Fulton Hogan

Design and Construction of Additional Crossing of the Clarence River at Grafton

OPERATIONAL NOISE REPORT (100% DESIGN)

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GLOSSARY

A-Weighted	A spectrum adaptation that is applied to measured noise levels to approximate human hearing. A-weighted levels are used as human hearing does not respond equally at all frequencies.
Day(time)	For road traffic noise, the daytime period is taken to be between 7 am and 10 pm.
dB	Decibel—a unit of measurement used to express sound level, based on a logarithmic scale. We typically perceive a 10 dB increase in sound as a doubling of that sound level.
dB(A)	Units of A-weighted sound levels.
DGA	Dense Graded Asphalt
EIS	Environmental Impact Statement
ENMM	Roads and Maritime Services *Environmental Noise Management Manual*
FH	Fulton Hogan
L_{90}	The sound pressure level exceeded for 90% of the measurement period. For 90% of the measurement period, it was louder than the L_{90}.
L_{eq}	Equivalent Noise Level—Energy averaged noise level over the measurement time.
$L_{eq,1h}$	Equivalent (energy averaged) noise level over a one-hour period. Used to assess road traffic noise for some non-residential receivers.
$L_{eq,15h}$	Equivalent (energy averaged) noise level over the daytime period. Used to assess road traffic noise for residences.
$L_{eq,9h}$	Equivalent (energy averaged) noise level over the night time period. Used to assess road traffic noise for residences.
L_{max}	The maximum noise level measured during a period, using the fast time weighting on a sound level meter.
Night(-time)	For road traffic noise, the night-time period is taken to be between 10 pm and 7 am.
RBL	Rating Background Level – the medium value of the assessment background level for the period over all of the days measured.
RMS	Roads and Maritime Services (Roads and Maritime)
RNP	Department of Environment, Climate Change and Water *NSW Road Noise Policy*
SMA	Stone Mastic Asphalt
SWTC	Scope of Works & Technical Criteria

1 Introduction

1.1 Project Description

The current Summerland Way crossing of the Clarence River is the only crossing of the river in the Grafton Area. The current bridge is operating at capacity during peak periods and forecast traffic growth will worsen congestion problems. Therefore RMS is undertaking this project to create an additional crossing of the Clarence River in Grafton.

The new crossing will connect the Pacific Highway and Gwydir Highway at South Grafton with Villiers Street north of the river, via Pound Street. The existing bridge will remain open to provide two crossings of the Clarence River within Grafton.

A map of the project identifying key features is included in Appendix 1.

1.2 Description of Report

This Operational Noise Management Report provides a summary of the work undertaken by Resonate Acoustics for the Design of the Additional Crossing of the Clarence River at Grafton (Grafton Bridge) and documents how the project operational noise obligations have been addressed and satisfied.

The operational noise assessment details the noise mitigation measures required for the Fulton Hogan 100% design to ensure consistency with the Roads and Maritime Services (RMS) Reference Design and meet the requirements of the Minister's Conditions of Approval.

Information on construction mitigation measures and management processes are being documented in a Construction Noise and Vibration Management Plan (CNVMP).

The key documents addressed in this report include:

- Grafton Bridge – Scope of Works and Technical Criteria (SWTC)
- Grafton Bridge – SWTC Appendix 4 *Additional Environmental Requirements*
- Grafton Bridge – SWTC Appendix 9 *Geometric Performance and Design Requirements.*
- Additional project documents have been considered and referenced where appropriate, including the Environmental Impact Statement Assessment (EIS) Appendix F *Technical Paper: Noise and vibration* assessment.

This design report provides the following information in relation to this Design:

- Applicable operational noise criteria
- A description of the prevailing ambient noise environment
- Summary of inputs into the acoustic assessment
- Details of changes from the Roads and Maritime Services (RMS) Reference Design
- Noise contour maps for design years 2019 and 2029
- An assessment of maximum noise levels to evaluate sleep disturbance impacts
- Identification of noise-sensitive receivers exposed to noise levels exceeding relevant assessment criteria in 2029
- Noise mitigation measures incorporated into the design
- Options for alternative designs of mitigation measures where relevant.
- An assessment of the proposed pump station.
- An assessment of the proposed rail viaduct replacement.

2 Design Compliance

2.1 Minister's Conditions of Approval

The Minister's Condition of Approval D11 for the project states that:

D11. The Proponent shall undertake a review of the operational noise mitigation measures proposed to be implemented for the SSI, within six months of commencing construction, unless otherwise agreed by the secretary, and be prepared in consultation with the EPA, and shall:

(a) confirm the operational noise predictions of the SSI based on detailed design. This 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 documents listed in condition A2. The review shall take into account the detailed design of the SSI and, where feasible and reasonable, 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; and

(c) where necessary, investigate additional feasible and reasonable noise mitigation measures to achieve the criteria outlined in the NSW Road Noise Policy *(DECCW, 2011).*

This report provides advice to the design team regarding any change in predicted operational noise levels relative to the RMS Reference Design, and informs the design of noise mitigation measures.

This report will be updated as the design progresses, with the review of the operational noise mitigation measures prepared based on the constructed design.

The Minister's Condition of Approval D11 (CoA D11) is met within this report as described in Table 1.

Table 1: Compliance with CoA D11

Condition	Report Section
D11(a) confirm the operational noise predictions of the SSI based on detailed design. This operational noise assessment shall be based on an appropriately calibrated noise model (which has incorporated additional noise monitoring, where necessary for calibration purposes);	Model an existing 'no build scenario' and compare the results with the equivalent Environmental Assessment stage results. Confirm that the results are the same as (or within an acceptable tolerance of) the previous assessment to demonstrate model validation. This includes validation to the measured noise levels in the EIS. Refer to Section 4.4.1 for details of noise model validation.
D11(b) review the suitability of the operational noise mitigation measures identified in the documents listed in condition A2. The review shall take into account the detailed design of the SSI and, where feasible and reasonable, 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;	Assess predicted road traffic noise levels from the Fulton Hogan Design against the predicted noise levels from the RMS Reference Design and the RNP criteria. Demonstrate that the proposed noise mitigation strategy based on the requirements of the SWTC satisfactorily meets the requirements of the RNP criteria. Refine the current mitigation strategy if necessary to meet the requirements of the RNP Criteria. Refer to Section 4.6. A review of the noise mitigation scheme for the project is presented within this section.
D11 (b) refers to documents listed in Condition A2. The list of documents is reproduced below for reference. (a) State significant infrastructure application SSI-6103; (b) *Additional Crossing of the Clarence River at Grafton Environmental Impact Statement Main Volume and Appendices A - L,* prepared by Roads and Maritime Services, dated August 2014;	The documents listed in Condition A2 were referenced in order to determine the reference noise mitigation scheme that was then reviewed in accordance with Condition D11.

Condition	Report Section
(c) *Additional Crossing of the Clarence River at Grafton Submissions Report Main Volume and Appendices,* prepared by Roads and Maritime Services, dated October 2014; (d) Correspondence from Roads and Maritime Services to the Department titled *Grafton Bridge - Additional Crossing of the Clarence River at Grafton – Proposed Early Works* dated 1 December 2014; (e) Modification request 1 and letter dated 24 September 2015 to modify the approval to update references to public authorities in the conditions of approval; and (f) Minister Conditions of Approval.	
D11(c) where necessary, investigate additional feasible and reasonable noise mitigation measures to achieve the criteria outlined in the NSW *Road Noise Policy* (DECCW, 2011).	If deemed necessary consider additional reasonable and feasible mitigation measures. Refer to Section 4.6 A discussion of additional reasonable and feasible measures is provided if required.

2.2 SWTC

The SWTC clauses relevant to the operational noise assessment of the design are summarised below.

2.2.1 Appendix 4 Clause 4.21

The SWTC clauses relevant to the operational noise assessment of the design are provided in Appendix 4 Clause 4.21. Clause 4.21 states, broadly, that:

- Operational mitigation by the contractor shall not consist of at-residence treatments.
- Certain residences were shown to require at-residence treatments in the RMS Reference Design; RMS will administer these treatments.
- Noise mitigation is not required for commercial or industrial premises.
- As a minimum, a prescribed noise barrier must be included in the design scheme.
- Operational noise levels shall be controlled to the applicable new road and redeveloped road criteria provided by the NSW Road Noise Policy (RNP). Evidence of this is to be provided by way of comparison of detailed design operational noise emission contours against the Environmental Assessment operational noise emission contours.
- Where the detailed design varies from the reference design documents, the contractor must undertake noise modelling using prescribed technical parameters and demonstrate compliance with the operational noise criteria for the year of opening (2019) and ten years after opening (2029).

The operational noise criteria are reproduced in Section 2.3.1 to 2.5 of this document. The road traffic noise modelling parameters prescribed by SWTC Clause 4.21 detailed in Section 4.2.

Operational noise levels are to be assessed against the applicable new road and redeveloped road criteria provided by the *Road Noise Policy* (RNP) prepared by the NSW Department of Environment, Climate Change and Water (DEECW) and released in 2011.

RMS has developed noise modelling for the project based on the concept design in the Environmental Assessment (RMS Reference Design), and provided this RMS Noise Data to Fulton Hogan. This data will be used during the design stages in the design and identification of noise mitigation measures.

Where the constructed design varies from the RMS Reference Design, Fulton Hogan must undertake noise modelling using prescribed technical parameters and demonstrate compliance with the operational noise criteria for the year of opening (2019) and ten years after opening (2029).

Specifically, Clause 4.21(e) states that the design and mitigation provided for the road must be undertaken:

> *(e)(ii) to maintain operational noise levels of 60 dB(A) / 55dB(A) LA eq 15hr (day) or less and 55dB(A) / 50dB (A) LAeq9hr (night) or less, for the years 2019 (at opening) and 20 29 (ten years after opening) for redeveloped / new roads respectively as appropriate at the locations identified by the respective noise contour lines described in Figures 9.13 of Appendix 9 of the Scope of Works and Technical Criteria.*

2.2.2 Appendix 4 Clause 4.22A

Clause 4.22A broadly requires Fulton Hogan to prepare an Operational Noise Management Report as part of the design documentation for the noise mitigation measures. This is in accordance with Minister's Condition of Approval D11.

2.3 Assessment Criteria

2.3.1 Operational Road Noise

The Environmental Impact Statement for the Grafton Bridge Project assessed the RMS Reference Design scheme against the requirements of the *Road Noise Policy* (RNP). The RNP, prepared by the NSW Department of Environment, Climate Change and Water (DECCW) and released in 2011, is the relevant policy to assess road traffic noise impacts from the proposed Grafton Bridge.

The RNP criteria relevant to this project are the 'New' and 'Redeveloped' road traffic noise assessment criteria for:

- Residential land uses including a relative increase criteria
- Educational buildings
- Places of worship
- Childcare facilities, and
- Aged care facilities.

2.3.2 Residential Land Use Assessment Criteria

Road traffic noise assessment criteria for residential land use are presented in Table 2. These are also relevant to aged care facilities.

Table 2: Road traffic noise assessment criteria for residential land use

Road Category	Type of project/land use	Assessment criteria dB(A)	
		Day (7 am – 10 pm)	Night (10 pm – 7 am)
Freeway/ arterial/ sub-arterial	Existing residences affected by noise from new freeway / arterial / sub-arterial road corridors. New residential developments affected by noise from existing freeways / arterial / sub-arterial roads	$L_{eq,15h}$ 55 dB(A) (external)	$L_{eq,9h}$ 50 dB(A) (external)
	Existing residences affected by noise from redevelopment of freeway / arterial / sub-arterial road corridors. Existing residences affected by noise from additional traffic on existing freeway / arterial / sub-arterial roads generated by land use developments.	$L_{eq,15h}$ 60 dB(A) (external)	$L_{eq,9h}$ 55 dB(A) (external)

The criteria apply at a distance of 1 m from the building facade. At this location, predictions and measurements are subject to a facade reflection factor. In accordance with the RNP, this facade reflection factor is taken to be +2.5 dB and is incorporated into the RNP criteria.

In order to determine if the 'New' or 'Redeveloped' criteria apply to an individual residence, it is necessary to follow the procedures set out in the Environmental Noise Management Manual (ENMM, RTA, 2001).

Broadly, the new road criteria apply at a receiver where there is no 'existing road traffic noise exposure' or if the receiver is subject to a new source of road traffic noise as a result of a project. 'Existing road traffic noise exposure' is defined as noise levels that exceed $L_{eq,15h}$ of 55 dB(A) (daytime) or $L_{eq,9h}$ of 50 dB(A) (night-time).

A receiver is considered to be subject to noise from a new source if the project would result in any of the following:

- A new road where a road of the same category did not previously exist.
- A new road within an existing corridor that was previously undeveloped.
- An alignment or realignment producing noise at the receiver from a different direction which makes a significant contribution to noise exposure, on top of any increase in traffic noise from the same direction as at present. A significant increase in traffic noise is taken to be an increase of more than 2 dB(A) at any exposed façade.
- For a receiver to be eligible for the consideration of noise mitigation from a 'Redeveloped' road, the predicted noise levels must either:
  - Exceed the noise criteria and be significantly affected by the project. Significantly affected is taken to be an increase of more than 2 dB(A) at any exposed façade.
  - Be considered to be 'acute'. Residential receivers are considered acutely affected where noise levels exceed $L_{eq,15h}$ 65 dB(A) (daytime) or $L_{eq,9h}$ 60 dB(A) (night-time).
  - For a receiver to be eligible for the consideration of noise mitigation from a 'New' road, the predicted noise levels must exceed the applicable criteria.

This ENMM procedure was followed as part of the EIS. Through comparison of measured noise levels (on-site noise logging summarised in the EIS), concurrent traffic counts and computer noise modelling of the existing scenario, the EIS determined:

- The EIS stage computer noise model was calibrated to the existing scenario (it produced predictions in agreement with real-world noise levels); and
- On the basis of these calibrated predictions, made a determination of which residential receivers were subject to 'New' and 'Redeveloped' criteria based on 'existing road traffic noise exposure'.

2.3.3 Relative Increase Criteria

The RNP also specifies additional relative increase criteria for residential land uses, with the aim of mitigating overly significant increases in noise levels at residences, even where the final noise level may be below the applicable criterion from Table 2.

The relative increase criteria are shown in Table 3. Where these criteria are exceeded, the residence should be considered for mitigation.

Table 3 – Relative Increase Criteria for Residences

Road Category	Description	Day 7 am – 10 pm	Night 10 pm – 7 am
Freeway / arterial / Sub-arterial	New road corridor / redevelopment of existing road	Existing traffic $L_{eq,15h}$ + 12 dB (external)	Existing traffic $L_{eq,9h}$ + 12 dB (external)

The RNP notes that a relative increase of 12 dB represents slightly more than an approximate doubling of perceived loudness and is therefore likely to trigger community reaction.

Where the existing road traffic noise level is less than 30 dB(A), the existing traffic noise level for the purpose of defining the relative increase criteria is deemed to be 30 dB(A).

2.3.4 Acute Noise Levels

Where predicted noise levels at residential receivers exceed $L_{eq,15h}$ of 65 dB(A) (daytime) or $L_{eq,9h}$ of 60 dB(A) (night-time), then the RNP considers road traffic noise levels to be 'acute'.

Residential receivers exposed to 'acute' noise levels as part of a road project are considered for mitigation regardless of the increase associated with the project, as long as the dominant noise at the receiver is due to the project.

2.3.5 Other Land Use Assessment Criteria

Road traffic noise assessment criteria for other land uses are presented in Table 4.

Table 4 Road traffic noise assessment criteria for other land uses

Road Category	Day criteria, dB(A) (7 am – 10 pm)	Night criteria, dB(A) (10 pm – 7 am)	Additional considerations
School classrooms	$L_{eq,1h}$ (internal) 40 dB(A) when in use	-	In the case of buildings used for education, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the 'maximum' levels shown in Australian Standard 2107:2000 (Standards Australia 2000).
Places of worship	$L_{eq,1h}$ (internal) 40 dB(A) when in use	$L_{eq,1h}$ (internal) 40 dB(A) when in use	Areas outside of a place of worship may also warrant consideration. This could include areas where outdoor services may take place such as weddings and funerals. The RNP provides criteria for passive recreation areas that could be taken into consideration in these instances.
Childcare facilities	$L_{eq,1h}$ (internal) 35 dB(A)	-	Applies to sleeping rooms when in use.
	$L_{eq,1h}$ (internal) 40 dB(A)	-	Applies to indoor play areas when in use.
	$L_{eq,1h}$ (external) 55 dB(A)	-	Applies to outdoor play areas when in use. Free-field criterion (not subject to facade reflection factor).
Aged care facilities	-	-	Refer to residential land use criteria defined in Table 2.

2.3.6 Sleep Disturbance and Maximum Noise Levels

The RNP includes a discussion of current knowledge regarding sleep disturbance due to road traffic noise, and states "despite intensive research, the triggers for and effects of sleep disturbance have not yet been conclusively determined."

Current research does indicate that the main acoustic characteristic that influences sleep disturbance is the emergence (e.g. magnitude) and number of noisy events heard distinctly above the background level. The RNP suggests that intermittent noisy events, such as truck pass-bys, could be assessed on the basis of emergence events determined as the difference between L_{max} levels and the steadier L_{eq} or L_{90} levels.

The RNP makes reference to Practice Note iii of the ENMM which suggests that the $L_{eq,9h}$ road traffic noise guidelines should sufficiently account for sleep disturbance impacts except where both of the following conditions are met:

- the L_{max} emergence over the ambient $L_{eq,1h}$ is greater than 15 dB(A) and
- the L_{max} level is greater than 65 dB(A).

In these cases, additional consideration of sleep disturbance impacts may be required.

2.4 Rail Noise Criteria

As part of the project, the existing rail viaduct at Pound Street will need to be replaced to provide sufficient vertical clearance for the proposed updated of Pound Street. An assessment of rail noise impacts on nearby sensitive receivers will be required during design and therefore reference has been made to the NSW Environment Protection Authority *Rail Infrastructure Noise Guideline* (RING).

