Appendix A

Consideration of clause 228(2) factors and matters of national environmental significance

Clause 228(2) Checklist

In addition to the requirements of the *Is an EIS required?* guideline (DUAP 1995/1996) and the *Roads and Related Facilities EIS Guideline* (DUAP 1996) as detailed in the REF, the following factors, listed in clause 228(2) of the *Environmental Planning and Assessment Regulation 2000*, have also been considered to assess the likely impacts of the proposal on the natural and built environment.

Factor	Impact
a. Any environmental impact on a community?	
The proposal would result in short-term negative impacts to the local community as a result of noise generation, visual impact, dust, and traffic detours and disruptions. Safeguards and management measures listed in Section 7.2 would be implemented to minimise these impacts.	Short-term Moderate Negative
The proposal includes removal of the existing Camp Street Bridge, which has local heritage significance. As discussed in Section 6.1, the SOHI identified that the bridge type is common for a bridge of that era. Mitigation measures would be implemented including photographic recording and interpretation of the bridge prior to work commencing. The art deco light fittings on the existing bridge would be reused as part of the new bridge to retain items of key visual and heritage value.	Long-term Major Negative
The proposal would improve safety for motorists, pedestrians and cyclists through wider travel lanes, improved road approaches and the removal of potential safety risks associated with the existing bridge structure.	Long-term Moderate Positive
b. Any transformation of a locality?	
The proposal would involve demolition of the existing Camp Street Bridge and construction of a new wider bridge within the current alignment. The new bridge would have a different character to the existing structure yet its overall built form would be similar to the existing structure.	Long-term Minor Negative
There would be no change to the use of open spaces and waterways which would continue to operate in the same way. The proposed changes to the existing crossing would enhance the arrival into the town and the interface with Lake Forbes, providing a positive contribution to the identity and character of the township.	Long-term Minor Positive

Factor	Impact
c. Any environmental impact on the ecosystems of the locality? The terrestrial and aquatic habitat values are considered poor. The local ecosystems are degraded. The proposal may require clearing of a small number of individual planted trees, however this would be offset by plantings as part of the proposal landscape design. The proposal has potential for temporary environmental impact on aquatic biodiversity during demolition and construction works as a result of lowering of water levels in Lake Forbes, sheet piling and excavation, increased erosion and sedimentation, obstruction of fish passage due to temporary instream structures, spread of weeds and chemical or fuel spills during construction. These risks would be minimised by implementing the safeguards listed in Section 7.2.	 Short-term Minor Negative
d. Any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality? During demolition and construction works, the proposal would result in short-term reduction of the aesthetic and recreational quality of the locality as a result of visual impacts, dust emissions, noise generation and traffic detours. Access to Lake Forbes at the proposal site would be restricted during demolition and construction. These impacts would be minimised through implementation of the safeguards listed in Section 7.2. The new bridge would have a different character to the existing structure yet its overall built form has been designed to blend in and soften the visual intrusion of the bridge. This limits the effect on the current parkland setting.	 Short-term Moderate Negative Long-term Minor Negative
e. Any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations? The proposal would remove the heritage-listed Camp Street Bridge. As discussed in Section 6.1, the SOHI identified that the bridge type is common for a bridge of that era. Mitigation measures would be implemented including photographic recording and interpretation of the bridge prior to work commencing. The art deco light fittings on the existing bridge would be reused as part of the new bridge to retain items of key visual and heritage value. There are no known sites of Aboriginal significance recorded within the study area and the Stage 1 PACHCI assessment concluded that the proposal is unlikely to harm an Aboriginal object of place of cultural heritage significance.	 Long-term Major Negative Nil

Factor	Impact
f. Any impact on the habitat of protected fauna (within the meaning of the *National Parks and Wildlife Act* 1974)? The terrestrial and aquatic habitat values of Lake Forbes and the study area are poor. The proposal may require clearing of a small number of individual planted trees, however this would be offset by plantings as part of the proposal landscape design. Demolition and construction works have the potential to impact on aquatic biodiversity, as a result of lowering of water levels in Lake Forbes, sheet piling and excavation, increased erosion and sedimentation, obstruction of fish passage due to temporary instream structures, spread of weeds and chemical or fuel spills. The proposal is unlikely to have a significant impact on threatened species, populations or ecological communities and their habitats. Potential impacts to the habitat or protected fauna would be minimised by implementing the safeguards listed in Section 7.2. The proposed plantings would improve the habitat values of the area in the long term.	 Short-term Minor Negative Long term positive
g. Any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air? The proposal would not endanger a species of animal, plant or other form of life. The aquatic and terrestrial habitat values of Lake Forbes are poor. Demolition and construction works have the potential to temporary impact on aquatic biodiversity, as a result of lowering of water levels in Lake Forbes, sheet piling and excavation, increased erosion and sedimentation, obstruction of fish passage due to temporary instream structures, spread of weeds and chemical or fuel spills. The proposal is unlikely to have a significant impact on threatened species, populations or ecological communities and their habitats. Potential impacts to the habitat or protected fauna would be minimised by implementing the safeguards listed in Section 7.2.	 Short-term Minor Negative
h. Any long-term effects on the environment? The proposal would remove an item of local heritage significance and would therefore change the heritage and aesthetic value of the study area. The new bridge would have a different character to the existing structure, yet its overall built form would be similar to the existing structure. The proposal would improve safety for motorists, pedestrians and cyclists through wider travel lanes, improved road approaches and the removal of potential safety risks associated with the existing bridge structure.	 Long-term Major Negative Long-term Moderate Positive

Factor	Impact
i. Any degradation of the quality of the environment?	
The proposal would result in short-term degradation of the environment as a result of temporary noise generation, visual impacts, dust emissions, and traffic detours and disruptions during construction.	Short-term Moderate Negative
Water quality may be temporarily impacted during the proposal as a result of erosion and sedimentation, lowering of water levels in Lake Forbes, increased turbidity due to sheet piling and excavation, and potential fuel or chemical spills during construction. Safeguards and management measures listed in Section 7.2 would be implemented to minimise these impacts.	
j. Any risk to the safety of the environment?	
There is potential for road safety to be affected as a result of changed traffic conditions and detours. Traffic management safeguards listed in Section 7.2 would be implemented, including preparation of a traffic management plan, to address safety risks.	Short-term Minor Negative
The proposal would require the removal of asbestos containing material identified within the existing bridge structure. The removal of asbestos would be undertaken in accordance with the requirements of the *Code of Practice How to Safely Remove Asbestos* (Safe Work Australia, 2016) and with the safeguards listed in Section 7.2.	Short-term Minor Negative
The proposal would improve safety for motorists, pedestrians and cyclists through wider travel lanes, improved road approaches and the removal of potential safety risks associated with the existing bridge structure.	Long-term Moderate Positive
k. Any reduction in the range of beneficial uses of the environment?	
The proposal would result in short-term impact to traffic access as a result traffic detours and recreational use of Lake Forbes within the study area as a result of the bridge closure. These impacts would be mitigated through the implementation of safeguards listed in Section 7.2..	Short-term Minor Negative
In the long-term, there would be no change to the use of open spaces and waterways which would continue to operate in the same way.	Nil
l. Any pollution of the environment?	
The proposal would result in short-term pollution impacts as a result of noise generation, visual impacts, and dust emissions. Water quality may be impacted during the proposal as a result of erosion and sedimentation, lowering of water levels in Lake Forbes, increased turbidity due to sheet piling and excavation, and potential fuel or chemical spills. Safeguards and management measures listed in Section 7.2. would be implemented to minimise these impacts.	Short-term Moderate Negative

