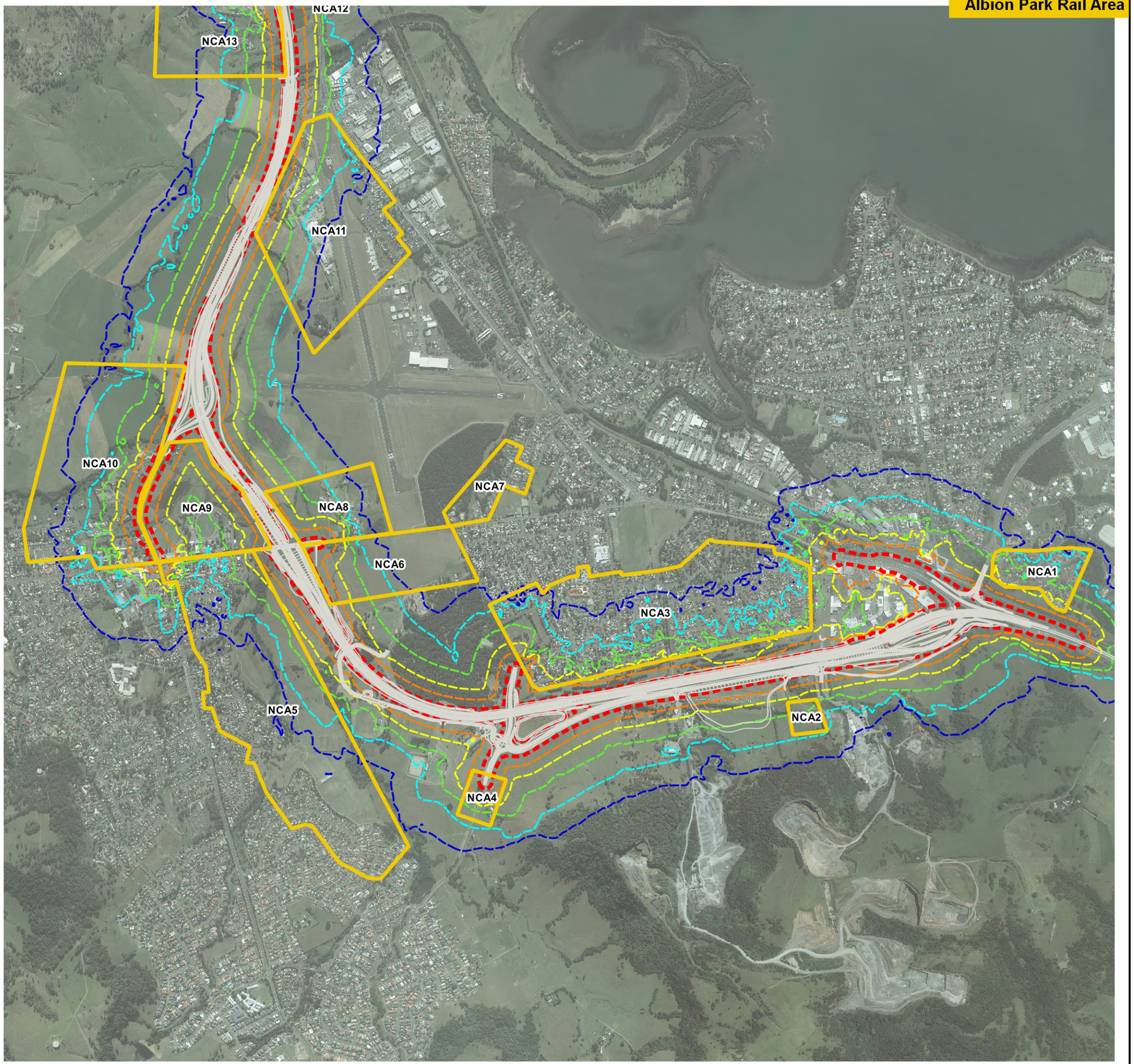
Scenario	Typical major plant and equipment	Sound power level, dB		
		Typical maximum L_{Aeq}		Typical L_{Amax}
		Item	Activity	Activity
A1: Mobilisation and site establishment	Trucks	110	115	118
	Generators	109		
	Light vehicles	98		
	Excavators	109		
	Chainsaws	115		
	Mulchers	120		
	Water carts	110		
	Drilling rigs	115		
	Cranes	112		
A2: Road work and road surfacing	Graders	112	113	118
	Backhoes	110		
	Front end loaders	112		
	Trucks	110		
	Water carts	110		
	Vibratory rollers	107		
	Excavators	109		
	Pavers	112		
A3: Drainage	Trucks	110	112	116
	Bulldozers	114		
	Excavators	109		

Scenario	Typical major plant and equipment	Sound power level, dB		
		Typical maximum L_{Aeq}		Typical L_{Amax}
		Item	Activity	Activity
	Concrete pumps	105		
	Concrete trucks	113		
A4: Bulk earthwork	Trucks	110	115	121
	Bulldozers	114		
	Excavators	109		
	Front end loaders	112		
	Vibratory rollers	107		
A5: Bridgework	Batching plant	120	116	120
	Bored piling rig	110		
	Concrete pumps	105		
	Concrete trucks	113		
	Cranes	112		
	Excavators	109		
	Trucks	110		
A6: Finishing work	Trucks	110	108	114
	Generators	109		
	Light vehicles	98		
	Cranes	112		
A7: Ancillary sites and compounds	Trucks	110	114	117
	Excavators	109		
	Front end loaders	112		
	Compressors	110		
	Cranes	112		
	Vibratory rollers	107		
	Generators	109		

Scenario	Typical major plant and equipment	Sound power level, dB		
		Typical maximum L_{Aeq}		Typical L_{Amax}
		Item	Activity	Activity
A8: Material Processing including crushing and screening	Rock crusher/screener	113	115	122
	Bulldozer D9	109		
	Excavator (tracked) 35t	107		
	Truck	103		

Appendix B Typical worst case construction noise contours

Albion Park Rail Area



APPENDIX B
FIGURE 1a

ALBION PARK RAIL BYPASS
Illawarra, NSW
Noise and Vibration Management Plan

Typical worst-case construction noise levels - Site Establishment

Client: Fulton Hogan
Drawn by: TRE
Checked by: AP
Dated: August 2018
Page size: A3
Data sources: FH / RMS

Legend

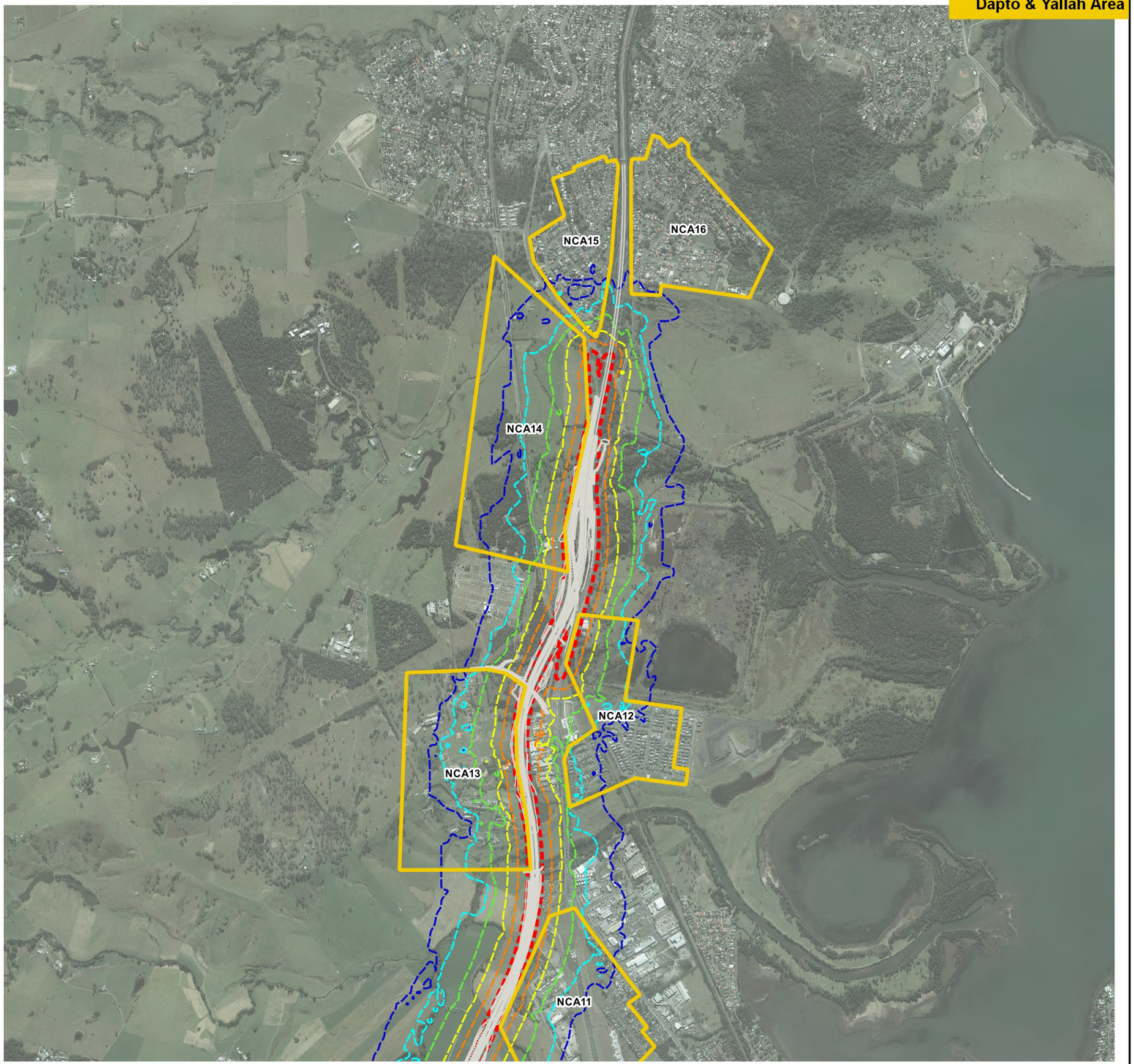
- Road Design
- Noise Catchment Area

Typical worst case construction noise level, LAeq,15min

- 45 dB
- 50 dB
- 55 dB
- 60 dB
- 65 dB
- 75 dB Highly Noise Affected

0 250 500 750 1000 m

Resonate



APPENDIX B
FIGURE 1b

ALBION PARK RAIL BYPASS
Illawarra, NSW
Noise and Vibration Management Plan

Typical worst-case construction noise levels - Site Establishment

Client: Fulton Hogan
Drawn by: TRE
Checked by: AP
Dated: August 2018
Page size: A3
Data sources: FH / RMS

Legend

- Road Design
- Noise Catchment Area

Typical worst case construction noise, Leq,15min

- 45 dB(A)
- 50 dB(A)
- 55 dB(A)
- 60 dB(A)
- 65 dB(A)
- 75 dB(A) Highly Noise Affected

0 250 500 750 1000 m

Resonate

Albion Park Rail Area

NCA12
NCA13
NCA11
NCA10
NCA9
NCA8
NCA7
NCA6
NCA5
NCA4
NCA3
NCA2
NCA1

APPENDIX B
FIGURE 2a

ALBION PARK RAIL BYPASS
Illawarra, NSW
Noise and Vibration Management Plan

Typical worst-case construction noise levels - Roadwork

Client: Fulton Hogan
Drawn by: TRE
Checked by: AP
Dated: August 2018
Page size: A3
Data sources: FH / RMS

Legend

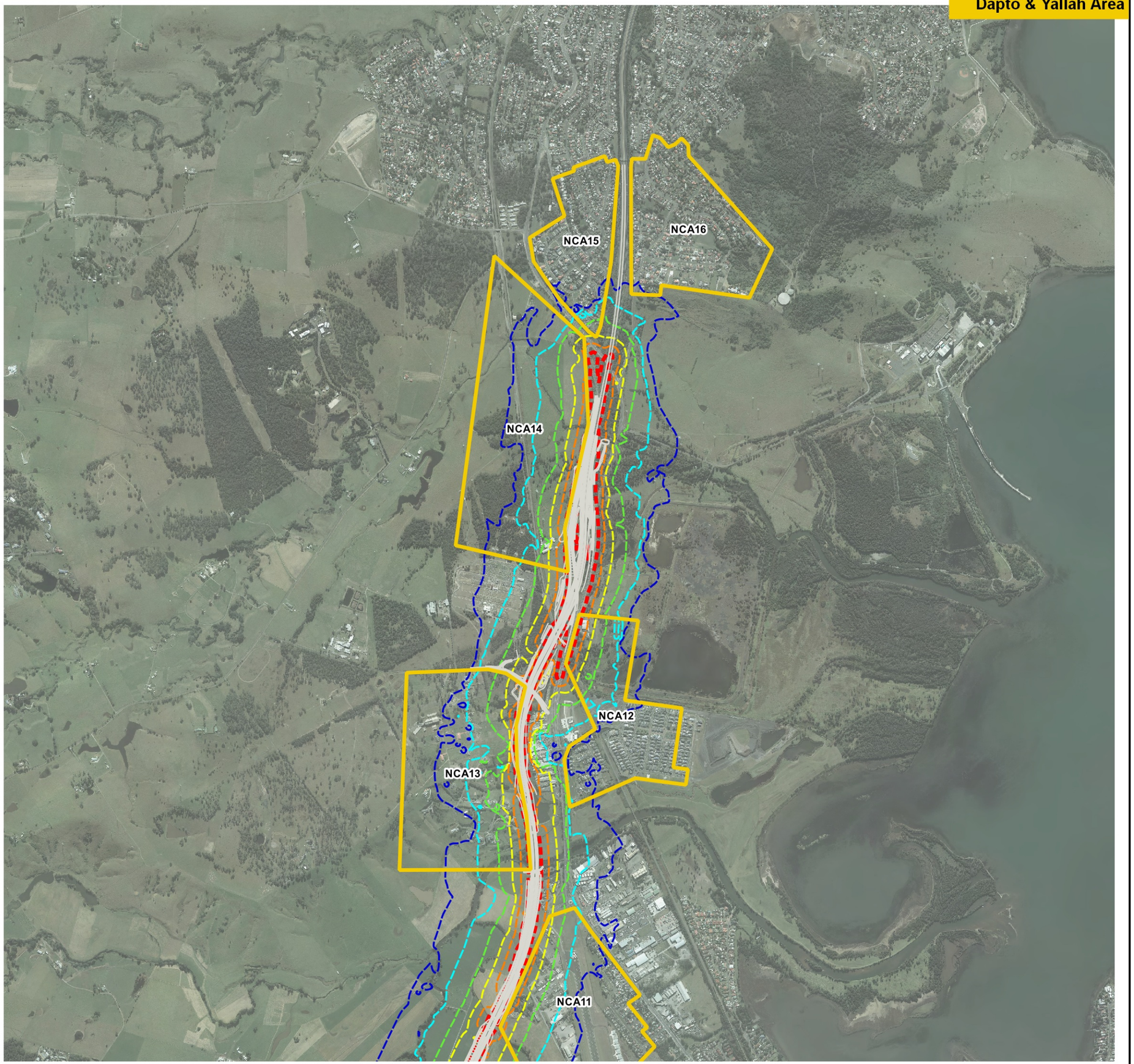
- Road Design
- Noise Catchment Area

Typical worst case construction noise level, LAeq,15min

- 45 dB
- 50 dB
- 55 dB
- 60 dB
- 65 dB
- 75 dB Highly Noise Affected

0 250 500 750 1000 m

Resonate



APPENDIX B
FIGURE 2b

ALBION PARK RAIL BYPASS
Illawarra, NSW
Noise and Vibration Management Plan

Typical worst-case construction noise levels - Roadwork

Client: Fulton Hogan
Drawn by: TRE
Checked by: AP
Dated: August 2018
Page size: A3
Data sources: FH / RMS