The RING defines rail noise criteria for both residential and other non-residential noise sensitive receivers. Only residential receivers have been considered here as they are most relevant to the Pound Street viaduct.

Additionally, only airborne noise criteria have been considered as airborne rail noise will control the predicted noise levels at receivers rather than ground-borne rail noise.

The external airborne rail noise trigger levels for residential land uses are presented in Table 5. These are relevant to redevelopments of existing rail lines as is the case for the Pound Street viaduct.

Table 5: RING rail noise trigger levels

Type of project	Noise trigger level, dB(A)	
	Day (7 am – 10 pm)	Night (10 pm – 7 am)
Redevelopment of existing rail line.	The development will increase existing L_{eq} rail noise levels by 2 dB or more, or existing L_{max} rail noise levels by 3 dB or more, and predicted rail noise levels exceed:	
	$L_{eq,15h}$ 65 OR L_{max} 85	$L_{eq,9h}$ 60 OR L_{max} 85

Where the airborne rail noise trigger levels are exceeded, then an assessment of potential noise mitigation measures to reduce rail noise is required.

2.5 Pump Station Noise Criteria

A new flood pump station in north Grafton is proposed as part of the project to extract water from the detention basin and convey it to the Clarence River. This is required to allow flood-free access to the new bridge in 20-year average recurrence interval event floods.

The EIS derived noise criteria for the pump station in accordance with the NSW *Industrial Noise Policy*, based on noise logging results at the most representative sensitive receiver (8 Fitzroy Street on the northern side of the river). The intrusive and amenity criteria determined in the EIS and stipulated in the SWTC are presented in Table 6, with the limiting criterion for each time period highlighted in bold type.

Table 6: Pump station INP criteria

Time of day	Intrusive criteria, dB(A)	Amenity criteria, dB(A)
Day, 7 am – 6 pm	63	**56**
Evening, 6 pm – 10 pm	**51**	56
Night, 10 pm – 7 am	**36**	43

3 Existing Environment

The existing noise environment within the Grafton area varies depending on the proximity to existing roads and the town centres. The main contributors to the existing noise levels in the Grafton area are road traffic noise along the main arterial roads, general road traffic around the centres, passenger and freight rail on the Northern Railway Line, rural industry and machinery, and local insect and animal noise.

Table 7 describes the different noise catchment areas within the project area identified within the EIS. For consistency, these noise catchment areas have been maintained in this assessment and are shown on the map in Appendix 1.

Table 7: Noise Catchment Areas

Noise Catchment Area	Typical land uses within catchment
NCA 1	This area is predominantly commercial and industrial with a few residential single-storey detached dwellings.
NCA 2	This is a residential area consisting predominantly of single-storey and high-set detached dwellings and aged care facilities.
NCA 3	This area is a mixture of residential single-storey and high-set detached dwellings and an area owned by the Catholic Church consisting of some two-storey buildings used for a range of purposes such as education, places of worship and residential.
NCA 4	This area is largely made up of the North Coast TAFE campus and residential single-storey and high-set detached dwellings.
NCA 5	This is a residential area and consisting predominantly of single-storey and high-set detached dwellings and the Gummyaney Pre-School.
NCA 6	This is a residential area consisting predominantly of single-storey and high-set detached dwellings.
NCA 7	This area is predominantly rural with a few isolated residential dwellings.
NCA 8	This area is a mixture of rural land, commercial properties such as a petrol station and public open spaces.
NCA 9	This area is a mixture of residential single-storey and high-set detached dwellings, the main South Grafton commercial precinct, other commercial and industrial areas and rural land.
NCA 10	This area is predominantly rural with a few isolated residential dwellings.
NCA 11	This area is predominantly rural with a few isolated residential dwellings. It also includes part of Junction Hill which is predominantly residential.
NCA 12	This area is a mixture of residential single-storey and high-set detached dwellings, some industrial areas and the Grafton racecourse.
NCA 13	This area is a mixture of residential single-storey and high-set detached dwellings, the main Grafton commercial precinct, the TAFE and an area owned by the Catholic Church consisting of two-storey buildings used for a range of purposes such as education, places of worship and residential.
NCA 14	This is a residential area consisting predominantly of single-storey and high-set detached dwellings.

3.1 Noise Monitoring

Noise monitoring was undertaken by Arup as part of the EIS. Surveys were undertaken during three separate periods in 2010, 2011 and 2013. The noise monitoring locations are shown on the map in Appendix 1.

Table 8 presents the summary of the Arup noise monitoring results for each survey period. In some cases, attended monitoring was undertaken in addition to the unattended monitoring to derive road traffic noise levels where it was deemed that the measured noise levels would be influenced by extraneous noise sources. Instances where the noise logger failed are marked with a dash.

Generally, the ambient (L_{eq}) noise levels can be relatively high where the receiver is located close to roads or rail. However, the background (RBL) noise levels are generally much lower, particularly in the rural areas outside of the Grafton town centres.

Table 8: Noise monitoring results

Ref	Location	Measured noise level, dB(A)							
		Road traffic noise		Ambient background noise					
		Day-time Leq,15h	Night time Leq,9h	Day 7 am – 6 pm		Evening 6 pm – 10 pm		Night 10 pm – 7 am	
				Leq	RBL	Leq	RBL	Leq	RBL
2010 Survey									
1	Villiers Street, near TAFE	66[1]	58[1]	55	48	51	42	48	35
2	30 Pound Street	53[1]	43	55	44	54	39	54	35
3	8 Fitzroy Street	59[1]	53	61	53	61	41	53	31
4	Clarence Street	53	47	54	46	50	43	48	32
5	12 Bent Street	68	59	66	59	63	46	60	36
6	8 Beatson Street	56	49	56	45	52	39	49	32
7	Schwinghammer Street	66	66	66	53	67	46	66	42
2011 Survey									
8	245 Lawrence Road	58	51	59	38	56	36	51	34
9	86 Great Marlow Road	66	45	67	30	50	32	45	31
10	591 Summerland Way	65	59	65	44	61	34	59	28
11	Cnr Hoof St / Clarence St	49	45	50	35	47	35	45	32
12	94 Dobie Street	58	51	–	–	–	–	–	–
13	81 Edward Ogilvie Drive	60	56	60	43	58	42	56	35
14	Pacific Highway	71	70	71	49	71	48	70	41
15	326 Centenary Drive	50	49	50	33	49	35	49	36
16	Cnr Iolanthe St / Butters Ln	52	49	53	39	49	42	49	37
17	146-148 Ryan Street	63	56	64	45	60	40	56	29
18	5 School Drive	69	68	69	43	69	42	68	32
19	End of Meona Lane	64	47	66	35	46	38	47	35
20	4 Bacon Street	–	–	72	37	76	39	76	34
21	40 Dobie Street	–	–	57	35	–	–	–	–
22	22 Fry Street	–	–	–	–	–	–	–	–
2013 Survey									
23	320 Back Lane	–	–	50	29	52	36	52	35
24	235 Carr Street	–	–	–	–	–	–	–	–
25	98 Through Street	–	–	55	40	54	37	48	34
26	Maclennan's Lane	–	–	54	30	66	41	47	37

1. *15-minute attended measurements employed.*

4 Operational Noise Assessment

4.1 Summary of Methodology – Road Traffic Noise

The primary aim of this operational noise management report is to review any changes to predicted noise levels that result from the design compared to the RMS Reference Design on which the EIS was undertaken.

This is consistent with SWTC Project Deed Exhibit A 5.10.2 (b), (*'Grafton Bridge SWTC RFT.pdf'*) which states:

> *Notwithstanding noise data provided by RMS, the Contractor must prepare, validate and utilise its own noise model to determine the extent of noise mitigation measures required to comply with its obligations under the Environmental Documents and the deed.*

Therefore, to ensure consistency, this assessment has been conducted using the RMS Reference Design as a benchmark for the design. The methodology of this operational noise assessment is as follows:

- Model an existing 'no build scenario' and compare the results with the equivalent Environmental Assessment stage results. Confirm that the results are the same as (or within an acceptable tolerance of) the previous assessment to demonstrate model validation. This includes validation to the measured noise levels in the EIS.
- Confirm agreement with the EIS stage selection of 'New' or 'Redeveloped' road noise criteria for each residence (which are based on existing exposure to road traffic noise in accordance with ENMM Practice Note (i)).
- Calculate road traffic noise levels based on the Fulton Hogan detailed design and compare with the results of the equivalent EIS stage scenario. Confirm that the results are the same as (or within an acceptable tolerance of) the previous assessment.
- It is also necessary to meet the requirements of Minister' Condition of Approval D11 (CoA D11). The process described above largely conforms to the requirements of CoA D11 as described in Table 9 with an additional step relating to reconfirming the appropriateness of the noise mitigation measures determined as part of the EIS.

Table 9 Methodology to Comply with CoA D11

4.1.1.1.1 Condition	4.1.1.1.2 Report Section
D11(a) confirm the operational noise predictions of the SSI based on detailed design. This operational noise assessment shall be based on an appropriately calibrated noise model (which has incorporated additional noise monitoring, where necessary for calibration purposes);	Model an existing 'no build scenario' and compare the results with the equivalent Environmental Assessment stage results. Confirm that the results are the same as (or within an acceptable tolerance of) the previous assessment to demonstrate model validation. This includes validation to the measured noise levels in the EIS. Refer to Section 4.4.1 for details of noise model validation.
D11(b) review the suitability of the operational noise mitigation measures identified in the documents listed in condition A2. The review shall take into account the detailed design of the SSI and, where feasible and reasonable, 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;	Assess predicted road traffic noise levels from the Fulton Hogan Design against the predicted noise levels from the RMS Reference Design and the RNP criteria. Demonstrate that the proposed noise mitigation strategy based on the requirements of the SWTC satisfactorily meets the requirements of the RNP criteria. Refine the current mitigation strategy if necessary to meet the requirements of the RNP Criteria.Refer to Section 4.6 A review of the noise mitigation scheme for the project is conducted within this section.
D11(c) where necessary, investigate additional feasible and reasonable noise mitigation measures to achieve the criteria outlined in the NSW *Road Noise Policy* (DECCW, 2011).	If deemed necessary consider additional reasonable and feasible mitigation measures. Refer to Section 4.6 A discussion of additional reasonable and feasible measures is provided if required.

4.2 Prescribed Road Traffic Noise Modelling Parameters

The prescribed road traffic noise modelling parameters and procedures set out in SWTC Appendix 4, Clause 4.21 (e) (iii to xiv) are shown in Table 10.

Table 10: Prescribed road traffic noise modelling parameters

SWTC App 4 Clause 4.21 (e)	Parameter	Detailed design noise model
iii	Vehicle speed – main carriageways; 15 hour 7 am to 10 pm (day)	60 km/hr
	Vehicle speed – main carriageways; 9 hour 10 pm to 7 am (night)	60 km/hr
	Local roads	Posted traffic speed identified in Figure 9.2 of Appendix 9 of Scope of Works and Technical Criteria
iv	Traffic volumes Year 2019 (at opening)	Table 9.8 of Appendix 9 of Scope of Works and Technical Criteria and reproduced in Appendix 4.
	Traffic volumes Year 2029 (10 years after opening)	Table 9.9 of Appendix 9 of Scope of Works and Technical Criteria and reproduced in Appendix 4.
v	Road traffic noise prediction algorithm	Calculation of Road Traffic Noise (CoRTN) 1988
	'Appropriate adjustments for NSW noise descriptors'	The 15 hour and 9 hour traffic flows have been divided by 15 and 9 respectively. The CoRTN $L_{10,1hr}$ predictions have been converted to $L_{eq,15h}$ and $L_{eq,9h}$ by subtracting 3 dB from the result for each period. A 3 dB difference between L_{10} and L_{eq} levels is widely accepted.[1]
vi	Three source heights	0.5 m above ground for car exhausts, car engines, car tyres (single source string) 0.5 m above ground for truck tyres 1.5 m above ground for truck engines 3.6 m above ground truck exhausts
vi	Source corrections	-0.6 dB for truck engines -8.6 dB for truck exhausts[2]
vii	Pavement corrections	0 dB(A) for Densely Graded Asphalt (DGA) applied to the car and truck tyre string No other road surface corrections have been modelled
viii	Receiver heights	1.5 m above ground for ground floor receiver 4.5 m above ground for first floor receiver or as adjusted for elevated ground floor situations based on site obversations

[1] Kean, S, 2008, *Is CoRTN an L_{eq} or L_{10} procedure?* Proceedings of Acoustics 2008, Geelong.

[2] Appendix 4 Clause 4.25 (e) (vi) states that the truck exhaust correction is -8.4 dB(A). The modelling results in this report are based on a correction factor of -8.6 dB(A) as this is consistent with the EIS stage predictions based on the statement in that report, *'The 3.6 m source which represents heavy vehicle exhaust noise sources, is 8 dB(A) below the 1.5 m source'* and is also consistent with usual practice. As truck exhausts are not the controlling source of road traffic noise, a minor 0.2 dB change in the source level will have negligible influence on the predicted noise levels.

SWTC App 4 Clause 4.21 (e)	Parameter	Detailed design noise model
ix	Ground absorption factor	50% (i.e an absorption coefficient of 0.5) for land and 0% (i.e an absorption coefficient of 0.1) for water
x	Search radius	3 km
xi	Grid spacing and height above ground	20 m grid 1.5 m above ground
xii	Model validation	Refer to validation against measured data below.
xiii	Safety factor	1.0 dB(A) has been added to the build and no-build scenarios
xiv	Façade reflection correction	+ 2.5 dB(A) at 1 m from facade (single point receiver calculations) Noise contour plots (grid noise maps) are presented as free field noise levels (i.e. with no + 2.5 dB(A) façade reflection correction
	ARRB Australian condition correction	-1.7 dB(A) for standard correction at 1 m from facade.

4.3 Road Traffic Noise Models

Using the parameters above, noise models have been developed for the scenarios listed in Table 11.

Table 11: Road traffic noise models

Noise model	Description
No Build Road Alignment (NO)	Existing situation used for validating the road traffic noise model against EIS measurements. Traffic volumes have been based on: – existing traffic volumes sourced from EIS Appendix D *Technical Paper: Traffic and transport* – No Build 2019 and 2029 traffic volumes from EIS Appendix F *Technical Paper: Noise and vibration assessment.*
RMS Reference Design (RD)	RMS Reference Design (Concept Design) upon which EIS was based (Option C), received as part of the RFT Package. This provides a comparison point for all design predictions. Traffic volumes have been based on: – Build 2019 and 2029 traffic volumes for new roads from SWTC Appendix 9.10 Table 9.8 and 9.9 – Build 2019 and 2029 traffic volumes for existing roads from EIS Appendix F *Technical Paper: Noise and vibration assessment.*
FH design (FH)	Fulton Hogan design received 2 August 2016. Traffic volumes consistent with Reference Design assessment.

4.4 No Build Road Alignment

A noise model of the existing road alignment (i.e. the 'no build' scenario) was developed based on the:

- Survey drawing showing existing ground contours (*'Consolidated.dwg'*)
- Ground contours (*'Ground contours 150731.dwg'*) contained in Information Document 31
- Additional ground contours obtained from Clarence Valley Council
- DGA surface for all roads.

4.4.1 Noise Model Validation

An existing model of the roads was developed based on the existing road alignments and the existing traffic volumes documented in the EIS Appendix D *Technical Paper: Traffic and transport*. The parameters used for the validation model are presented in Table 12.

The validation noise model incorporates the following parameters:

Table 12:Validation model parameters

Correction	Comment	Surface Correction
Road surface	10mm or 14/7mm chip seal	+ 3 dB[1]
Truck Engine		-0.6 dB
Truck Exhaust		-8.6 dB
ARRB Correction	Facade	-1.7 dB
ARRB Correction	Free Field	-0.7 dB
Façade Correction		+ 2.5 dB

1 A surface correction of +3 dB for 10mm or 14/7mm chip seal has been assumed (as opposed to 4 dB for new chip seal pavement)

The predicted noise levels from the model were compared to the three locations used for the model validation as part of the EIS, with the validation presented in Table 13.

Table 13: Road traffic noise model validation

Ref	Location	Daytime road noise level, dB(A)			Night time road noise level, dB(A)		
		Measured	Predicted	Difference	Measured	Predicted	Difference
1	Villiers Street near TAFE[1]	54.2	53.367	-0.9	48	47.1	-0.9
3	8 Fitzroy Street, Grafton	59	58.1	-0.9	53	51.9	-1.1
5	12 Bent Street, Grafton Aged care home	68	66.7	-1.3	59	59.7	0.7

1. *Predictions include Villiers Street, which was not included in other No Build models. During a site visit on 17 November 2015, it was noted that Villiers Street was the controlling source at this location.*

A comparison of the modelled versus measured noise levels showed the following:

- A median under prediction of -0.9 dB with standard deviation of 0.2 dB during the daytime.
- A median under prediction of -0.9 dB with standard deviation of 0.1 dB during the night-time (excluding the over-prediction at Location 5).

The noise model has shown a consistent under-prediction of more than 1 standard deviation. A validation factor of 1 dB has therefore been added. The validated comparison of modelled versus measured is as follows:

- A median over prediction of 0.1 dB with standard deviation of 0.2 dB during the daytime.
- A median over prediction of 0.1 dB with standard deviation of 0.2 dB during the night-time.

This validation factor has been added to the Design Noise Model.

The predicted and measured road traffic noise levels agree within a tolerance of less than ±1 dB, which is considered a suitable level of accuracy for road traffic noise projects.

The validated 2019 and 2029 No Build noise models were used to predict road traffic noise levels at each sensitive receiver identified in the EIS. These predictions are included in Appendix 2.