Factor	Impact
m. Any environmental problems associated with the disposal of waste? The largest quantities of waste from the proposal would be generated during demolition of the existing bridge structure. This waste would consist primarily of metal and concrete components and would be recycled where possible. Waste materials would be classified in accordance with the EPA's Waste Classification Guidelines. The proposal would require the removal of asbestos containing material identified within the existing bridge structure. The removal and disposal of asbestos containing material would be undertaken in accordance with the requirements of the *Code of Practice How to Safely Remove Asbestos* (Safe Work Australia, 2016) and with the safeguards listed in Section 7.2.	 Nil Short-term Minor Negative
n. Any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply? Resources required for the proposal are readily available and not in short supply.	 Nil
o. Any cumulative environmental effect with other existing or likely future activities? There are no other activities known to occur concurrently with the proposed work. Given the minor nature of the work and the isolated nature of the site, the proposal is unlikely to have a cumulative environmental impact.	 Nil
p. Any impact on coastal processes and coastal hazards, including those under projected climate change conditions? The proposal is not located within a coastal area and would not impact on coastal processes and coastal hazards.	 Nil

Matters of National Environmental Significance

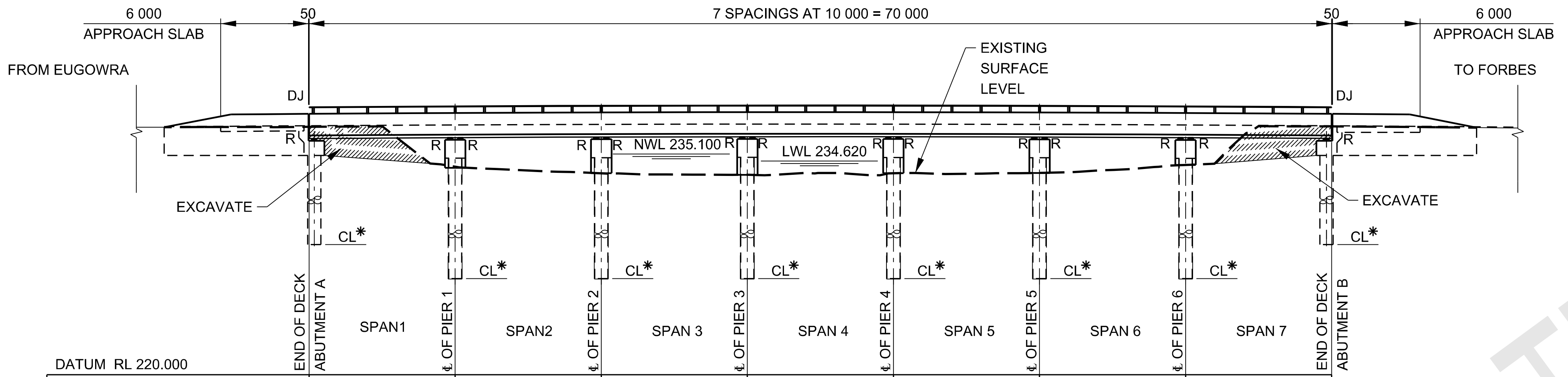
Under the environmental assessment provisions of the *Environment Protection and Biodiversity Conservation Act 1999*, the following matters of national environmental significance and impacts on Commonwealth land are required to be considered to assist in determining whether the proposal should be referred to the Australian Government Department of the Environment.

A referral is not required for proposed actions that may affect nationally listed threatened species, populations, endangered ecological communities and migratory species. Impacts on these matters are still assessed as part of the REF in accordance with Australian Government significant impact criteria and taking into account relevant guidelines and policies.

Factor	Impact
a. Any impact on a World Heritage property? No impact. There are no World Heritage properties in the study area.	Nil
b. Any impact on a National Heritage place? No impact. There are no National Heritage places in the study area.	Nil
c. Any impact on a wetland of international importance? An EPBC Protected Matters search identified four wetlands of international importance located 500 – 900 km upstream of the study area, including: • Banrock station wetland complex; • Hattah-kulkyne lakes; • Riverland; and • The Coorong, and Lakes Alexandrina and Albert Wetland. The proposal is unlikely to impact on these areas given the minor nature of the proposal, they are upstream of the site, and the considerable distances to these wetlands.	Nil
d. Any impact on a listed threatened species or communities? An EPBC Protected Matters search identified 30 listed threatened species and three listed threatened ecological communities with potential to occur within 1km of the study area. The biodiversity assessment concluded that the proposal is unlikely to have a significant impact to listed threatened species, populations or ecological communities.	Nil
e. Any impacts on listed migratory species? An EPBC Protected Matters search identified 11 listed migratory species with potential to occur within 1km of the study area. The biodiversity assessment concluded that the proposal is unlikely to have a significant impact to listed migratory species.	Nil
f. Any impact on a Commonwealth marine area? No impact. There are no Commonwealth marine areas in the study area	Nil
g. Does the proposal involve a nuclear action (including uranium mining)? No impact. The proposal does not involve a nuclear action.	Nil
Additionally, any impact (direct or indirect) on Commonwealth land? No impact. There are no Commonwealth lands in the study area.	Nil