Legend

- Road Design
- Noise Catchment Area

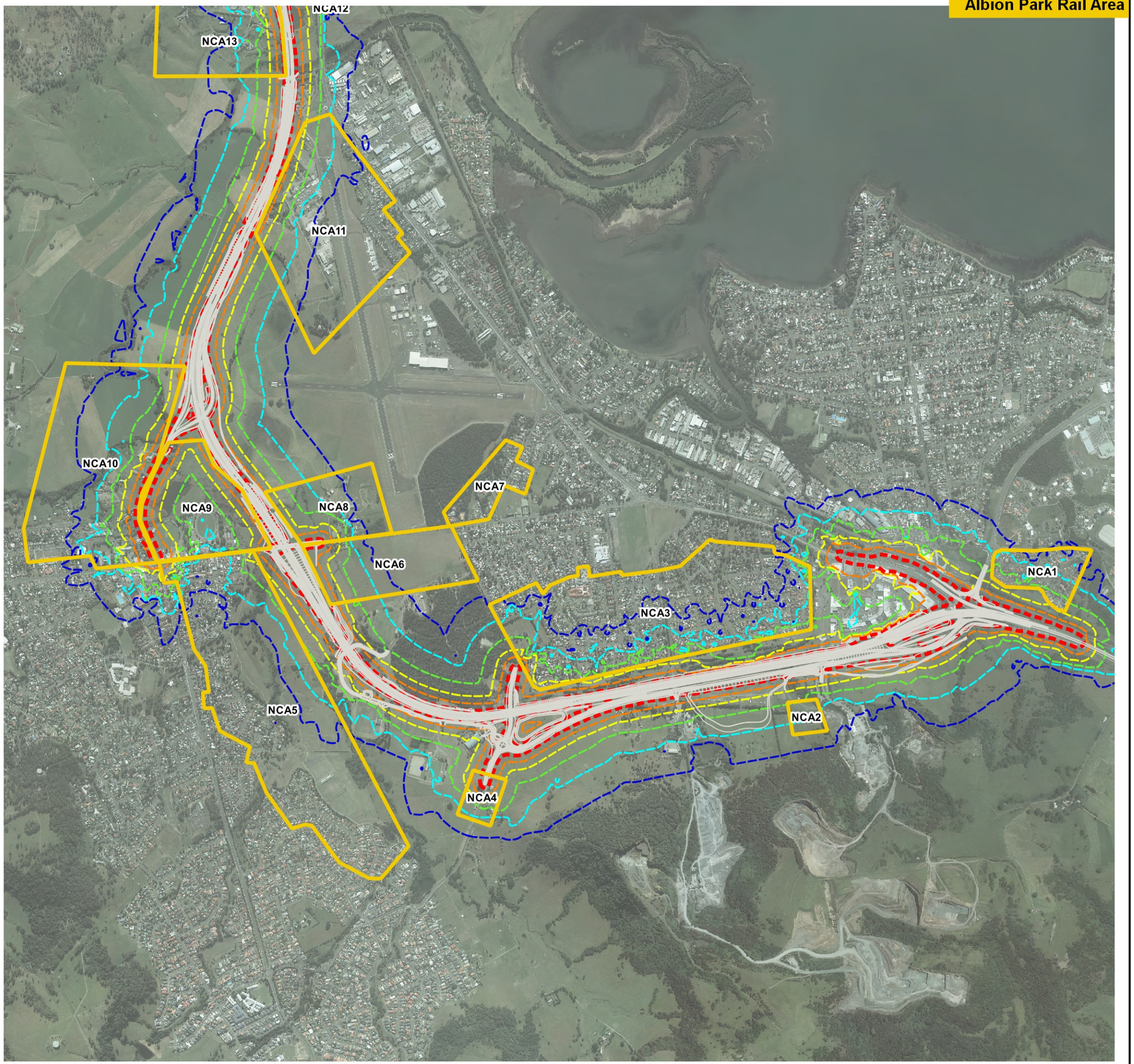
Typical worst case construction noise level, LAeq,15min

- 45 dB
- 50 dB
- 55 dB
- 60 dB
- 65 dB
- 75 dB Highly Noise Affected

0 250 500 750 1000 m

Resonate

Albion Park Rail Area



APPENDIX B
FIGURE 3a

ALBION PARK RAIL BYPASS
Illawarra, NSW
Noise and Vibration Management Plan

Typical worst-case construction noise levels - Drainage Works

Client: Fulton Hogan
Drawn by: TRE
Checked by: AP
Dated: August 2018
Page size: A3
Data sources: FH / RMS

Legend

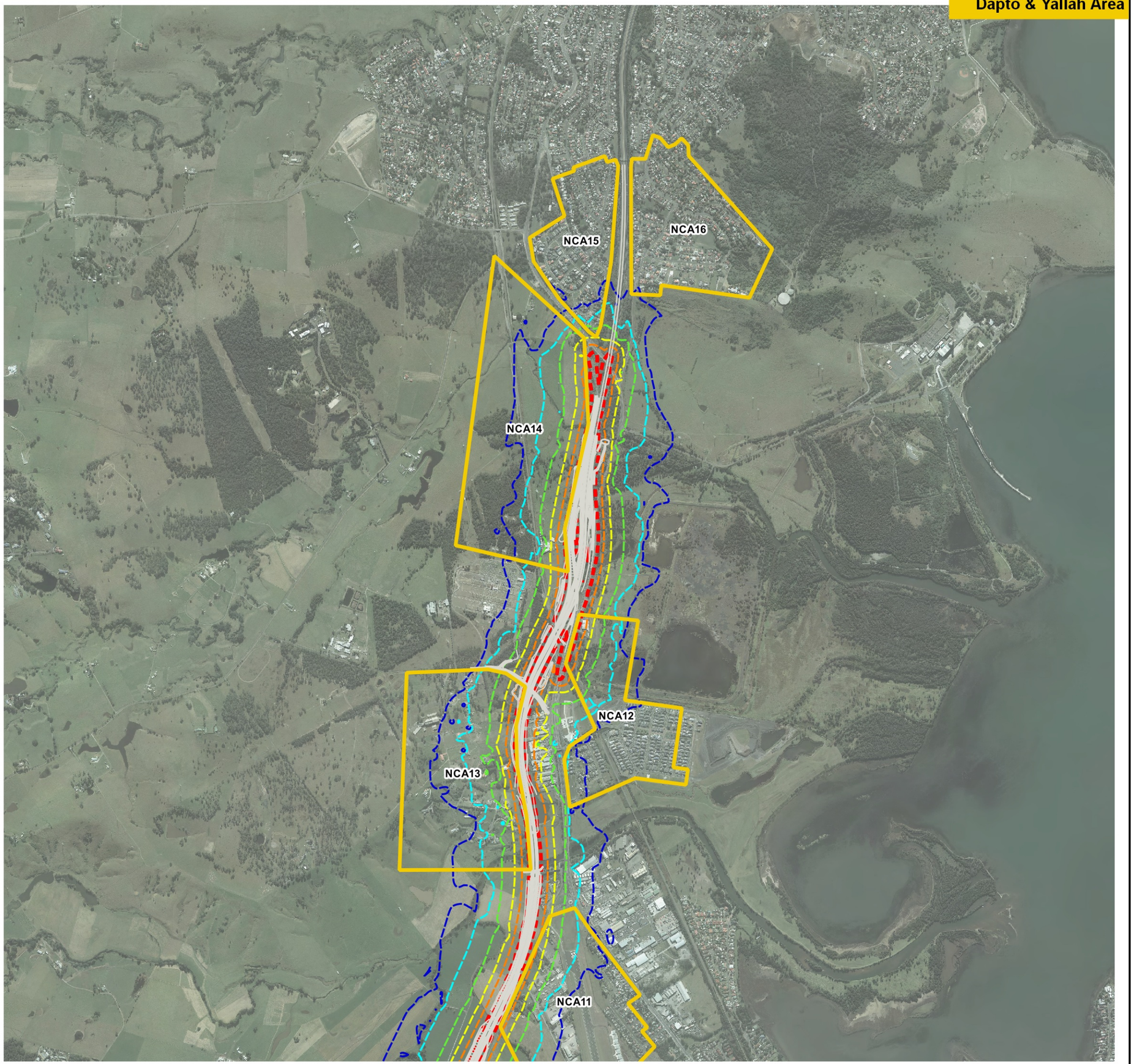
- Road Design
- Noise Catchment Area

Typical worst case construction noise level, LAeq,15min

- 45 dB
- 50 dB
- 55 dB
- 60 dB
- 65 dB
- 75 dB Highly Noise Affected

0 250 500 750 1000 m

Resonate



APPENDIX B
FIGURE 3b

ALBION PARK RAIL BYPASS
Illawarra, NSW
Noise and Vibration Management Plan

Typical worst-case construction noise levels - Drainage Works

Client: Fulton Hogan
Drawn by: TRE
Checked by: AP
Dated: August 2018
Page size: A3
Data sources: FH / RMS

Legend

- Road Design
- Noise Catchment Area

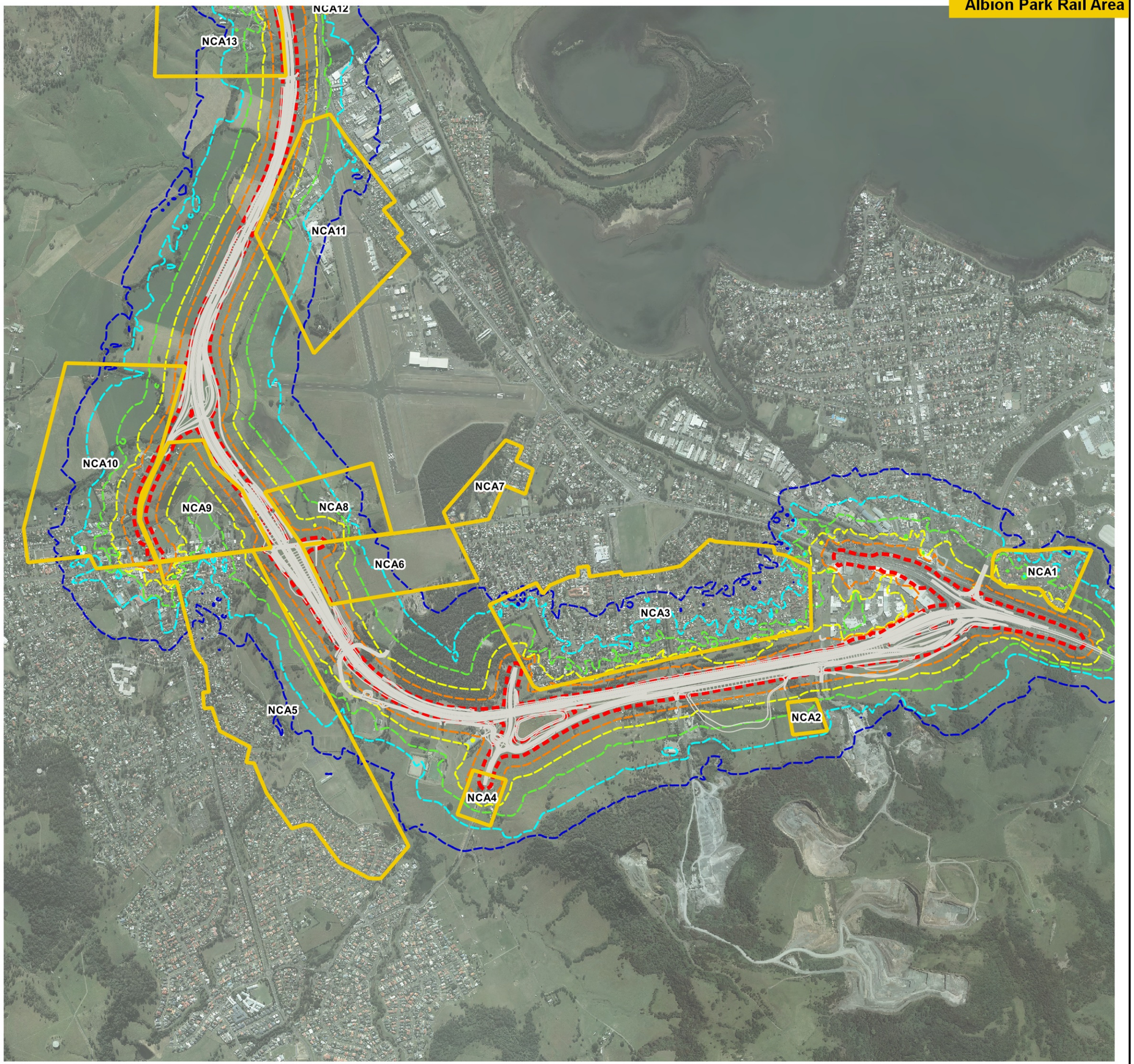
Typical worst case construction noise level, LAeq,15min

- 45 dB
- 50 dB
- 55 dB
- 60 dB
- 65 dB
- 75 dB Highly Noise Affected

0 250 500 750 1000 m

Resonate

Albion Park Rail Area



APPENDIX B
FIGURE 4a

ALBION PARK RAIL BYPASS
Illawarra, NSW
Noise and Vibration Management Plan

Typical worst-case construction noise levels - Bulk Earthwork

Client: Fulton Hogan
Drawn by: TRE
Checked by: AP
Dated: August 2018
Page size: A3
Data sources: FH / RMS

Legend

- Road Design
- Noise Catchment Area

Typical worst case construction noise level, LAeq,15min

- 45 dB
- 50 dB
- 55 dB
- 60 dB
- 65 dB
- 75 dB Highly Noise Affected

0 250 500 750 1000 m

Resonate

Dapto & Yallah Area

NCA15
NCA16
NCA14
NCA12
NCA13
NCA11

APPENDIX B
FIGURE 4b

ALBION PARK RAIL BYPASS
Illawarra, NSW
Noise and Vibration Management Plan

Typical worst-case construction noise levels - Bulk Earthwork

Client: Fulton Hogan
Drawn by: TRE
Checked by: AP
Dated: August 2018
Page size: A3
Data sources: FH / RMS

