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 D and are:

1. [redacted] (NCA1)
2. [redacted] (NCA3)
3. [redacted] (NCA3)
4. [redacted] (NCA4)
5. [redacted] (NCA5)
6. [redacted] (NCA5)
7. [redacted] (NCA8)

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 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.

Monitoring details	Record	Frequency	Responsibility	Test procedures
Where Verification is required in accordance with CNVG and mitigation measures in Chapter 8.	Noise Monitoring Record	Monthly	Environmental Manager	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.
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	
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
Spot checks for worst-case noise impact scenarios or when new predicted high noise impact activities commence	Noise Monitoring Record	As required	Environmental Manager	

Monitoring details	Record	Frequency	Responsibility	Test procedures
Where required for the purposes of refining construction methods or techniques to reduce noise levels.	Noise Monitoring Record	As required	Environmental Manager	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.
VIBRATION MONITORING				
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.
Where Verification is required in accordance with CNVG and mitigation measures in Chapter 8.				

Monitoring details	Record	Frequency	Responsibility	Test procedures
Where a complaint is received and monitoring is considered an appropriate response.				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 an activity may occur within safe working distances for cosmetic damage for no more than one day continuously.				
During construction to confirm minimum safe working distances in Section 7.5.2 and refine construction methods if vibration levels exceed guideline values.				

Monitoring details	Record	Frequency	Responsibility	Test procedures
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.
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 outside of the amendments detailed in Section 1.4 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.

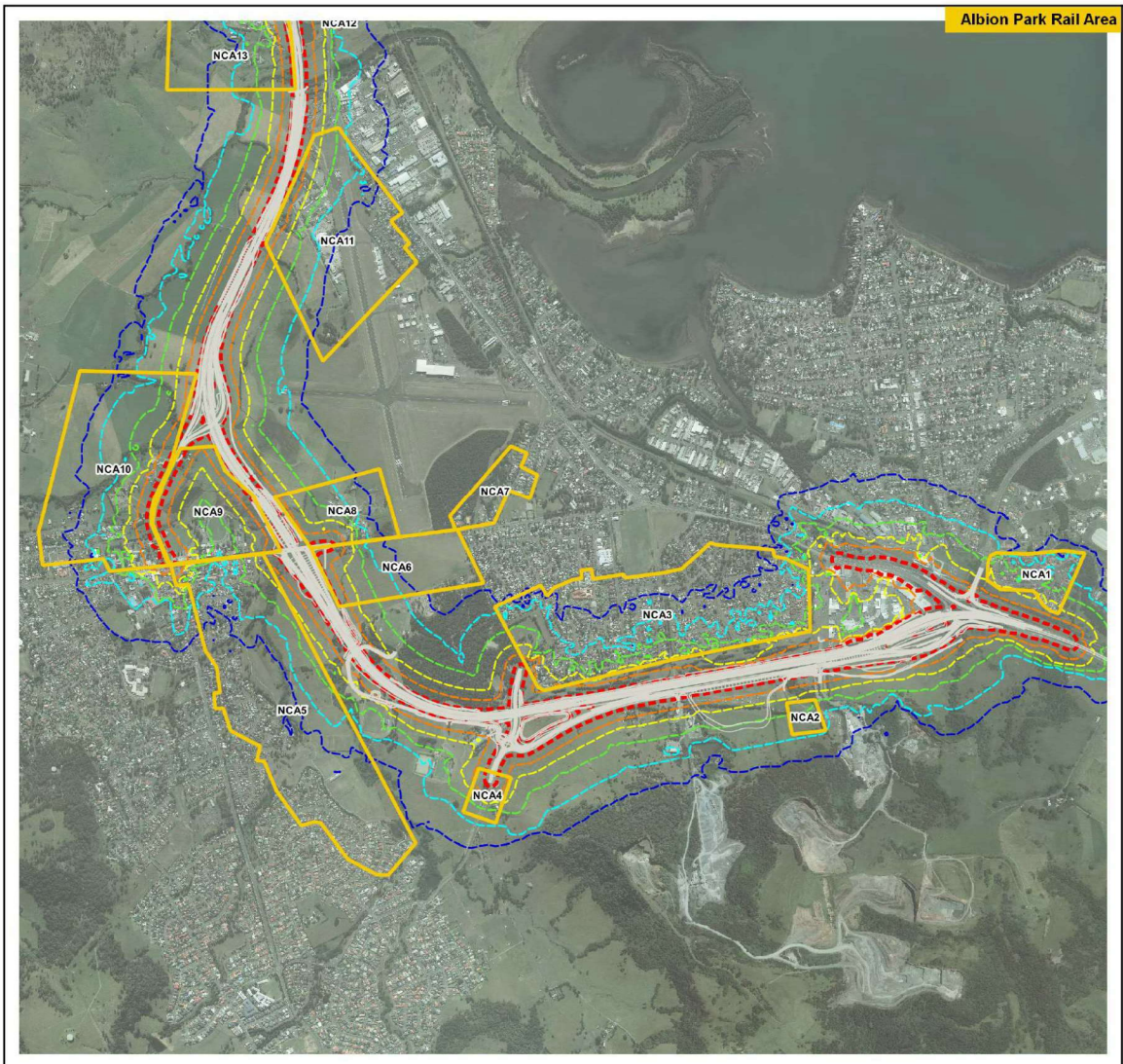
Table A-1: Construction scenarios and associated plant and equipment