4.5 RMS Reference Design

A noise model of the reference scheme road design was developed based on the:

- RMS Reference Design alignment provided in Information Document 28
- Survey drawing showing existing ground contours (*'Consolidated.dwg')*
- Ground contours (*'Ground contours 150731.dwg'*) contained in Information Document 31
- Additional ground contours obtained from Clarence Valley Council
- DGA surface for all roads
- 340 m long, 3 m high noise barrier on the eastern edge of the bridge deck on the northern embankment between chainage 1340 to chainage 1680.

The RMS Reference Design model was used to predict noise levels for comparison with the EIS predicted Reference Design noise levels to assess the accuracy of the Build noise model. Predicted noise levels were found to agree well with the EIS predicted noise levels, being within 1.0 dB those receivers most affected by the project, e.g. those shielded by the proposed noise barrier.

The predicted RMS Reference Design noise levels are included in Appendix 2.

4.6 Fulton Hogan Detailed Design

The 100% detailed design noise model included:

- Fulton Hogan design (*'x-gft-d-rd-plan-3d.dwg'*) with the road model domain matching that of the reference design in order to allow appropriate noise level comparisons to be made.
- Survey drawing showing existing ground contours (*'Consolidated.dwg')*
- Additional ground contours obtained from Clarence Valley Council
- DGA surface for all roads
- 340 m long, 3 m high noise barrier (relative to road height) along the eastern edge of the bridge deck along the same extent as the Reference Design.
- Parameters as shown in Table 14

Table 14: Design model parameters

Correction	Comment	Surface Correction	SWTC Requirement Implemented
Model Validation Factor		+1 dB	Yes
Safety Factor		+1 dB	Yes
Road surface	DGA	+0 dB	Yes
Truck Engine		-0.6 dB	Yes
Truck Exhaust		-8.6 dB	Yes
ARRB Correction	Facade	-1.7 dB	Yes
ARRB Correction	Free Field	-0.7 dB	Yes
Façade Correction		+ 2.5 dB	Yes

4.6.1 Summary of Predicted Noise Levels

Single Point Receiver Results

The Fulton Hogan design broadly follows the RMS Reference Design. With regards to the most affected noise sensitive receivers on the northern bank of the Clarence River, the Fulton Hogan design is located marginally higher than the Reference Design. This marginally reduces predicted road traffic noise levels at adjacent residences.

Predicted single point receiver road traffic noise levels for each receiver within the Fulton Hogan design are included in Appendix 2 for the following scenarios:

- 2019 daytime and night-time
- 2029 daytime and night-time

RMS reference design noise level predictions are also presented for comparison. The results show that the Fulton Hogan detailed design noise levels at sensitive receiver locations are generally consistent with the Reference Design predictions and are typically within a range approximately +/- 1 dB.

A summary of the RNP criteria exceedances for the Fulton Hogan detailed design is provided in Table 15 (refer to Appendix 2 for details). It should be noted that these values do not include any receivers where noise levels have been reduced below the RNP criteria as a result of the prescribed 3m high noise barrier.

Table 15 RNP Exceedances

Criterion Exceeded	Number of Exceedances	
	Fulton Hogan	Reference
$L_{Aeq,5hr}$ or $L_{Aeq,9hr}$ and with treatment proposed	44	47
Acute with property treatment proposed	4	5
Acute with decrease in noise level as a result of the project with no property treatment proposed	11	14

An analysis of the detailed design noise modelling results has shown that the requirement for architectural treatments aligns closely with the outcome of the EIS. There are 3 locations that marginally qualified for treatment in the EIS and no longer trigger as a result of the detailed design. A commitment to provide treatment to those locations was made in the EIS and are therefore noted as requiring treatment within Appendix 2.

Architectural treatments for operational road traffic noise will be administered by RMS.

Noise Level Contours

Predicted noise contours showing free-field predicted daytime and night time road traffic noise levels for the Fulton Hogan design in 2029 are included in Appendix 3, and compared with the RMS-provided EIS noise contours.

The following observations have been made:

The predicted noise level contours agree well, particularly in those areas where the sensitive receivers are located.

- The noise contours deviate marginally where the road bridge passes over the river. This deviation is of no consequence with respect to noise sensitive receivers and the RNP Criteria. The reasons for the deviation are as follows:
  - Slight variation in horizontal alignment of the bridge relative to the reference design.
  - Slight variations in the barrier effect afforded by the jersey kerb barriers over the bridge relative to the reference design.

- The noise level contours deviate where the new road alignment intersects with Charles St (A1) just west of Alipou Street. This deviation is of no consequence with respect to noise sensitive receivers and the RNP Criteria. The reason for the deviation is as follows:
  - The modelled alignment (ie road string in the noise model) extends slightly further to the east when compared to the reference design.
- The noise level contours deviate to the south of the Gwydir Highway, west of Bent Street. This deviation is of no consequence with respect to noise sensitive receivers and the RNP criteria. The reason for this deviation is as follows:
  - Minor changes to road alignments and slight differences in digital terrain models (EIS compared to detailed design).
- The noise level contours deviate to the east of the new road alignment between the river and Charles Street, South Grafton. This deviation is of no consequence with respect to noise sensitive receivers and the RNP criteria. The reasons for this deviation are as follows:
  - Minor changes to road alignments and slight differences in digital terrain models (EIS compared to detailed design).

Based on our assessment, it can be concluded that the Fulton Hogan design conforms with the operational road traffic noise requirements of the RMS SWTC.

4.6.2 Review of Operational Road Traffic Noise Mitigation Requirements

The following noise mitigation measures were included for consideration as part of the EIS.

- Low noise pavement with consideration given to Dense Graded Asphalt (DGA) and Stone Mastic Asphalt (SMA) pavement.
- Noise barriers
- Architectural treatments

The applicability of each measure to the EIS and detailed design is discussed below.

Low Noise Pavement

The EIS determined that DGA was an appropriate pavement selection on the basis that the project area will have a maximum speed of 60km/h or less without the steady state traffic flows (and therefore noise levels) that would be expected on a highway.

The Fulton Hogan design is based on a DGA road surface that reduces road traffic noise levels relative to non-asphalt surface types. The DGA surface is consistent with the RMS Reference Design.

Furthermore, it is noted that DGA is the preferred pavement from availability, durability, cost and constructability perspectives.

Noise Barriers

A single noise barrier was proposed as part of the EIS and mandated within the SWTC. The noise barrier of 3m in height and approximately 300m in length is proposed to be located on the eastern side of the northern approach to the road bridge. In addition to the proposed noise barrier, solid 830 mm high jersey kerbs will be included on both sides of the new bridge, providing some additional mitigation of road traffic noise.

An extension of the noise barrier is not reasonable to the north of the bridge due to local road access and the rail bridge.

The extension of the barrier to the south is not reasonable because the extension does not result in additional noise level reductions at the receivers to the east of the bridge at North Grafton.

The placement of noise barriers at other exceedance locations is not reasonable due to groupings of receivers being 3 or less or the receivers requiring access to the road.

This noise barrier has been incorporated as part of the detailed design for the following reasons:

- The proposed location is the only reasonable location for a noise barrier to be installed within the project area in that any other location where a noise level exceedance exists would require a noise barrier to be constructed across driveways etc (not a reasonable outcome).
- The proposed barrier achieves the minimum 5 dB noise reduction at at least one receiver.
- The noise barrier is a key expectation of the community.

A review of the noise barrier height optimisation analysis undertaken in the EIS has been conducted on the basis of the detailed design in accordance with the ENMM Practice Note IV (refer to Figure 1 and Figure 2 for the daytime and night-time respectively).

Figure 1 Noise Barrier Optimisation Curves – Daytime

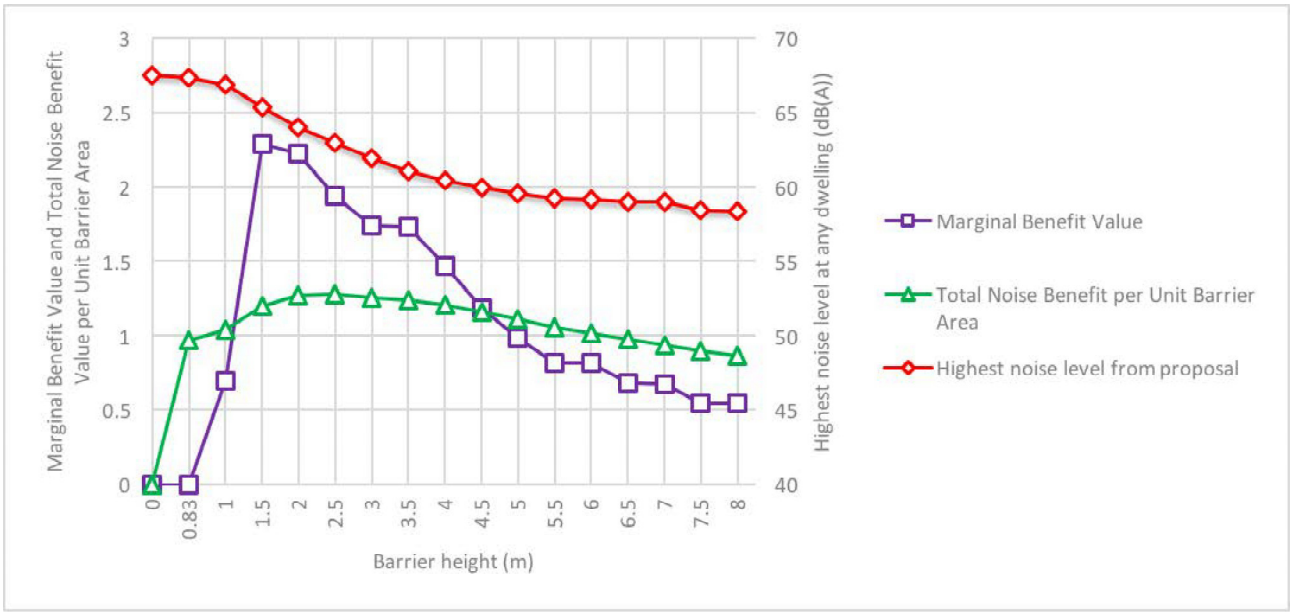
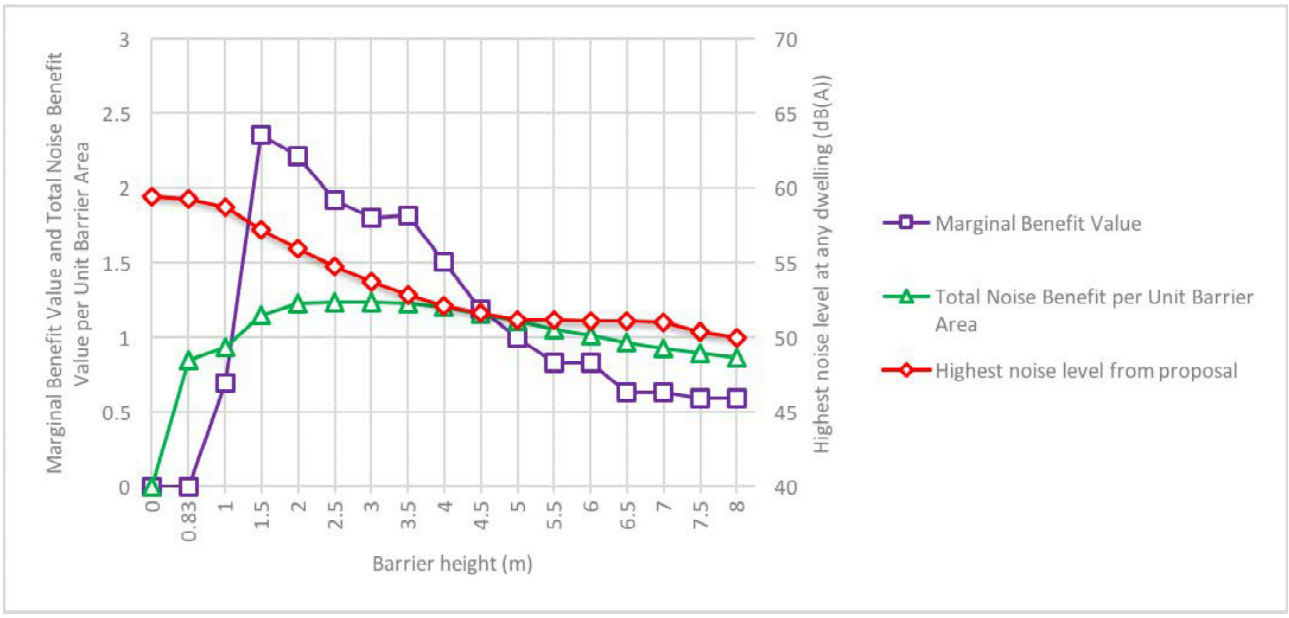


Figure 2 Noise Barrier Optimisation Curves – Night-time



The assessed barrier is selected on the basis of an objective assessment of peaks in the MBV and TNBA curves and minimum insertion loss requirements at the most affected receiver in the catchment behind the proposed barrier. Also please note that the minimum barrier height allowable in accordance with the SWTC is 3m in height.

The results demonstrate maxima in the MBV curve at barrier heights of 1.5 m and 3 m with the minimum insertion loss of 5 dB achieved at a barrier height of 3 m. The peak in the TNBA curve is at 3 m. The RNP criteria cannot be achieved at all locations for any barrier height up to 8 m. Therefore the 3.0m noise barrier height has been adopted for the detailed design and further augmentation is not warranted. The noise barrier location is presented in Figure 3.

Figure 3 Noise Barrier Location

Architectural Treatments

For the reasonable and feasible reasons outlined above in relation to the use of pavement and noise barriers it is necessary to provide architectural treatments to the receivers that still exceed the RNP criteria.

An analysis of the detailed design noise modelling results has shown that the requirement for architectural treatments aligns closely with the outcome of the EIS. There are 3 locations that marginally qualified for treatment in the EIS and no longer trigger as a result of the detailed design. Commitments to provide treatment to those locations was made in the EIS and are therefore noted as requiring treatment within Appendix 2.

RMS will administer architectural treatments for operational road traffic noise.

4.6.3 Maximum Noise Level Assessment

Section 7 of the EIS provided an assessment of heavy vehicle maximum noise level events on a per noise catchment area basis with reference to the background noise levels per catchment. The assessment assumed a reference noise level based on the results of a study of downhill maximum noise level events. The relative distance to noise sensitive receivers combined with the redistribution of traffic flows resulting from the project was used to determine the change in maximum noise level events.

The findings were as follows:

- The total number of maximum noise level events was not predicted to increase as a result of the project
- The number of maximum noise level events was predicted to reduce at receivers in the vicinity of the existing bridge with L_{Amax} noise levels ranging between 60 dBA and 86 dBA
- The number of maximum noise level events was predicted to increase at receivers in the vicinity of the new bridge with L_{Amax} noise levels ranging between 62 dBA and 80 dBA.

On the basis of the aforementioned results the following can be said about maximum noise levels and sleep disturbance:

- It can be seen that existing emergence events (calculated as L_{max} less $L_{eq,1h}$ over the night time period) do exceed the 15 dB(A) sleep disturbance goal from Practice Note iii of the ENMM.
- Despite this, receivers exposed to a new road, or where a road is relocated substantially closer, would be likely to be exposed to emergence events exceeding 15 dB(A) above the background L_{eq} level. This will be mitigated to some degree by the provision of mitigation measures as discussed in Section 4.6.2, with the likelihood of emergence events decreasing at receivers further from the new road as maximum noise levels (which are representative of acoustic point sources at distance) will be attenuated with distance at twice the rate of the overall L_{eq} traffic noise levels (which are representative of acoustic line sources).
- Overall, neither the RNP nor the ENMM specify requirements for noise barriers and other forms of mitigation to reduce the occurrence of sleep disturbance events, particularly as mitigation methods such as barriers will also reduce the L_{eq} levels and therefore have little effect on emergence. Reduction of the likelihood of sleep disturbance events is typically provided by programs to reduce truck exhaust brake noise through management of driver behaviour and appropriate design of new vehicles.

4.7 Rail Noise Assessment

4.7.1 Overview

To provide sufficient vertical clearance on Pound Street beneath the railway line, the existing railway viaduct overpass at Pound Street will require replacement. The existing section of viaduct will be replaced with a steel-concrete composite bridge, with track on sleepers and ballast laid on concrete slabs supported by steel cross beams and trusses.

The bridge replacement will not result in a change to the vertical or horizontal alignment of the railway corridor nor will it result in an increase in rail traffic. The change in bridge design relative to the existing all concrete viaduct may result in an increase in noise levels due to a greater structure-borne noise component from the bridge. An assessment of these potential impacts is required to be conducted in accordance with the RING.

The ring trigger levels for the redevelopment of an existing railway line are applicable in this situation and are detailed in Section 2.4.

4.7.2 Methodology

The two nearest noise sensitive receivers to the rail bridge are as follows:

- 30 Pound Street located at a distance of approximately 66m from the rail bridge and railway track.
- 24 Pound Street located at a distance of approximately 51m from the rail bridge and railway track.
- 1 Bridge Street located at a distance of 44 m from the rail bridge and 20 m from the railway track.

A noise logger was placed at 30 Pound Street as part of the EIS (refer to Page C2 of the EIS noise and vibration technical paper). These noise monitoring results have been used as the reference for the existing level of rail traffic noise at this location and as the basis for predicting the existing level of rail noise each location.

A correction to the overall noise levels has been included in order to determine the potential increase in overall noise levels that may result from the rail bridge replacement. The following references provide an indication of potential bridge noise increase factors and recommendation of appropriate correction factors for noise modelling purposes.