Appendix B

Concept design



DATUM RL 220.000

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EXISTING SURFACE LEVEL ALONG CONTROL LINE (MC10)	237.0	234.2	233.8	233.7	233.8	233.8	234.4	237.0
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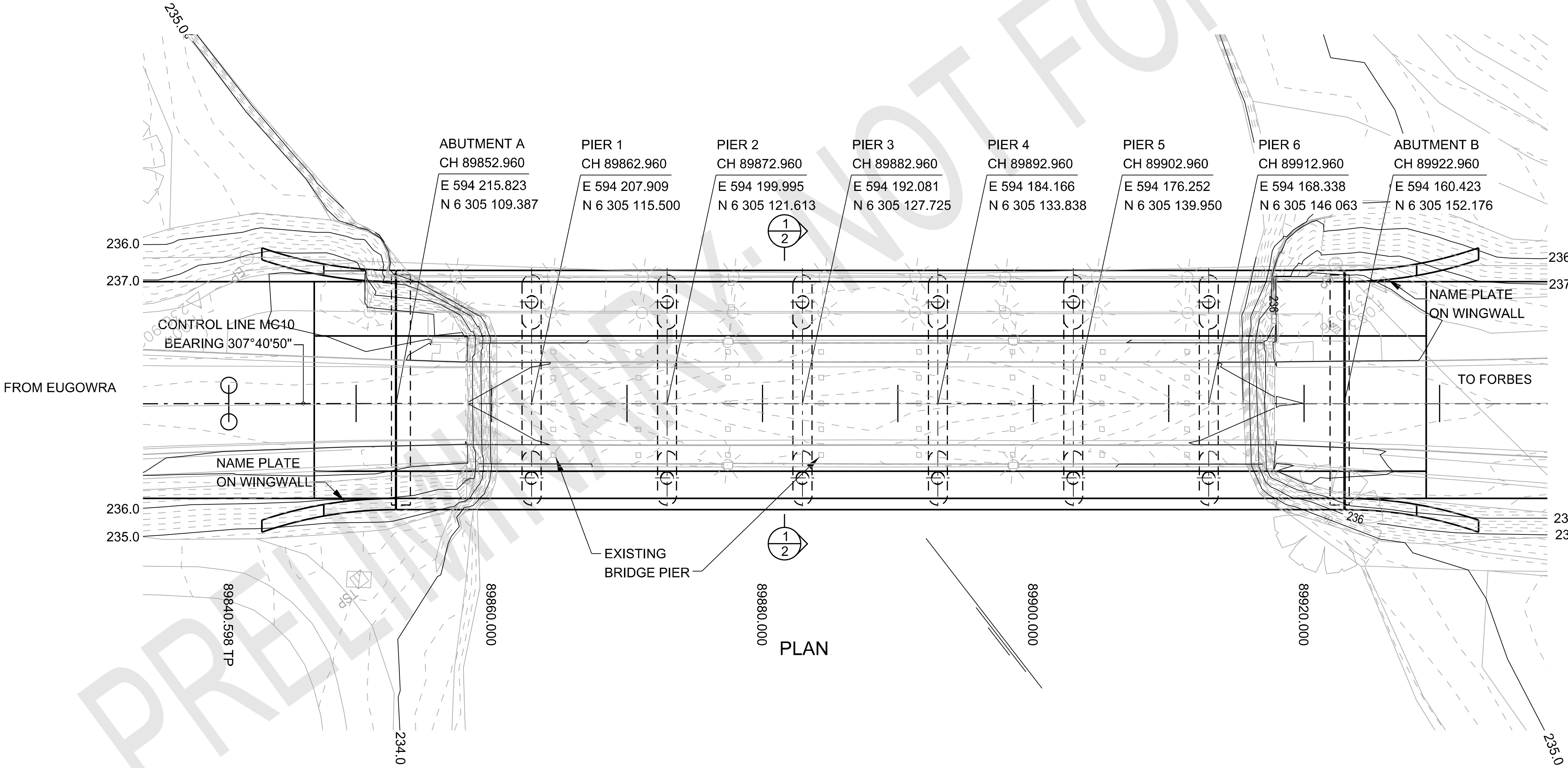
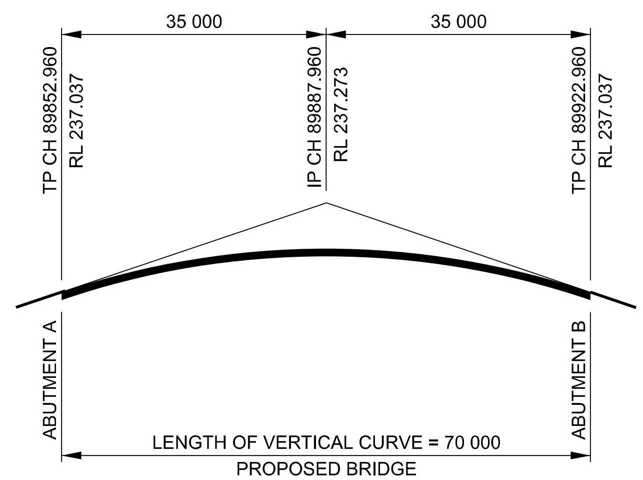


PLAN

LOCALITY PLAN

THE BRIDGE SITE IS APPROXIMATELY 376km BY ROAD FROM SYDNEY



VERTICAL ALIGNMENT DIAGRAM

NOT TO SCALE

GENERAL NOTES

SCALE 0 2 4 6 8 10m

DIMENSIONS ARE IN MILLIMETRES.
CHAINAGES, REDUCED LEVELS AND COORDINATES ARE IN METRES.
REDUCED LEVELS ARE TO AUSTRALIAN HEIGHT DATUM (AHD).
COORDNIATES ARE TO MAP GRID OF AUSTRALIA (MGA).
R DENOTES RESTRAINED BEARING.
DJ DENOTES DECK JOINT.
* PILE CONTRACT LEVEL TO BE DETERMINED AT DESIGN STAGE.

ISSUE	DATE	AMENDMENT DESCRIPTION	PREP	CHECK	AUTH

MAIN ROAD No 56 — SHIRE OF FORBES

BRIDGE OVER LAKE FORBES

AT FORBES

CONCEPT SKETCH - SHEET A

PREPARED BY
BRIDGE ENGINEERING SECTION
PHONE (02) 8837-0810

NSW GOVERNMENT — Transport Roads & Maritime Services — www.rms.nsw.gov.au

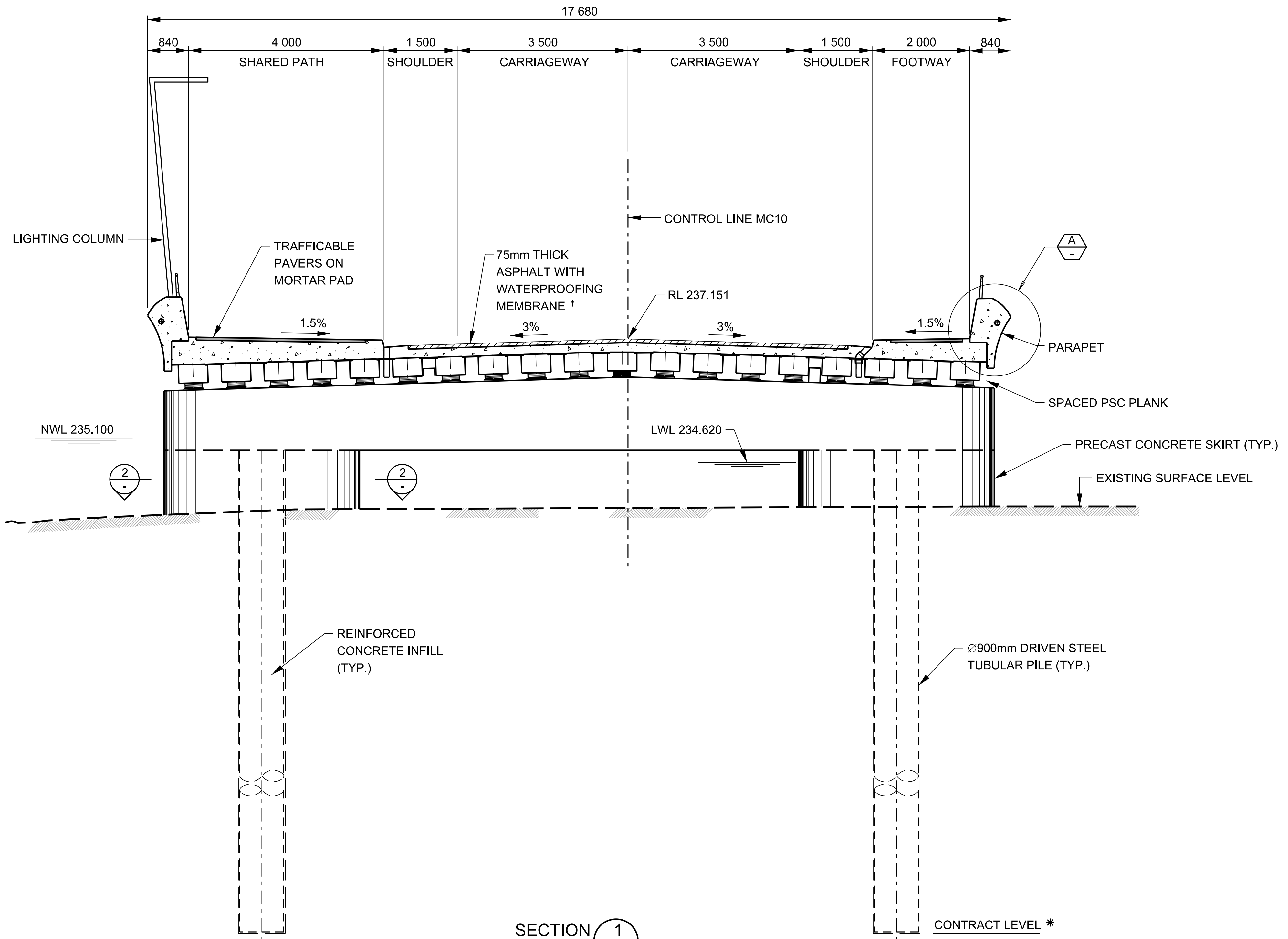
	PREPARED	CHECKED
DESIGN		
DRAWING	Y. CHEN 14.03.18	