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



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

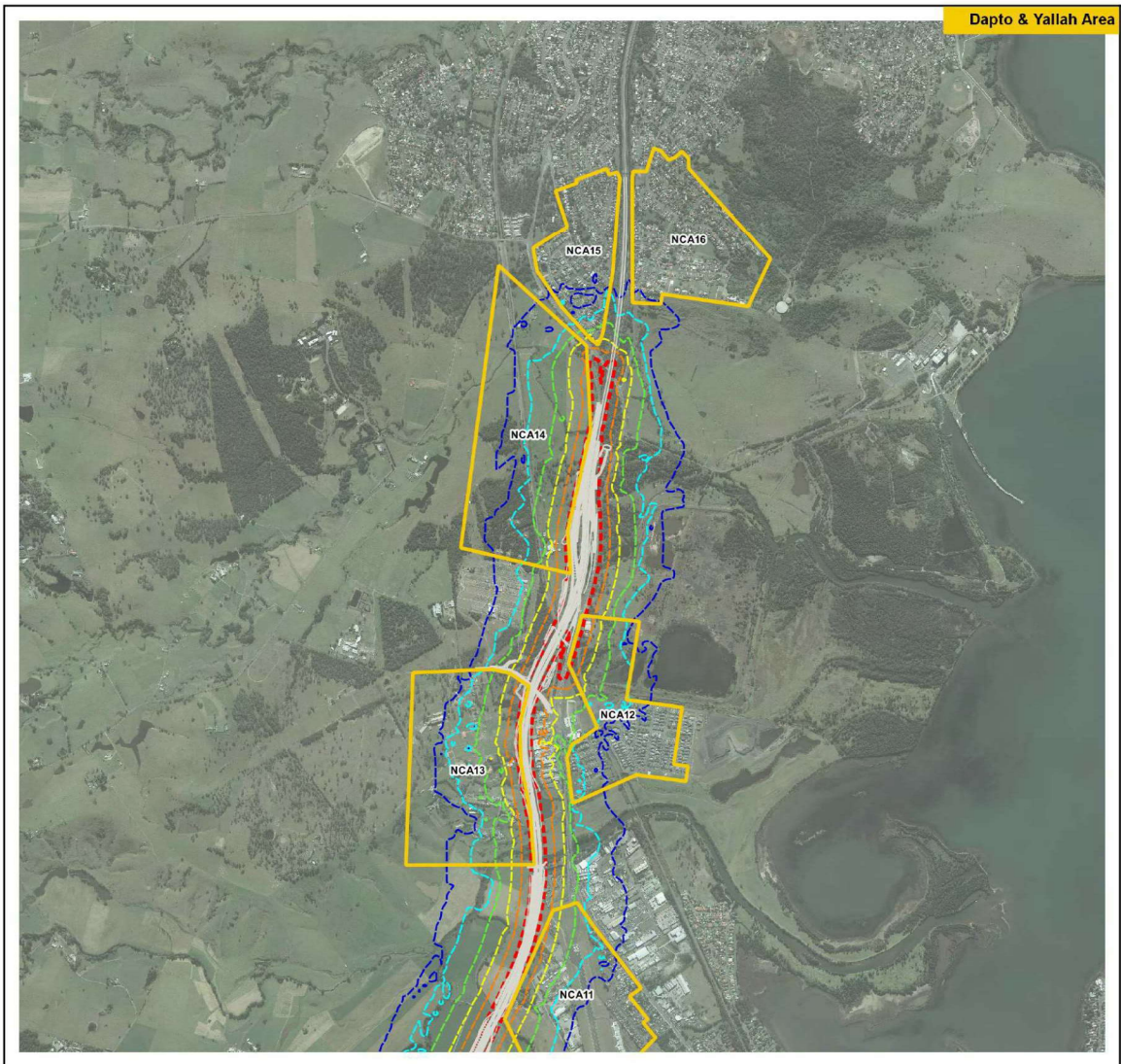
- Road Design
- Noise Catchment Area

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

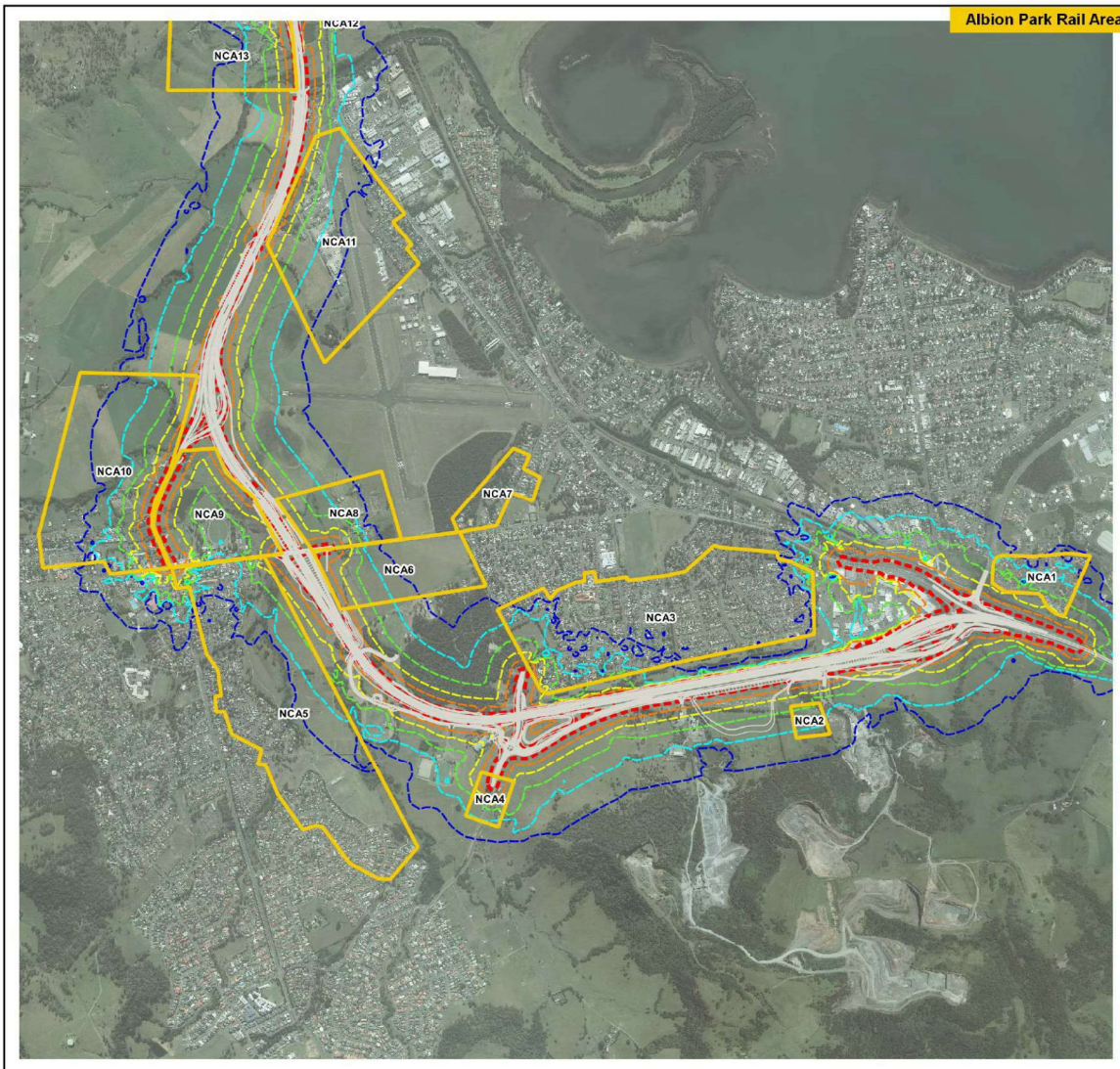
- Road Design
- Noise Catchment Area