- Transport for NSW Rail Noise Database provides the following options for bridge noise corrections:
  - Open transom, fabricated steel web, no side screens: + 10 dB
  - Open transom, fabricated web forming side screens: + 8 dB
  - Ballasted, steel box girder no side screens: + 4 dB
  - Ballasted fabricated web forming side screens: + 4 dB
  - Ballasted concrete span, no side screens: + 0 dB
- Paper by Ungar and Wittig (1980) suggest typical correction factors for concrete / steel composite bridges ranging between 0 and 5 dB are typical.
- UK Department of Transport: Calculation of Railway Noise (1995):
  - Concrete bridges and viaducts: +1 dB
  - Steel Bridges: +4 dB
  - Directly fixed box girders and open transom type structures: +9 dB

A review of the information above suggests that the new bridge could result in a localised increase in noise levels ranging between 1 dB and 4 dB. A 4 dB correction has been conservatively assumed for this assessment.

It has been conservatively assumed that the L_{Aeq} is controlled by the bridge noise emission with the exception of 1 Bridge Street (located at 20 m from the track on embankment) which would be governed by the L_{Aeq} noise levels emitted directly adjacent.

It has been conservatively assumed that the L_{Amax} is controlled by the bridge noise emission with the exception of 1 Bridge Street (located at 20 m from the track on embankment) which would be governed by the maximum noise levels emitted directly adjacent.

4.7.3 Prediction and Assessment

The predicted noise levels for the three receivers noted above are provided in Table 15. The overall trigger levels are shown in brackets.

Table 15 Rail Noise Predictions

Location	Existing (dBA)			Incorporating New Bridge (dBA)			Trigger level exceedance?
	$L_{Aeq15hr}$	L_{Aeq9hr}	L_{Amax}	$L_{Aeq15hr}$	L_{Aeq9hr}	L_{Amax}	
Trigger Levels	***65***	***60***	***85***	***65***	***60***	***85***	**-**
30 Pound Street	55	43	78	59	47	82	No
24 Pound Street	56	44	80	60	48	84	No
1 Bridge Street	58	48	88	58	48	88	No

The RING trigger levels are not predicted to be exceeded at any of the prediction locations. Whilst the existing L_{Amax} noise level at 1 Bridge Street is predicted to be greater than the overall trigger level of 85 dB(A), it is not predicted to increase as a result of the new rail bridge. The current scope of mitigation measures for the road upgrade adequately account for both the rail bridge and the road upgrade. Therefore does not trigger the need for further consideration of noise mitigation.

Notwithstanding this it should be noted that:

- The new viaduct will be constructed of track on sleepers and ballast.
- Any expansion joints will not result in a railhead discontinuity, which in turn will not result in impulsive noise events during train pass by events.
- It is noted that the nearest noise sensitive receivers to the rail bridge will be receiving architectural treatments related to road noise.

4.8 Pump Station Noise Assessment

4.8.1 Overview

A detailed description of the pump station is provided in document reference GB-PS-01-RPT-0001 (pump station design report).

The key features of consequence from an acoustics perspective are:

- Two submersible centrifugal wastewater pumps (Xylem 3501/835 3).
- One emergency backup generator (Kohler Power Systems KH700).

The pump station will only operate under flood conditions and the backup generator will only operate if the permanent power supply is disrupted during flood conditions. The backup generator will have the ability to operate continuously for 72 hours without a refuel.

An assessment against the INP criteria is required. The night-time intrusiveness criterion is the controlling criterion.

4.8.2 Methodology

The following assumptions have been made for the purposes of this assessment:

- Source Levels
  - Source sound pressure level of each pump: 93 dB(A) at 1m (estimated from Bies & Hansen for pump with power greater than 75 kW).
  - Source sound pressure level of generator: 88 dB(A) at 1m (Kohler KH700 data sheet).

Two scenarios are presented:

- Pumps and generator running simultaneously for 100% of a 15-minute period.
- Pumps running without the generator for 100% of a 15-minute period.

The nearest receivers to the pumps and generators are as follows:

- 5 Kent Street (60 m from pumps, 130m from generator).
- 6 Greaves Street (170 m from pumps, 65 m from generator).

The submersible pumps will be located below ground level and completely covered from site via a steel access hatch and assumed to be fully submerged.

The predictions assume clear line of sight between the backup generator and 6 Greaves Street.

4.8.3 Prediction and Assessment

The predicted noise levels for the aforementioned scenarios are presented in Table 16.

Table 16: Pump Station Noise Predictions

Receiver	$L_{Aeq(15minute)}$ Pumps and Generator (dBA)	$L_{Aeq(15minute)}$ Pumps Only (dBA)	Night-time Intrusiveness Criterion (dBA)
5 Kent Street	41	34	36
6 Greaves Street	52	26	36

The pump station is predicted to comply with the INP criteria for the pump only scenario. The INP criteria are predicted to be exceeded during periods when the backup generator is required to operate. It is understood that this is only during emergency power outages.

No additional treatment is required for the pumps.

It is noted that the nearest noise sensitive receivers to the pump station and backup generator will be receiving architectural treatments related to road noise. This measure is deemed adequate on the basis that the backup generator would be infrequently required and within the context of an emergency situation.

5 Conclusion

This Operational Noise Assessment design report has been prepared for the Fulton Hogan Detailed Design. An acoustic assessment of the design has been undertaken based on relevant sections of:

- Minister's Condition of Approval (D11).
- Scope of Works and Technical Criteria (SWTC).

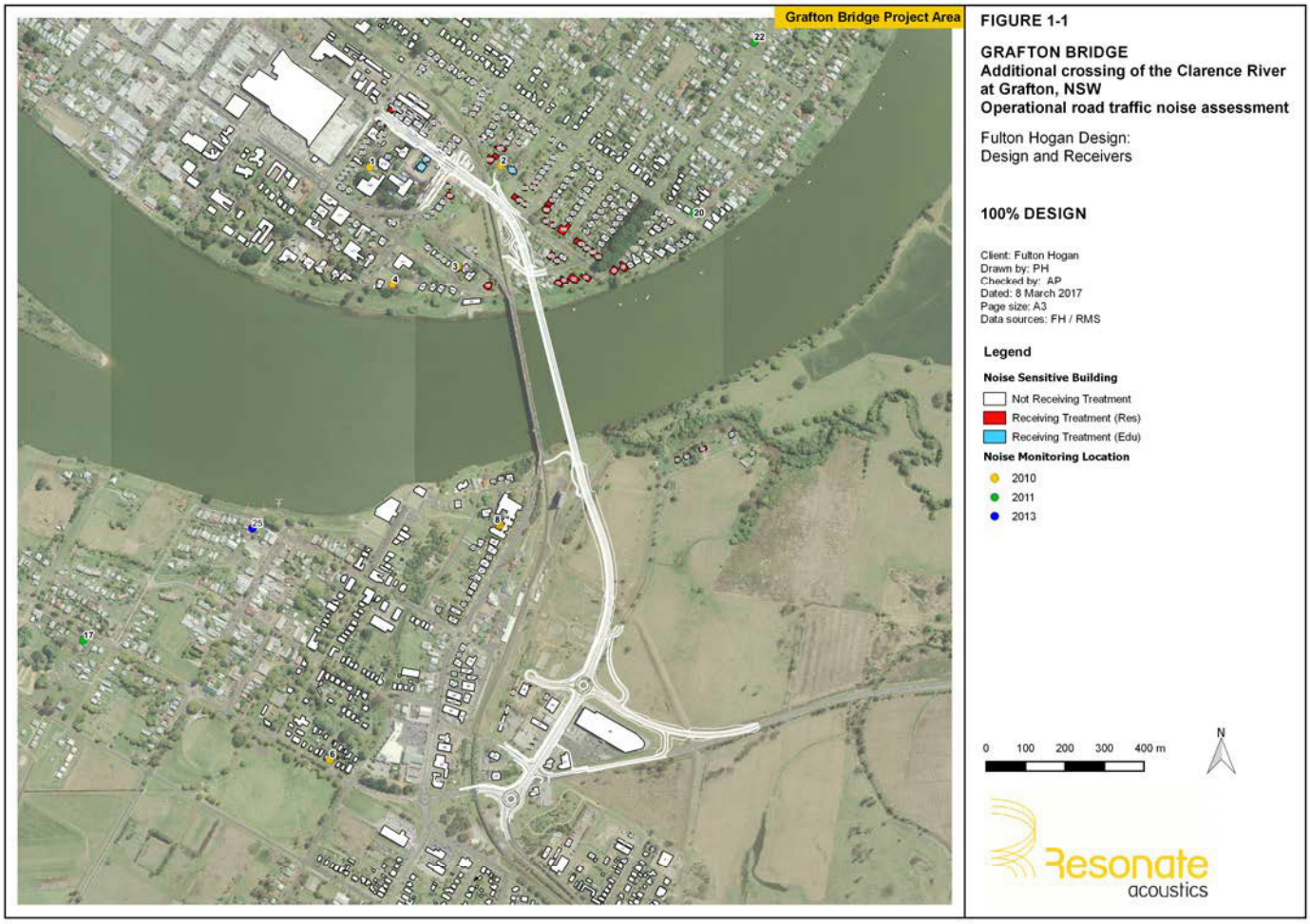
The road traffic noise predictions indicate that the Fulton Hogan Detailed Design is largely consistent with the RMS Reference Design, with no significant change in predicted noise levels between the two designs at most noise sensitive receiver locations. Where changes in noise levels have occurred, these are typically minor (approximately 1 dB) and do not necessitate additional noise mitigation measures.

A review of the mitigation measures determined that no additional mitigation measures are warranted for road traffic noise.

The assessment has also indicated that:

- The rail viaduct replacement at Pound Street is not predicted to exceed the RING trigger levels and therefore no additional mitigation measures are required.
- The pump station is not predicted to exceed the INP criteria. The associated backup generator is predicted to exceed the INP intrusiveness criteria at the nearest noise sensitive receivers. It is noted that the nearest noise sensitive receivers to the pump station and backup generator will be receiving architectural treatments related to road noise. This measure is deemed adequate on the basis that the backup generator would be infrequently required and within the context of an emergency situation.

Appendix 1: Noise Catchment Areas and Monitoring Locations


Grafton Bridge Project Area
FIGURE 1-1
GRAFTON BRIDGE
Additional crossing of the Clarence River at Grafton, NSW
Operational road traffic noise assessment
Fulton Hogan Design:
Design and Receivers
100% DESIGN
Client: Fulton Hogan
Drawn by: PH
Checked by: AP
Dated: 8 March 2017
Page size: A3
Data sources: FH / RMS
Legend
Noise Sensitive Building
Not Receiving Treatment
Receiving Treatment (Res)
Receiving Treatment (Edu)
Noise Monitoring Location
2010
2011
2013
0 100 200 300 400 m
N
Resonate
acoustics