Legend

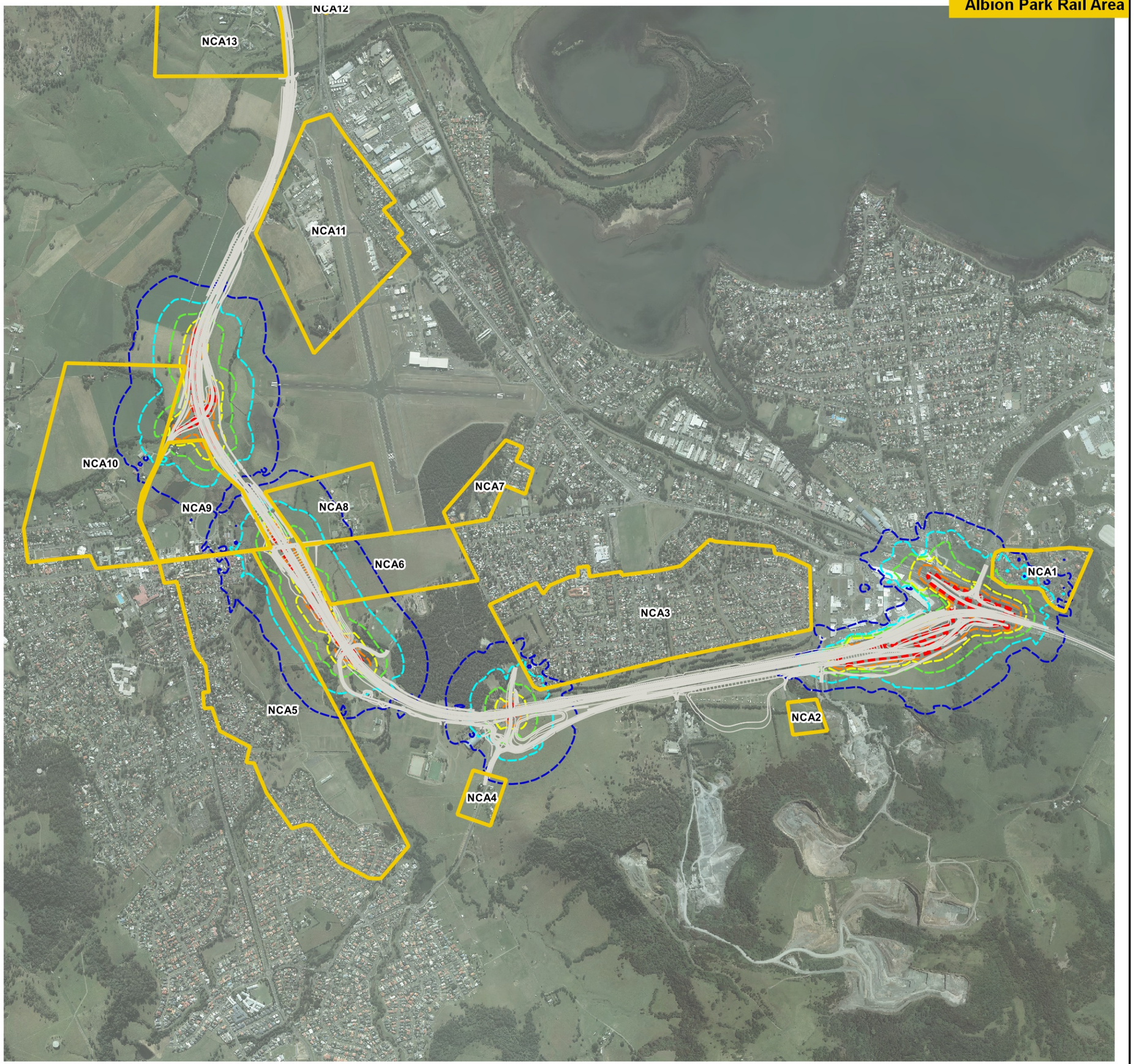
- Road Design
- Noise Catchment Area

Typical worst case construction noise level, LAeq,15min

- 45 dB
- 50 dB
- 55 dB
- 60 dB
- 65 dB
- 75 dB Highly Noise Affected

0 250 500 750 1000 m

Resonate



APPENDIX B
FIGURE 5a

ALBION PARK RAIL BYPASS
Illawarra, NSW
Noise and Vibration Management Plan

Typical worst-case construction noise levels - Bridgework

Client: Fulton Hogan
Drawn by: TRE
Checked by: AP
Dated: August 2018
Page size: A3
Data sources: FH / RMS

Legend

- Road Design
- Noise Catchment Area

Typical worst case construction noise level, LAeq,15min

- 45 dB
- 50 dB
- 55 dB
- 60 dB
- 65 dB
- 75 dB Highly Noise Affected

0 250 500 750 1000 m

Resonate

APPENDIX B
FIGURE 5b

ALBION PARK RAIL BYPASS
Illawarra, NSW
Noise and Vibration Management Plan

Typical worst-case construction noise levels - Bridgework

Client: Fulton Hogan
Drawn by: TRE
Checked by: AP
Dated: August 2018
Page size: A3
Data sources: FH / RMS

Legend

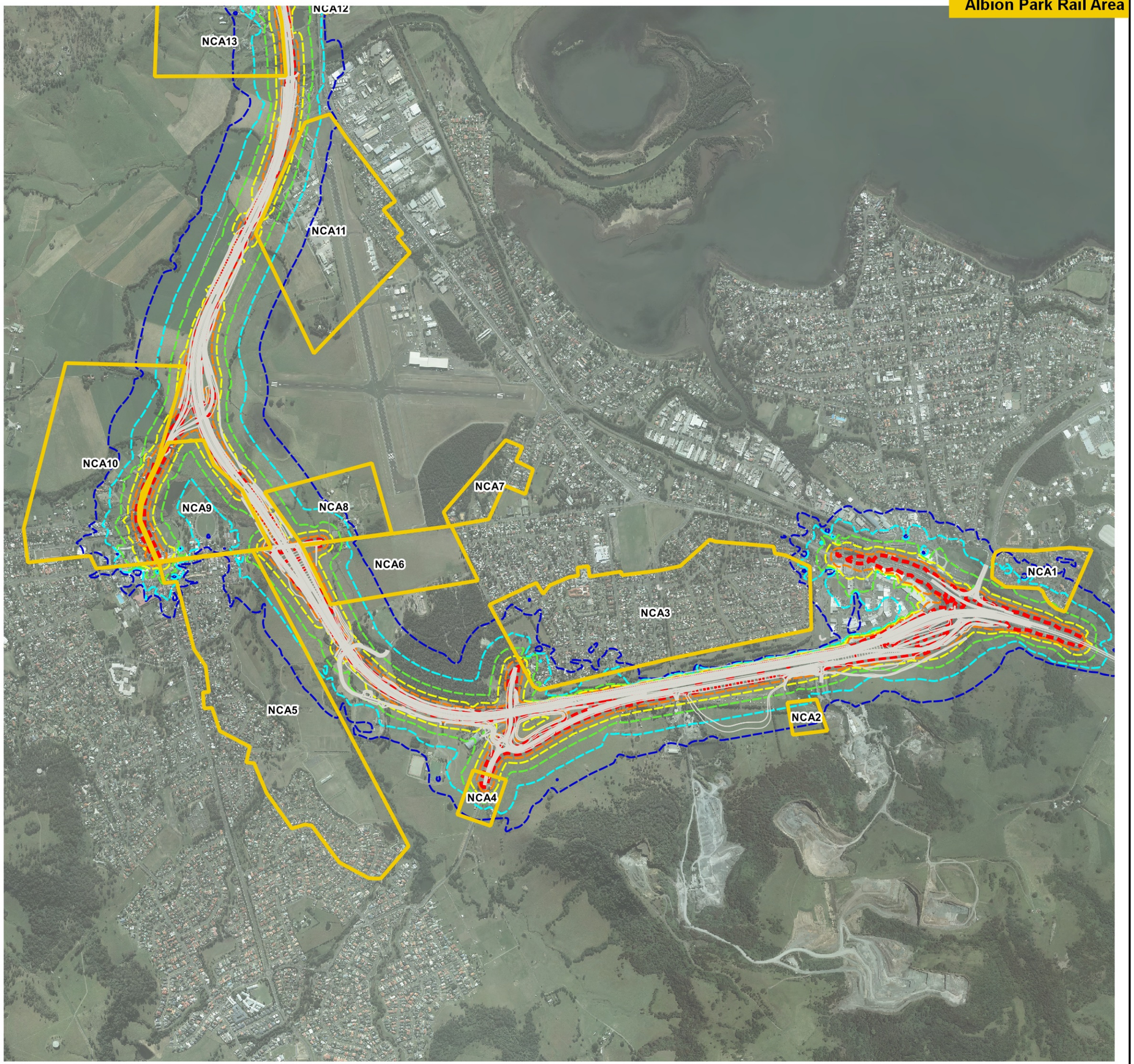
- Road Design
- Noise Catchment Area

Typical worst case construction noise level, LAeq,15min

- 45 dB
- 50 dB
- 55 dB
- 60 dB
- 65 dB
- 75 dB Highly Noise Affected

0 250 500 750 1000 m

Resonate



APPENDIX B
FIGURE 6a

ALBION PARK RAIL BYPASS
Illawarra, NSW
Noise and Vibration Management Plan

Typical worst-case construction noise levels - Finishing Work

Client: Fulton Hogan
Drawn by: TRE
Checked by: AP
Dated: August 2018
Page size: A3
Data sources: FH / RMS

Legend

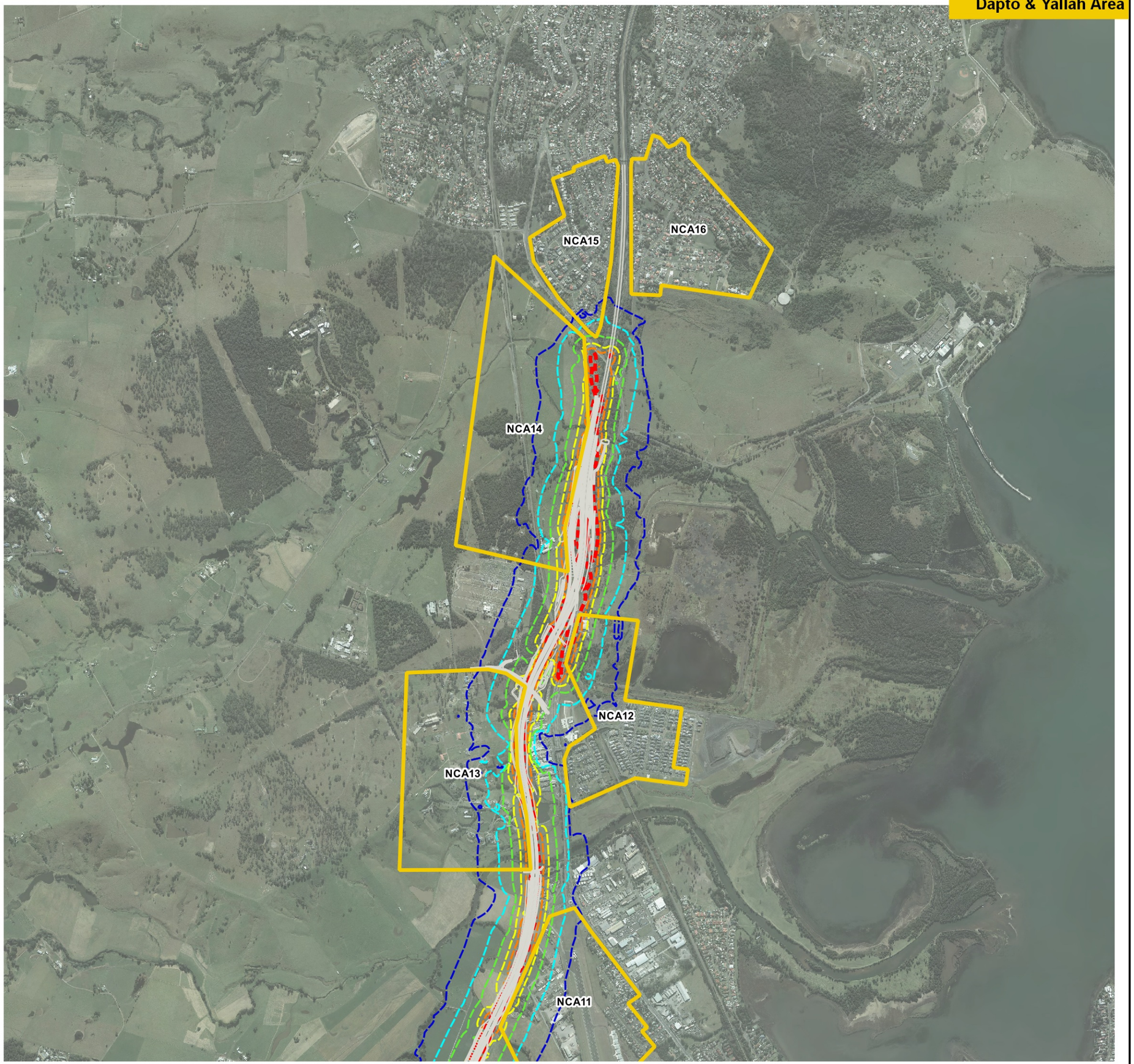
- Road Design
- Noise Catchment Area

Typical worst case construction noise level, LAeq,15min

- 45 dB
- 50 dB
- 55 dB
- 60 dB
- 65 dB
- 75 dB Highly Noise Affected

0 250 500 750 1000 m

Resonate



APPENDIX B
FIGURE 6b

ALBION PARK RAIL BYPASS
Illawarra, NSW
Noise and Vibration Management Plan

Typical worst-case construction noise levels - Finishing Work

Client: Fulton Hogan
Drawn by: TRE
Checked by: AP
Dated: August 2018
Page size: A3
Data sources: FH / RMS

Legend

- Road Design
- Noise Catchment Area

Typical worst case construction noise level, LAeq,15min

- 45 dB
- 50 dB
- 55 dB
- 60 dB
- 65 dB
- 75 dB Highly Noise Affected

0 250 500 750 1000 m

Resonate

Albion Park Rail Area

NCA12
NCA13
NCA11
NCA10
NCA9
NCA8
NCA7
NCA6
NCA3
NCA1
NCA5
NCA2
NCA4

APPENDIX B
FIGURE 7a

ALBION PARK RAIL BYPASS
Illawarra, NSW
Noise and Vibration Management Plan

Typical worst-case construction noise levels - Construction Compounds

Client: Fulton Hogan
Drawn by: TRE
Checked by: AP
Dated: June 2018
Page size: A3
Data sources: FH / RMS