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



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

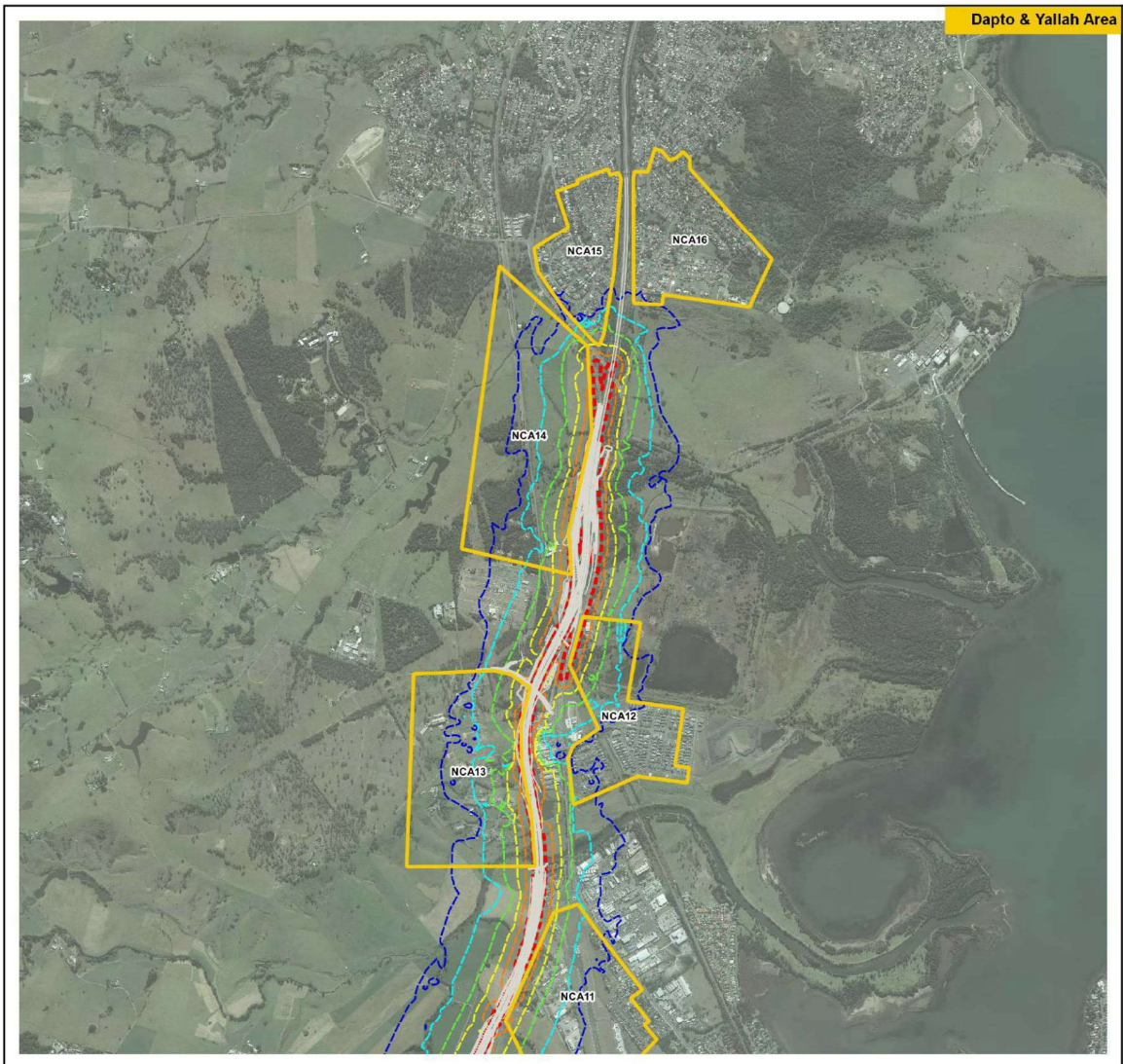
- Road Design
- Noise Catchment Area

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

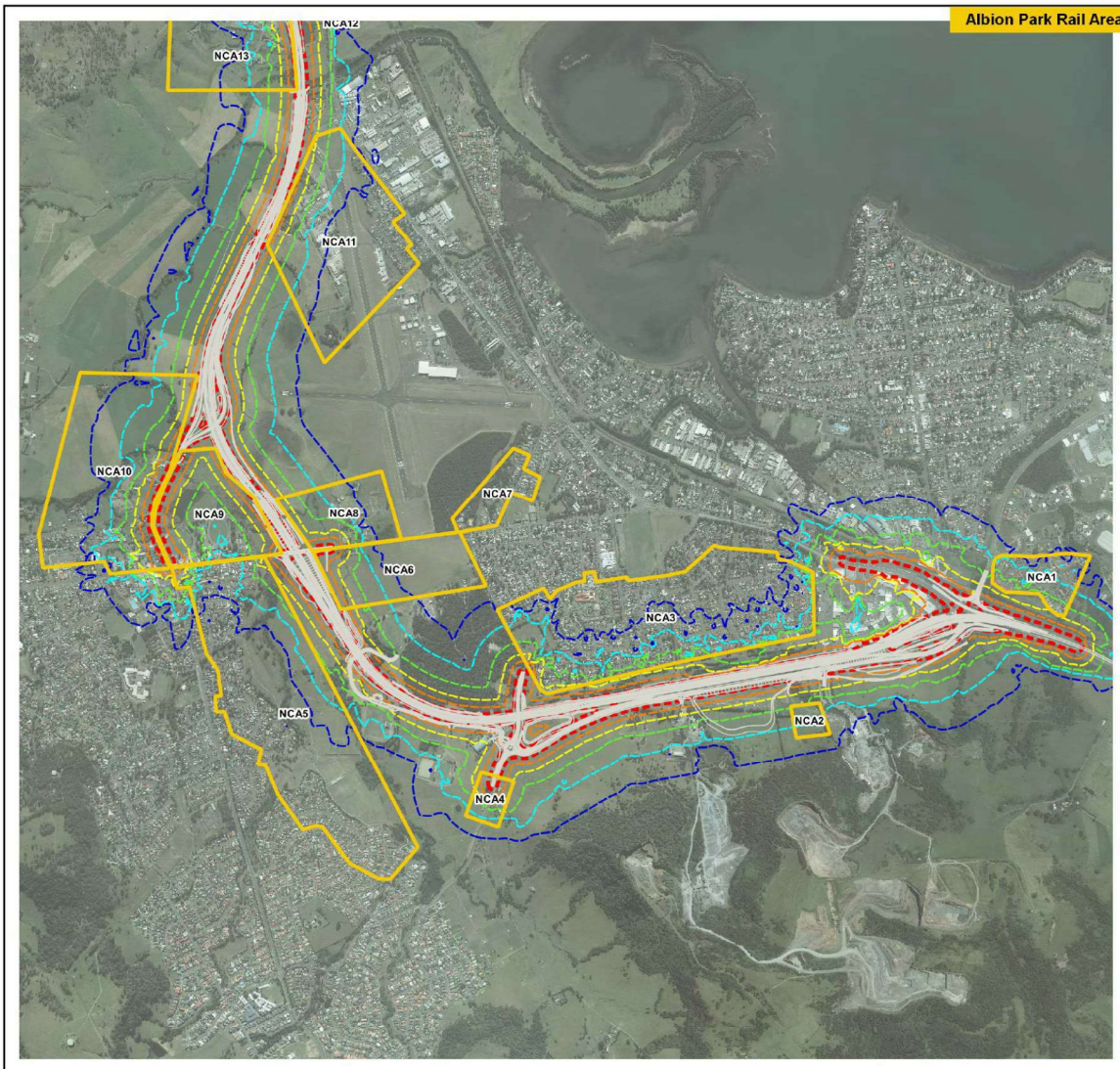
- Road Design
- Noise Catchment Area

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