Appendix 2: Predicted operational noise levels

Table B-1: Predicted operational road traffic noise levels

Receiver	Usage	Receiver Height Above Ground	No Build				Criteria						Reference Design (shaded cell indicates exceedance of the absolute criteria)				Fulton Hogan Design (shaded cell indicates exceedance of the absolute criteria)				FH Build 2029 - No build 2019		FH take Ref	Absolute Noise Criteria Exceeded (Yes / No)		Relative 2 dB Noise Level Increase Exceeded? (Yes / No)		Qualifies for treatments (Yes / No)		Acute (Yes / No)
			2019		2029		Absolute		Relative		Acute		2019		2029		2019		2029					Reference Design	Fulton Hogan Design	Reference Design	Fulton Hogan Design	Reference Design	Fulton Hogan Design	
			day	night	day	night	day	night	day	night	day	night	day	night	day	night	day	night	day	night	day	night	2029							
R001	RES	1.5	44.9	36.5	46.2	37.8	55	50	59.1	50.7	65	60	51.3	43.9	52.7	45.3	49.8	41.8	51.5	44.3	6.6	7.8	-1.2			Yes	Yes			
R002	RES	3	45.7	37.5	47	38.7	55	50	59.9	51.6	65	60	52.1	44.5	53.4	45.9	50.4	42.6	51.9	45	6.2	7.5	-1.5			Yes	Yes			
R003	RES	1.5	45.7	37.5	47	38.7	55	50	59.9	51.6	65	60	50.9	42.8	52.1	44	42.9	35.2	44.5	37.6	-1.2	0.1	-7.6			Yes				
R005	RES	1.5	46	37.8	47.2	39	55	50	60.1	51.9	65	60	52.5	45.1	53.8	46.5	50.9	43	52.4	45.3	6.4	7.5	-1.4			Yes	Yes			
R007	RES	1.5	43.9	35.5	45.2	36.7	55	50	58.1	49.6	65	60	51.8	44.8	53.2	46.3	49.6	41.9	51.8	45	7.9	9.5	-1.4			Yes	Yes			
R009	RES	1.5	45.1	36.9	46.4	38.1	55	50	59.3	51	65	60	52	45.1	53.4	46.5	49.8	42.2	51.8	45	6.7	8.1	-1.6			Yes	Yes			
R047	RES	1.5	67.2	57.9	68.7	59.3	55	50	81.6	72.2	65	60	62.8	54.1	63.2	54.3	62.4	53.7	62.7	53.9	-4.5	-4	-0.5							
R049	RES	1.5	67.5	58.1	68.9	59.6	55	50	81.8	72.5	65	60	63	54.3	63.3	54.4	62.4	53.7	62.6	53.9	-4.9	-4.2	-0.7							
R051	RES	1.5	67.2	57.9	68.7	59.4	55	50	81.6	72.3	65	60	62.9	54.2	63	54.2	61.7	53.1	61.9	53.1	-5.3	-4.8	-1.1							
R053	RES	1.5	68.3	59.1	69.8	60.6	55	50	82.7	73.5	65	60	64	55.4	64.2	55.5	62.9	54.3	63	54.4	-5.3	-4.7	-1.2							
R056	RES	1.5	69.2	61	70.4	62.3	55	50	83.3	75.2	65	60	66.1	58.1	67	59.1	65.3	57.3	66.2	58.3	-3	-2.7	-0.8							Yes
R057	RES	1.5	68	60	69.3	61.2	55	50	82.2	74.1	65	60	65.1	57.1	66	58.2	64.4	56.5	65.3	57.5	-2.7	-2.5	-0.7							
R058	RES	1.5	51.3	42.8	52.6	44.1	55	50	65.5	57	65	60	49	40.9	50	41.8	48.2	40.1	49.2	41.1	-2.1	-1.7	-0.8							
R059	RES	1.5	69.5	61.5	70.7	62.7	55	50	83.6	75.6	65	60	66.6	58.7	67.6	59.9	65.9	58	66.9	59.2	-2.6	-2.3	-0.7							Yes
R060	RES	1.5	68.7	60.8	70	62	55	50	82.9	74.9	65	60	65.9	58	66.9	59.1	65.2	57.3	66.3	58.5	-2.4	-2.3	-0.6							Yes
R061	RES	1.5	68.4	60.5	69.7	61.7	55	50	82.6	74.6	65	60	65.6	57.7	66.6	58.9	65	57.1	66	58.3	-2.4	-2.2	-0.6							Yes
R062	RES	1.5	69.4	61.5	70.6	62.7	55	50	83.5	75.6	65	60	66.5	58.6	67.5	59.8	65.8	57.9	66.7	59.1	-2.7	-2.4	-0.8							Yes
R063	RES	1.5	68.5	60.6	69.7	61.8	55	50	82.6	74.7	65	60	65.7	57.8	66.7	58.9	64.8	56.8	65.7	58	-2.8	-2.6	-1							Yes
R064	RES	1.5	68.2	60.3	69.4	61.5	55	50	82.3	74.4	65	60	65.4	57.5	66.4	58.7	64.3	56.3	65.2	57.6	-3	-2.7	-1.2							
R065	RES	1.5	68.5	60.7	69.8	61.9	55	50	82.7	74.8	65	60	65.7	57.8	66.8	59	64.5	56.7	65.6	57.8	-2.9	-2.9	-1.2							Yes
R066	RES	4.5	67.8	59.9	69	61.1	55	50	81.9	74	65	60	65	57.1	66.1	58.3	63.9	56	65	57.2	-2.8	-2.7	-1.1							
R067	RES	1.5	68.3	60.5	69.6	61.7	55	50	82.5	74.6	65	60	65.6	57.6	66.6	58.8	64.7	56.7	65.7	57.9	-2.6	-2.6	-0.9							Yes
R068	DA	2.5	50	42.1	51.3	43.3	55	50	64.2	56.2	65	60	50	44.2	51.1	45.3	49.3	43.5	50.4	44.6	0.4	2.5	-0.7			Yes	Yes			
R069	RES	1.5	65.9	58	67.1	59.2	55	50	80	72.1	65	60	63.2	55.3	64.3	56.5	62.5	54.6	63.6	55.8	-2.3	-2.2	-0.7							
R070	RES	2.5	49.8	41.9	51	43.1	55	50	63.9	56	65	60	48.6	40.7	49.7	41.9	48	40	49.1	41.3	-0.7	-0.6	-0.6							
R071	AC	2.5	68.3	60.5	69.6	61.7	55	50	82.5	74.6	65	60	65.7	57.8	66.7	59	64.8	56.8	65.8	58.1	-2.5	-2.4	-0.9							Yes
R072	RES	2.5	54.6	46.9	55.8	48	55	50	68.7	60.9	65	60	54	46.2	55.1	47.4	54	46.2	55.1	47.4	0.5	0.5	0							
R074	RES	4.5	50.8	43.1	52	44.3	55	50	64.9	57.2	65	60	50.2	42.3	51.3	43.6	50.3	42.4	51.2	43.5	0.4	0.4	-0.1							
R075	RES	4.5	55.4	47.8	56.6	49	55	50	69.5	61.9	65	60	54.5	46.9	55.7	48.1	55	47.5	56.3	48.7	0.9	0.9	0.6	YES - RES	YES - RES					
R076	RES	4.5	60.9	53.3	62.1	54.5	55	50	75	67.4	65	60	59.6	52	60.7	53.2	59.8	52.1	60.8	53.3	-0.1	0	0.1							
R078	RES	1.5	52.4	44.6	53.7	45.8	55	50	66.6	58.7	65	60	56	48.3	57.2	49.6	55.3	47.6	56.7	49.2	4.3	4.6	-0.5	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R079	RES	4.5	50.1	42.2	51.3	43.4	55	50	64.2	56.3	65	60	53.9	46.3	55.2	47.6	53	45.3	54.6	47	4.5	4.8	-0.6			Yes	Yes			
R080	RES	1.5	49.6	41.6	50.8	42.7	55	50	63.7	55.6	65	60	52.8	45.2	54.1	46.5	51.6	43.9	53.1	45.5	3.5	3.9	-1			Yes	Yes			
R081	RES	1.5	51	43.2	52.2	44.4	55	50	65.1	57.3	65	60	54.2	46.6	55.5	47.9	53.3	45.7	54.8	47.3	3.8	4.1	-0.7	YES - RES	YES - RES	Yes	Yes	YES - RES	Yes (EIS)	
R082	RES	1.5	50.4	42.6	51.6	43.8	55	50	64.5	56.7	65	60	53.3	45.7	54.5	47	52.2	44.4	53.5	46	3.1	3.4	-1			Yes	Yes			
R083	CR	1.5	59.2	51.8	60.4	53	60	-	-	-	-	-	58.4	53.1	59.5	54.3	58.8	53.5	59.7	54.7	0.5	2.9	0.2			Yes	Yes			
R084	RES	1.5	59.5	52	60.7	53.2	55	50	73.6	66.1	65	60	58.5	50.8	59.6	52.1	58	50.3	58.9	51.5	-0.6	-0.5	-0.7							
R085	RES	1.5	58.2	50.7	59.3	51.8	55	50	72.2	64.7	65	60	56.8	49.1	57.9	50.3	55.6	47.8	56.8	49.1	-1.4	-1.6	-1.1							
R086	RES	2	55.6	48.2	57.6	50	55	50	70.5	62.9	65	60	59.5	51.9	60.8	53.3	55.9	48	57.7	50.1	2.1	1.9	-3.1	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R087	RES	4.5	55.5	47.9	56.7	49	55	50	69.6	61.9	65	60	57.3	49.7	58.6	51	55.6	47.8	58.1	50.5	2.6	2.6	-0.5	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R088	RES	1.5	55.4	47.8	56.6	48.9	55	50	69.5	61.8	65	60	57.2	49.6	58.4	50.9	55.6	47.8	57.8	50.5	2.4	2.7	-0.6	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R089	RES	4.5	58	50.4	59.2	51.5	55	50	72.1	64.4	65	60	56.7	48.9	57.7	50.1	55.5	47.6	56.6	49	-1.4	-1.4	-1.1							
R090	RES	1.5	57.5	49.8	58.6	50.9	55	50	71.5	63.8	65	60	55.8	48	56.9	49.3	54.5	46.7	55.8	48.2	-1.7	-1.6	-1.1							
R091	RES	1.5	59	51.7	60.2	52.8	55	50	73.1	65.7	65	60	60.9	53.3	62.1	54.5	60.6	52.9	61.2	53.6	2.2	1.9	-0.9	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R092	RES	1.5	53.9	46.2	55.1	47.4	55	50	68	60.3	65	60	56	48.3	57.3	49.6	54.4	46.5	56.7	49.1	2.8	2.9	-0.6	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R093	CH	4.5	54.2	46.4	55.2	47.5	50	50	-	-	-	-	54.7	48.7	55.8	49.9	53.8	47.8	55	49	0.8	2.6	-0.8			Yes	Yes			
R094	CH	4.5	52.2	44.5	53.3	45.5	50	50	-	-	-	-	53.1	47.2	54.3	48.4	52.7	46.7	53.9	48	1.7	3.5	-0.4			Yes	Yes			
R095	RES	4.5	53.8	46.1	55	47.3	55	50	67.9	60.2	65	60	56.7	49	58	50.3	55.2	47.5	57.1	49.5	3.3	3.4	-0.9	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R096	RES	1.5	60.8	53.5	62	54.7	55	50	74.9	67.6	65	60	60.6	53.1	61.8	54.3	59.6	51.9	60.3	53	-0.5	-0.5	-1.5	YES - RES	YES - RES					
R097	RES	1.5	52.3	44.6	53.5	45.8	55	50	66.4	58.7	65	60	54.1	46.4	55.3	47.7	52.9	45.1	54.9	47.3	2.6	2.7	-0.4	YES - RES	Yes (EIS)	Yes	Yes	YES - RES	Yes (EIS)	
R098	CH	1.5	50.3	42.6	51.3	43.6	50	50	-	-	-	-	51.6	45.6	52.7	46.8	50.8	44.8	51.9	46	1.6	3.4	-0.8			Yes	Yes			
R099	RES	1.5	51.7	44	52.9	45.2	55	50	65.8	58.1	65	60	53.3	45.6	54.6	46.9	52.5	44.8	53.9	46.1	2.2	2.1	-0.7			Yes	Yes			
R100	RES	1.5	62.9	55.6	64.2	56.7	55	50	77.1	69.6	65	60	61	53.4	62	54.7	60.3	52.6	60.8	53.5	-2.1	-2.1	-1.2							
R101	RES	1.5	62.6	55.3	63.8	56.5	55	50	76.7	69.4	65	60	61.5	54	62.6	55.3	60.9	53.3	61.6	54.4	-1	-0.9	-1							
R102	RES	1.5	50.6	42.9	51.8	44.1	55	50	64.7	57	65	60	52.3	44.6	53.6	45.9	51.5	43.7	52.8	45	2.2	2.1	-0.8			Yes	Yes			
R103	RES	4.5	54.6	46.9	55.8	48.1	55	50	68.7	61	65	60	59.1	51.6	60.4	52.9	58.5	50.9	59.8	52.3	5.2	5.4	-0.6	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R104	RES	1.5	51.1	43.4	52.3	44.6	55	50	65.2	57.5	65	60	52.9	45.2	54.1	46.4	52.6	44.9	53.8	46.1	2.7	2.7	-0.3			Yes	Yes			
R105	RES	4.5	63.2	55.8	64.4	56.9	55	50	77.3	69.8	65	60	61.1	53.5	62.1	54.7	59.3	51.6	60.5	53.1	-2.7	-2.7	-1.6							
R106	CH	4	50.8	43	51.8	44	50	50	-	-	-	-	52	46.1	53.2	47.3	51.5	45.6	52.7	46.8	1.9	3.8	-0.5			Yes	Yes			
R107	RES	2.5	48.8	40.9	50	42.1	55	50	62.9	55	65	60	53.1	45.3	54.3	46.6	52.1	44.2	53.3	45.5	4.5	4.6	-1			Yes	Yes			
R108	RES	1.5	51.4	43.6	52.6	44.8	55	50	65.5	57.7	65	60	56	48.3	57.3	49.6	54.2	46.5	55.8	48.3	4.4	4.7	-1.5	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R109	RES	4.5	53.8	46.1	55	47.3	55	50	67.9	60.2	65	60	60.8	53.3	62.1	54.6	59.9	52.3	61.4	54	7.6	7.9	-0.7	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R110	EDU	4	48.1	40.4	49.1	41.3	50	-	-	-	-	-	49.7	43.8	50.8	44.9	49	43.1	50.1	44.2	2	3.8	-0.7	YES - EDU		Yes	Yes			
R111	HEA	1.5	59.3	51.6	60.4	52.6	45	45	-	-	-	-	58.8	52.8	59.8	53.9	57.9	51.8	59	53.2	-0.3	1.6	-0.8							
R112	RES	4.5	63.3	55.9	64.5	57	55	50	77.4	69.9	65	60	61.1	53.5	62.1	54.7	59.3	51.7	60.4	53.1	-2.9	-2.8	-1.7							
R113	RES	1.5	50.2	42.4	51.4	43.6	55	50	64.3	56.5	65	60	52.3	44.5	53.5	45.8	51.6	43.6	53.1	45.5	2.9	3.1	-0.4			Yes	Yes			
R114	RES	1.5	55.3	47.5	56.5	48.7	55	50	69.4	61.6	65	60	54.1	46.3	55.2	47.5	53.2	45.4	54.5	46.7	-0.8	-0.8	-0.7							
R115	RES	1.5	51.7	43.9	52.9	45.1	55	50	65.8	58	65	60	56.2	48.5	57.5	49.8	54.8	47.1	56.3	48.7	4.6	4.8	-1.2	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R116	EDU	4	48.5	40.8	49.6	41.8	50	-	-	-	-	-	50	44.1	51.1	45.2	49.4	43.4	50.4	44.5	1.9	3.7	-0.7							
R117	EDU	1.5	50.5	42.7	51.4	43.6	50	-	-	-	-	-	51.8	46	52.9	47.1	51.2	45.3	52.3	46.4	1.8	3.7	-0.6							
R118	RES	2	63.5	56	64.7	57.2	55	50	77.6	70.1	65	60	61.1	53.5	62.1	54.7	59.5	51.8	60.6	53.2	-2.9	-2.8	-1.5							
R119	RES	1.5	59.4	51.8	60.5	53	55	50	73.4	65.9	65	60	57.4	49.7	58.3	50.9	55.6	47.9	56.5	49.2	-2.9	-2.6	-1.8							
R120	EDU	6	41.1	33.3	41.8	34	50	-	-	-	-	-	42.6	36.6	43.6	37.7	42	36	42.9	37	1.8	3.7	-0.7			Yes	Yes			
R121	RES	1.5	49.5	41.8	50.7	43	55	50	63.6	55.9	65	60	51.4	43.7	52.7	45	50.4	42.4	52.2	44.4	2.7	2.6	-0.5			Yes	Yes			
R122	RES	2.5	51.6	43.8	52.8	45	55	50	65.7	57.9	65	60	56.4	48.7	57.7	50	55.1	47.5	56.6	48.8	5	5	-1.1	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R123	RES	3.5	63.9	56.4	65.1	57.6	55	50	78	70.5	65	60	61.4	53.8	62.4	55	59.9	52.2	61.1	53.7	-2.8	-2.7	-1.3							
R125	RES	1.5	49.3	41.6	50.5	42.8	55	50	63.4	55.7	65	60	51.3	43.6	52.5	44.8	50.5	42.6	52.2	44.3	2.9	2.7	-0.3			Yes	Yes			
R126	RES	1.5	51.3	43.6	52.5	44.8	55	50	65.4	57.7	65	60	56.7	49	57.9	50.2	55.6	47.9	56.7	49.1	5.4	5.5	-1.2	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R127	RES	4.5	48.4	40.8	49.6	42	55	50	62.5	54.9	65	60	50.5	42.7	51.7	44	49.9	42.1	51	43.3	2.6	2.5	-0.7			Yes	Yes			
R128	RES	2	64.4	56.8	65.6	58	55	50	78.5	70.9	65	60	61.8	54.1	62.8	55.3	61.7	53.9	63.1	55.5	-1.3	-1.3	0.3							