Legend

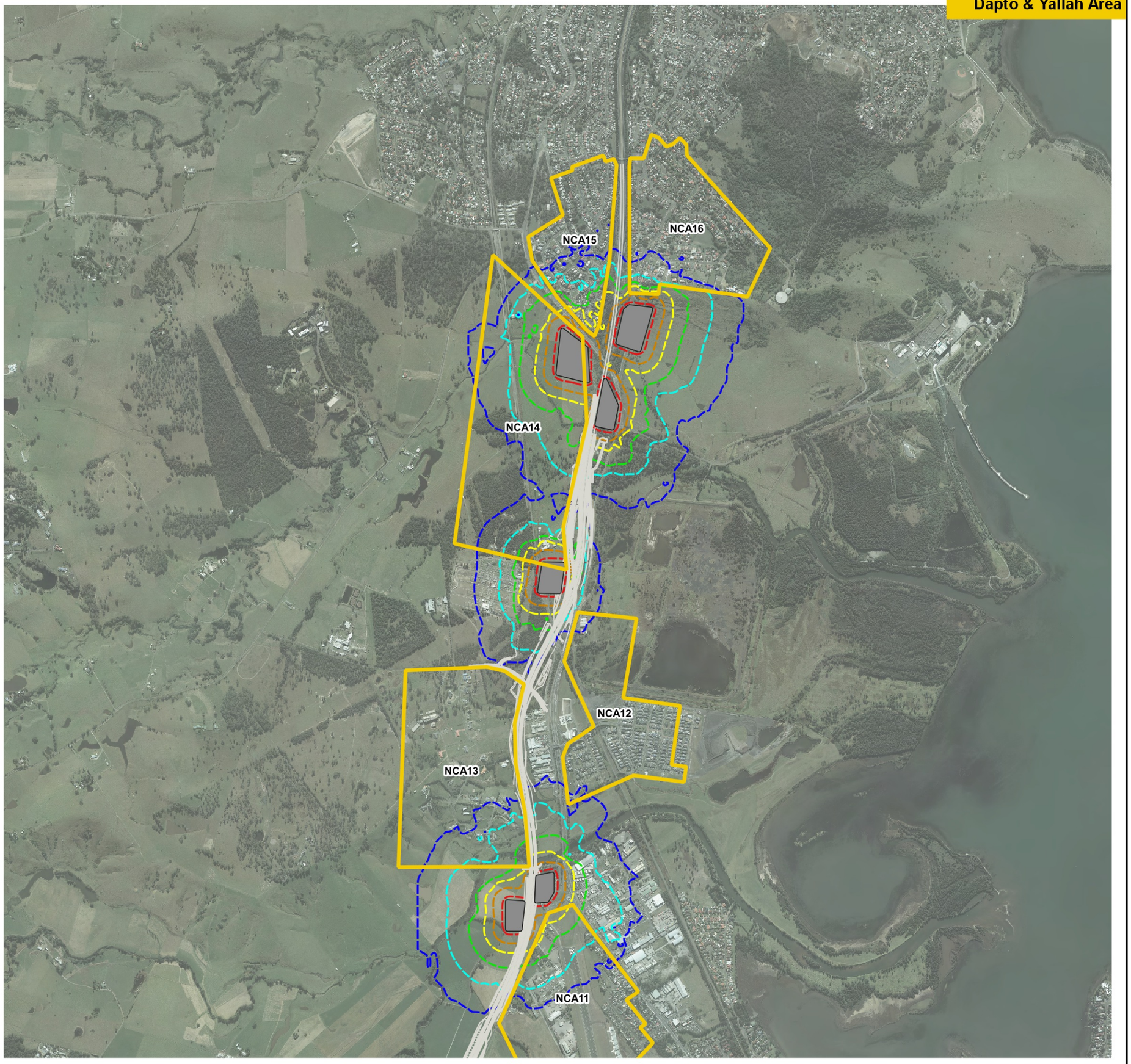
- Road Design
- Noise Catchment Area
- Potential Compound Site

Typical worst case construction noise, LAeq,15min

- 45 dB
- 50 dB
- 55 dB
- 60 dB
- 65 dB
- 75 dB Highly Noise Affected

0 250 500 750 1000 m

Resonate



APPENDIX B
FIGURE 7b

ALBION PARK RAIL BYPASS
Illawarra, NSW
Noise and Vibration Management Plan

Typical worst-case construction noise levels - Construction Compounds

Client: Fulton Hogan
Drawn by: TRE
Checked by: AP
Dated: June 2018
Page size: A3
Data sources: FH / RMS

Legend

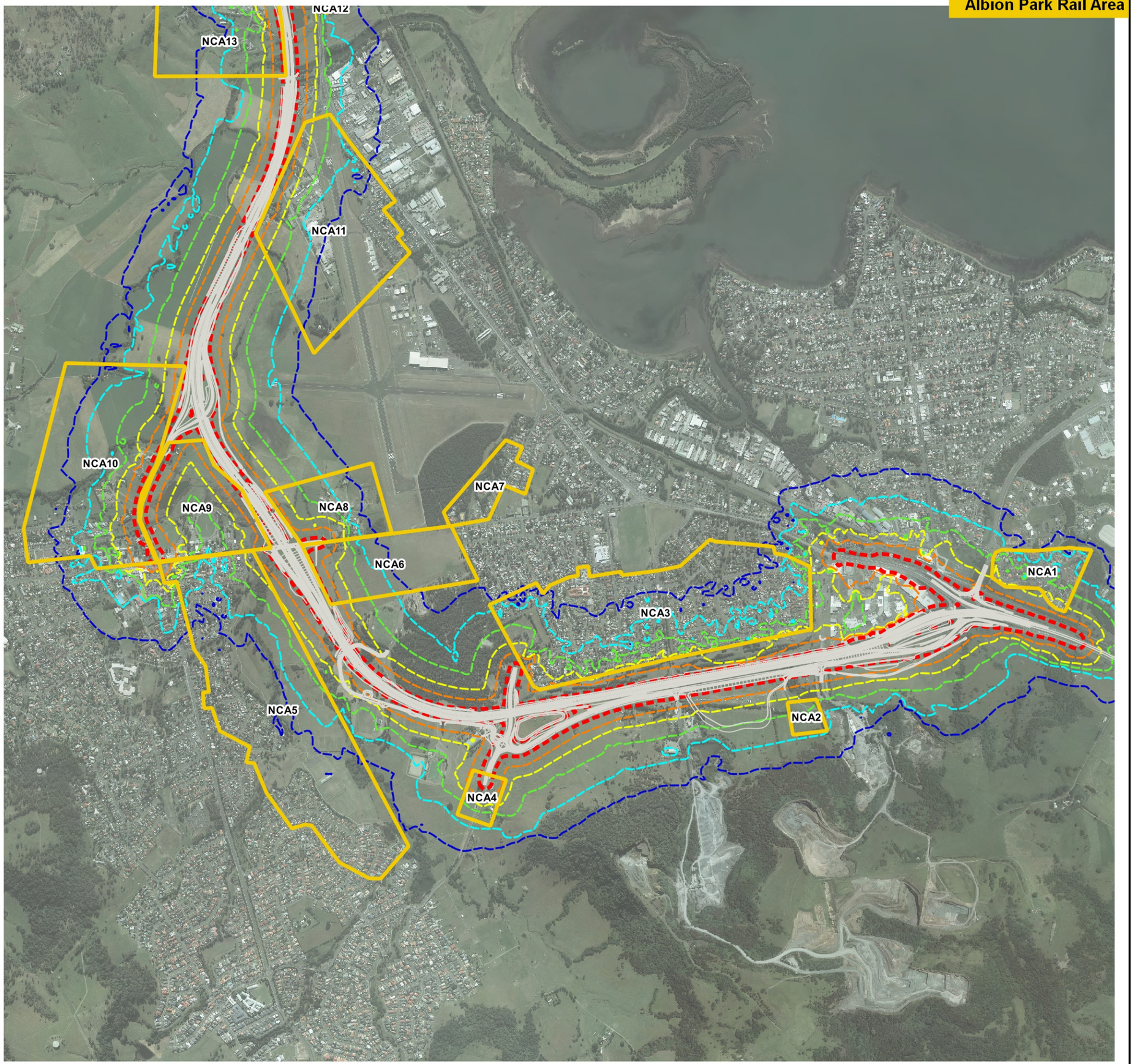
- Road Design
- Noise Catchment Area
- Potential Compound Site

Typical worst case construction noise, LAeq,15min

- 45 dB
- 50 dB
- 55 dB
- 60 dB
- 65 dB
- 75 dB Highly Noise Affected

0 250 500 750 1000 m

Resonate



APPENDIX B
FIGURE 8a

ALBION PARK RAIL BYPASS
Illawarra, NSW
Noise and Vibration Management Plan

Typical worst-case construction noise levels - Material Processing

Client: Fulton Hogan
Drawn by: TRE
Checked by: AP
Dated: August 2019
Page size: A3
Data sources: FH / RMS

Legend

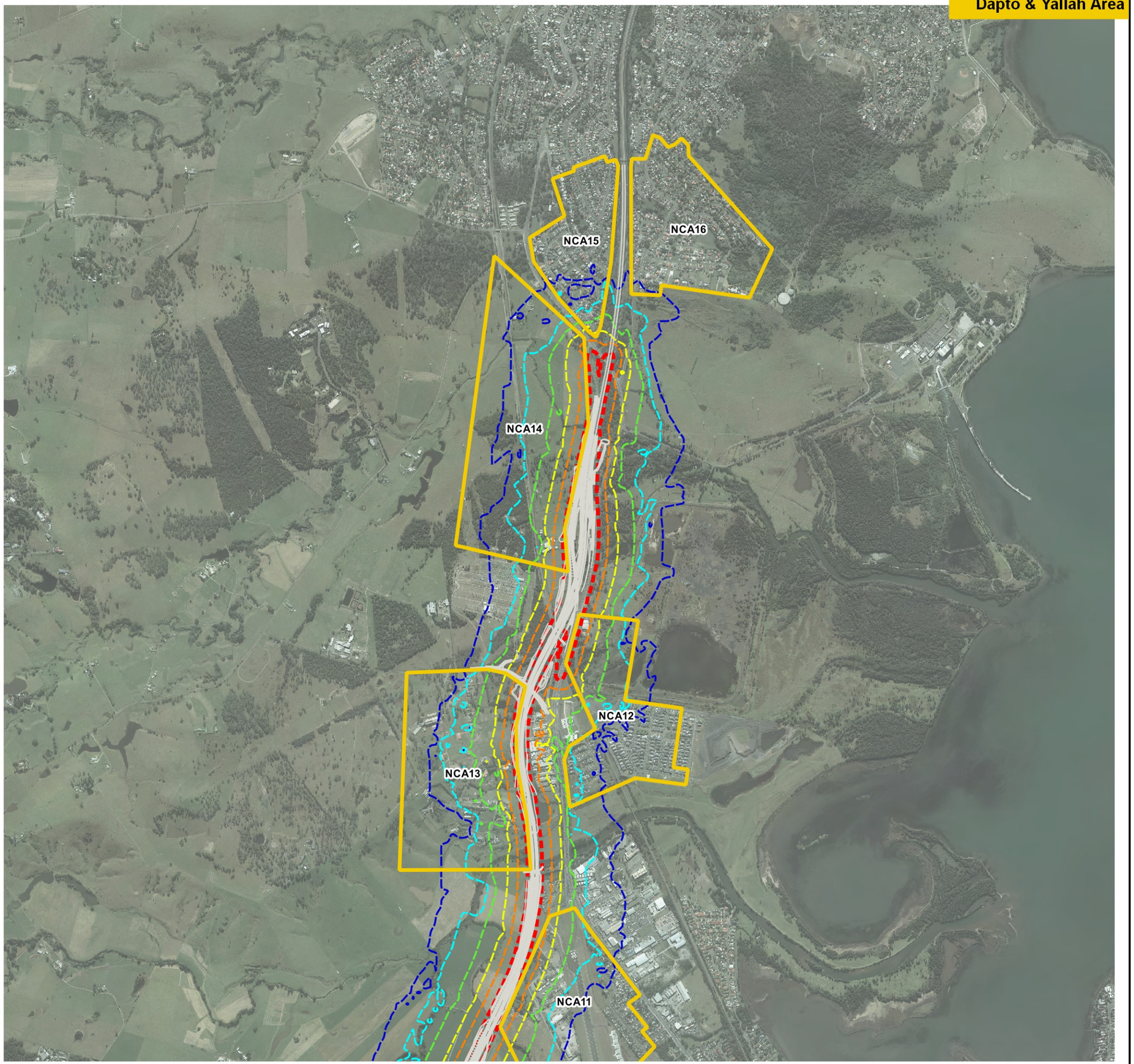
- Road Design
- Noise Catchment Area

Typical worst case construction noise level, LAeq,15min

- 45 dB
- 50 dB
- 55 dB
- 60 dB
- 65 dB
- 75 dB Highly Noise Affected

0 250 500 750 1000 m

Resonate



APPENDIX B
FIGURE 8b

ALBION PARK RAIL BYPASS
Illawarra, NSW
Noise and Vibration Management Plan

Typical worst-case construction noise levels - Material Processing

Client: Fulton Hogan
Drawn by: TRE
Checked by: AP
Dated: August 2019
Page size: A3
Data sources: FH / RMS

Legend

- Road Design
- Noise Catchment Area

Typical worst case construction noise level, LAeq,15min

- 45 dB
- 50 dB
- 55 dB
- 60 dB
- 65 dB
- 75 dB Highly Noise Affected

0 250 500 750 1000 m

Resonate

Appendix C Out of Hours Work Approval Procedure

This work procedure has been developed to assist compliance with environmental legislation and project obligations, and to effectively manage potential environmental impacts associated with noise during construction of the Project.

It has been prepared in accordance with the Conditions of Approval, Environment Protection Licence (EPL), Interim Construction Noise Guideline (ICNG), Roads and Maritime Construction Noise and Vibration Guideline (CNVG) management measures and Noise and Vibration Management Plan (NVMP). The Procedure is to be applied where Out of Hours Work (OOHW) is proposed for the Project.

Objectives

This procedure outlines the project requirements for construction working hours and documents a process to be implemented when work outside of standard hours is required. The key objective of the procedure is to ensure that impacts to the local community are avoided and minimised and the requirements of the CoA.

Specific objectives include:

- Minimising potential adverse noise impacts to the community;
- Identify sensitive receivers and ensure appropriate noise control measures are implemented during construction activities;
- Ensure appropriate measures are implemented to comply with all relevant legislation and other requirements as described in the NVMP; and
- Ensuring appropriate measures are implemented to meet the CoA and the intent of the ICNG and CNVG.

Project Requirements

In accordance with the CoA, standard construction hours are:

- 7 am to 7 pm Mondays to Fridays inclusive;
- 8 am to 5 pm Saturdays; and
- At no time Sundays or public holidays.

Works carried out during the standard construction hours are not assessed using this OOHW Approval Procedure but are assessed and managed in accordance with the NVMP.

High noise impact works and activities will only be undertaken:

- between the hours of 8 am to 6 pm Monday to Friday;
- between the hours of 8 am to 1 pm Saturday; and
- in continuous blocks not exceeding three hours each with a minimum respite from those activities and works of not less than one hour between each block.

For the purposes of the above condition, ‘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. ‘High noise impact works’ are considered to be those resulting in noise levels above 75 dB $L_{Aeq,(15min)}$ at noise-sensitive receivers and significant high impact works are not expected during the Project construction, particularly during OOHW.

Additional Project requirements include:

- CoA E38 – this condition allows OOHW for certain scenarios that are addressed within this OOHW Approval Procedure.
- CoA E40 – this condition requires Fulton Hogan to notify relevant authorities of any OOHW Emergency Works as soon as possible, and to undertake its best endeavours to notify affected sensitive receivers.

Environment Protection Licence

Where an EPL is issued for the Project, OOHW will need to be conducted in accordance with the EPL.

Expected OOHW

The Project involves significant construction works for a new road as well as upgrade works Motorway where the Project connects in. Therefore it is likely that, from time to time, work outside of standard working hours and outside of the extended approved hours will be required. OOHW that are expected as part of the Project will include:

- Installation and removal of main site office buildings for some ancillary sites.
- Temporary barrier installation, adjustment and removal on major existing roads.
- Earthworks and embankment construction around the Oak Flats interchange.
- Service relocations at some existing roads that interchange with the Project.
- Pavement construction, profiling and line-marking on major existing roads where Project works are occurring.
- Drainage works near major existing roads.
- Traffic switch works across the site.
- Safety barrier works.
- Traffic control signal works.
- Delivery of pre-cast bridge girders to bridge sites and installation works at some bridges that cross major existing roads.
- Delivery of materials required outside of standard hours by the NSW Police Force or other authorities for safety reasons.
- Emergency works to avoid injury or the loss of life, property and/or to prevent environmental harm.