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

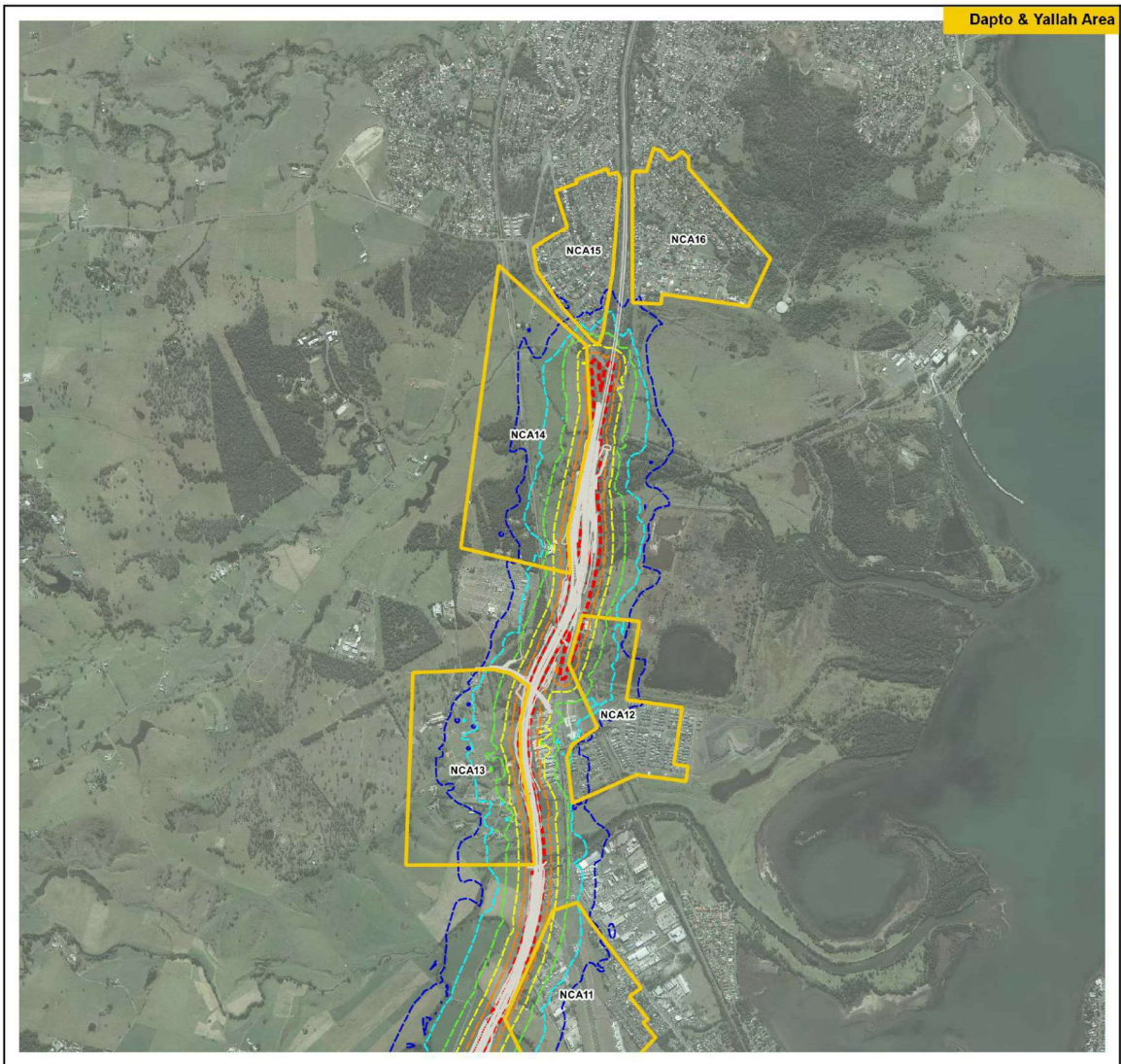
- Road Design
- Noise Catchment Area

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

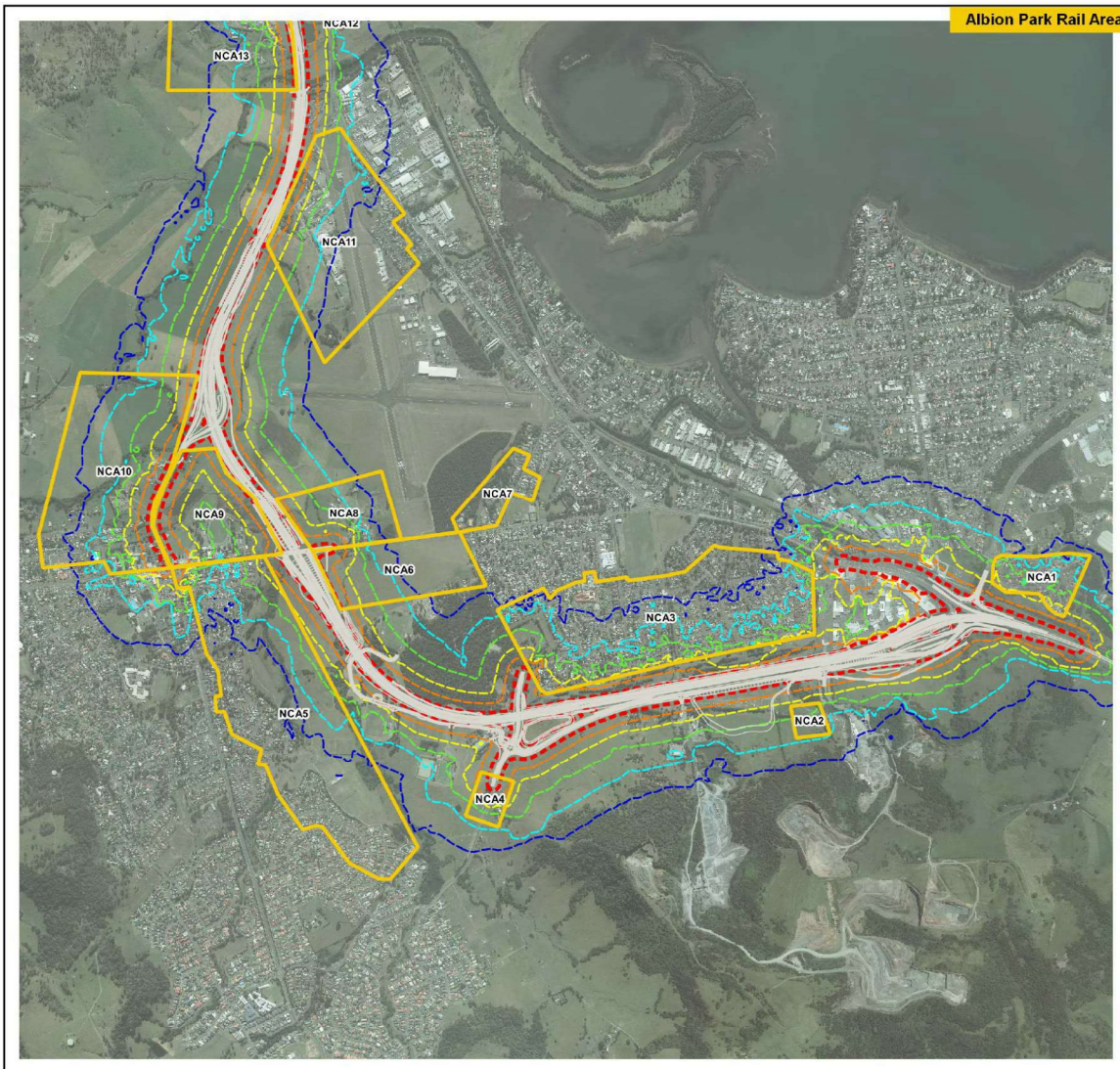
- Road Design
- Noise Catchment Area

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