Receiver	Usage	Receiver Height Above Ground	No Build				Criteria						Reference Design (shaded cell indicates exceedance of the absolute criteria)				Fulton Hogan Design (shaded cell indicates exceedance of the absolute criteria)				FH Build 2029 - No build 2019		FH take Ref	Absolute Noise Criteria Exceeded (Yes / No)		Relative 2 dB Noise Level Increase Exceeded? (Yes / No)		Qualifies for treatments (Yes / No)		Acute (Yes / No)
			2019		2029		Absolute		Relative		Acute		2019		2029		2019		2029					Reference Design	Fulton Hogan Design	Reference Design	Fulton Hogan Design	Reference Design	Fulton Hogan Design	
			day	night	day	night	day	night	day	night	day	night	day	night	day	night	day	night	day	night	day	night	2029							
R129	EDU	1.5	52.2	44.4	53.2	45.3	50	-	-	-	-	-	53	47.1	54.1	48.2	52.4	46.5	53.6	47.7	1.4	3.3	-0.5			Yes	Yes			
R130	RES	1.5	46.9	39	48.1	40.2	55	50	61	53.1	65	60	49.7	41.8	51	43.1	48.9	40.9	50.2	42.2	3.3	3.2	-0.8			Yes	Yes			
R131	RES	4.5	51.1	43.4	52.3	44.6	55	50	65.2	57.5	65	60	56.5	48.8	57.8	50.1	55	47.4	56.3	48.7	5.2	5.3	-1.5	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R133	RES	1.5	49.3	41.5	50.5	42.7	55	50	63.4	55.6	65	60	50.9	43.1	52.1	44.3	50.1	42.3	51.4	43.5	2.1	2	-0.7			Yes	Yes			
R134	EDU	4	48.4	40.6	49.5	41.6	50	-	-	-	-	-	49.8	43.9	50.9	45.1	49.3	43.4	50.4	44.6	2	4	-0.5			Yes	Yes			
R135	RES	1.5	60.8	53	61.7	53.8	55	50	74.6	66.7	65	60	59.4	51.5	60.4	52.7	58.8	50.9	60	52.2	-0.8	-0.8	-0.4							
R136	EDU	1.5	50.6	42.8	51.4	43.6	50	-	-	-	-	-	51.7	45.8	52.8	46.9	51.2	45.2	52.3	46.4	1.7	3.6	-0.5		YES - EDU					
R138	RES	1.5	48	40.2	49.2	41.4	55	50	62.1	54.3	65	60	50.5	42.7	51.8	43.9	49.2	41.5	50.7	42.8	2.7	2.6	-1.1			Yes	Yes			
R139	RES	1.5	46.7	39	47.9	40.1	55	50	60.8	53	65	60	49	41.1	50.3	42.4	48.1	40.2	49.5	41.6	2.8	2.6	-0.8			Yes	Yes			
R140	RES	1.5	45.4	37.6	46.6	38.8	55	50	59.5	51.7	65	60	47.5	39.5	48.6	40.8	46.7	38.7	47.8	40.1	2.4	2.5	-0.8			Yes	Yes			
R141	RES	1.5	51.7	44	52.9	45.1	55	50	65.8	58	65	60	58.6	50.9	59.8	52.2	56.9	49.2	58	50.5	6.3	6.5	-1.8	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R143	RES	2	61.7	53.9	62.4	54.5	55	50	75.3	67.4	65	60	60.3	52.4	61.3	53.5	59.7	51.8	60.8	52.9	-0.9	-1	-0.5							
R144	RES	1.5	40.9	33	42	34.1	55	50	54.9	47	65	60	44.4	36.4	45.6	37.6	43.7	35.6	44.9	36.9	4	3.9	-0.7			Yes	Yes			
R145	RES	1.5	48.1	40.3	49.3	41.5	55	50	62.2	54.4	65	60	50.4	42.5	51.6	43.7	49.6	41.7	50.9	43	2.8	2.7	-0.7			Yes	Yes			
R146	RES	1.5	49.7	42	50.9	43.2	55	50	63.8	56.1	65	60	52.9	45.2	54.1	46.5	52.1	44.3	53.3	45.7	3.6	3.7	-0.8			Yes	Yes			
R147	RES	2.5	49.2	41.4	50.4	42.6	55	50	63.3	55.5	65	60	50.7	42.9	51.9	44.2	49.9	41.9	51.2	43.5	2	2.1	-0.7			Yes	Yes			
R148	RES	4.5	51.9	44.2	53.1	45.4	55	50	66	58.3	65	60	58.6	51	59.9	52.4	58	50.4	59.1	51.7	7.2	7.5	-0.8	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R149	RES	1.5	39.7	31.8	40.9	32.9	55	50	53.8	45.8	65	60	42.9	34.9	44.2	36.2	42.1	34.1	43.5	35.5	3.8	3.7	-0.7			Yes	Yes			
R150	RES	1.5	44.6	36.9	45.8	38	55	50	58.7	50.9	65	60	48	40	49.2	41.3	47.2	39.1	48.4	40.5	3.8	3.6	-0.8			Yes	Yes			
R151	HOT	1.5	62.9	55.1	63.5	55.7	55	50	76.4	68.6	65	60	61.5	53.7	62.5	54.7	60.9	53.1	61.9	54.1	-1	-1	-0.6							
R152	RES	4.5	49.5	41.8	50.7	42.9	55	50	63.6	55.8	65	60	52.3	44.5	53.6	45.8	51.6	43.8	52.9	45.1	3.4	3.3	-0.7			Yes	Yes			
R153	RES	4.5	51.6	44	52.8	45.2	55	50	65.7	58.1	65	60	60.3	52.7	61.6	54	58.5	51	59.9	52.4	8.3	8.4	-1.7	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R154	RES	1.5	42.9	35	44.1	36.2	55	50	57	49.1	65	60	45.8	37.9	47.1	39.2	44.9	36.8	46.3	38.4	3.4	3.4	-0.8			Yes	Yes			
R156	RES	2.5	46.1	38.4	47.3	39.6	55	50	60.2	52.5	65	60	51.4	43.5	52.7	44.8	50.7	42.8	52	44.2	5.9	5.8	-0.7			Yes	Yes			
R158	HOT	2	64.1	56.3	64.7	56.8	55	50	77.6	69.7	65	60	62.7	54.9	63.7	55.9	62.1	54.3	63.2	55.3	-0.9	-1	-0.5							
R159	RES	2.5	44.8	37	45.9	38.1	55	50	58.8	51	65	60	48.4	40.4	49.6	41.7	47.6	39.7	48.8	40.9	4	3.9	-0.8			Yes	Yes			
R160	RES	4.5	45	37.3	46.2	38.4	55	50	59.1	51.3	65	60	47.8	39.9	49	41.1	47	39.1	48.3	40.4	3.3	3.1	-0.7			Yes	Yes			
R161	RES	2	71.6	63.8	72.8	64.9	55	50	85.7	77.8	65	60	68.4	60.5	69.2	61.6	67	59	68.2	60.6	-3.4	-3.2	-1							Yes
R162	RES	1.5	63.3	55.5	63.9	56	55	50	76.8	68.9	65	60	61.9	54.1	62.9	55.1	61.3	53.5	62.3	54.5	-1	-1	-0.6							
R163	RES	1.5	48.4	40.6	49.6	41.8	55	50	62.5	54.7	65	60	50.4	42.6	51.7	43.8	49.6	41.8	50.9	43	2.5	2.4	-0.8			Yes	Yes			
R164	RES	2	64.9	57.2	66.1	58.4	55	50	79	71.3	65	60	61.8	54	62.7	55.2	60.4	52.5	61.7	54.1	-3.2	-3.1	-1							
R165	RES	1.5	39.7	31.8	40.9	33	55	50	53.8	45.9	65	60	43	35	44.2	36.2	42	33.8	43.3	35.2	3.6	3.4	-0.9			Yes	Yes			
R166	RES	2.5	47.2	39.5	48.4	40.6	55	50	61.3	53.5	65	60	51.1	43.3	52.4	44.6	50.3	42.5	51.7	43.8	4.5	4.3	-0.7			Yes	Yes			
R167	RES	1.5	43.2	35.4	44.4	36.5	55	50	57.3	49.4	65	60	46.6	38.6	47.8	39.9	46	37.9	47.1	39.3	3.9	3.9	-0.7			Yes	Yes			
R168	RES	1.5	43.3	35.4	44.5	36.6	55	50	57.4	49.5	65	60	47.1	39.1	48.3	40.4	46.4	38.3	47.6	39.7	4.3	4.3	-0.7			Yes	Yes			
R169	RES	1.5	49.3	41.5	49.9	42	55	50	62.8	54.9	65	60	48.4	40.6	49.3	41.6	48	40.2	48.9	41.2	-0.4	-0.3	-0.4							
R170	RES	4.5	52	44.4	53.2	45.5	55	50	66.1	58.4	65	60	58	50.5	59.3	51.8	57.3	49.7	58.5	51	6.5	6.6	-0.8	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R171	HOT	1.5	67.6	59.8	68.2	60.3	55	50	81.1	73.2	65	60	66.1	58.3	67.1	59.3	65.6	57.8	66.5	58.7	-1.1	-1.1	-0.6							Yes
R172	RES	2.5	60.9	53.2	62.1	54.4	55	50	75	67.3	65	60	60.4	52.6	61.5	53.8	59.3	51.4	60.5	52.8	-0.4	-0.4	-1	YES - RES	YES - RES					
R173	RES	3	48.6	40.7	49.8	41.9	55	50	62.7	54.8	65	60	50.7	42.9	51.9	44.1	49.9	42	51.2	43.4	2.6	2.7	-0.7			Yes	Yes			
R174	EDU	1.5	50.4	42.6	51	43.2	50	-	-	-	-	-	51.4	45.4	52.5	46.4	50.9	45	52	46	1.6	3.4	-0.5		YES - EDU					
R175	RES	2.5	53.5	45.9	54.7	47	55	50	67.6	59.9	65	60	62.3	54.7	63.7	56.1	59.9	52.3	61.7	54.1	8.2	8.2	-2	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R176	RES	4.5	48.4	40.7	49.6	41.9	55	50	62.5	54.8	65	60	51.5	43.7	52.7	44.9	50.9	43	52	44.3	3.6	3.6	-0.7			Yes	Yes			
R177	RES	2.5	43.6	35.8	44.8	36.9	55	50	57.7	49.8	65	60	47	39.1	48.2	40.3	46.1	38.2	47.4	39.6	3.8	3.8	-0.8			Yes	Yes			
R178	RES	2	58.8	51.1	60	52.3	55	50	72.9	65.2	65	60	59.8	51.9	61	53.2	58.8	50.9	60	52.1	1.2	1	-1	YES - RES	YES - RES					
R179	RES	4.5	42.3	34.4	43.5	35.6	55	50	56.4	48.5	65	60	46.4	38.4	47.6	39.7	45.7	37.7	46.9	39	4.6	4.6	-0.7			Yes	Yes			
R180	RES	1.5	47.2	39.5	48.3	40.6	55	50	61.2	53.5	65	60	49.6	41.8	50.8	43	48.8	40.9	50	42.2	2.8	2.7	-0.8			Yes	Yes			
R181	RES	4.5	54.6	47	55.8	48.2	55	50	68.7	61.1	65	60	64.1	56.4	65.4	57.8	61.5	53.9	63.1	55.8	8.5	8.8	-2.3	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R182	RES	4.5	49.1	41.6	50.3	42.7	55	50	63.2	55.6	65	60	54.9	47.3	56.2	48.6	54.1	46.5	55.3	47.8	6.2	6.2	-0.9	YES - RES	Yes (EIS)	Yes	Yes	YES - RES	Yes (EIS)	
R183	RES	3	42.3	34.5	43.4	35.5	55	50	56.3	48.4	65	60	45.8	37.9	47.1	39.2	45.1	37.1	46.4	38.6	4.1	4.1	-0.7			Yes	Yes			
R184	EDU	1.5	65	57.2	65.7	57.8	50	-	-	-	-	-	64.8	58.7	65.7	59.7	60.8	54.7	61.7	55.7	-3.3	-1.5	-4							
R185	RES	2.5	53.4	45.8	54.6	47	55	50	67.5	59.9	65	60	63.7	56.1	65	57.4	60.7	53.2	62.4	55	9	9.2	-2.6	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R186	RES	4.5	48.6	41	49.8	42.2	55	50	62.7	55.1	65	60	54.3	46.6	55.6	48	53.4	45.7	55.6	47.2	7	6.2	0	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R187	RES	3.5	57.8	50.1	59	51.3	55	50	71.9	64.2	65	60	61.5	53.6	62.8	54.9	60.9	53.1	62.2	54.3	4.4	4.2	-0.6	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R188	RES	4.5	47.8	40.1	49	41.3	55	50	61.9	54.2	65	60	50.5	42.6	51.7	43.9	49.6	41.8	50.8	43.1	3	3	-0.9			Yes	Yes			
R190	RES	4.5	48.4	40.7	49.6	41.9	55	50	62.5	54.8	65	60	50.6	42.7	51.8	44	49.8	41.9	51	43.3	2.6	2.6	-0.8			Yes	Yes			
R192	EDU	1.5	64	56.2	64.6	56.7	50	-	-	-	-	-	64.1	58	65.1	59	63.6	57.5	64.6	58.5	0.6	2.3	-0.5			Yes	Yes			
R193	RES	1.5	46.6	38.7	47.7	39.9	55	50	60.6	52.8	65	60	49.1	41.2	50.4	42.5	48.3	40.3	49.6	41.7	3	3	-0.8			Yes	Yes			
R194	RES	1.5	48.1	40.5	49.2	41.7	55	50	62.1	54.6	65	60	53.3	45.6	54.6	46.9	49.7	42.1	51.5	44	3.4	3.5	-3.1			Yes	Yes			
R195	RES	2.5	47.1	39.2	48.3	40.4	55	50	61.2	53.3	65	60	50.2	42.2	51.3	43.4	49.5	41.5	50.7	42.8	3.6	3.6	-0.6			Yes	Yes			
R196	RES	2.5	46	38.3	47.1	39.4	55	50	60	52.3	65	60	48.4	40.5	49.6	41.8	47.6	39.7	48.8	41	2.8	2.7	-0.8			Yes	Yes			
R197	RES	4.5	48.9	41.2	50.1	42.4	55	50	63	55.3	65	60	51.2	43.3	52.4	44.6	50.3	42.4	51.7	43.8	2.8	2.6	-0.7			Yes	Yes			
R199	RES	4.5	48.8	41.1	50	42.3	55	50	62.9	55.2	65	60	54.9	47.3	56.1	48.6	53.8	46	55.5	48	6.7	6.9	-0.6	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R200	RES	4.5	47.4	39.6	48.6	40.7	55	50	61.5	53.6	65	60	49.4	41.6	50.6	42.8	48.8	40.9	49.9	42.1	2.5	2.5	-0.7			Yes	Yes			
R201	RES	4.5	50.1	42.4	51.3	43.6	55	50	64.2	56.5	65	60	54.9	47.3	56.1	48.6	54.4	46.8	55.5	48	5.4	5.6	-0.6	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R202	RES	2.5	47.6	40	48.7	41.1	55	50	61.6	54	65	60	51.5	43.7	52.7	45	50.9	43	52.1	44.4	4.5	4.4	-0.6			Yes	Yes			
R203	RES	2.5	49.9	42.1	51	43.2	55	50	63.9	56.1	65	60	56.3	48.4	57.5	49.7	52.4	44.7	57.5	49.7	7.6	7.6	0	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R204	RES	4.5	44.9	37	45.9	38	55	50	58.8	50.9	65	60	64.4	56.5	65.7	57.7	63.8	56	65	57	20.1	20	-0.7	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R205	EDU	1.5	51.6	43.8	52.3	44.5	50	-	-	-	-	-	52.6	46.6	53.7	47.7	52	46.1	53.1	47.2	1.5	3.4	-0.6		YES - EDU					
R206	RES	1.5	46.1	38.3	47.3	39.4	55	50	60.2	52.3	65	60	48.9	41	50.1	42.3	47.9	40	49.2	41.4	3.1	3.1	-0.9			Yes	Yes			
R207	RES	1.5	61	53.2	61.7	53.8	55	50	74.6	66.7	65	60	59.8	51.9	60.7	52.9	59.2	51.4	60.2	52.3	-0.8	-0.9	-0.5	YES - RES	YES - RES					
R208	RES	2.5	47.4	39.8	48.5	40.9	55	50	61.4	53.8	65	60	51.1	43.3	52.3	44.6	50.4	42.6	51.6	44	4.2	4.2	-0.7			Yes	Yes			
R209	RES	4.5	47.8	40	49	41.1	55	50	61.9	54	65	60	53.3	45.4	54.6	46.7	52.8	44.9	54	46.1	6.2	6.1	-0.6			Yes	Yes			
R210	RES	2.5	42.2	34.4	43.4	35.5	55	50	56.3	48.4	65	60	46.9	38.9	48.1	40.1	46.2	38.2	47.4	39.4	5.2	5	-0.7			Yes	Yes			
R211	RES	1.5	47.9	40.3	49.1	41.4	55	50	62	54.3	65	60	50.1	42.3	51.3	43.5	49.3	41.4	50.4	42.7	2.5	2.4	-0.9			Yes	Yes			
R212	RES	1.5	55.3	47.4	55.9	48	55	50	68.8	60.9	65	60	54.1	46.3	55.1	47.3	53.8	46	54.8	46.9	-0.5	-0.5	-0.3							
R213	RES	4.5	47.5	39.9	48.7	41	55	50	61.6	53.9	65	60	50.6	42.9	51.9	44.1	49.9	42.1	51.2	43.4	3.7	3.5	-0.7			Yes	Yes			
R214	EDU	1.5	51.8	44.2	53	45.4	50	-	-	-	-	-	58.7	52.7	59.9	54	54.4	48.5	56	50.3	4.2	6.1	-3.9	YES - EDU	YES - EDU	Yes	Yes	YES - EDU	YES - EDU	
R215	EDU	1.5	50.7	42.9	51.5	43.6	50	-	-	-	-	-	52.1	46.1	53.1	47.2	51.5	45.5	52.5	46.6	1.8	3.7	-0.6		YES - EDU					
R216	RES	4.5	49	41.3	50.2	42.5	55	50	63.1	55.4	65	60	52	44.3	53.2	45.6	51.3	43.6	52.4	44.8	3.4	3.5	-0.8			Yes	Yes			