Details on the locations where OOHW are expected are provided in Section 7.3 of the NVMP.

OOHW Assessment and Application Process

To enable the OOHW listed above to occur outside of standard construction hours, the following process will be implemented:

1. Project engineers will consult with the Environmental Manager (EM) and Community Relations Manager 6 weeks in advance of proposed out of hours works. The engineer is to submit an out of hours works (OOHW) request form (refer to Attachment 1) which will allow the EM to determine the justification for the OOHW and the predicted noise and vibration level (if required).
2. The EM will assess the OOHW request and determine:
    a. If the proposed works are likely to exceed RBL + 5 dB or the Noise Management Levels specified in the Interim Construction Noise Guideline (refer to Table 5-1 of the NVMP) or if they will occur within the safe working distances for human comfort from vibration (refer to Table 7-13 of the NVMP). For the purposes of this OOHW Approval Procedure, works further than 500 m from sensitive receivers can be assumed to not generate noise or vibration levels in excess of the relevant management levels.
    b. If a negotiated agreement has been reached with affected receivers (where permitted by an EPL), for works within 500 m of residences where the prescribed noise and vibration levels cannot be achieved.

c. If the works are for the delivery of materials required outside of standard hours by the NSW Police Force or other authorities for safety reasons.

d. Where it is required in an emergency to avoid injury or the loss of life, property and/or to prevent environmental harm.

3. If items 2c) and/or 2d) apply, then works will be applied for without a specific noise assessment.
4. If the EM determines, based on initial noise assessment, that the works will generate $L_{(Aeq,15min)}$ noise levels that will be significantly less than the NML and no vibration impacts are expected, the OOHW approval form will be submitted to Roads and Maritime for approval. This will include works further than 500 m from receivers. Standard OOHW noise management measures, in accordance with Chapter 8 of the NVMP, will be included in the approval and noise monitoring undertaken.
5. If there is a risk that the noise levels will exceed the relevant NMLs and/or works may occur within the safe working distances for vibration, a Noise and/or Vibration Impact Assessment will be undertaken as described below to assess compliance with the OOHW management levels.

Noise and Vibration Impact Assessment

Where there is a risk that the proposed OOHW will exceed RBL + 5 dB, a noise and vibration impact assessment for the works will be undertaken and include the following:

- Details of the nature and scope of each activity and work, including details of times, vehicles, plant and equipment to be used to undertake that activity or work.
- Analysis to justify the scheduling and duration of each activity and work outside the standard construction hours, including taking into account:
  - the predicted impact on noise sensitive receivers of OOHW; and
  - the preference that high noise impact works be undertaken during the day.
- Analysis to justify use of the selected construction and work methods, plant and equipment compared to alternatives taking into consideration noise and vibration impacts.
- A table showing details of the noise and vibration mitigation measures for each activity and work, including respite periods, proposed to be adopted to minimise noise and vibration impacts on surrounding noise sensitive receivers in each locality.
- A table showing for each activity and work in each noise catchment:
  - the addresses of the most affected noise sensitive receivers;
  - the background noise level for each of the noise sensitive receivers listed in the table;
  - noise management levels as described in Section 4.1.4 of the NVMP;
  - the predicted $L_{Aeq,15min}$ noise level, incorporating any 5 dB correction for particularly annoying activities as listed on page 16 of the ICNG;
  - for night works, the predicted $L_{Aeq,1min}$ noise level, incorporating any 5 dB correction for particularly annoying activities as listed on page 16 of the ICNG; and
  - an assessment of sleep disturbance as set out in Section 4.3 of the ICNG (DECC, 2009), where works are planned to extend over more than two consecutive nights within 400 m of a particular residence.
- Details of the specific noise mitigation measures to be adopted in respect of any activity or work predicted to generate noise levels at any noise sensitive receiver exceeding the noise affected $L_{Aeq,15min}$ level of background plus 5 dB outside the standard hours and/or exceeding an $L_{Aeq,1min}$ level of 15 dB. The details should include predictions showing that the mitigation measures reduce the predicted noise levels to be compliant with the noise affected levels.

- A diagram showing noise and vibration monitoring locations in relation to each of the most affected noise sensitive receivers for each activity and work in each noise catchment.
- Community notification and consultation requirements as per the CCS and OOHW mitigation measures detailed in Chapter 8 of the NVMP that are dependent on the predicted noise level.

Following the completion of the noise and vibration impact assessment, the EM will document the assessment required by this condition in a report, including the OOHW risk factor.

The assessment will be included as part of the OOHW application for Roads and Maritime approval. Applications for approval of OOHW with medium or high risk factors must be supported by a construction noise impact assessment as detailed above. Specifically, this includes:

- Works with the potential for sleep disturbance exceedances;
- Works at night time
- Prolonged OOHW (> 1 week)
- OOHW with impulsive noise such as vibratory rolling or rock-breaking.

Noise and Vibration Monitoring

The EM will ensure that the following noise and vibration monitoring is undertaken for all OOHW where the NMLs are predicted to be exceeded by at least 5 dB and/or where vibration levels are predicted to exceed human comfort criteria:

- Undertake attended noise and/or vibration monitoring at representative stages of the activity or work to confirm whether the noise and vibration predictions in its noise and vibration assessment were accurate.
- Where noise monitoring indicates that the activity, work or combination of simultaneous activities or works has caused or is causing noise or vibration levels higher than the predicted levels at any noise sensitive receiver (i.e. difference of greater than 3 dB), mitigation and management measures will be re-evaluated and re-assessed as part of an OOHW application.

Monitoring will also be undertaken at any location where 2 or more complaints are received about the specific OOHW activity or works on the telephone complaints line.

Community Notification

The Community Relations Manager will notify the community in accordance with the Community Consultation Strategy (CCS) and in accordance with the OOHW mitigation measures listed in Chapter 8 of the NVMP. This notification will:

- Be made by targeted letterbox drop, door knock, phone call or email to noise sensitive receivers as detailed in Chapter 8.3 of the NVMP and the CNVG.
- Be posted on the Project website.
- Be made within the timeframes as detailed in Chapter 8.3 of the NVMP and the CNVG before commencement of any OOHW and include:
    - a diagram that clearly identifies the location of the proposed OOHW in relation to nearby cross streets and local landmarks or geographical features;
    - details of the timing, nature, scope and duration of the proposed works and activities;
    - detail of why the proposed works and activities are being undertaken outside of standard construction hours;
    - details of the predicted noise and vibration impacts of the works on identified sensitive receivers;
    - details of all proposed mitigation measures, including respite periods and proposed scheduling;

- details of the types of plant and equipment that will be used to undertake the work;
- details of how complaints may be made and additional information obtained about the work;
- contact details in community languages relevant to the locality; and include notification of any upcoming project community meetings / forums.

Negotiation with Stakeholders

Where permitted by an EPL, negotiation will be undertaken with affected residents for OOHW that may have a considerable noise and/or vibration impact on residences. Following the assessment of OOHW, this will be undertaken for those works that:

- Are not required in accordance with Step 2c) and/or 2d) of the Application Process; and
- Occur within 400 m of one or more particular sensitive receivers; and:
  - Result in predicted noise levels more than 5 dB above the relevant Night NMLs OR
  - May result in vibration levels in excess of the human comfort vibration management levels.

Negotiation with stakeholders will include:

- A discussion of the reasons that OOHW are proposed and alternatives that would occur if the OOHW could not proceed as planned (e.g. significantly longer duration of works at other times).
- A discussion of noise and vibration mitigation and management measures proposed for the works, and alternatives proposed by the stakeholders.
- A discussion of potential scheduling that could be undertaken considering the particular needs of the stakeholders.
- Documentation of the outcomes of the negotiation and submission to relevant authorities.

If agreement is not received for the proposed OOHW with all affected stakeholders, then the EM will consult with relevant approval authorities regarding the works to obtain approval and feedback on the implemented management measures. If approval for these works is not received from the approval authority and agreement has not been reached with the potentially affected stakeholders, the works will not proceed until the proposal has been suitably altered to obtain stakeholder and/or authority approval.

Complaints

Any complaints received as a result of the OOHW are to be managed in accordance addressed in accordance with Section 6.3 of the CEMP and with the Community Communication Strategy. On receipt of two or more complaints regarding OOHW in a particular area, the works will cease until noise monitoring can be undertaken to confirm compliance with the predicted noise levels. If compliant, the works will recommence.

If the noise monitoring determines noise levels greater than predicted, the construction process will be reviewed and additional noise mitigation measures will be implemented where reasonable and feasible.

Record keeping

All OOHWs applications are recorded electronically and documented with a unique identification number. Each application is entered into the OOHW database and tracked accordingly.

All noise monitoring results will be recorded using “Noise Monitoring Field Sheet” and data entered into the noise monitoring database

ATTACHMENT 1 – OUT OF HOURS REQUEST FORM

ALBION PARK RAIL BYPASS – FULTON HOGAN	
Out of Hours Request No:	
Application Date:	
Name of Person Requesting Work:	
Why work outside of standard hours is required? Include any alternatives considered	

CONTACT DETAILS	Name	Mobile number	Email
Contractor's Representative:			
Contractor's 24 Hour Contact:			
Roads and Maritime Project Manager:			
Roads and Maritime Environment & Planning Manager			
Roads and Maritime Public Affairs Manager / Officer			

OUT OF HOURS WORK DETAILS	
Location:	
Description of the Work:	
Proposed Dates / Duration:	
Start Time of Works (each day):	
Finish Time of Works (each day):	
OOHW Period Classification: Period 1 and/or Period 2 as per CNVG	

OUT OF HOURS WORK DETAILS	
Plant and Equipment to be Used: List all plant and noise generating equipment / activities to be used Where plant is not used for entire OOHW period, note when it will be used	
Map Attached showing worksites and nearest noise sensitive receivers	☐ Yes
Names of Foremen Supervising Work:	
Subcontractor Details (if applicable):	
Details on any concurrent OOHW being undertaken in same area (within 500 m):	

NOISE AND VIBRATION	
Distance from works to nearest sensitive receivers:	
Are there any shielding features (barriers / buildings) between works and receivers that can be used to reduce noise levels?	
Could the works generate audible noise or perceptible vibration at the nearest sensitive receivers? Describe plant / equipment / activities that may generate audible noise or perceptible vibration	
Preliminary noise assessment If unsure, acoustic report should be prepared	☐ Less than RBL + 5 dB(A) for $L_{eq,15min}$ and RBL + 15 dB(A) for $L_{eq,1min}$ (select if distance to receivers > 500 m) ☐ Above RBL + 5 dB(A) for $L_{eq,15min}$ or RBL + 15 dB(A) for $L_{eq,1min}$ (NOISE REPORT REQUIRED)
Preliminary vibration assessment If unsure, vibration report should be prepared	☐ Works occurring outside safe working distance for human comfort ☐ Works occurring inside safe working distance for human comfort **(VIBRATION REPORT REQUIRED)**

NOISE AND VIBRATION	
Noise and/or Vibration report attached Check all that apply	☐ Noise ☐ Vibration ☐ Not required
Programming measures to be implemented Detail work programming that will be adopted to minimise impacts on particular receivers	
Noise mitigation measures to be implemented Refer to NVMP and provide specific measures for equipment to be used	
Vibration mitigation measures to be implemented Refer to NVMP and provide specific measures for equipment to be used	
Noise and vibration monitoring to be undertaken? Provide details of location and frequency	

TRAFFIC IMPACTS	
Will the work require traffic control?	
Describe the location and nature of any disruption to traffic from OOHW	
Who is planning the traffic control?	

Who is responsible for traffic control during the work?	

OTHER CONSIDERATIONS		
Identify other potential impacts of the works:	☐ Dust ☐ Lighting ☐ Pedestrian access ☐ Other (specify)	☐ Public transport e.g. schedule changes ☐ Parking ☐ Property access
Describe mitigation measures to be implemented to address these potential impacts		
What lighting is to be provided for night work?		
Does the work team comprise a minimum of two persons?		
Who in the work team holds current senior first aid qualifications?		
Where is the first aid kit to be located?		
What means of communications is to be used to summon assistance in an emergency?		
Has a check of the functionality of the proposed emergency means been made?		

CONSULTATION & NOTIFICATION STRATEGY	
Detail consultation and notification strategy for works Ensure strategy is in accordance with CSCP and NVMP requirements	
Is negotiation required with affected receivers? Refer to situations under which this is required in OOHW Approval Procedure	☐ Yes (Attach negotiation summary and evidence of submission to EPA) ☐ No
If agreement has not been obtained with affected receivers,	☐ Attached (include details below of any EPA requirements)

CONSULTATION & NOTIFICATION STRATEGY	
then consultation must be carried out with EPA	☐ Not required

CONTRACTOR APPROVALS		
ENVIRONMENTAL	NAME: SIGNATURE:	DATE:
COMMUNITY	NAME: SIGNATURE:	DATE:
SAFETY	NAME: SIGNATURE:	DATE:
TRAFFIC	NAME: SIGNATURE:	DATE:

ROADS AND MARITIME REVIEW & APPROVAL	
ROADS AND MARITIME COMMUNICATIONS TEAM Provide comments on consultation and notification strategy	
	☐ Community notification required? ☐ Application on Register?
ROADS AND MARITIME APPROVAL	☐ EPA approval required?
	Approved by Roads and Maritime Representative: NAME: DATE: SIGNATURE:

Appendix D Blast Management Strategy

Fulton Hogan

Blast Management Strategy

Albion Park Rail bypass (Stage 2 – Princes Motorway between Yallah and Oak Flats)

Table of Contents

List of tables

Definitions

Airblast/Overpressure	An airborne shock wave resulting from detonation of explosives caused by overburden movement or the release of expanding gas.
Bench	A horizontal ledge from which holes can be drilled vertically down into the material to be blasted.
Blast, Blasting	The firing of explosive materials for such purposes as breaking rock or other material
Blast Controller	Coordinates and takes overall control of the blasting and associated activities on the day of the blast.
Blast Guard	Controls access at designated areas to ensure the blast area is clear of members of the public and the workforce leading up to and at the time of the blast.
Burden	The distance from the drill hole to the nearest free face.
Drill hole	A hole drilled into the material to be blasted for the purpose to contain the explosive charge.
Flyrock	Rocks propelled from the blast area by the force of an explosion.
Ground Vibration	Movement of the ground by elastic waves emanating from a blast, measured by particle velocity.
Initiation	Detonation in an explosive material
Misfire	A blast, drill hole or explosive material that failed to detonate as planned.
MIC	Maximum Instantaneous Charge. Measured in kilograms, is the maximum amount of explosive charge to be fired in any one instant of the shot.
Overburden	Material of any nature lying on top of a deposit that is to be blasted.
Particle Velocity	A measure of the intensity of ground vibration.
Sensitive Receiver	People, property, environment and infrastructure susceptible to the effects from blasting.
Shotfirer	The qualified person responsible for the loading and firing of a blast.
Spacing	Distance between drill holes.
Stemming	Inert material placed into the drill hole on top of or between separate charges of explosive material. Used to confine the explosives.
VMS	Variable Message Signs

1. Introduction

This Blast Management Strategy (BMS) outlines the risks, responsibilities and procedures to be used by Fulton Hogan to effectively manage the anticipated blasting activities during construction of the Albion Park Rail bypass (Stage 2 – Princes Motorway between Yallah and Oak Flats) (the Project). This is to be read in conjunction with the Fulton Hogan Explosives Procedure.