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

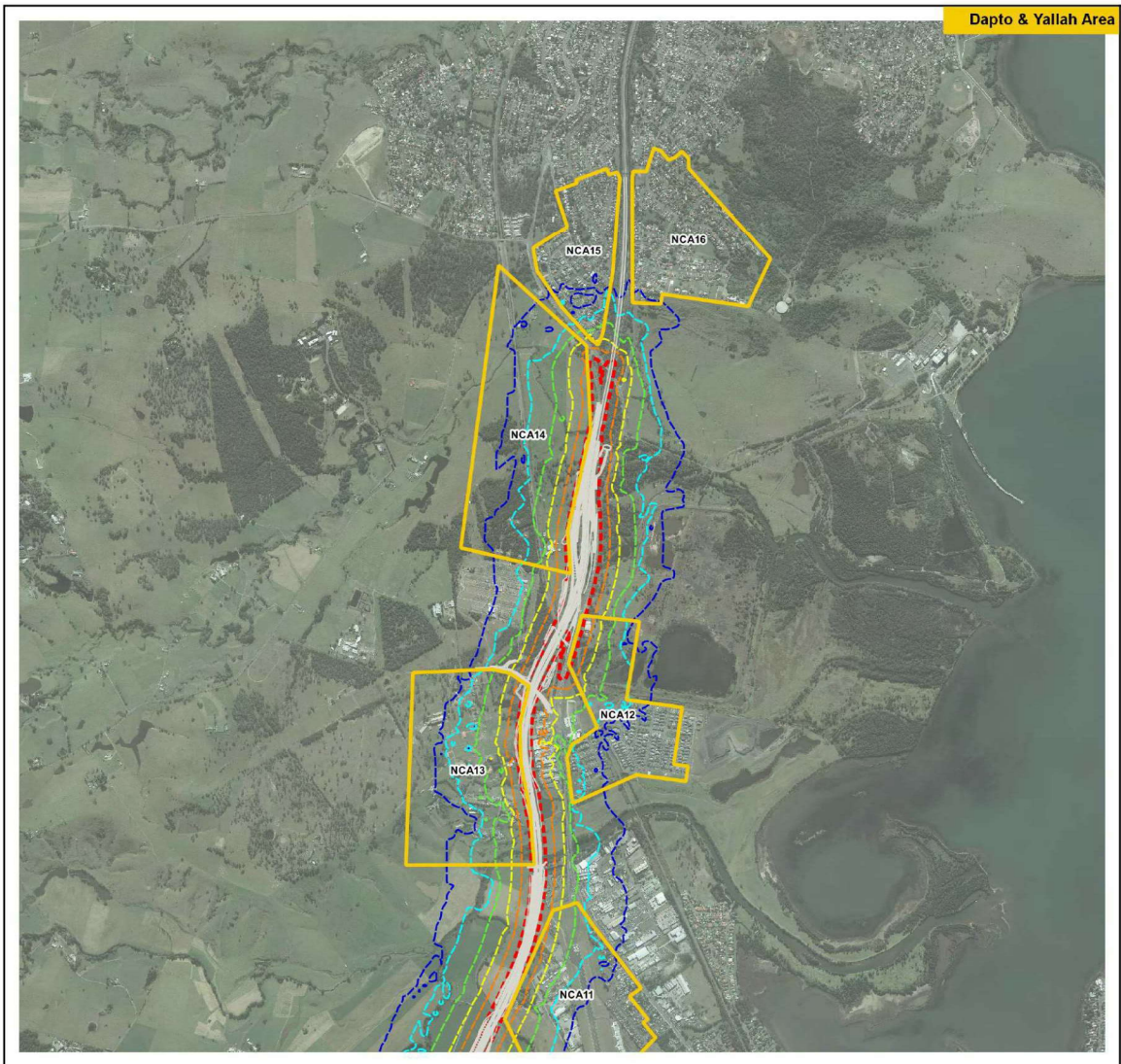
- Road Design
- Noise Catchment Area

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



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

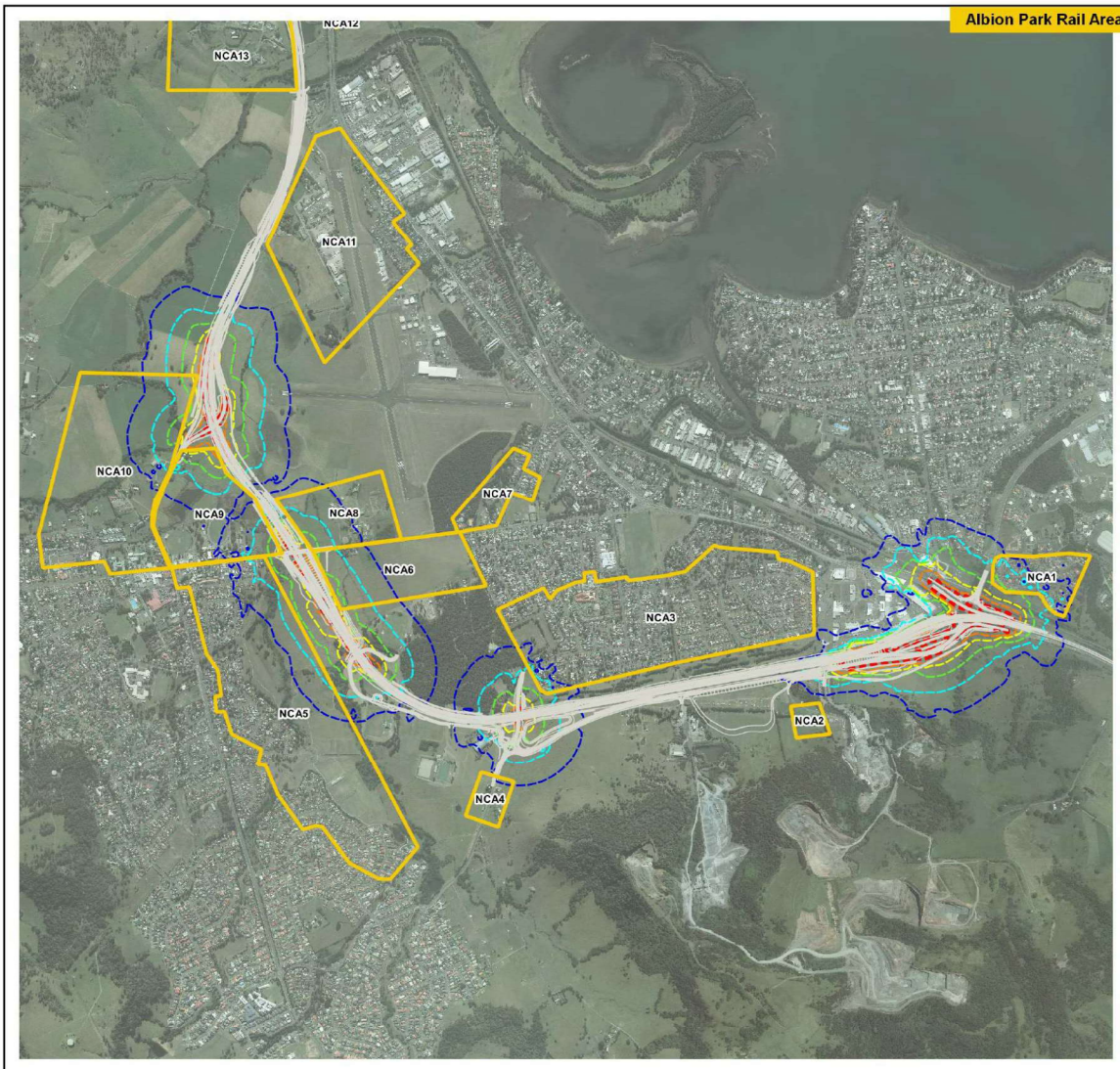
- Road Design
- Noise Catchment Area

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