SKETCHES SET No: KD1086CS
BRIDGE No: B11707
ISSUE STATUS: ADVANCED

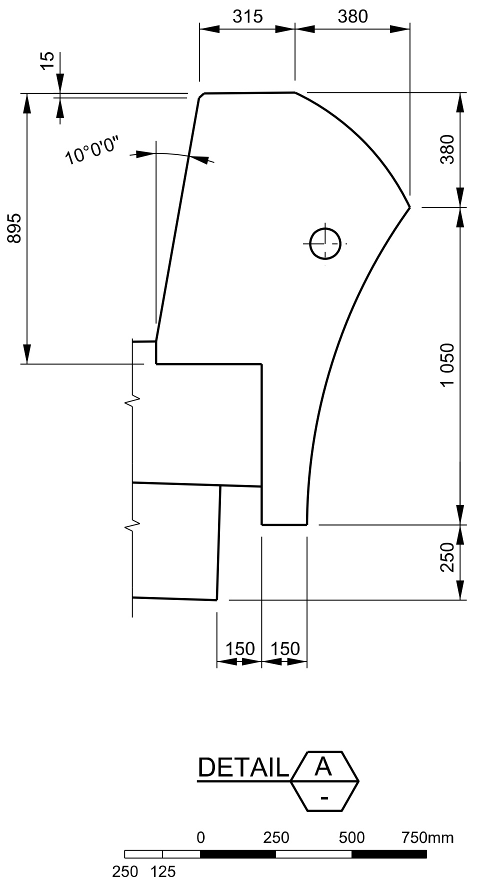
Salah Assi 16/03/18
BRIDGE ENGINEER (NEW DESIGN)

ISSUE 0 | No SHEETS 2 | SHEET No 1

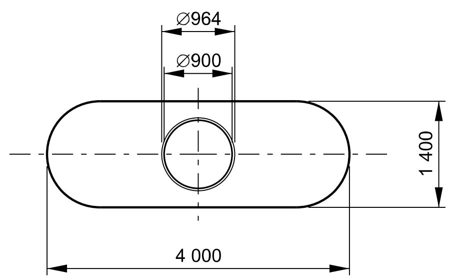
CAD No KD1086CSA.dgn



SECTION 1/1 AT PIER 3



DETAIL A/-



SECTION 2/-

GENERAL NOTES

SCALE 0 1 000 2 000 3 000mm / 1 000 500

FOR OTHER GENERAL NOTES RELATING TO THIS SHEET, SEE SHEET No.1

† THE BRIDGE DECK WATERPROOFING MEMBRANE SHALL BE COMBINED SYSTEM IV IN ACCORDANCE WITH B344/1 SBWM DOUBLE/DOUBLE SPRAYED SEAL COMPRISING:

-- FIRST LAYER: SBWM WITH 14mm COVER AGGREGATE

-- SECOND LAYER: BITUMEN SPRAYED SEAL WITH 7mm COVER AGGREGATE

BOTH LAYER MUST BE APPLIED ON THE SAME DAY

ISSUE	DATE	AMENDMENT DESCRIPTION	PREP	CHECK	AUTH

MAIN ROAD No 56 — SHIRE OF FORBES

BRIDGE OVER LAKE FORBES

AT FORBES

CONCEPT SKETCH - SHEET B

PREPARED BY
BRIDGE ENGINEERING SECTION
PHONE (02) 8837-0810

NSW GOVERNMENT | Transport Roads & Maritime Services
www.rms.nsw.gov.au

	PREPARED	CHECKED
DESIGN		
DRAWING	Y. CHEN 14.03.18	

Salah Assi 16/03/18
BRIDGE ENGINEER (NEW DESIGN)

SKETCHES SET No KD1086CS

BRIDGE No B11707

ISSUE STATUS ADVANCED

ISSUE 0 | No SHEETS 2 | SHEET No 2

CAD No KD1086CSB.dgn

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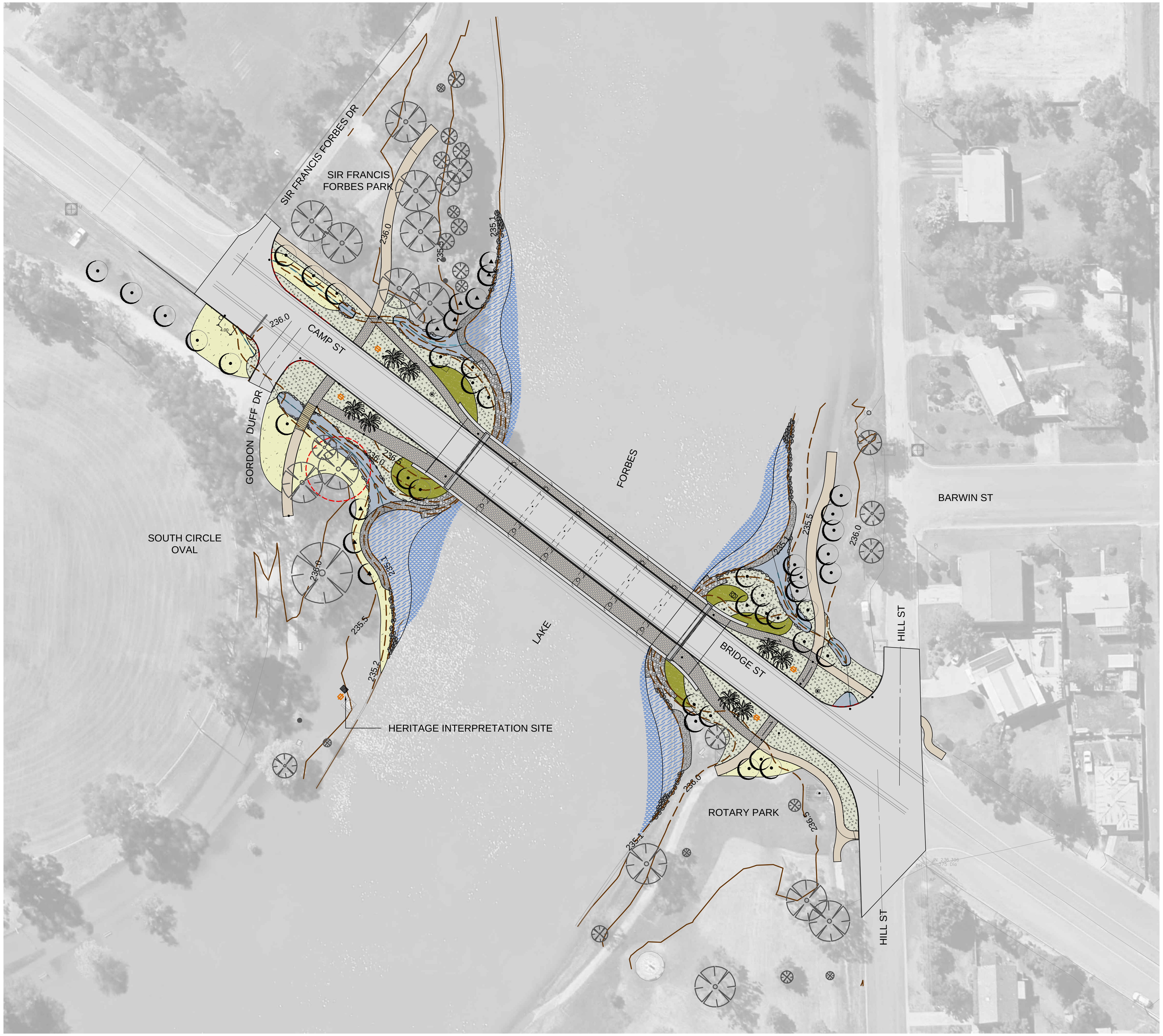