This BMS has been prepared to address the requirements of the Ministers' Conditions of Approval (CoA), the Albion Park Rail Bypass Environmental Impact Statement (EIS), as amended by the Submissions and Preferred Infrastructure Report (SPIR), including the revised environmental management measures (REMM) listed in the SPIR and G36 Clause 4.7.3.

2. Legal and Other Requirements

Refer to Chapter 3 of the Noise and Vibration Management Sub-plan (NVMP) for Environmental requirements, including the CoA and REMM.

3. Existing Environment

3.1. Sensitive Receivers

There are two large residential areas and one large industrial area in the vicinity of Cut 5. From the initial vibration impact assessment, smaller blocks have been highlighted as potentially receiving vibration from blasting. The locations of these sensitive receivers in the vicinity of blasting at Cut 5 are shown in Appendix B. These sensitive receivers are also identified in Table 1 below. The sensitive receivers in industrial area (A1) are densely situated, and are grouped into a block and the closest receivers will be assessed as the defining point for vibration. There are five sets of residential blocks that are highlighted as being sensitive.

Table 1: Sensitive receivers in the vicinity of blasting

ID	Sensitive Receivers
	Cut 5
A1	Industrial Zone to the North of Cut 5 (Durgadin Drive, Shaban Street & Shandan Circuit)
A2	Residential Block to the North West of Cut 5 (20 houses on Jarrah Way)
A3	Residential Block to the North West of Cut 5 (11 houses on Jarrah Way)
A4	Residential Block to the North East of Cut 5 (10 houses on Conway Crescent)
A5	Residential Block to the North East of Cut 5 (6 houses on Conway Crescent)
A6	Residential Block to the North East of Cut 5 (8 houses on Conway Crescent)
A7	33kv Overhead Power Line to the South of Cut 5

4. Blast Criteria

To fully understand the impacts of the proposed blasting at Cut 5 a review was undertaken by John Heilig & Partners in August of 2017 to assess various maximum instantaneous charge (MIC) levels and the subsequent vibration impacts. This report is included as Appendix A.

Table 2 shows the Project limits for Vibration and Air Blast for the sensitive receivers shown in Appendix B.

The blasting criteria may be exceeded where written agreement has been obtained from the landowner to increase the relevant criteria in accordance with the requirements of CoA E45.

Table 2: Project Vibration and Air Blast Limits for Blasting

ID	Receiver	Nearest Distance (m)	Peak Particle Velocity (mm/s)	Air Blast (dBL)	MIC(1) (kg)
	Cut 5				
A1	Industrial Zone to the North of Cut 5 (Durgadin Drive, Shaban Street & Shandan Circuit)	60	25	120	TBA
A2	Residential Block to the North West of Cut 5 (20 houses on Jarrah Way)	233	10	120	TBA
A3	Residential Block to the North West of Cut 5 (11 houses on Jarrah Way)	358	10	120	TBA
A4	Residential Block to the North East of Cut 5 (10 houses on Conway Crescent)	472	10	120	TBA
A5	Residential Block to the North East of Cut 5 (6 houses on Conway Crescent)	567	10	120	TBA
A6	Residential Block to the North East of Cut 5 (8 houses on Conway Crescent)	620	10	120	TBA
A7	33kv Power Line to the South of Cut 5	80	25	120	TBA

Notes: (1) MIC to be calculated using the Nearest Distance and the initial site factors prescribed by Roads and Maritime Specification D&C R44 Clause 4.6.5 when blast designs are developed.

5. Environmental Aspects and Impacts

5.1. Risks Associated with Blasting

The following discusses key risks, mostly related to safety, associated with the planned blasting activities on the Project.

5.1.1. Plant or Personnel in Blast Zone

At the time of handing over to the shot firer, all public, site personnel and plant will be clear of the blast zone. Initially, this exclusion limit will be set to a 300 metre radius. This zone relates to people being either outside or in a vehicle. Buildings within this radius will be either evacuated, or a blast warden will be positioned within the building to ensure all people remain inside and away from windows. The buildings on Durgadin Drive are 60 metres from the closest point of blasting to the closest point of the building, however this is the rear of the building and the construction is >6 metres solid wall with no windows or pedestrian access. The access is from the front of the building on Durgadin Drive and the distance to this point is 90 metres. This exclusion zone will be documented within the Blast Procedure. After a sufficient number of blasts have been completed, a risk assessment may be undertaken considering the performance of the completed blasts with the intention of reducing this radius to 150 metres.

5.1.2. Flyrock

Blast designs are completed for every blast to ensure that the explosive is correctly proportioned to the rock type and the explosive energy upon detonation is contained within the rock mass. Contributing blast parameters that can lead to a flyrock event are:

- Insufficient stemming length
- Poor stemming type / particle size / particle shape
- Insufficient front burden
- Weak rock seams or broken ground
- Overloaded blast hole
- Powder Factor too high, and
- Excessive ground water.

Drillers will record any geological features encountered while drilling the blast holes on the drill sheet and these records will be used to adjust explosive quantities as required i.e. Holes where broken ground or seams are encountered will be down loaded to ensure that the explosive gases do not cause weak rock to be ejected from these areas.

Blasts will be recorded by video to ensure that reviews of blast performance and trends of potential flyrock incidents are identified and refinements made for future blasts.

5.1.3. Vibration exceedance

The level of vibration will be controlled by adjusting the amount of explosive that is detonated at any instant (MIC). Site relationships between the distance to the receiver and the MIC will be established for each blast site based on conservative trial blast results and vibration results obtained and analysed during further blast operations.

This will enable vibration calculations to be completed prior to blasting, to ensure compliance with the project vibration limit.

5.1.4. Airblast exceedance

Airblast is the pressure wave produced by the blast and transmitted through the atmosphere. Airblast exceedances are a result of explosive gases venting from the blast (i.e. a flyrock event will most likely be an airblast exceedance).

Weather conditions also contribute to the airblast result from a blast. On a cloudy day with wind blowing in the direction of nearby residents it may be decided to delay the blast or increase the stemming length to avoid exceedance issues.

5.1.5. Free face – fall from heights

Blasting to a free face will assist with fragmentation and excavation by allowing maximum swell to the blasted rock. Blasting to a free face will also assist with vibration levels as the rock has more relief and ability to move, therefore dissipating vibration. The risk that requires controlling when a free face is exposed for blasting is the potential for workers to fall. Suitable control measures will be addressed in the Safe Work Method Statement (SWMS) consisting of barricading, bunds or other method to remove the potential for workers to fall.

5.1.6. Explosives on site

Explosive products are to be kept in the explosive delivering vehicle within the certified storage magazines until they are required. It is important that detonators or explosive product is not carelessly placed on the ground during loading as there is the potential that it is lost and will remain a risk of detonation following the blast. The shotfirer will ensure that only the required explosives are placed at each hole to be loaded and the quantity checked against the blast design to ensure that all explosives are accounted for.

5.1.7. Excavation of blasted rock – potential to discover undetonated explosives

Following each blast, the shotfirer will inspect all surface detonators and the movement of the blasted rock to determine that all explosives have detonated prior to giving the 'All-clear' call. Toolbox talks will be developed to familiarise personnel with the different products utilised in blasting so they are able to identify potentially dangerous materials. A SWMS will be developed for the excavation of blasted material to address the specific control measures.

5.1.8. Interaction with Road Users

Due to the proximity of the East West Link, Princes Highway and other local roads, traffic control will be deployed for road closures on several occasions. While this will control the proximity of motorists, additional controls will be put in place to ensure there is no damage to pavements from fly rock or debris on the road prior to releasing traffic.

6. Blast Design and Execution

6.1. Scope of Blasting

Thorough analysis of the available geotechnical data within the project boundary shows significant masses of High Strength rock belonging to either the Sandstone (SR3) or Latite (IR3) units. The defect spacing, extent of fractures found naturally in the rock mass and the seismic velocities have been reviewed to estimate the most suitable excavation method. The estimated volume of material to be blasted and the approximate number of blasts is identified in Table 3 below. Blasting activities will include pre-splitting for the formation and protection of cut batters, and burden blasting for the mass excavation of the cut.

Table 3: Estimated volume of material to be blasted and approximate number of blasts

Location	Approximate Chainage		Estimated Volume to Be Blasted (m^3)	Approximate Number of Blasts (1)
	From	**To**		
Cut 5	24,900	25,250	107,000	20

Notes: (1) These are approximate values only and are subject to change. Production calculations are yet to be finalised.

Blasting may be required in additional areas if rock masses encountered vary from what is expected. This BMS will be revised to include any additional areas prior to commencement of blasting.

6.2. Blast Program

Table 4 below shows the programmed blasting period for Cut 5.

Table 4: Blast Program

Location	Quarter 1 2019	Quarter 2 2019	Quarter 3 2019	Quarter 4 2019	Quarter 1 2020	Quarter 2 2020	Quarter 3 2020
Cut 5			X	X	X		

6.3. Approved Times for Blasting

In accordance with the CoA E42, blasting is permitted during the following hours:

- 9:00am to 5:00pm, Monday to Fridays, inclusive,
- 9:00am to 1:00pm on Saturdays, and
- at no time on Sundays or Public Holidays.

The timing of each blast will consider the approval times for any traffic control associated with the blast, time required to load and fire the shot and any contingency time required to manage any specific risks.

6.4. Planning

CoA specific to blasting and noise and vibration in general are listed in the NVMP.

Prior to commencement of Blasting, the following approvals will be obtained (in addition to other approvals required as detailed in the CEMP):

- Approval of each Blast Procedure in accordance with Roads and Maritime Specification D&C R44 Clause 4.6.1
- Approval of a specific Traffic Control Plan (TCP) to control the exclusion zone for a blast.

6.5. Dilapidation Reports

A Dilapidation Report will be completed for all properties within 500m of the blast area one month prior to commencement of blasting. Surveys of buildings and structures will also be undertaken immediately following a monitored exceedance of the relevant vibration criteria where applicable.

A copy of the relevant Dilapidation Report will be provided to each resident prior to commencement of blasting.

6.6. Traffic Control

To ensure the safety of local and highway traffic, roads will be closed when they are within the blast exclusion zone of 300m. This will occur in regard to Cut 2a, Cut 3 and Cut 4.

TCP's will be developed in accordance with Chapter 9 of the Traffic and Transport Management Sub-plan. Consultation and notification will be carried out in accordance with the Road Occupancy License requirements and the *Community Communication Strategy*. Traffic disruptions will be conveyed to the travelling public by use of Variable Message Signs (VMS) set up on the Princes Highway at a location to be determined as suitable.

6.7. Blast Procedure

Each location requiring blasting will have its own individual Blast Plan, which will include but not necessarily be limited to:

- A Risk Assessment for Drill and Blast activities for the specific location
- A SWMS for drill and blast activities
- A Blast Design
- A restricted access sketch showing Blast Sentry locations and the area to be evacuated

Community Consultation will be carried in accordance with the *Community Communication Strategy (CCS)*.

Detailed site procedure to:

- Ensure Sentries are in place and site is controlled
- Area is free from personnel (excluding shotfirer and assistants)
- Traffic control is in place where required
- Hand over to shotfirer
- Shot Firing sequence including specific warning sounds, radio calls and the procedure to follow in the event of a misfire
- Release of the site from the shotfirer, and
- Assessment of the shot to ensure stability prior to releasing traffic and removing sentries

6.8. Blast Designs

Blast designs will be developed for each blast by experienced and qualified personnel to ensure that the required blast outcomes are achieved. The objectives for each blast design are to ensure:

- Flyrock is not produced from the blast

- Vibration and Airblast Limits are not exceeded
- Damage to batters is prevented
- Required fragmentation of shot rock is achieved, and
- No community complaints.

Blast designs will be finalised following trial blasting and establishment of site constants in each area, and will include the following information which will be submitted as Hold Points in accordance with Roads and Maritime *Specification D&C R44* Clause 4.6.1:

- Details of the quantity and type of explosive to be detonated
- The blasting pattern
- Vibration sensitive receivers for the specific blast and noise monitoring locations
- Measures to limit noise / airblast overpressure
- The calculated Maximum Instantaneous Charge (MIC) of explosives and the predicted vibration levels at the sensitive receivers
- Location and Time of blast
- Shotfirer name and copy of License

6.9. Trial Blasting

Trial blasting will be using the following methodology:

- A single charge will be detonated in a confined blast hole at the blast site with monitors set to record the vibration. This charge will be approximately 20% of the charge calculated using the Australian Standard *AS2187* Appendix J7.3 vibration equation to comply with the vibration limit for the nearby residences. The monitor will then be checked and calculations made to determine the site relationship between charge mass, distance and vibration level.
- If appropriate, the charge will then be increased by small increments on the required number of occasions to obtain the required information to develop the specific site laws which will be used to determine the MIC permitted for future blasting.

6.10. Transport and Use of Explosives

There will be no storage of explosive on site other than on the day of loading. The explosives will be kept in the licensed explosive delivery vehicle until required for loading into blast holes. Explosive material will be under the instruction of the shotfirer.

Transport of explosives will be by a licensed explosive supplier on the day of each blast. Transport will be carried out in accordance with relevant legislation and Australian Standard *AS2187.*

6.11. Sleeping of Shots

If blasts are required to be fired on the day following loading, a specific Risk Assessment must be completed with suitably qualified personnel. As a minimum, the following controls will be implemented:

- A security guard will be used to guard the blast to prevent interference
- All blast holes with explosives loaded into them will be stemmed off to prevent the removal of any explosive product, and
- The surface detonator will not be connected until the blast day.

7. Mitigation Measures

Specific mitigation measures to address potential blasting impacts are outlined in Table 5.

Table 5: Blast mitigation measures

ID	Mitigation Measure	Timing		Responsibility
		PC[1]	C[2]	
BMM1a	Conduct dilapidation surveys on dwellings, surrounding assets and heritage items prior to blasting operation commencing	✓		Project Engineer
BMM1b	Conduct archival recording of relevant non-aboriginal heritage items where there is a potential impact of any application for increased blasting criteria	✓		Environmental Manager / Project Engineer
BMM2	Identify key dwellings near blasting operations and develop a communication strategy for opening and maintaining communication with them throughout the blasting operations	✓		Project Engineer
BMM3	Engage a suitably qualified and experienced subcontractor to perform the drill and blast works	✓		Project Manager
BMM4	Engage a suitably qualified and experienced Drill and Blast consultant to be available for blast designs and verification of subcontractor works	✓		Project Manager
BMM5	Program blasts to occur on Monday to Friday between the hours of 9am-5pm		✓	Superintendent, Project Engineer
BMM6	Conduct a trial blast of limited size to determine site constants for future blast designs		✓	Superintendent, Project Engineer
BMM7	Ensure correct stemming length is designed for and verified on site at the time of loading		✓	Foreman / Site Engineer
BMM8	Monitor and record drilling depths and drilling conditions encountered to ensure overloading of holes does not occur and any weak seam can be identified and managed for venting or fly rock		✓	Foreman / Site Engineer
BMM9	Audit hole diameters and drill bit diameters		✓	Foreman / Site Engineer
BMM10	Ensure blast monitoring is undertaken in accordance with the blast design and instruments are suitably verified as in good working order		✓	Foreman / Site Engineer
BMM11	Fire presplit before production blasts to reduce vibration transfer		✓	Superintendent, Project Engineer
BMM12	Fire shots to a free face to reduce contained energy when possible		✓	Superintendent, Project Engineer
BMM13	Load shots to a charge weight unless the hole depth and diameter is verified and the rise of charge required is calculated.		✓	Foreman / Site Engineer
BMM14	Review weather forecasts and consider the weather and its potential effects on the airblast readings for the shot		✓	Foreman / Site Engineer
BMM15	Put in place an exclusion zone of not less than 300 metres for shot firing. This is to include appropriate traffic control measures to detour traffic or close roads as necessary. This will be assessed and potentially reduced to 150m under consultation with the shot firer.		✓	Superintendent, Project Engineer
BMM16	Record each blast on video to assess the performance of the blast and refine the design where appropriate.		✓	Foreman / Site Engineer

ID	Mitigation Measure	Timing		Responsibility
		PC[1]	C[2]	
BMM17	Ensure any fresh concrete placed in the project works and within a 300m radius of blasting activities is greater than 24 hours old prior to firing the shot.		✓	Project Engineer
BMM18	Ensure residents within the defined exclusion zone are either held in their house or removed from the zone for the time of the blast.		✓	Project Engineer
BMM19	Ensure any affected heritage structures are inspected before and after each blast.		✓	Project Engineer

[1] *PC means pre-construction*

[2] *C means construction*

8. Compliance Management

8.1. Roles and Responsibilities

The roles outlined below in Table 6 will control and ensure the safety of the drill and blast operations.