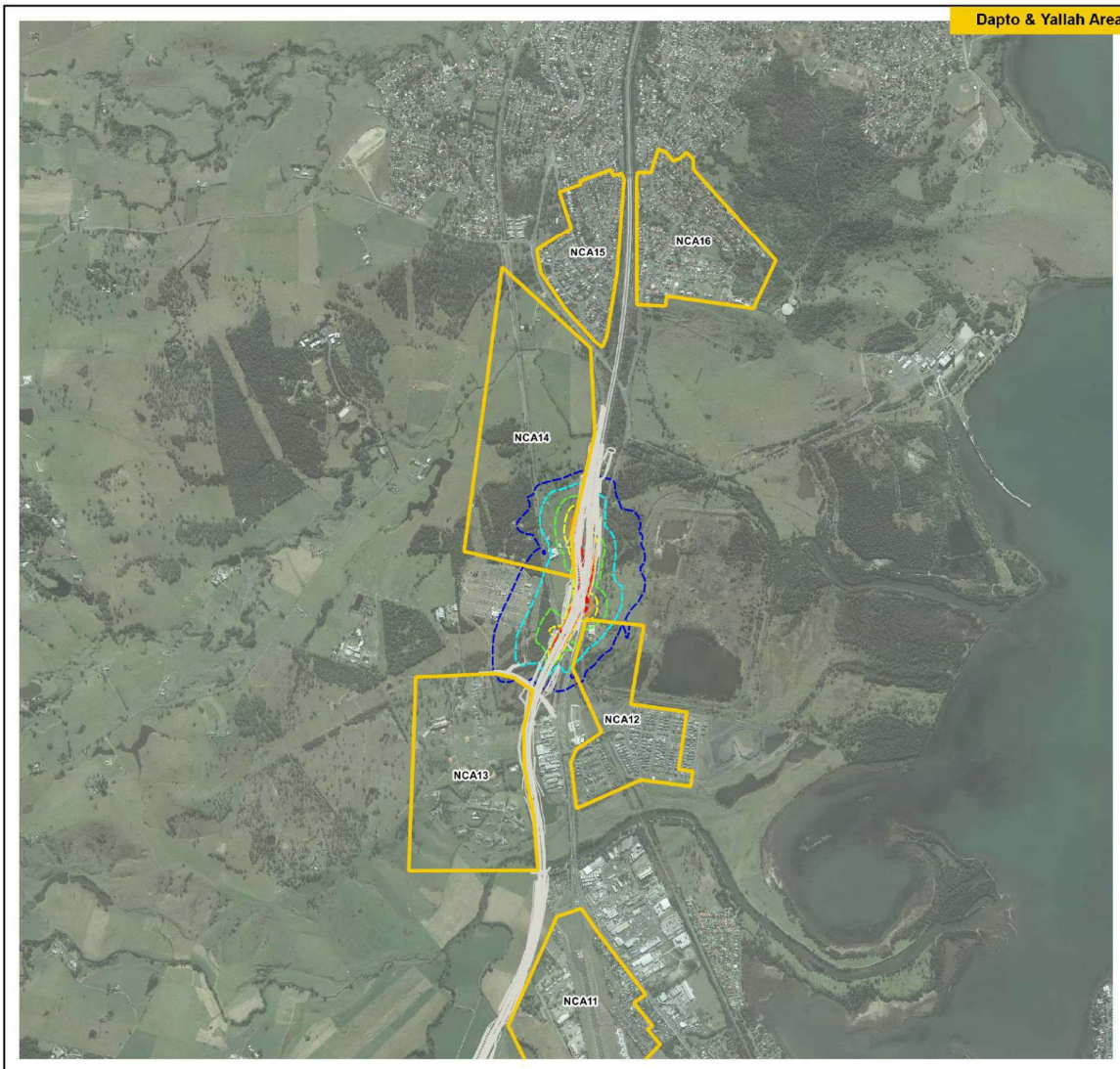
- Road Design
- Noise Catchment Area

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

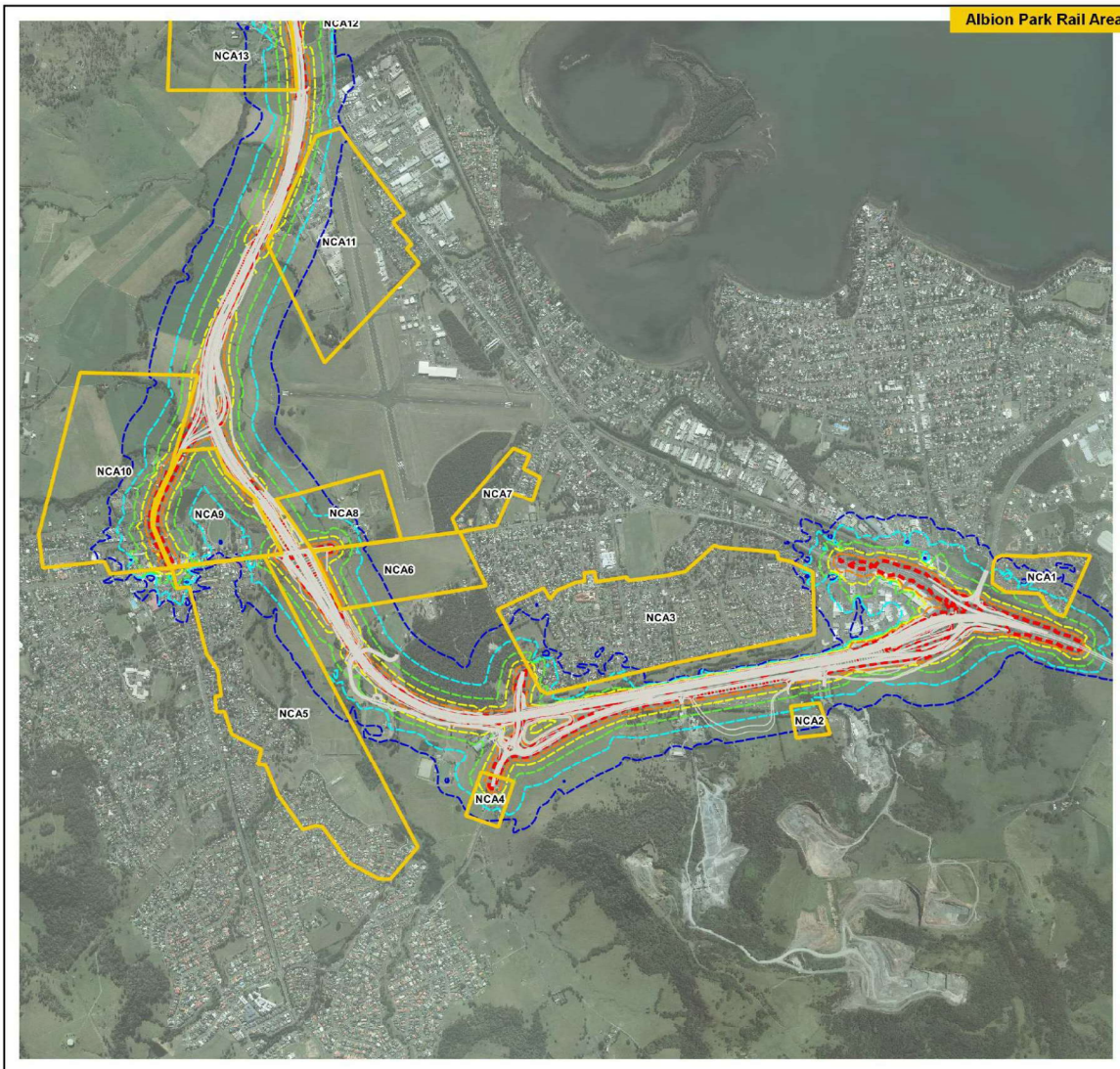
- Road Design
- Noise Catchment Area

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

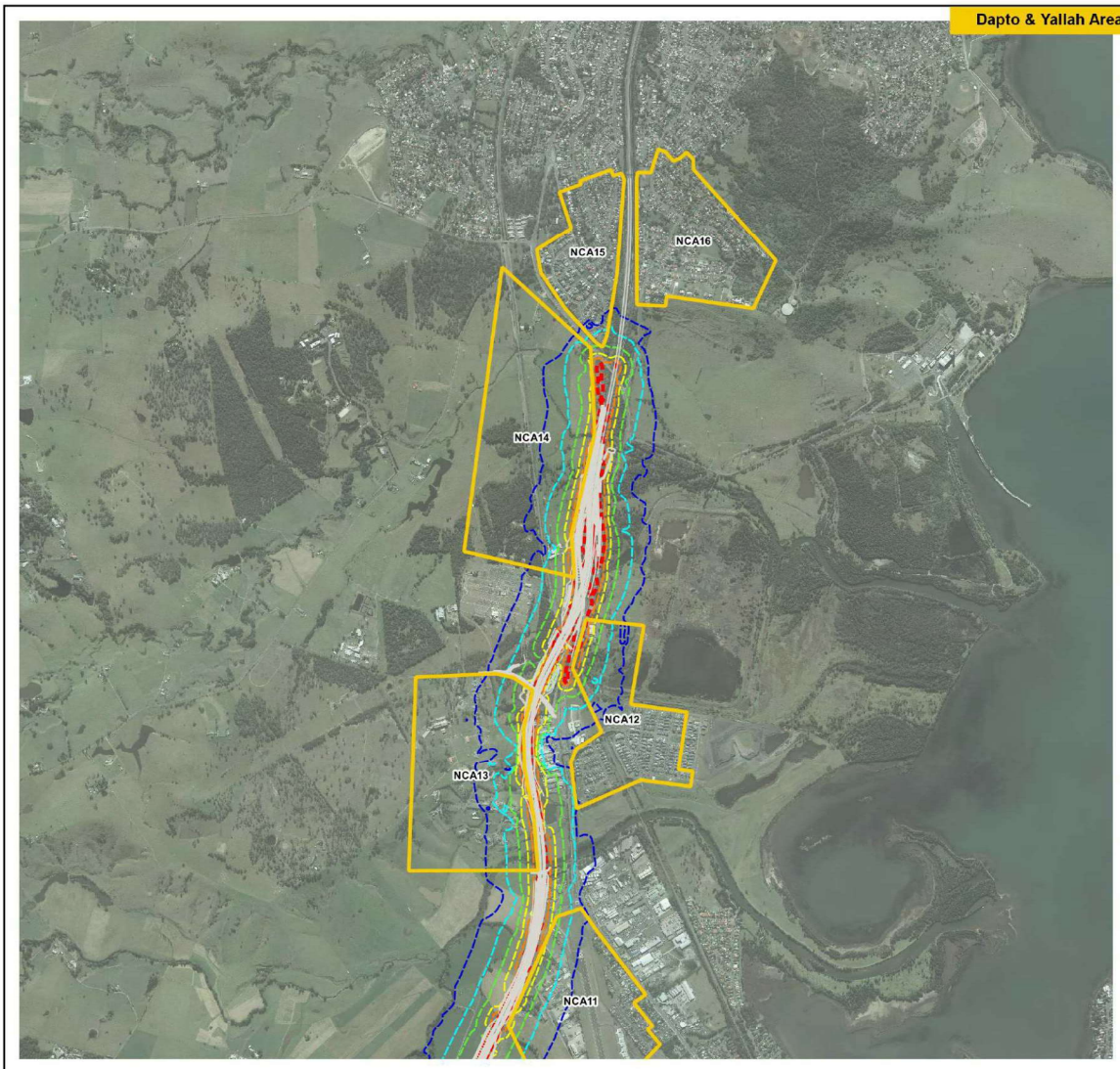
- Road Design
- Noise Catchment Area