Receiver	Usage	Receiver Height Above Ground	No Build				Criteria						Reference Design (shaded cell indicates exceedance of the absolute criteria)				Fulton Hogan Design (shaded cell indicates exceedance of the absolute criteria)				FH Build 2029 - No build 2019		FH take Ref	Absolute Noise Criteria Exceeded (Yes / No)		Relative 2 dB Noise Level Increase Exceeded? (Yes / No)		Qualifies for treatments (Yes / No)		Acute (Yes / No)
			2019		2029		Absolute		Relative		Acute		2019		2029		2019		2029					Reference Design	Fulton Hogan Design	Reference Design	Fulton Hogan Design	Reference Design	Fulton Hogan Design	
			day	night	day	night	day	night	day	night	day	night	day	night	day	night	day	night	day	night	day	night	2029							
R217	RES	4.5	49	41.3	50.1	42.4	55	50	63	55.3	65	60	50.9	43.1	52.1	44.4	50.1	42.2	51.3	43.7	2.3	2.4	-0.8			Yes	Yes			
R218	RES	1.5	53.1	45.3	53.7	45.8	55	50	66.6	58.7	65	60	52.2	44.3	53.2	45.4	51.9	44	52.9	45.1	-0.2	-0.2	-0.3							
R219	RES	4.5	47.3	39.8	48.5	40.9	55	50	61.4	53.8	65	60	50.3	42.6	51.6	43.9	49.5	41.8	50.8	43.1	3.5	3.3	-0.8			Yes	Yes			
R220	RES	4.5	48.6	41	49.8	42.1	55	50	62.7	55	65	60	51.4	43.7	52.6	45	50.6	42.9	51.9	44.2	3.3	3.2	-0.7			Yes	Yes			
R221	EDU	1.5	43.6	35.7	44.6	36.7	50	-	-	-	-	-	61.2	55.3	62.4	56.5	60.3	54.5	61.6	55.7	18	20	-0.8	YES - EDU	YES - EDU	Yes	Yes	YES - EDU	YES - EDU	
R222	RES	1.5	49.7	41.9	50.3	42.4	55	50	63.2	55.3	65	60	49.4	41.5	50.4	42.5	48.9	41	49.8	42	0.1	0.1	-0.6							
R223	RES	1.5	50.8	43.3	52	44.5	55	50	64.9	57.4	65	60	57.3	49.6	58.6	51	55	47.4	56.6	49.1	5.8	5.8	-2	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R224	RES	4.5	44	36.2	45.1	37.2	55	50	58	50.1	65	60	47.6	39.7	48.8	40.9	46.8	38.9	48.1	40.2	4.1	4	-0.7			Yes	Yes			
R225	RES	4.5	48.2	40.5	49.4	41.7	55	50	62.3	54.6	65	60	50.9	43.2	52.2	44.5	50.2	42.5	51.5	43.8	3.3	3.3	-0.7			Yes	Yes			
R226	EDU	1.5	40.1	32.2	41.1	33.2	50	-	-	-	-	-	72.7	66.8	73.9	68	72.5	66.5	73.4	67.5	33.3	35.3	-0.5	YES - EDU	YES - EDU	Yes	Yes	YES - EDU	YES - EDU	Yes
R227	RES	1.5	51	43.5	52.2	44.7	55	50	65.1	57.6	65	60	56.4	48.8	57.7	50.1	56	48.3	57.2	49.7	6.2	6.2	-0.5	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R228	RES	1.5	49.5	41.6	50.1	42.2	55	50	63	55.1	65	60	49.4	41.5	50.5	42.6	49	41.1	50.1	42.2	0.6	0.6	-0.4							
R229	EDU	1.5	43.8	35.8	44.6	36.7	50	-	-	-	-	-	59.2	53.2	60.4	54.4	58.6	52.6	59.4	53.5	15.6	17.7	-1	YES - EDU	YES - EDU	Yes	Yes	YES - EDU	YES - EDU	
R231	RES	4.5	48.4	40.7	49.6	41.8	55	50	62.5	54.7	65	60	51	43.2	52.2	44.5	50.3	42.4	51.5	43.8	3.1	3.1	-0.7			Yes	Yes			
R232	RES	1.5	47.5	39.7	48.2	40.3	55	50	61.1	53.2	65	60	48.4	40.5	49.5	41.6	47.9	40	48.9	41.1	1.4	1.4	-0.6							
R233	RES	1.5	49.7	42.2	50.9	43.3	55	50	63.8	56.2	65	60	55.3	47.6	56.6	48.9	52.8	45.2	56.6	48.9	6.9	6.7	0	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R234	EDU	1.5	43.3	35.4	44.2	36.2	50	-	-	-	-	-	68	62	69.3	63.3	67.1	61.2	67.9	62	24.6	26.6	-1.4	YES - EDU	YES - EDU	Yes	Yes	YES - EDU	YES - EDU	Yes
R237	RES	1.5	47.9	40.3	49.1	41.5	55	50	62	54.4	65	60	50.8	43.1	52	44.3	50.1	42.5	55	47.3	7.1	7	3			Yes	Yes			
R238	RES	1.5	50.3	42.7	51.5	43.8	55	50	64.4	56.7	65	60	53.3	45.4	54.5	46.7	50.9	43	52.3	44.6	2	1.9	-2.2			Yes	Yes			
R239	RES	1.5	47.9	40	48.5	40.6	55	50	61.4	53.5	65	60	49	41.1	50.1	42.2	49.2	41.1	49.5	41.6	1.6	1.6	-0.6							
R240	RES	4.5	48.4	40.6	49.5	41.8	55	50	62.4	54.7	65	60	51	43.1	52.2	44.4	49.2	41.4	50.7	42.9	2.3	2.3	-1.5			Yes	Yes			
R242	RES	4.5	48	40.3	49.1	41.4	55	50	62	54.3	65	60	54.3	46.5	55.5	47.7	53.7	46	55.1	47.3	7.1	7	-0.4	YES - RES		Yes	Yes	YES - RES		
R243	EDU	1.5	44.3	36.7	45.5	37.6	50	-	-	-	-	-	63	57	64.2	58.2	62.5	56.5	63.2	57.2	18.9	20.5	-1	YES - EDU	YES - EDU	Yes	Yes	YES - EDU	YES - EDU	
R244	RES	4.5	48.6	41	49.8	42.1	55	50	62.7	55	65	60	50.9	43.1	52.1	44.3	49.6	41.9	50.9	43.2	2.3	2.2	-1.2			Yes	Yes			
R245	RES	1.5	46.9	39.1	47.5	39.6	55	50	60.4	52.5	65	60	48.4	40.4	49.5	41.6	48	39.9	48.9	41	2	1.9	-0.6			Yes	Yes			
R246	RES	1.5	46.2	38.4	47.3	39.5	55	50	60.2	52.4	65	60	49.8	41.9	51	43.1	49.2	41.3	50.4	42.6	4.2	4.2	-0.6			Yes	Yes			
R247	EDU	1.5	43.1	35.2	44	36.1	50	-	-	-	-	-	59.7	53.7	61	55	59.1	53.1	59.9	54	16.8	18.8	-1.1	YES - EDU	YES - EDU	Yes	Yes	YES - EDU	YES - EDU	
R248	RES	1.5	44.2	36.3	45.2	37.3	55	50	58.1	50.2	65	60	48.5	40.5	49.7	41.8	48.1	40	49.2	41.3	5	5	-0.5			Yes	Yes			
R250	RES	1.5	50.3	42.7	51.5	43.9	55	50	64.4	56.8	65	60	52.6	44.9	53.9	46.2	51	43.3	52.4	44.7	2.1	2	-1.5			Yes	Yes			
R251	RES	2.5	45.9	38	46.7	38.8	55	50	59.6	51.7	65	60	52.4	44.5	53.6	45.7	52	44.1	55.4	46.9	9.5	8.9	1.8			Yes	Yes			
R252	EDU	1.5	42	34.1	42.9	34.9	50	-	-	-	-	-	67.4	61.5	68.7	62.7	66.6	60.8	67.5	61.5	25.5	27.4	-1.2	YES - EDU	YES - EDU	Yes	Yes	YES - EDU	YES - EDU	Yes
R253	EDU	1.5	43.8	35.9	44.5	36.6	50	-	-	-	-	-	59.8	53.8	61.1	55.1	59.3	53.3	60.4	54.4	16.6	18.5	-0.7	YES - EDU	YES - EDU	Yes	Yes	YES - EDU	YES - EDU	
R254	RES	3.5	49.9	42.2	51	43.3	55	50	63.9	56.2	65	60	52.4	44.7	53.7	46	51.8	44	53.2	45.4	3.3	3.2	-0.5			Yes	Yes			
R255	EDU	3	45.7	37.8	46.3	38.4	50	-	-	-	-	-	51.3	45.3	52.5	46.5	51.1	45.2	52.2	46.2	6.5	8.4	-0.3	YES - EDU	YES - EDU	Yes	Yes	YES - EDU	YES - EDU	
R256	RES	4.5	47.3	39.6	48.4	40.8	55	50	61.3	53.7	65	60	51.7	43.9	53	45.1	49.1	41.4	50.6	42.8	3.3	3.2	-2.4			Yes	Yes			
R260	RES	1.5	44.9	37.1	45.7	37.9	55	50	58.6	50.8	65	60	50.8	42.9	52	44.1	50.3	42.3	51.4	43.5	6.5	6.4	-0.6			Yes	Yes			
R261	RES	4.5	40.6	32.7	41.3	33.4	55	50	54.2	46.3	65	60	59.4	51.4	60.6	52.6	59.1	51.1	59.9	52	19.3	19.3	-0.7	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	
R262	RES	2.5	48	40.3	49.1	41.4	55	50	62	54.3	65	60	50.4	42.6	51.6	43.8	49.8	41.9	50.9	43.1	2.9	2.8	-0.7			Yes	Yes			
R264	RES	4.5	46	38.3	47.2	39.4	55	50	60.1	52.3	65	60	48.8	40.9	50	42.1	48.1	40.1	49.3	41.5	3.3	3.2	-0.7			Yes	Yes			
R266	RES	1.5	44.3	36.5	45.1	37.2	55	50	58	50.1	65	60	49.8	41.9	51.1	43.1	49.1	41.3	50.3	42.4	6	5.9	-0.8			Yes	Yes			
R267	RES	4.5	47.3	39.6	48.4	40.7	55	50	61.3	53.6	65	60	52.5	44.6	53.7	45.8	51.8	43.9	53	45	5.7	5.4	-0.7			Yes	Yes			
R268	RES	1.5	46.8	39.1	48	40.3	55	50	60.9	53.2	65	60	52.8	45	54.1	46.2	51.8	44	53	45.1	6.2	6	-1.1			Yes	Yes			
R269	RES	1.5	49.2	41.5	50.3	42.5	55	50	63.2	55.4	65	60	69.3	61.3	70.6	62.6	68.7	60.7	69.6	61.7	20.4	20.2	-1	YES - RES	YES - RES	Yes	Yes	YES - RES	YES - RES	Yes
R271	RES	4.5	45.8	38	46.9	39.2	55	50	59.8	52.1	65	60	51.2	43.3	52.4	44.5	50.7	42.8	51.8	43.9	6	5.9	-0.6			Yes	Yes			
R272	RES	2.5	45.2	37.4	46.1	38.3	55	50	59	51.2	65	60	49.5	41.7	50.7	42.8	49	41.2	50.2	42.3	5	4.9	-0.5			Yes	Yes			
R274	RES	4.5	41.6	33.8	42.4	34.5	55	50	55.3	47.4	65	60	46.8	38.9	48	40.1	46.3	38.4	47.3	39.4	5.7	5.6	-0.7			Yes	Yes			
R275	RES	4.5	42.4	34.5	43.2	35.3	55	50	56.1	48.2	65	60	47.1	39.2	48.3	40.3	46.5	38.6	47.6	39.6	5.2	5.1	-0.7			Yes	Yes			
R278	RES	1.5	45.2	37.4	46.3	38.5	55	50	59.2	51.4	65	60	49.6	41.6	50.8	42.9	48.9	40.9	50.2	42.3	5	4.9	-0.6			Yes	Yes			
R279	RES	4.5	42.5	34.7	43.4	35.5	55	50	56.3	48.4	65	60	47.1	39.2	48.3	40.4	46.5	38.7	47.7	39.7	5.2	5	-0.6			Yes	Yes			
R280	RES	4.5	44.5	36.7	45.5	37.7	55	50	58.4	50.6	65	60	48.3	40.5	49.5	41.7	47.7	40	48.8	41	4.3	4.3	-0.7			Yes	Yes			
R281	RES	2.5	44.8	37.1	45.9	38.2	55	50	58.8	51.1	65	60	48.5	40.6	49.7	41.8	47.9	40	49	41.1	4.2	4	-0.7			Yes	Yes			
R282	RES	4.5	45.4	37.7	46.4	38.7	55	50	59.3	51.6	65	60	48.2	40.3	49.3	41.5	47.6	39.7	48.6	40.9	3.2	3.2	-0.7			Yes	Yes			
R283	RES	2	42.7	34.8	43.6	35.7	55	50	56.5	48.6	65	60	47.6	39.7	48.8	40.9	47.1	39.2	48.1	40.3	5.4	5.5	-0.7			Yes	Yes			
R284	RES	4.5	44.6	36.9	45.6	37.9	55	50	58.5	50.8	65	60	49.2	41.5	50.4	42.7	48.4	40.8	49.4	41.8	4.8	4.9	-1			Yes	Yes			
R285	RES	4.5	44.7	36.9	45.7	38	55	50	58.6	50.9	65	60	48.4	40.5	49.6	41.7	47.8	40	49	41.1	4.3	4.2	-0.6			Yes	Yes			
R286	RES	4.5	45	37.3	46	38.3	55	50	58.9	51.2	65	60	49.7	41.8	50.9	43.1	48.8	41	50	42.3	5	5	-0.9			Yes	Yes			
R287	RES	4.5	38.5	30.6	39.3	31.3	55	50	52.2	44.2	65	60	43.4	35.4	44.5	36.6	42.9	34.9	43.8	36	5.3	5.4	-0.7			Yes	Yes			
R288	RES	2.5	39	31.1	39.8	31.9	55	50	52.7	44.8	65	60	43.5	35.5	44.7	36.7	43	35	44.1	36.1	5.1	5	-0.6			Yes	Yes			
R289	RES	1.5	39.9	32	40.7	32.8	55	50	53.6	45.7	65	60	44.1	36.2	45.3	37.3	43.5	35.5	44.6	36.6	4.7	4.6	-0.7			Yes	Yes			
R290	RES	4.5	37.4	29.6	38.2	30.3	55	50	51.1	43.2	65	60	41.3	33.3	42.4	34.5	40.6	32.6	41.6	33.7	4.2	4.1	-0.8			Yes	Yes			

Appendix 3: Predicted operational noise contours

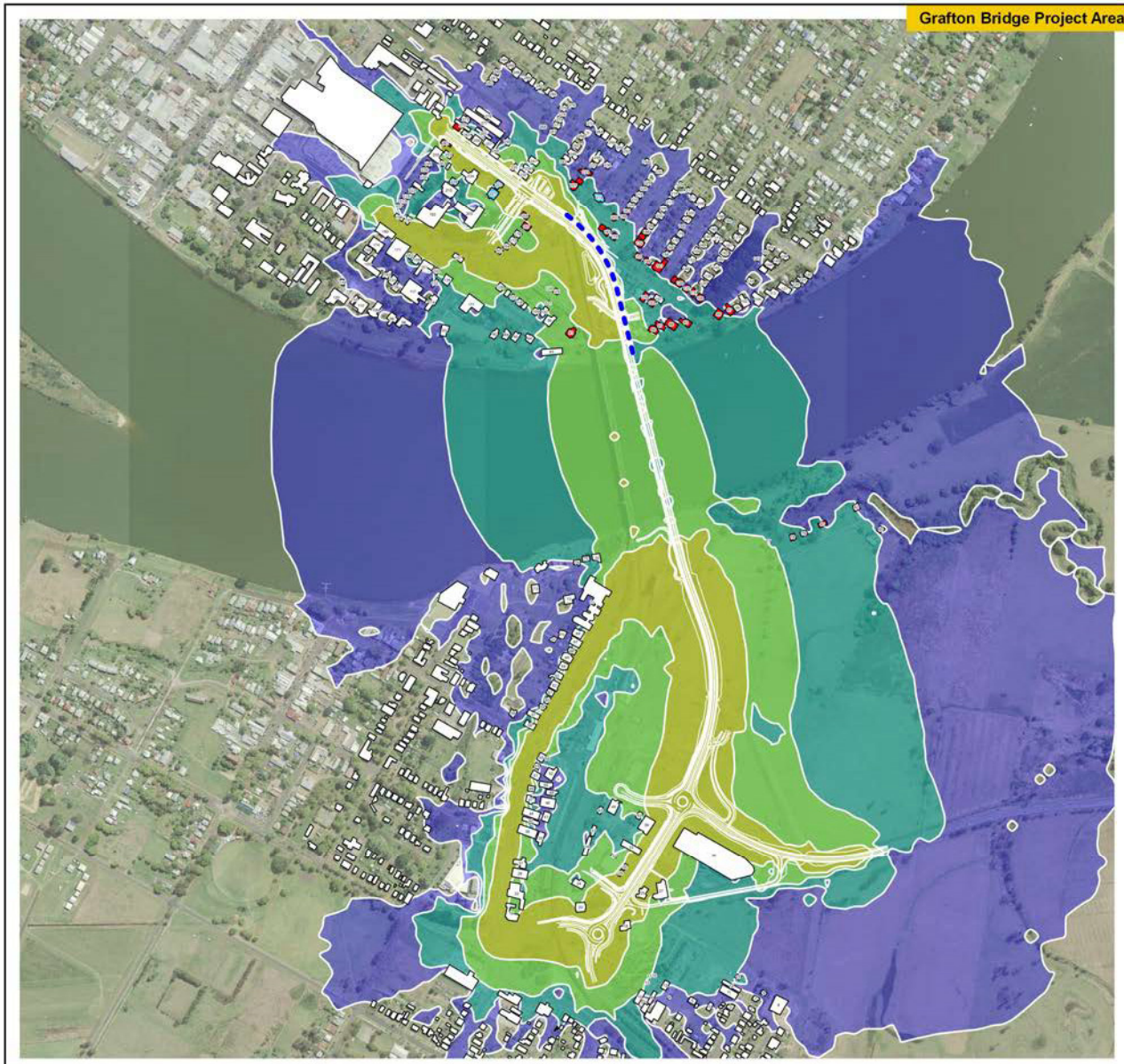


FIGURE 3-1

GRAFTON BRIDGE
Additional crossing of the Clarence River at Grafton, NSW
Operational road traffic noise assessment

Fulton Hogan Design:
Predicted daytime road traffic noise levels in 2019

100% DESIGN

Client: Fulton Hogan
Drawn by: PH
Checked by: AP
Dated: 8 March 2017
Page size: A3
Data sources: FH / RMS

Legend

100% Design

Noise Sensitive Building

- Not Receiving Treatment
- Receiving Treatment (Res)
- Receiving Treatment (Edu)
- Noise Barrier

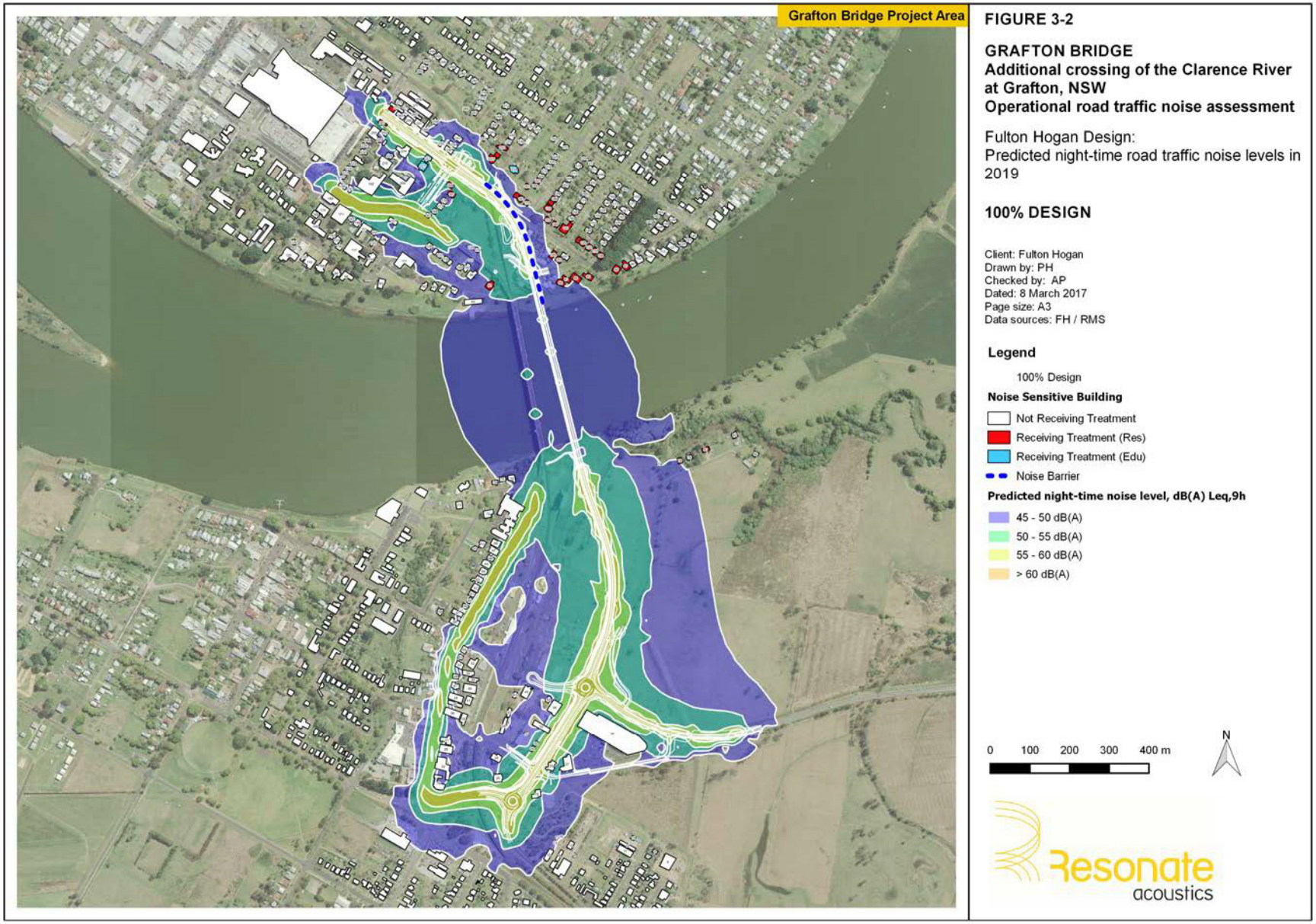
Predicted daytime noise level, dB(A) Leq,15h

- 45 - 50 dB(A)
- 50 - 55 dB(A)
- 55 - 60 dB(A)
- > 60 dB(A)

0 100 200 300 400 m

N

Resonate acoustics


Grafton Bridge Project Area
FIGURE 3-2
GRAFTON BRIDGE
Additional crossing of the Clarence River at Grafton, NSW
Operational road traffic noise assessment
Fulton Hogan Design:
Predicted night-time road traffic noise levels in 2019
100% DESIGN
Client: Fulton Hogan
Drawn by: PH
Checked by: AP
Dated: 8 March 2017
Page size: A3
Data sources: FH / RMS
Legend
100% Design
Noise Sensitive Building
Not Receiving Treatment
Receiving Treatment (Res)
Receiving Treatment (Edu)
Noise Barrier
Predicted night-time noise level, dB(A) Leq,9h
45 - 50 dB(A)
50 - 55 dB(A)
55 - 60 dB(A)
> 60 dB(A)
0 100 200 300 400 m
N
Resonate
acoustics