Table 6: Roles and responsibilities

Role	Responsibilities
Shotfirer	Qualified and Licensed person to ensure the safety of blasting works by carrying out best practice blast designs, blast hole loading, stemming, tie-in and initiation of each blast.
Drill and Blast Manager	Ensure that required resources are available to safely carry out blasting works.
Drill and Blast Engineer	Review blast designs, coordinate blasting operations, ensure subcontractor is performing works in accordance with the project Safety, Environmental and Quality requirements. Ensure that project blasting objectives are achieved.
Drill and Blast Supervisor	Coordinate the blast and site personnel for each blast. This includes establishing blast clearance zone, setting blast sentries and traffic controllers, coordinating clearance of the blast zone post shot.
Safety Coordinator	Ensuring that the blasting works are performed safely and in accordance with the safe work method statement.
Environmental Manager	Review blast designs to ensure vibration and airblast limits have been accurately calculated to ensure compliance with license limits for each blast.
Community Relations Manager	Community notification prior to blasting and addressing community concerns or complaints relating to blasting. Coordinate Dilapidation Surveys prior to blasting.
Traffic Manager	Ensure *Traffic Control Plans* are completed in accordance with the *Traffic and Transport Management Sub-plan* and in a timely manner for blasting works.

8.2. Monitoring and Inspections

All blasts will be monitored at the nearest sensitive receivers for vibration and airblast in accordance with Roads and Maritime *Specification D&C R44* Clause 4.6.1 and Clause 4.6.5. There will be a minimum of 3 monitoring locations for each blast with exception of the first Trial Blast, which will have a minimum of 5. The Blast Design will indicate the locations for monitoring for each blast.

As required by Roads and Maritime *Specification D&C R44* Clause 4.6.3, the following information will be recorded and kept with the lot records in accordance with the Project Quality Plan:

- Date, identification number and time of blast
- Location, number and diameter of blast holes loaded
- Depth of each drill hole loaded
- Inclination of drill holes
- Burden(s) and spacing(s)
- Types and amount of explosives used
- Maximum instantaneous charge
- Initiation plan
- Length and type of stemming in each blast hole, and
- Ground vibration and noise levels at measuring locations.

These records will be taken at the time of loading and verified by the shotfirer.

Each blast will be recorded on video to facilitate the assessment of its performance with regards to flyrock potential. The face and crest of the blasts will be captured in this video to determine if

there is any explosive energy that was not contained within the rock mass. This information will then be used when completing future blast designs to control the risk of flyrock.

8.3. Non-conformances

In the event of an exceedance to the project vibration limits, measured at the nearest sensitive receiver, a non-conformance will be recorded in accordance with Section 3.8 of the CEMP. This will include the following actions as a minimum:

- Survey of buildings and structures immediately following a monitored exceedance of the relevant vibration criteria by suitably qualified project staff, and
- Review of the site constant to ensure its suitability for continued use, or amend accordingly.

8.4. Complaints

Complaints will be recorded and addressed in accordance with the CEMP and the *Community Communication Strategy*.

9. Appendices

Appendix A – Heilig & Partners: Review of blasting options at Cut 5

Appendix B – Sensitive receivers surrounding Cut 5

Appendix A – Heilig & Partners: Review of blasting options at Cut 5

HEILIG & PARTNERS
Engineered Excellence

- Tunnelling
- Construction
- Open Pit Mining
- Quarrying
- Underground Mining
- Blast Design
- Blast Permitting
- Vibration Monitoring
- Vibration Analysis
- Expert Witness

91 Burdekin Drive
Sinnamon Park. QLD. 4073. Australia
P.O. Box 1176
Mt.Ommaney QLD. 4074. Australia

Telephone +61 7 3715 7599
Facsimile +61 7 3715 7588

Email group@heiligandpartners.com.au
www.heiligandpartners.com.au

datatrap
vibration management software

Tuesday, August 29, 2017

Ref:jhh:Cut 5 blast options

[redacted]

RE: Review of blasting options for Cut 5

Dear [redacted]

As per the discussions following on from the Cut 1 assessment and based upon our discussions for Cut 5, I have attached to this letter the results from the modelling of explosive quantities for Cut 5. Like Cut 1, the results consider three scenarios although the closest sensitive receivers are commercial and therefore the explosive quantities are not influenced to any degree by the vibration criterion for the residential properties. However as the permissible vibration limit for the commercial properties increases, so too does the allowable explosive weight. The attached plates show that the explosive weights are significantly affected for the lower vibration limit of 5mm/s. the modelled results are as follows:

- Compliance with a 5mm/s vibration limit at both the residential and commercial properties around Cut 5;
- Compliance with a 5mm/s vibration limit at the residential properties and a 10mm/s at the commercial properties
- Compliance with a 10mm/s vibration limit at both the residential and commercial properties around Cut 5.

Previously it was suggested should blasting continue to be considered in this area, it may be prudent to consider motivating for an increased limit beyond 10mm/s at the commercial properties. Given their industrial nature, this would appear very reasonable. A limit such as 25mm/s would continue to ensure the integrity of the structures but at the same time allowing for a more cost effective scale of blasting.

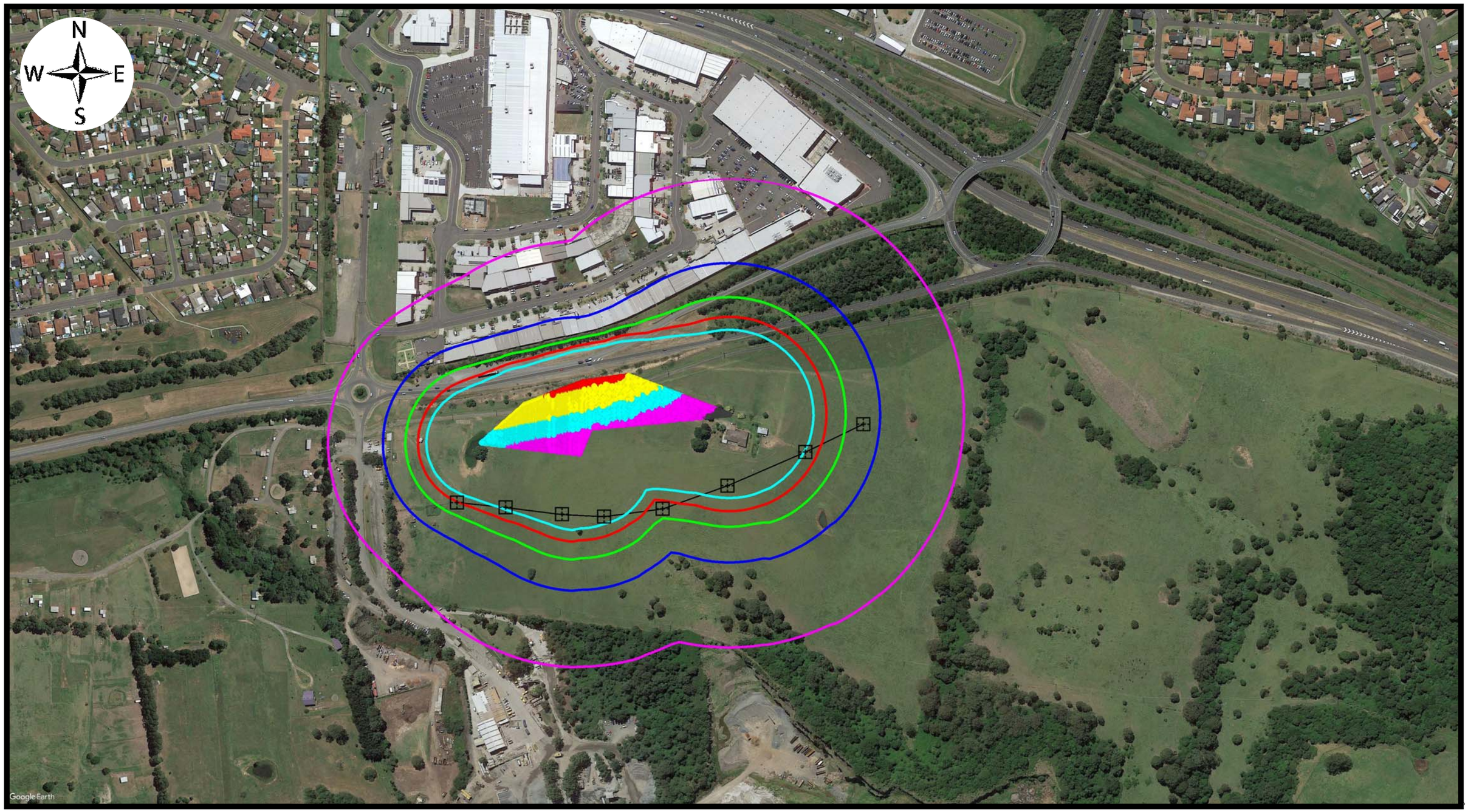
As requested, the locations of the high voltage power lines have also been marked on the drawings. The analyses indicate that based upon the location of the vibration contours, the maximum level that the footings of the high voltage power lines would be subjected to is less than 25mm/s. When compared to the information presented in the Australian Standard AS2187.2 (AS2187.2-2006 Explosives Storage and Use), the impact of this scale of blasting would have no impact on the footing integrity. The AS2187.2 document identities a suitable vibration criteria for the scale of blasting and resulting frequency of vibration as 50mm/s.

As always, you are most welcome to contact me at your convenience to discuss in further detail any of the issues raised in this letter.

Yours truly,

[redacted]

[redacted]



Created using TunnelTRAP Software

SCALE

0 50 100 150 200 250m

Surface Vibration Levels

- 10 mm/s Vibration Contour
- 8 mm/s Vibration Contour
- 6 mm/s Vibration Contour
- 4 mm/s Vibration Contour
- 2 mm/s Vibration Contour

Explosive Quantities

- More than 10 kilograms
- Between 5 and 10 kilograms
- Between 3 and 5 kilograms
- Between 2 and 3 kilograms
- Between 1 and 2 kilograms
- Less than 1 kilogram

Project Description: ALBION PARK - Cut 5 - Modelled explosive weights and associated vibration levels to comply with 5mm/s at adjacent residential properties and 5mm/s at adjacent commercial properties

HEILIG & PARTNERS Engineered Excellence

Telephone +61 7 3715 7599
Mobile 0419 196 369
Facsimile +61 7 3715 7588
Email john@heiligandpartners.com.au
P.O. Box 1176
Mt.Ommaney
QLD. 4074. Australia

Fulton Hogan

Plate No. A

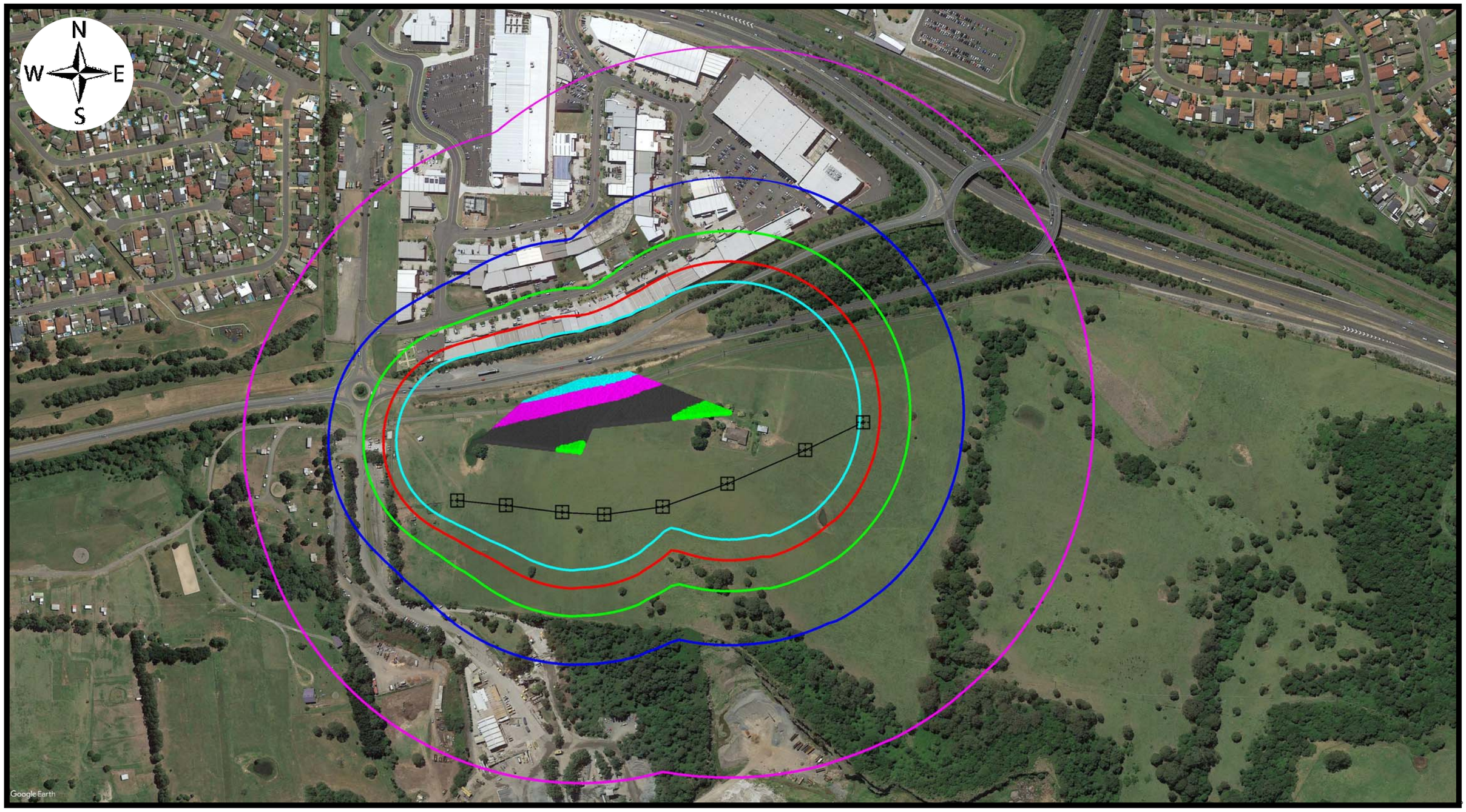
Revision History
R1: Original

Date Drawn:**27 August 2017**

Ref No: Albion Park Cut 5

Job No: HP1708-1

In preparing this drawing, HP have made certain assumptions. We have assumed that all information and documents provided to us by the Client or as a result of a specific request were complete, accurate and up to date. Where we have obtained information from a Government register or database, we have assumed that the information is accurate. Where an assumption has been made, we have not made any independent investigations with respect to the matters the subject of that assumption. We are not aware why any of the assumptions are incorrect.