LEGEND

EXISTING ELEMENTS

- TREES PROTECTED & RETAINED
- TREE PROTECTION ZONE
- + 78.0 EXISTING LEVELS
- • 78.0 DESIGN LEVELS
- 236.0 CONTOURS (EXIST.)
- CONTOURS (DESIGN)

SURFACES & INCIDENTAL WORKS

PAVINGS

- CONCRETE PATH
- FEATURE PAVING

INCIDENTAL WORKS

- BOARDWALK
- CULVERT
- RELOCATED HISTORIC BRIDGE LAMP

WATER SENSITIVE URBAN DESIGN

- VEGETATED SWALE
- ROCK MULCH SWALE
- ROCK BOULDERS
- ROCK MULCH EDGE
- ROCK BANK
- WETLAND FILTER LAKE EDGE
- SLOTTED KERB
- RECLAIMED WATER EDGE

PLANTING

MASS PLANTING BED 1 - NATIVE GRASSES
- 100MM TUBES PLANTED @ 6/M²
- 200MM DEPTH CULTIVATION
- 150MM DEPTH TOPSOIL (UNLESS OTHERWISE SHOWN)
- 75MM DEPTH WOODCHIP MULCH

MASS PLANTING BED 2 - LOW SHRUBS
- TUBESTOCK @ 1/M² OR AS SHOWN
- 200MM DEPTH CULTIVATION
- 150MM DEPTH TOPSOIL (UNLESS OTHERWISE SHOWN)
- 75MM DEPTH WOODCHIP MULCH

TURF
- MIN. 75MM DEPTH TOPSOIL

TREE PLANTING

- *Eucalyptus camaldulensis* River Red Gum
- *Phoenix canariensis* Canary Island Date Palm
- *Casuarina cunninghamiana* River Oak

No.	Amendment Description	Initials	Date
02			
01	ISSUED FOR 100% DETAILED DESIGN	VO	24/04/2018

A3 original — This sheet may be prepared using colour and may be incomplete if copied

SCALES

0 10 20 30 40 50
SCALE 1:1000m

Co-ordinate System: MGA Zone 56 — Height Datum: A.H.D.

level 3 studio 3 the cooperage
56 bowman street
pyrmont nsw 2009 australia
t +61 2 9571 7900
e info@kistudio.com.au
www.kistudio.com.au

DESIGNED: JVG / VO
REVIEWED: MW

ROADS AND MARITIME SERVICES

Forbes, NSW
CAMP ST BRIDGE

Landscape Design
Surfaces, Incidental Works & Planting

FILE No.	DRAWING	PRINTED DATE	SHEET No.
16_32	DWG_LD_101	24/04/2018	01

REGISTRATION NUMBER
KIS-1632-DWG-LD

LEGEND

EXISTING ELEMENTS

- TREES PROTECTED & RETAINED
- TREE PROTECTION ZONE
- + 78.0 EXISTING LEVELS
- • 78.0 DESIGN LEVELS
- 236.0 CONTOURS (EXIST.)
- CONTOURS (DESIGN)

SURFACES & INCIDENTAL WORKS

PAVINGS

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- FEATURE PAVING

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- BOARDWALK
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- TURF
  - MIN. 75MM DEPTH TOPSOIL

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02			
01	ISSUED FOR 100% DETAILED DESIGN	VO	24/04/2018

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SCALES

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SCALE 1:500m

Co-ordinate System: MGA Zone 56 | Height Datum: A.H.D.

level 3 studio 3 the cooperage
56 bowman street
pyrmont nsw 2009 australia
t +61 2 9571 7900
e info@kistudio.com.au
www.kistudio.com.au

DESIGNED JVG / VO
REVIEWED MW

ROADS AND MARITIME SERVICES

Forbes, NSW
CAMP ST BRIDGE

Landscape Design
Surfaces, Incidental Works & Planting

FILE No.	DRAWING	PRINTED DATE	SHEET No.
16_32	DWG_LD_102	24/04/2018	02

REGISTRATION NUMBER
KIS-1632-DWG-LD

LEGEND

EXISTING ELEMENTS

- TREES PROTECTED & RETAINED
- TREE PROTECTION ZONE
- + 78.0 EXISTING LEVELS
- • 78.0 DESIGN LEVELS
- 236.0 CONTOURS (EXIST.)
- CONTOURS (DESIGN)

SURFACES & INCIDENTAL WORKS

PAVINGS

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- FEATURE PAVING

INCIDENTAL WORKS

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01	ISSUED FOR 100% DETAILED DESIGN	VO	24/04/2018

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SCALES

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pyrmont nsw 2009 australia
t +61 2 9571 7900
e info@kistudio.com.au
www.kistudio.com.au