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

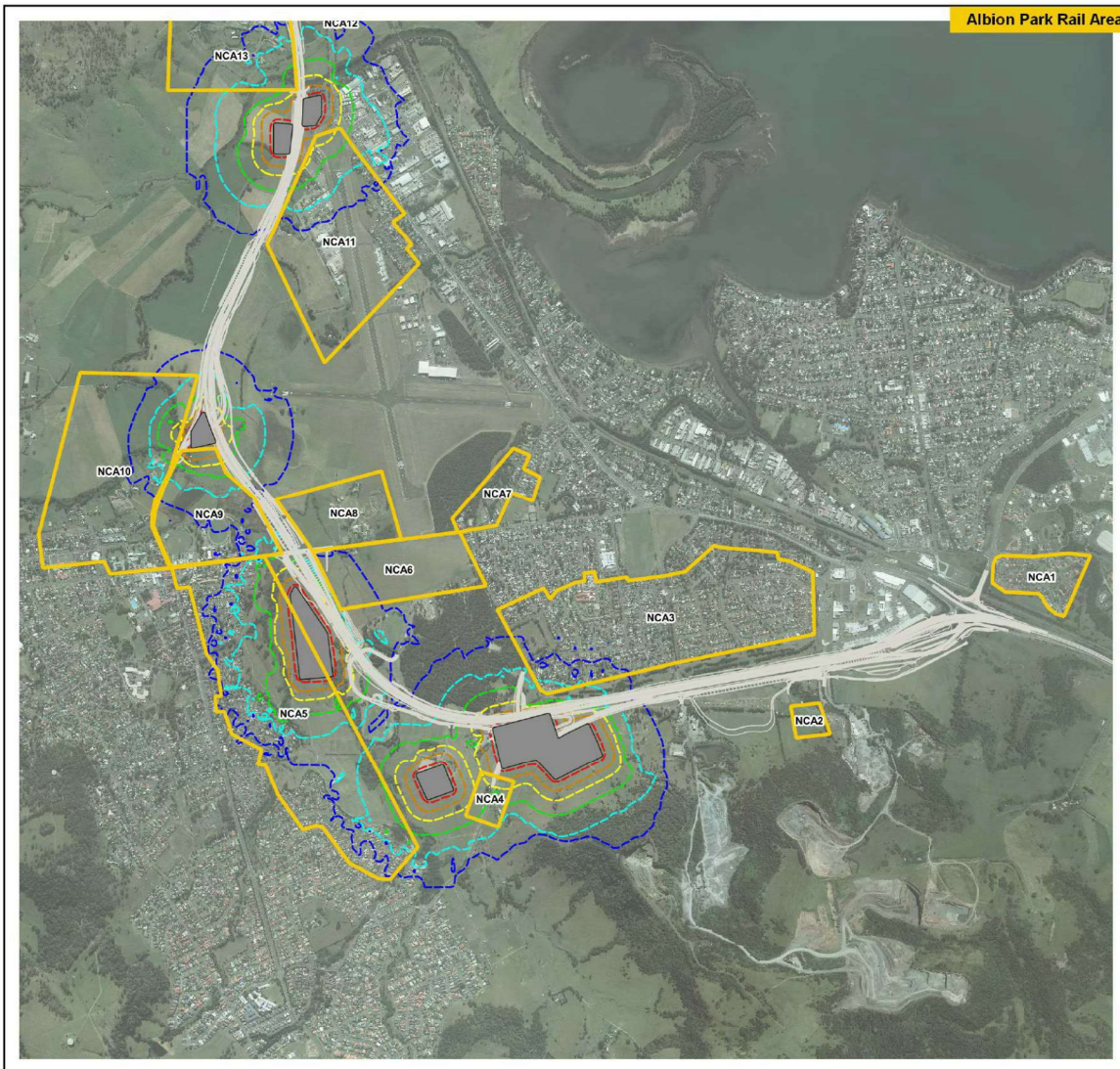
- Road Design
- Noise Catchment Area

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



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

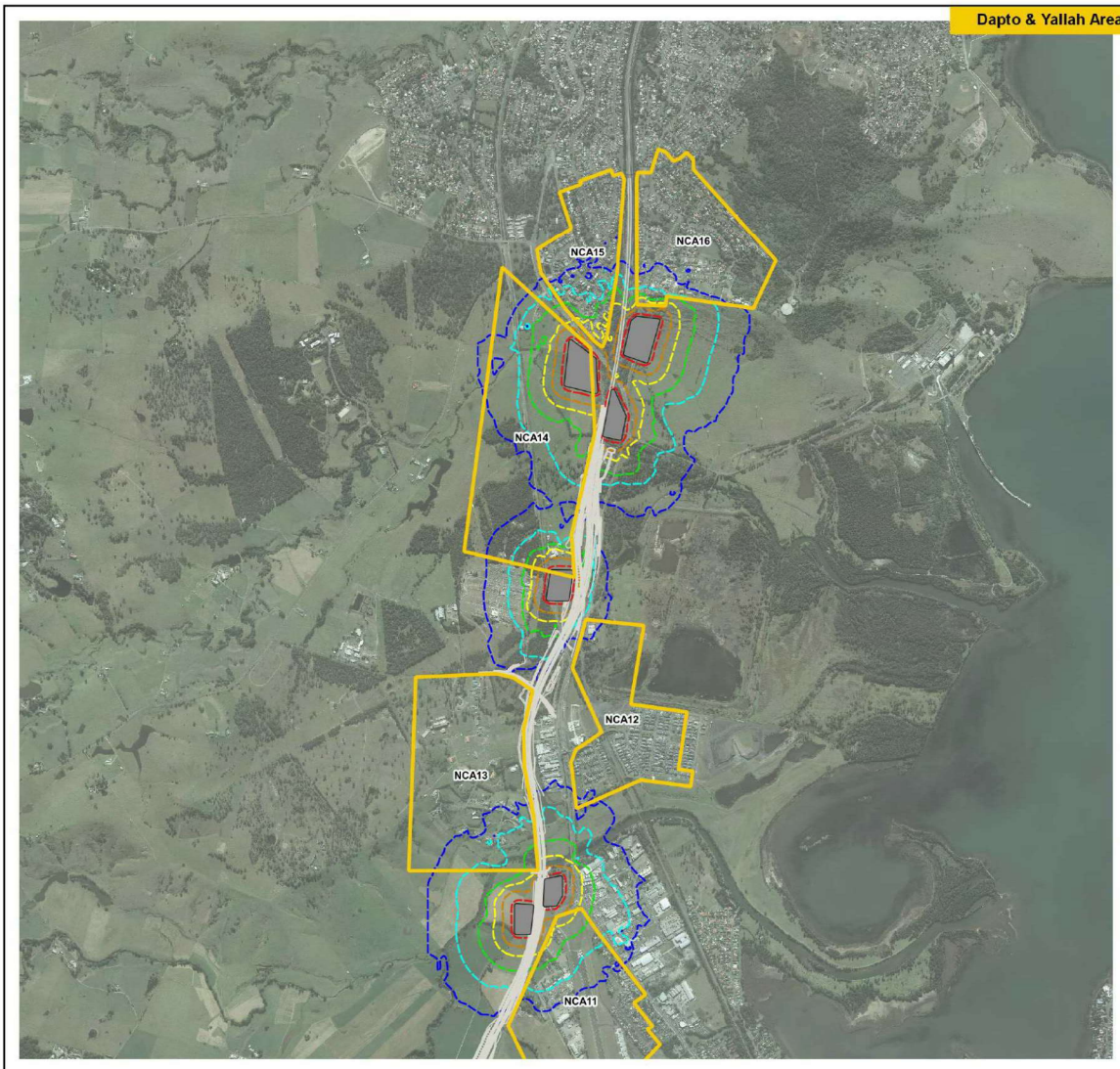
- Road Design
- Noise Catchment Area
- Potential Compound Site