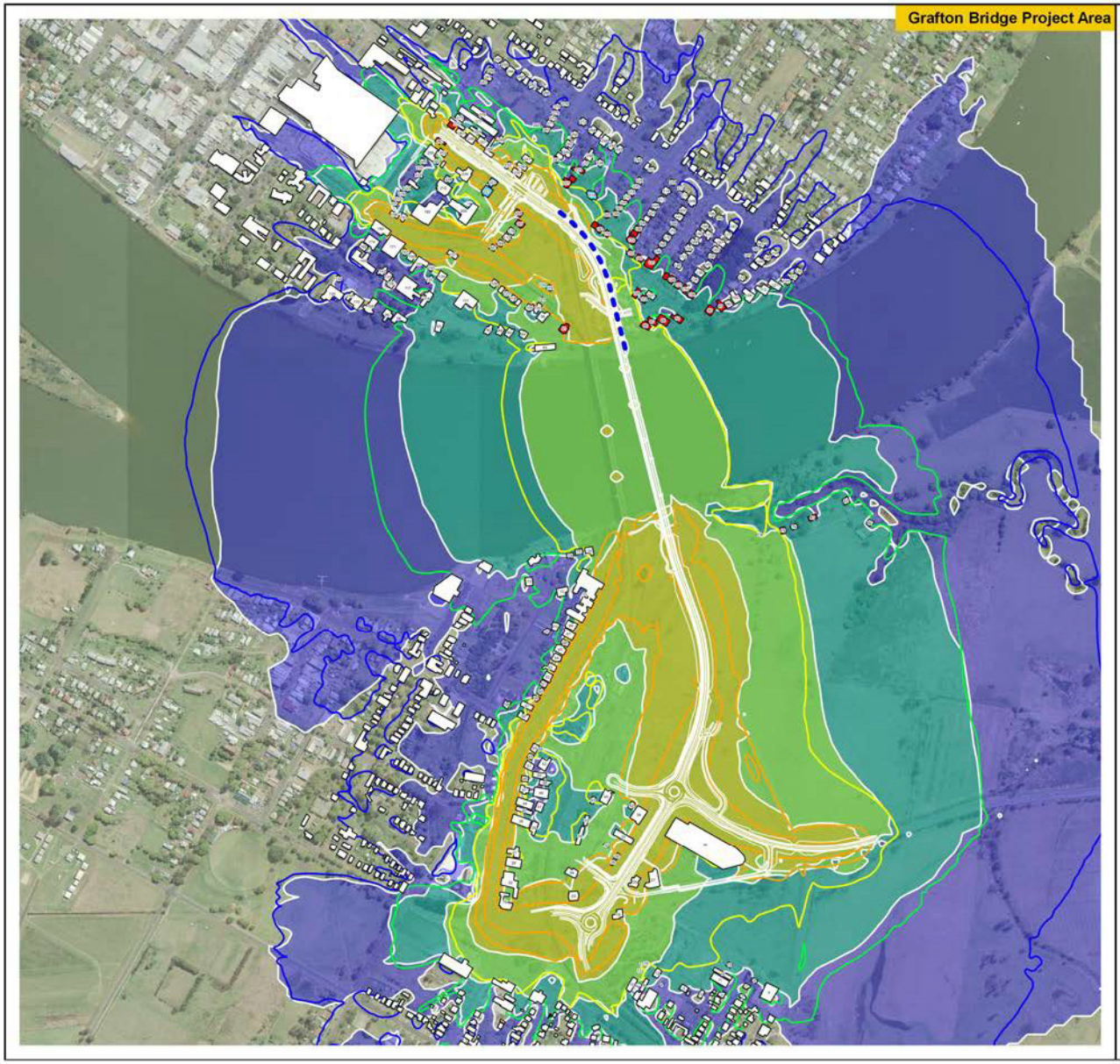


FIGURE 3-3

GRAFTON BRIDGE
Additional crossing of the Clarence River at Grafton, NSW
Operational road traffic noise assessment

Fulton Hogan Design:
Predicted daytime road traffic noise levels in 2029 and comparison to Reference Design

100% DESIGN

Client: Fulton Hogan
Drawn by: PH
Checked by: AP
Dated: 8 March 2017
Page size: A3
Data sources: FH / RMS

Legend

100% Design

Noise Sensitive Building

- Not Receiving Treatment
- Receiving Treatment (Res)
- Receiving Treatment (Edu)
- Noise Barrier

Predicted daytime noise level, dB(A) Leq,15h

- 45 - 50 dB(A)
- 50 - 55 dB(A)
- 55 - 60 dB(A)
- > 60 dB(A)

Reference Design daytime noise level, dB(A) Leq,15h

- 45 dB(A)
- 50 dB(A)
- 55 dB(A)
- 60 dB(A)

0 100 200 300 400 m

N

Resonate acoustics

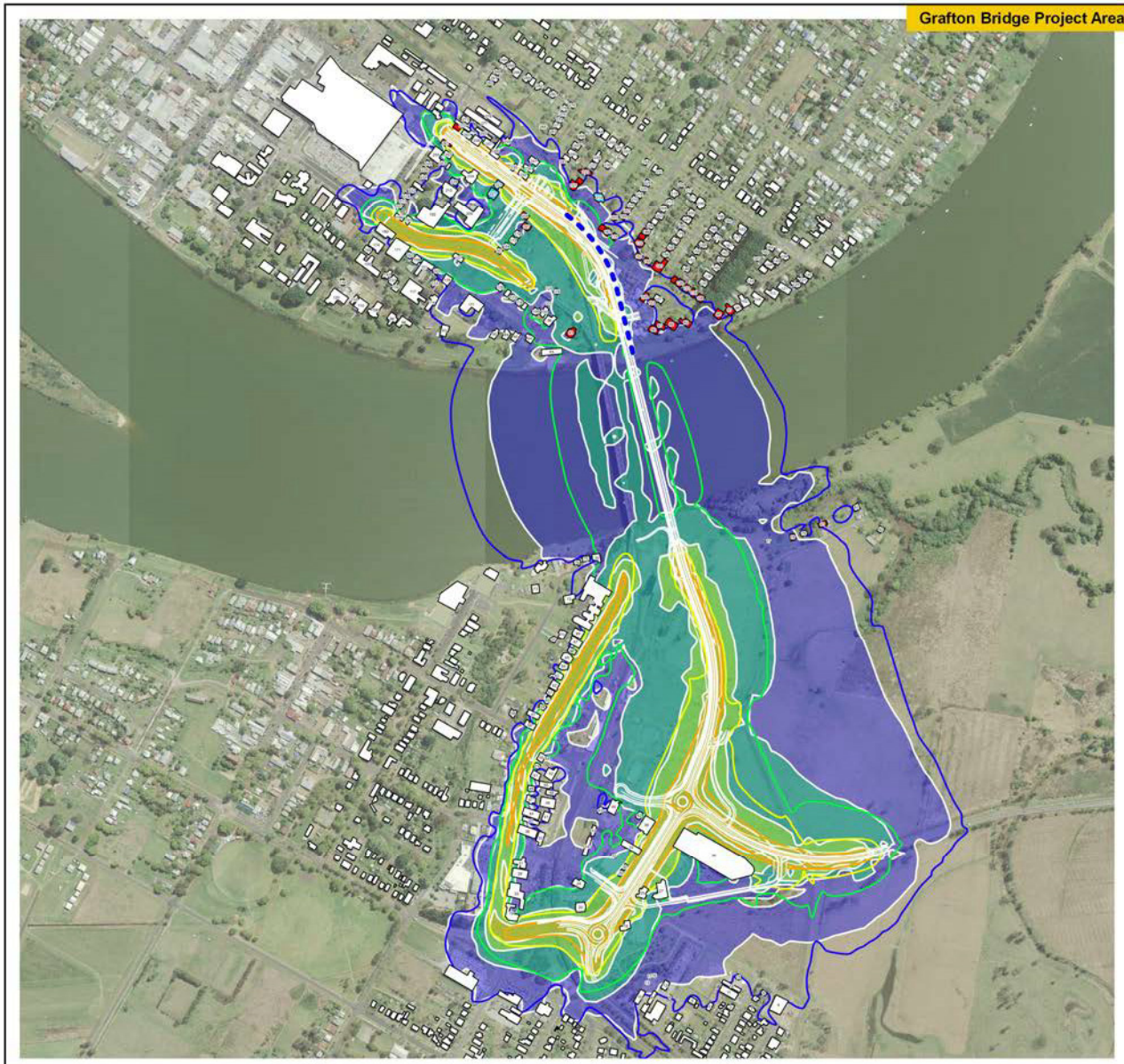


FIGURE 3-4

GRAFTON BRIDGE
Additional crossing of the Clarence River at Grafton, NSW
Operational road traffic noise assessment

Fulton Hogan Design:
Predicted night-time road traffic noise levels in 2029 and comparison to Reference Design

100% DESIGN

Client: Fulton Hogan
Drawn by: PH
Checked by: AP
Dated: 8 March 2017
Page size: A3
Data sources: FH / RMS

Legend

100% Design

Noise Sensitive Building

- Not Receiving Treatment
- Receiving Treatment (Res)
- Receiving Treatment (Edu)
- Noise Barrier

Predicted night-time noise level, dB(A) Leq,9h

- 45 - 50 dB(A)
- 50 - 55 dB(A)
- 55 - 60 dB(A)
- > 60 dB(A)

Reference Design night-time noise level, dB(A) Leq,9h

- 45 dB(A)
- 50 dB(A)
- 55 dB(A)
- 60 dB(A)

0 100 200 300 400 m

N

Resonate acoustics

Appendix 4: Road Traffic Volumes

Traffic Volumes – Year 2019 (Reproduced from SWTC Appendix 9)

Year 2019 (Opening) - Build	Day 15hr		Night 9hr	
	Light Vehicles	Heavy Vehicles	Light Vehicles	Heavy Vehicles
Main Carriageway				
Main Carriageway between Charles Street and Spring Street (Northbound)	842	67	84	13
Main Carriageway between Charles Street and Spring Street (Southbound)	923	73	92	14
Main Carriageway between Spring Street and Through Street (Northbound)	659	52	66	10
Main Carriageway between Spring Street and Through Street (Southbound)	609	48	61	9
Main Carriageway between Through Street and Clarence Street (Northbound)	659	52	66	10
Main Carriageway between Through Street and Clarence Street (Southbound)	609	48	61	9
Main Carriageway between Clarence Street and Villier Street (Northbound)	771	61	77	12
Main Carriageway between Clarence Street and Villier Street (Southbound)	610	49	61	9
Pacific Highway Connection South (Northbound)	564	44	37	6
Pacific Highway Connection South (Southbound)	572	44	37	6
Pacific Highway Connection North (Northbound)	247	30	29	11
Pacific Highway Connection South (Southbound)	390	47	46	18
Charles Street (Gwydir Highway)	1,172	90	75	13

Traffic Volumes – Year 2029 (Reproduced from SWTC Appendix 9)

Year 2029 - Build	Day 15hr		Night 9hr	
	Light Vehicles	Heavy Vehicles	Light Vehicles	Heavy Vehicles
Main Carriageway				
Main Carriageway between Charles Street and Spring Street (Northbound)	1080	85	108	16
Main Carriageway between Charles Street and Spring Street (Southbound)	1213	96	122	1
Main Carriageway between Spring Street and Through Street (Northbound)	900	71	91	13
Main Carriageway between Spring Street and Through Street (Southbound)	858	68	86	13
Main Carriageway between Through Street and Clarence Street (Northbound)	900	71	91	13
Main Carriageway between Through Street and Clarence Street (Southbound)	858	68	86	13
Main Carriageway between Clarence Street and Villiers Street (Northbound)	1026	81	103	15
Main Carriageway between Clarence Street and Villiers Street (Southbound)	855	68	86	13
Pacific Highway Connection South (Northbound)	693	53	45	7
Pacific Highway Connection South (Southbound)	758	58	49	8
Pacific Highway Connection North (Northbound)	375	45	44	17
Pacific Highway Connection North (Southbound)	568	69	68	25
Charles Street (Gwydir Highway)	1694	121	110	17

PROJECT NO	FH_CRB	PHONE	1800 633 332
PROJECT	Additional Crossing of the Clarence River at Grafton	FAX	02 4221 2549
COMPANY	Roads and Maritime Services of NSW	REF	TX#0356

Transmittal

STATUS CLOSED

ISSUED 20-March-17 02:15 PM

DUE

	AUTHOR	COMPANY	PHONE	MOBILE
	Brendan Keane	**Roads and Maritime Services of NSW**	**1800 633 332**	**0450 692 719**
COLLABORATORS	ACTION			
	Craig Dunk	EPA - Environmental Protection Agency		0427 237 154
	INFO			
	Andrew Lee	Fulton Hogan Construction	02 8346 9400	
	Gregory Nash	**Roads and Maritime Services of NSW**	**1800 633 332**	**0412 254 640**
	Mark Stevenson	**Fulton Hogan Construction**	**02 8346 9400**	
	Peter Borrelli	**Roads and Maritime Services of NSW**	**1800 633 332**	
	Peter Felsch	**Roads and Maritime Services of NSW**	**0435 168 081**	
	Roger Santos	**Fulton Hogan Construction**	**02 8346 9400**	**0419 514 567**

Grafton Bridge - Operational Noise Report

SENT FOR REV:Review

Craig,

As required by the Infrastructure Approval for the Additional Crossing of the Clarence River at Grafton, please find attached Operational Noise Report for EPA review and concurrence.

Regards,

Brendan Keane

(on behalf of Greg Nash)

ATTACHMENTS

Filed in : Not allocated to folders

FILE		NAME	REV	DATE	DESCRIPTION	FMT	STATUS
1	☑	APPENDIX 3 - PREDICTED OPERATIONAL NOISE CONTOURS	100% Design	20-March-17	No title provided. File:APPENDIX 3 - PREDICTED OPERATIONAL NOISE CONTOURS.pdf	PDF 18.6Mb	100%
2	☑	OPERATIONAL NOISE DESIGN REPORT REV2	100% Design	20-March-17	No title provided. File:Operational Noise Design Report rev2.pdf	PDF 4.3Mb	100%

Status Legend: 100% - Final Design, 15% - Developed Concept Design, 85% - Substantial Detailed Design, APR - Approved, CERT - Certification, IFC - Issued for Construction, INF - Information, P-IFC - Pre-Issued for Construction, REV - Review

DOWNLOAD

BY	TRANS#:DATE	FILES
EPA-CD	DBDN:EPA#0018 :30-March-17	[+]

RMS-GN DBDN:RMS#0537 :20-March-17 [+]

RMS-GN DBDN:RMS#0538 :20-March-17 [+]

COMMENTS

Craig Dunk (EPA-CD) CLOSED

30-May-17 08:30 AM

Hi Brendan,

The EPA appreciates the opportunity to review amendments made in response to comments previously provided by the EPA Noise Assessment Unit (NAU).

The NAU have reviewed the amendments and provided the following response:

> NAU has reviewed Grafton Bridge Operational Noise Report - in particular the Fulton Hogan Report titled -*Design and Construction of Additional Crossing of the Clarence River at Grafton – Operational Noise Report (100% Design).*
>
> In that document NAU identified some operational predicted noise levels [in Appendix 2] that were not consistent with the reference levels provided by RMS.
>
> Fulton Hogan has responded to this information by providing revised results in [Revised Appendix 2] for the operational noise predictions at R71, R91 and R269.
>
> The revised results are now consistent with the RMS reference operational predicted noise levels, and NAU accept the revised results as satisfactory.

The EPA has no further comments at this time.

Regards

Craig Dunk

Coordinator Pacific Highway Upgrade Team – North Coast Region

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Attached file: 50186068_~WRD000.jpg(823b)

Craig Dunk (EPA-CD) CLOSED

23-May-17 09:04 AM

Hi Brendan,

As discussed this morning I have forwarded your response to comments on the Grafton Bridge Operational Noise Report to the EPA Noise

Assessment Unit for review. If they have any further comments or advice I will forward these through to you.

Regards

Craig Dunk

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Attached file: 49655259_~WRD000.jpg(823b)

Brendan Keane (RMS-BK) CLOSED

22-May-17 09:12 AM

Craig,

Please see below for the designer's response to your comments:

1. In the case of receivers R71 and R269 a cell reference error in our analysis spreadsheet that deals with the predicted noise levels out of the noise model meant that the 2019 Build Scenario noise levels presented were not the correct values.

The values have been rectified for the reference error and now demonstrate showing the correct 2019 build noise levels for those receivers. The expected increase in noise levels between 2019 and 2029 is now demonstrated and the R71 2019 noise levels are in line with the EIS predictions.

2. In case of R91, the 2029 (Build) noise levels are higher than the 2019 (Build) noise levels in the amended version of the results table.

Please refer to the attached updated Appendix 2 with corrected table.

Regards,

Brendan Keane

Attached file: 49457287_S16318 REVISED APPENDIX 2 20170519.PDF(303k)

Craig Dunk (EPA-CD) CLOSED

3-May-17 02:53 PM

Hi Brendan,

Sorry for the delayed response I have been on leave for a couple of weeks and am just catching up on outstanding matters.

The EPA Noise Assessment Unit has reviewed the operational noise report provided in your email below on the 20 March 2017 for the Grafton Bridge project and has the following comments.

1. **RMS should explain why road noise levels predicted in the report for the aged care facility (R71) are significantly higher than predicted in the environmental impact statement for the project.**
    - Predicted road noise levels in the report are six decibels (6 dB) higher than in the EIS for both day and night time 2019.
2. **RMS should explain why road noise levels predicted at some receivers for 2029 are less than predicted for 2019, considering traffic numbers will increase by 2029.**

- The report suggests that traffic volumes will increase between 2019 and 2029, inferring that traffic noise levels will also increase.
- For receivers R71, R91 and R269 the predicted road traffic noise levels for night time 2029 are less than for night time 2019.
- For receiver R71, the predicted road traffic noise level for the day time 2029 is less than for the day time 2019.

Please give me a call if you would like to discuss this response.

Regards

Craig Dunk

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Brendan Keane (RMS-BK) CLOSED

20-March-17 02:15 PM

Transmittal Issued