DESIGNED JVG / VO
REVIEWED MW

ROADS AND MARITIME SERVICES

Forbes, NSW
CAMP ST BRIDGE

Landscape Design
Surfaces, Incidental Works & Planting

FILE No.	DRAWING	PRINTED DATE	SHEET No.
16_32	DWG_LD_103	23/04/2018	03

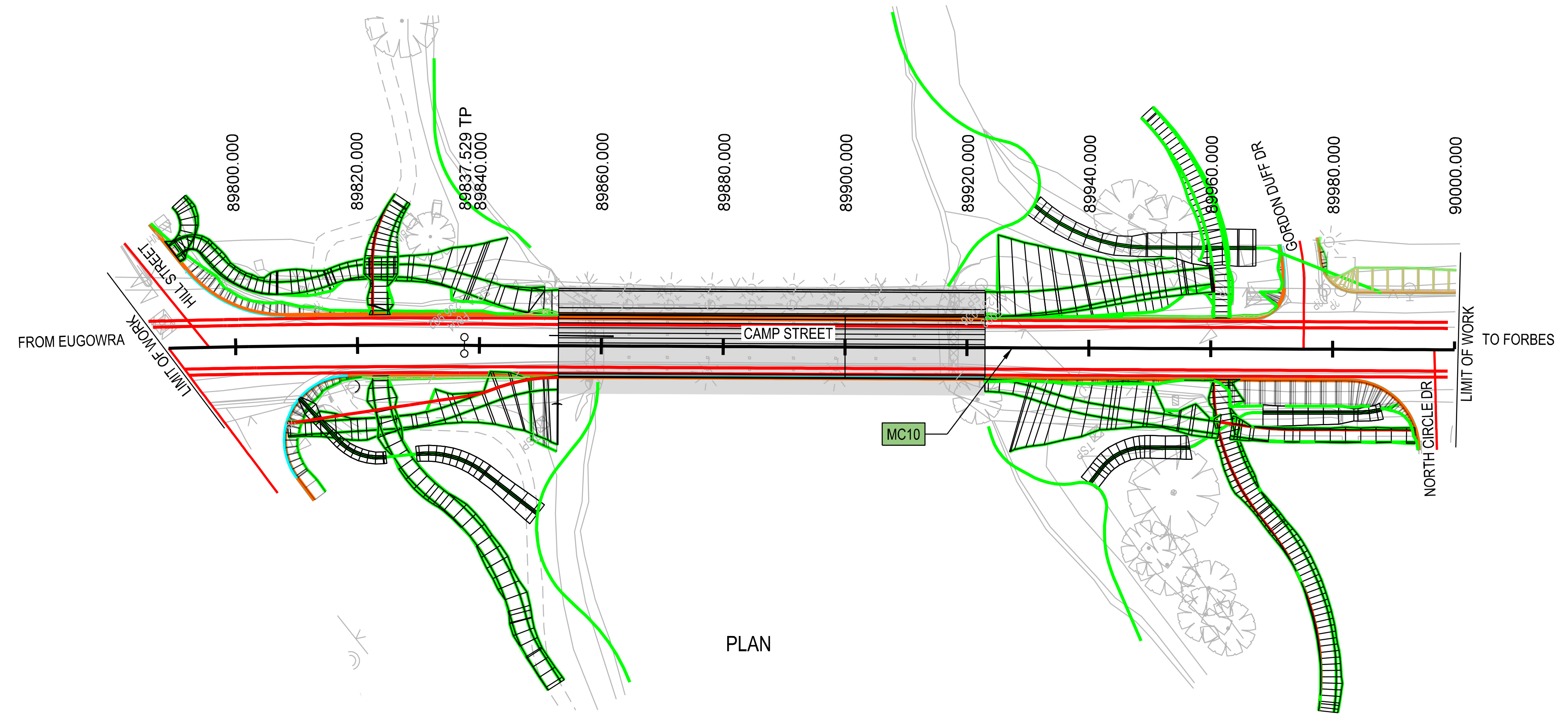
REGISTRATION NUMBER
KIS-1632-DWG-LD

LEGEND

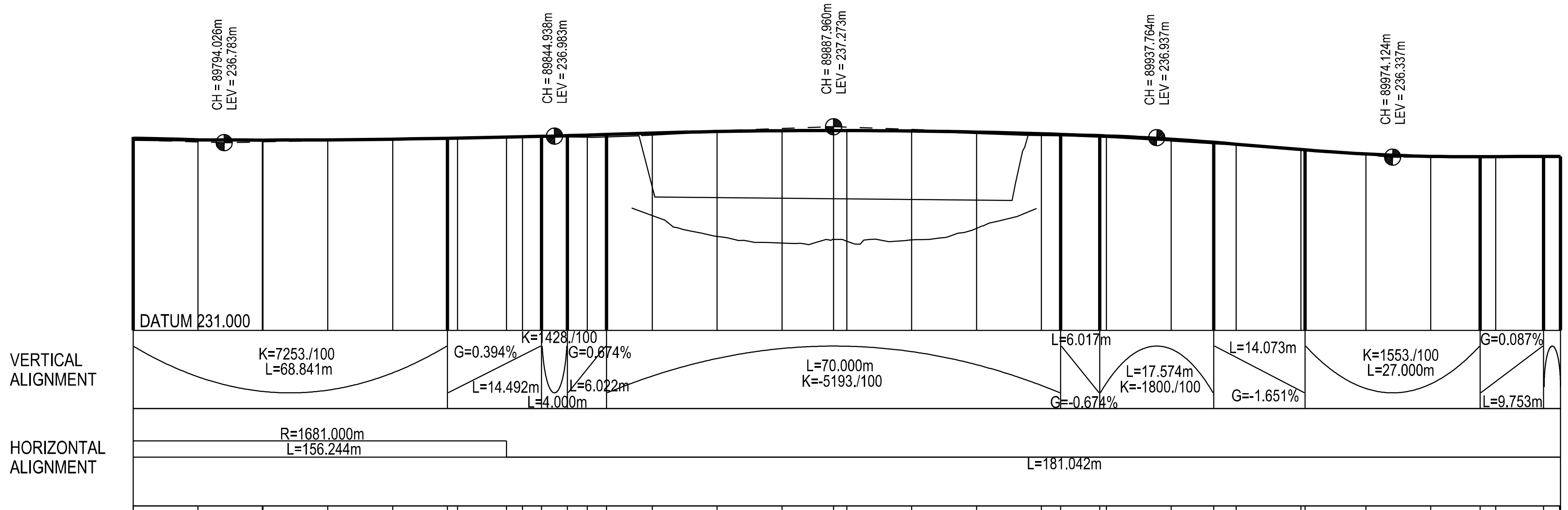
MC10	Master string label
	Survey Station
DP	Cadastral Boundary
	Road Sign
	Property Fence

NOTES

1. Dial Before You Dig and locating of utilities is to be undertaken prior to construction.
2. All measurements are in metres unless otherwise specified
3. Be aware of State and Permanent Survey Marks (SSM & PM). Do not remove without advice from RMS Engineering Services Western Region Survey Manager.



PLAN



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MC10 LONGITUDINAL SECTION

PRODUCED IN COLOUR

NOT FOR CONSTRUCTION

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A3 ORIGINAL

ISSUE	DATE	ISSUE / AMENDMENT DESCRIPTION

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VERTICAL SCALE 1:200m

CO-ORDINATE SYSTEM: MGA Zone 55 HEIGHT DATUM: A.H.D.

NSW GOVERNMENT Transport Roads & Maritime Services
ENGINEERING TECHNOLOGY
PROJECTS DELIVERY
DESIGN WESTERN
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ROADS AND MARITIME SERVICES

FORBES REGIONAL COUNCIL
MR56 LACHLAN VALLEY WAY
CAMP STREET BRIDGE REPLACEMENT
89.780 KM TO 90.000 KM FROM BRISBANE STREET COWRA
PLAN AND LONGITUDINAL SECTION - MC10