Created using TunnelTRAP Software

SCALE

0 50 100 150 200 250m

Surface Vibration Levels

- 10 mm/s Vibration Contour
- 8 mm/s Vibration Contour
- 6 mm/s Vibration Contour
- 4 mm/s Vibration Contour
- 2 mm/s Vibration Contour

Explosive Quantities

- More than 10 kilograms
- Between 5 and 10 kilograms
- Between 3 and 5 kilograms
- Between 2 and 3 kilograms
- Between 1 and 2 kilograms
- Less than 1 kilogram

Project Description: ALBION PARK - Cut 5 - Modelled explosive weights and associated vibration levels to comply with 5mm/s at adjacent residential properties and 10mm/s at adjacent commercial properties

HEILIG & PARTNERS
Engineered Excellence

Telephone +61 7 3715 7599
Mobile 0419 196 369
Facsimile +61 7 3715 7588
Email john@heiligandpartners.com.au
P.O. Box 1176
Mt.Ommaney
QLD. 4074. Australia

Fulton Hogan

Plate No. B

Date Drawn: **27 August 2017**

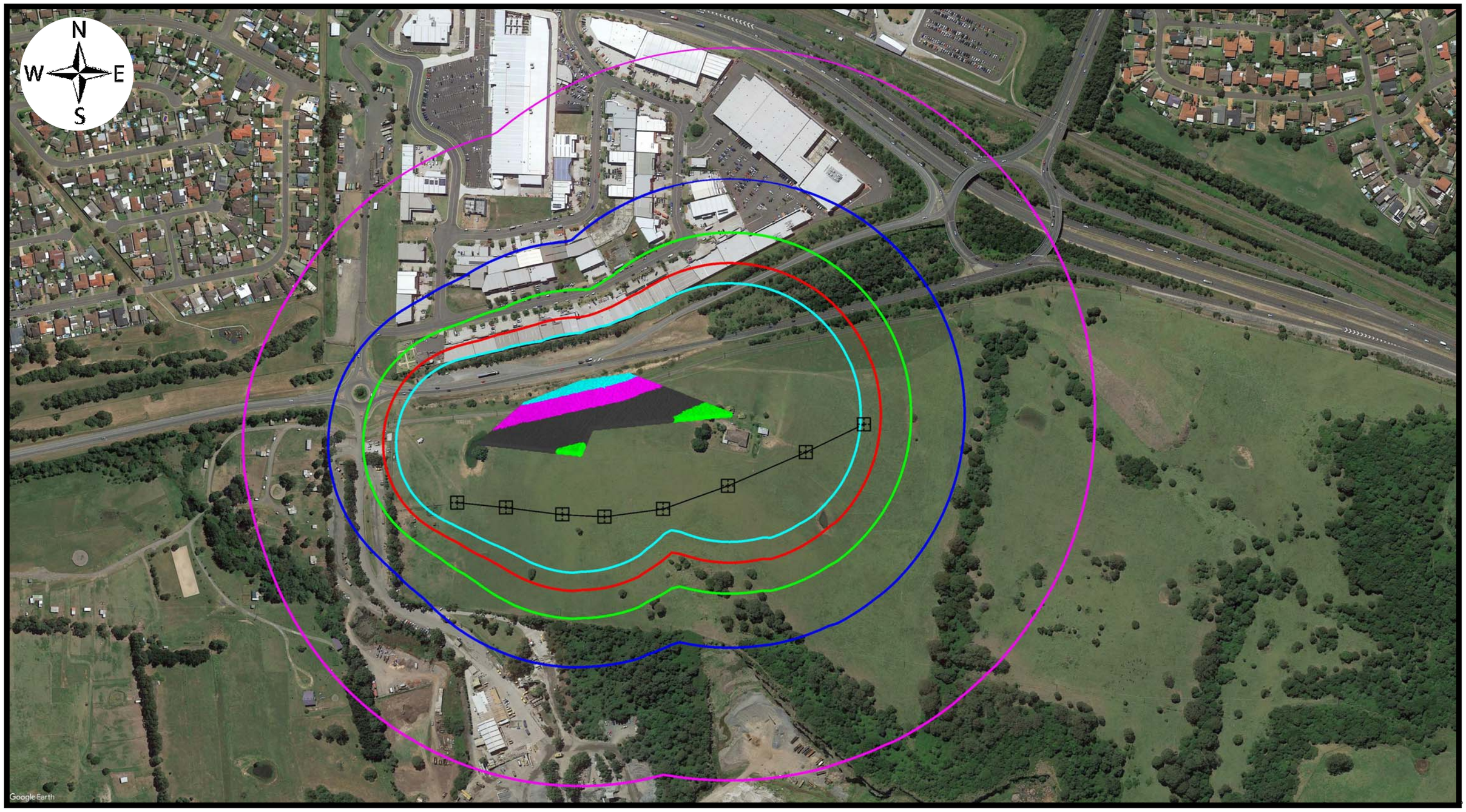
Revision History

R1: Original

Ref No: Albion Park Cut 5

Job No: HP1708-1

In preparing this drawing, HP have made certain assumptions. We have assumed that all information and documents provided to us by the Client or as a result of a specific request were complete, accurate and up to date. Where we have obtained information from a Government register or database, we have assumed that the information is accurate. Where an assumption has been made, we have not made any independent investigations with respect to the matters the subject of that assumption. We are not aware why any of the assumptions are incorrect.



Created using TunnelTRAP Software

SCALE

0 50 100 150 200 250m

Surface Vibration Levels

- 10 mm/s Vibration Contour
- 8 mm/s Vibration Contour
- 6 mm/s Vibration Contour
- 4 mm/s Vibration Contour
- 2 mm/s Vibration Contour

Explosive Quantities

- More than 10 kilograms
- Between 5 and 10 kilograms
- Between 3 and 5 kilograms
- Between 2 and 3 kilograms
- Between 1 and 2 kilograms
- Less than 1 kilogram

Project Description: ALBION PARK - Cut 5 - Modelled explosive weights and associated vibration levels to comply with 10mm/s at adjacent residential properties and 10mm/s at adjacent commercial properties

HEILIG & PARTNERS Engineered Excellence

Telephone +61 7 3715 7599
Mobile 0419 196 369
Facsimile +61 7 3715 7588
Email john@heiligandpartners.com.au
P.O. Box 1176
Mt.Ommaney
QLD. 4074. Australia

Fulton Hogan

Plate No. C

Revision History
R1: Original

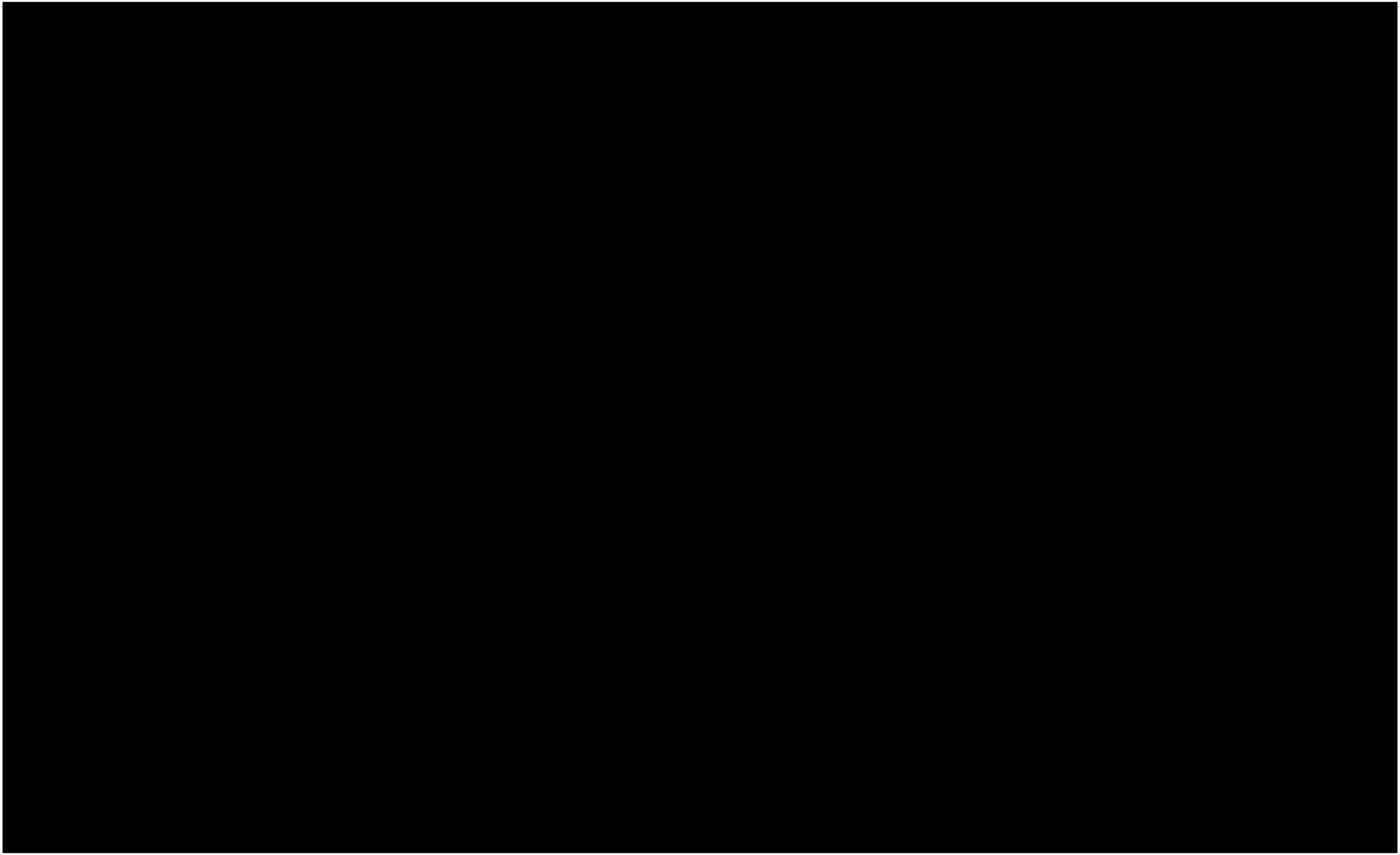
Date Drawn: **27 August 2017**

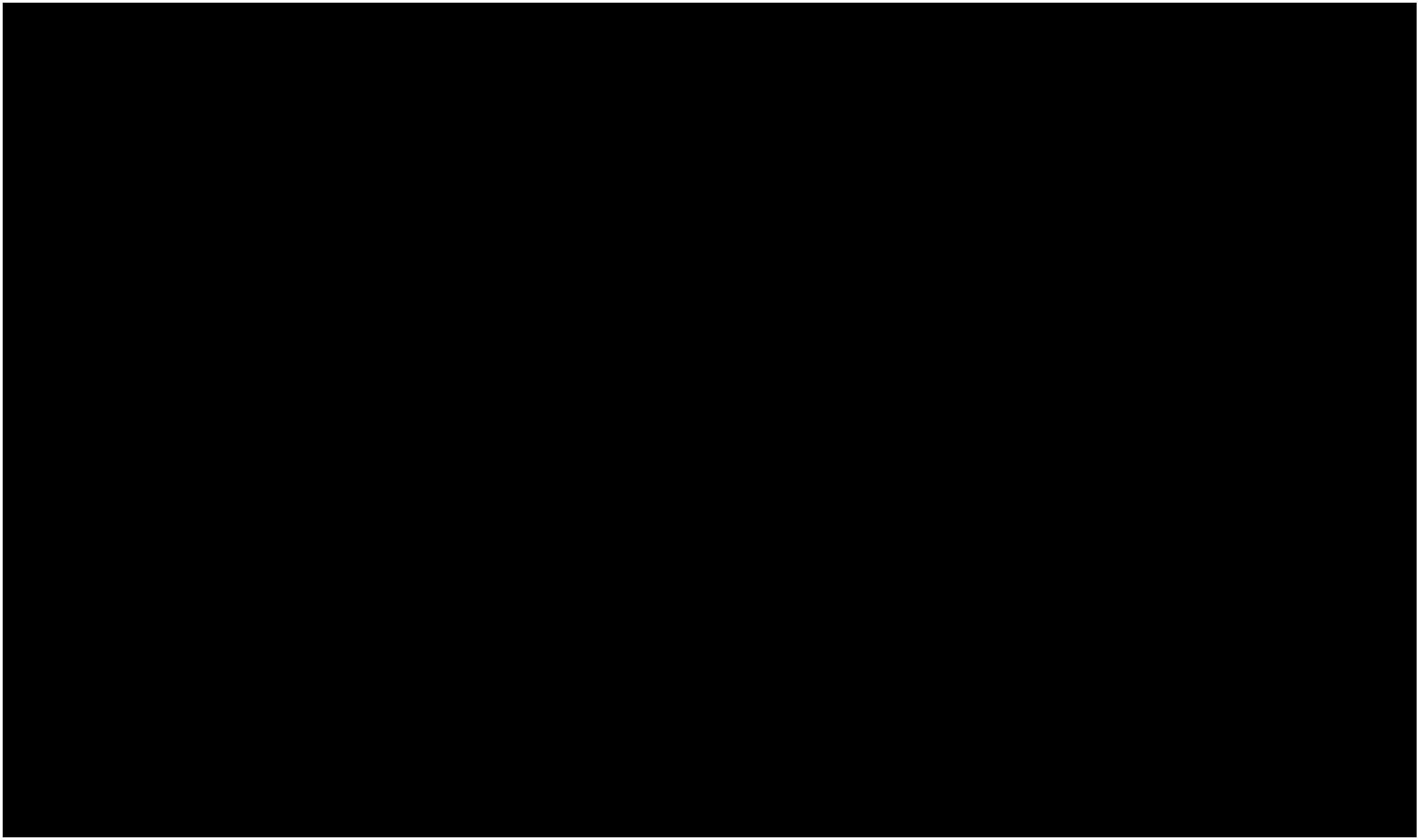
Ref No: Albion Park Cut 5

Job No: HP1708-1

In preparing this drawing, HP have made certain assumptions. We have assumed that all information and documents provided to us by the Client or as a result of a specific request were complete, accurate and up to date. Where we have obtained information from a Government register or database, we have assumed that the information is accurate. Where an assumption has been made, we have not made any independent investigations with respect to the matters the subject of that assumption. We are not aware why any of the assumptions are incorrect.

Appendix B – Sensitive receivers surrounding Cut 5





Appendix E Project Map

Appendix F Construction noise monitoring locations