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

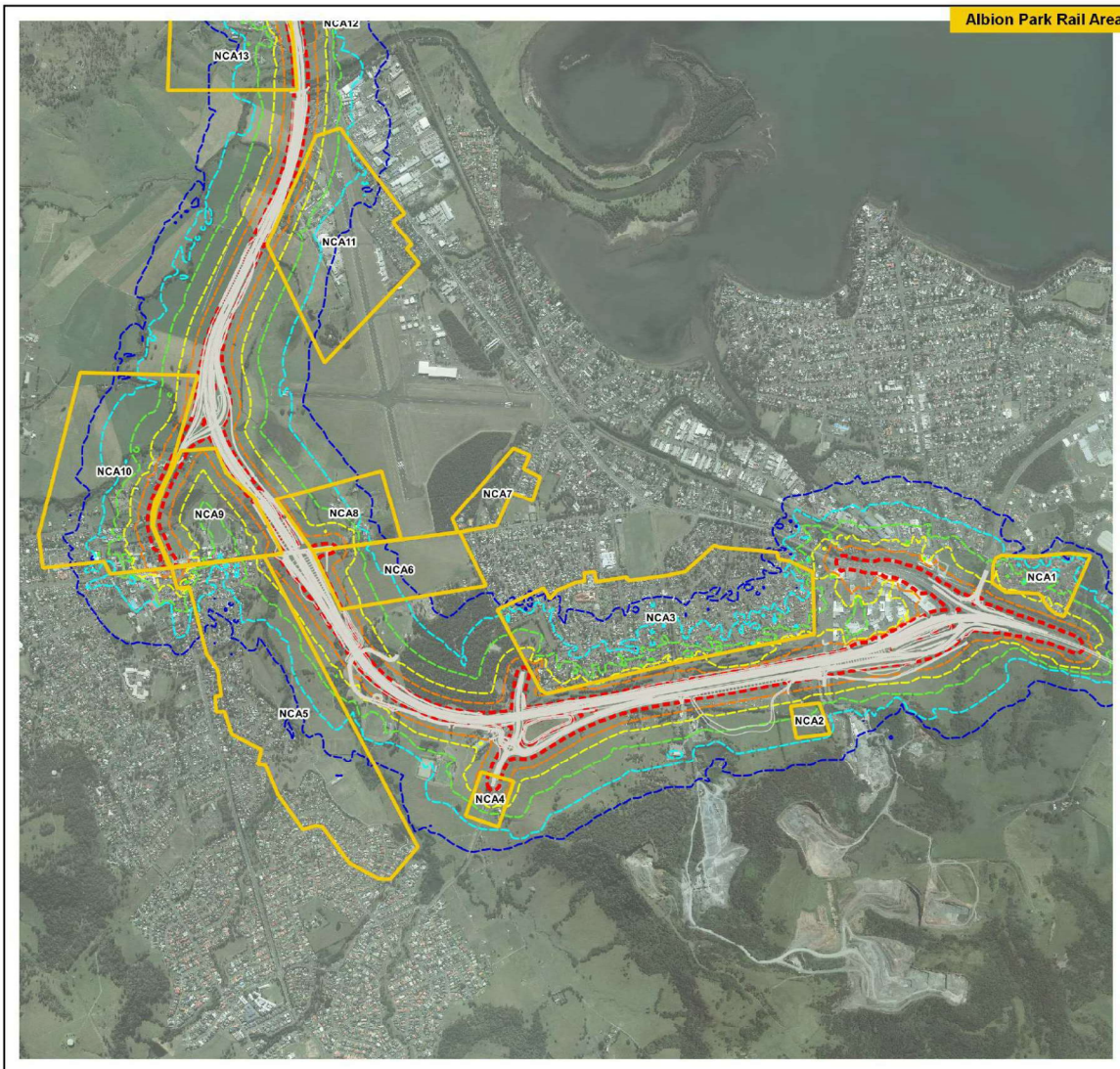
- Road Design
- Noise Catchment Area
- Potential Compound Site

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

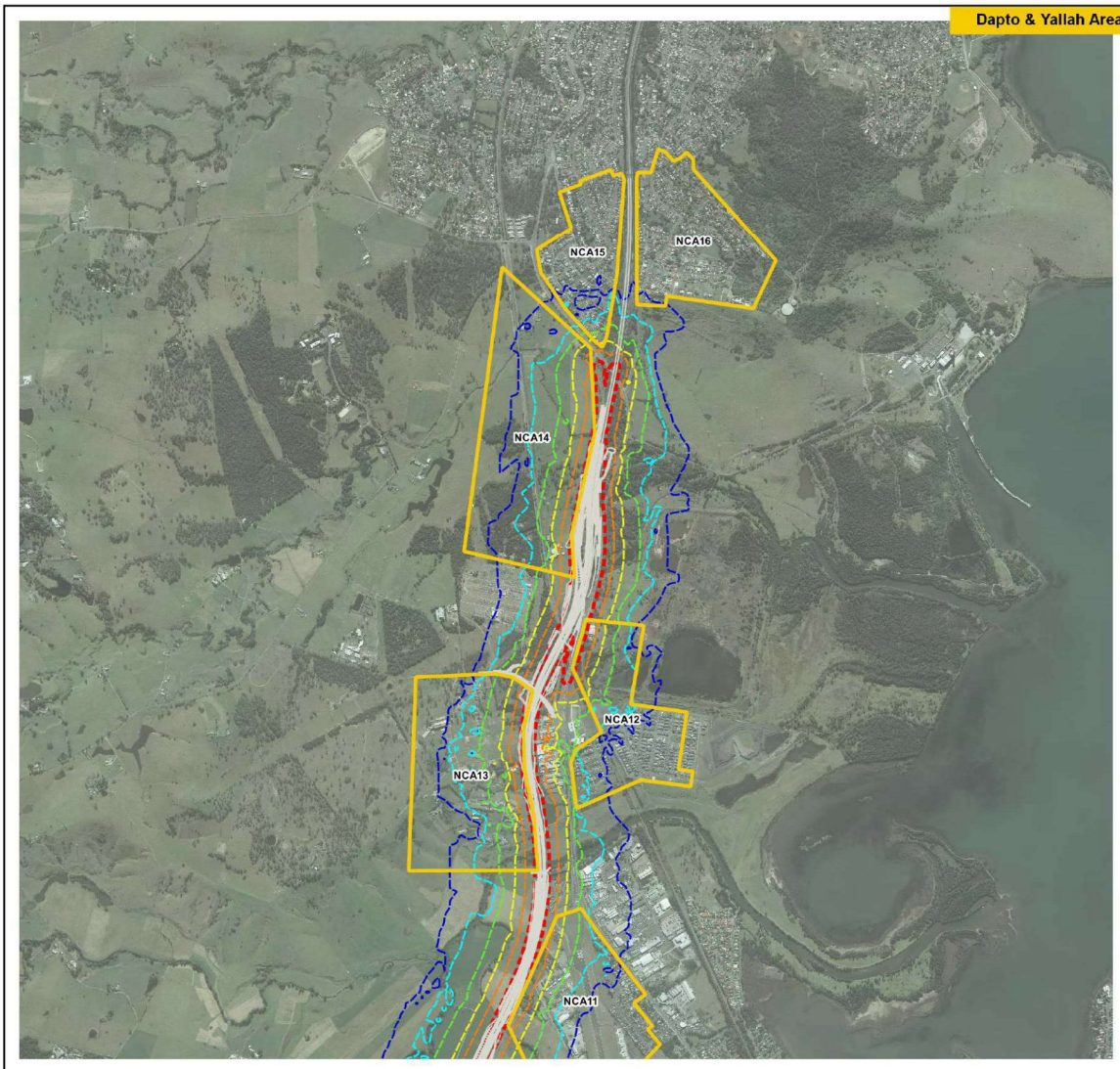
- Road Design
- Noise Catchment Area

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

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Resonate