DRAWING	STAGE	PART	ISSUE
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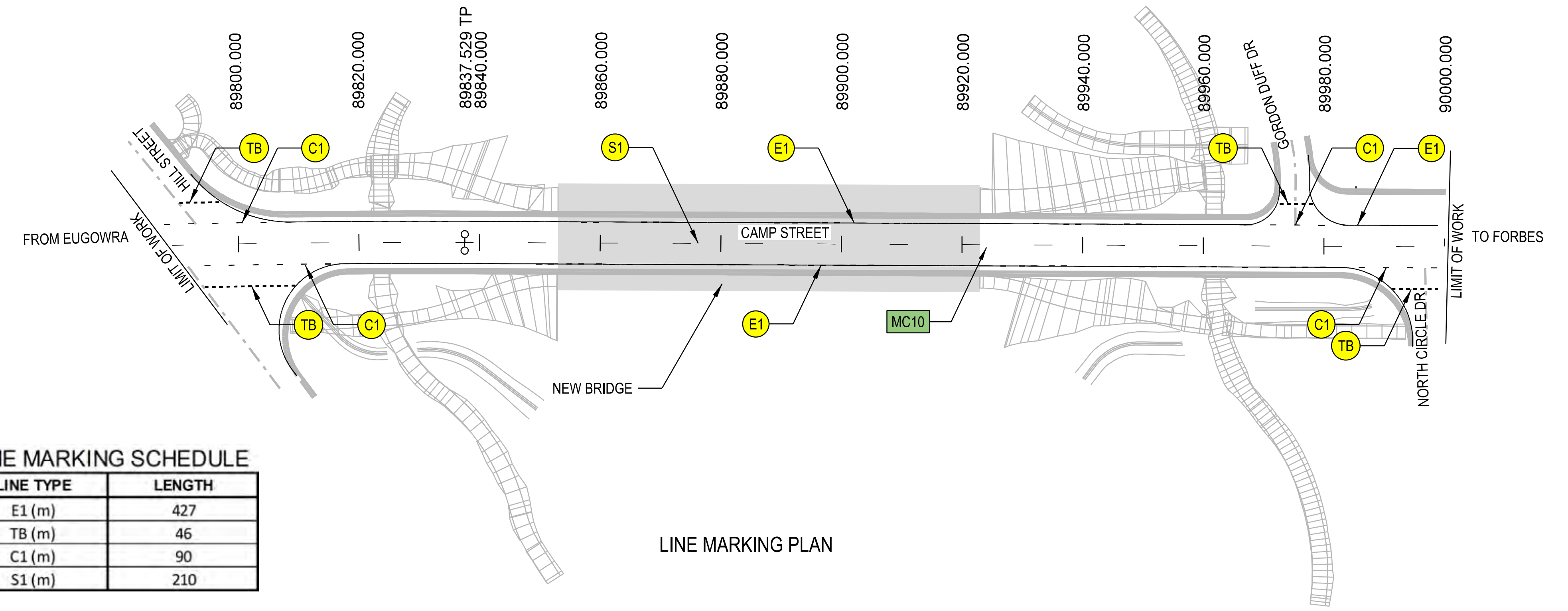
REGISTRATION NUMBER	SHEET No.
DS2018/000000	RD-0001

LEGEND

E1	Linemarking type
•	Install Guide Posts
MC10	Master string label
ɫ	Install Sign Post



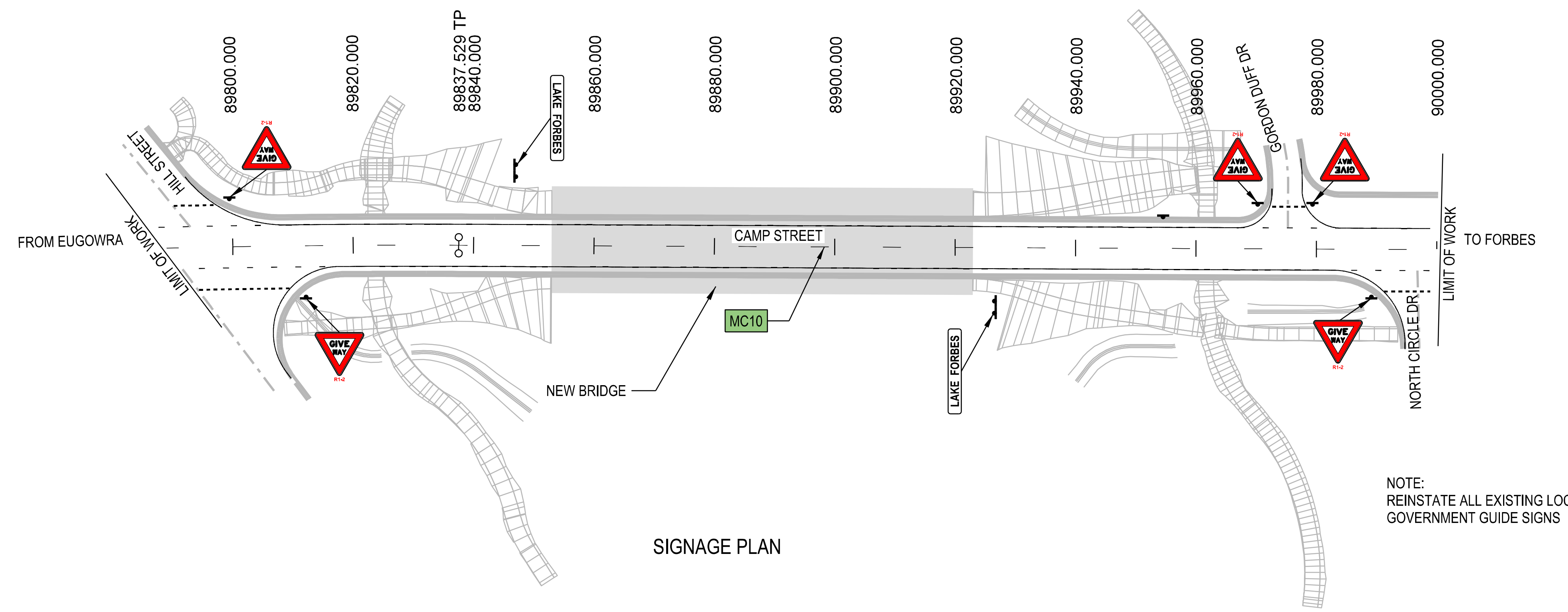
LINE MARKING PLAN

LINE MARKING SCHEDULE

LINE TYPE	LENGTH
E1 (m)	427
TB (m)	46
C1 (m)	90
S1 (m)	210

NOTES

1. All redundant linemarking to be removed.
2. Pavement marking and signposting in accordance with RMS standards.
3. All measurements are in metres unless otherwise specified
4. All signs and line marking to be set out in accordance with AS1742 and RTA Delineation Guidelines
5. All Safety Barrier to be installed to meet MASH TL3 and/or NCHRP 350 TL3
6. Reinstate all existing signs at completion of work



SIGNAGE PLAN

NOTE:
REINSTATE ALL EXISTING LOCAL GOVERNMENT GUIDE SIGNS

PRODUCED IN COLOUR

NOT FOR CONSTRUCTION

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PLOT DRIVER: PDF-PARKES.pltcfg
PEN TABLE: Parkes Universal Colour (Blue to Grey).tbl

A3 ORIGINAL

ISSUE	DATE	ISSUE / AMENDMENT DESCRIPTION

This sheet may be prepared using colour and may be incomplete if copied

SCALES
0 10 20 30 40
SCALE 1:1000m

CO-ORDINATE SYSTEM: MGA Zone 55 HEIGHT DATUM: A.H.D.

NSW GOVERNMENT Transport Roads & Maritime Services
ENGINEERING TECHNOLOGY
PROJECTS DELIVERY
DESIGN WESTERN

PRODUCED: 30/04/2018 2:22:50 PM

ROADS AND MARITIME SERVICES

FORBES REGIONAL COUNCIL
MR56 LACHLAN VALLEY WAY
CAMP STREET BRIDGE REPLACEMENT
89.780 KM TO 90.000 KM FROM BRISBANE STREET COWRA
PAVEMENT MARKING - MC10

DRAWING	STAGE	PART	ISSUE
RF-0101 - Pavement Markings.dgn	100% DETAIL	1	1

REGISTRATION NUMBER	SHEET No.
DS2018/000000	RF-0101

Appendix C

Urban design concept, landscape characters and visual assessment

CAMP STREET BRIDGE FORBES

urban design concept, landscape character & visual impact assessment

Prepared by:

kí STUDIO
INTEGRATED ENVIRONMENTAL DESIGN

Prepared for:

NSW GOVERNMENT
Transport Roads & Maritime Services

THIS REPORT HAS BEEN PREPARED

for:

Roads & Maritime Services (RMS)

by

Level 3, Studio 3
“The Cooperage”
56 Bowman Street
PYRMONT NSW 2009

t. +61 29571 7900
f. +61 29571 7600

email: mw@kistudio.com.au
Miguel Wustemann

email: jvg@kistudio.com.au
Judy van Gelderen

Issue	Date of Issue	Submission	Author	Review	Comments
A	08.08.2017	Draft Report	MW	JvG	
B	24.04.2018	Final Report	MW	JvG	

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1 INTRODUCTION

1.1 INTRODUCTION

The Camp Street Bridge is an important link to the southeast of town and beyond. The existing bridge is narrow and does not meet current load standards and is on a 25 metre long B-double Restricted Access Vehicle and Higher Mass Limit route.

Due to the poor structural condition of the bridge and the limited loading capacity, Roads and Maritime Services (Roads and Maritime) are considering the replacement of the bridge with a fully compliant structure.

The route is an important arterial connection used by B-doubles going to and from Eugowra, Cowra, Orange and Bathurst.

KI Studio has been engaged by Roads and Maritime to provide urban design input into the design of the structure, surrounding landscape setting and provide a landscape character and visual impact assessment of the proposed works as part of the required approval process.

1.2 PURPOSE OF THIS REPORT

This Urban Design Concept Report (Including Landscape Character and Visual Impact Assessment) has been prepared as part of the REF (Review of Environmental Factors) for the proposed new bridge crossing (the proposal). This document is a technical paper that supports the REF being prepared by Roads and Maritime.

The report also documents the landscape character and visual impacts of the proposal and has been prepared as part of the planning approval process. It aims to facilitate an integrated design outcome that responds to engineering and urban design requirements and identifies opportunities and issues within the study area.

1.3 METHODOLOGY

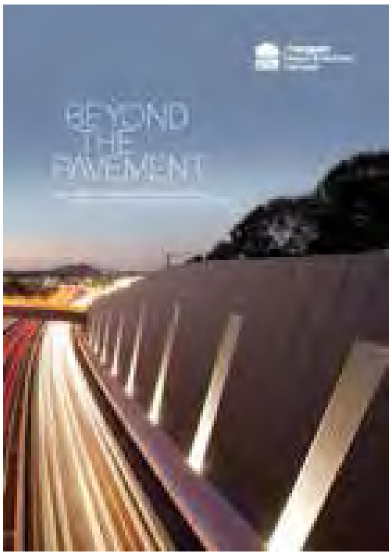
Preparation of this report has involved a desktop analysis and site visits. The methodology used to undertake the study is summarised as follows:

- Background review of supporting material to gain an appreciation of the project
- Detailed site visit to identify sensitivities, views, visual catchments, magnitude of change etc, and to gain a full appreciation of the interface of the proposed bridge in its setting
- Contextual analysis evaluating the characteristics of the site including land use, the lake, scenic values, character zones, streetscapes, heritage and landform
- Determination of sensitivity levels based on the contextual analysis
- Formulation of a project vision and identification of key urban design objectives and principles
- Identification of key constraints and opportunities and development of initial ideas in collaboration with the design team
- Development of a concept design that outlines key urban design strategies
- Iterative identification of strategies (in collaboration with the project team), to improve the outcome of the project from an urban design, landscape character and visual impact point of view
- Development of the integrated landscape design with the engineering components WSUD, and form language of the bridge, including resolution of key spaces and details
- Description of the design based on the urban design input and mitigation strategies
- Evaluation of the project's impact on the landscape character
- Determination of visual exposure and preparation of a visual envelope map to determine the visual catchment of the project
- Selection of viewpoints within the visual catchment that are representative of the varying site conditions and the project
- Evaluation of the project's visual impact by comparing the sensitivity of existing viewpoints and the magnitude of impact of the project upon them
- Identification of any further mitigating measures that could be incorporated into the design.

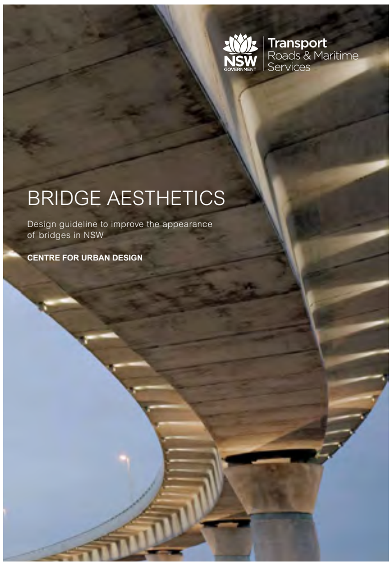
1.4 ROADS AND MARITIME DESIGN GUIDELINES

Roads and Maritime have produced a number of design guideline documents for specific disciplines and areas of design aimed at achieving good urban design outcomes. This report has been undertaken with reference to the following guidelines:

- Beyond the Pavement, January 2014
- Bridge Aesthetics, August 2012
- Landscape Design Guidelines, April 2008
- Guidelines for landscape character and visual impact assessment No. EIA-N04,"Version 2.0 Issue Date 28 March 2013"; and consideration of the Roads and Maritime latest revision to this document.
- Draft RMS Water Sensitive Urban Design Guideline, March 2016.


BEYOND
THE
PAVEMENT


Transport
Roads & Maritime
Services
NSW
Environmental Impact
Assessment Practice Note
Guideline for Landscape Character
and Visual Impact Assessment
EIA-N04


Transport
Roads & Maritime
Services
NSW
BRIDGE AESTHETICS
Design guideline to improve the appearance
of bridges in NSW
CENTRE FOR URBAN DESIGN


Landscape guideline

2 CONTEXTUAL ANALYSIS

2.1 REGIONAL CONTEXT

Forbes is a regional town in the Central West region of New South Wales (NSW), about 20 kilometres south of Parkes and 310 kilometres west of Sydney.

The town is located on the Newell Highway and is a picturesque historic town with a population of about 7,500. It is an important rural service centre noted for its fine parks and gardens and its large and gracious public buildings. The proposed bridge crosses Lake Forbes, a key focal open space adjacent to the town centre. The bridge interfaces with Camp Street.

As Camp Street links The Escort Way -a regional road that links Forbes with Orange to the east- with the Newell Highway at the Forbes town centre, there is much regional traffic along Camp Street

The topography of the area is generally flat with a gentle rise towards the south, to an area known as Camp Hill.

The rural economy in the district is based around major cattle sale yards, beef and hay exports, wool, wheat, grain seed crops, oil seed crops, fruit and vegetables.

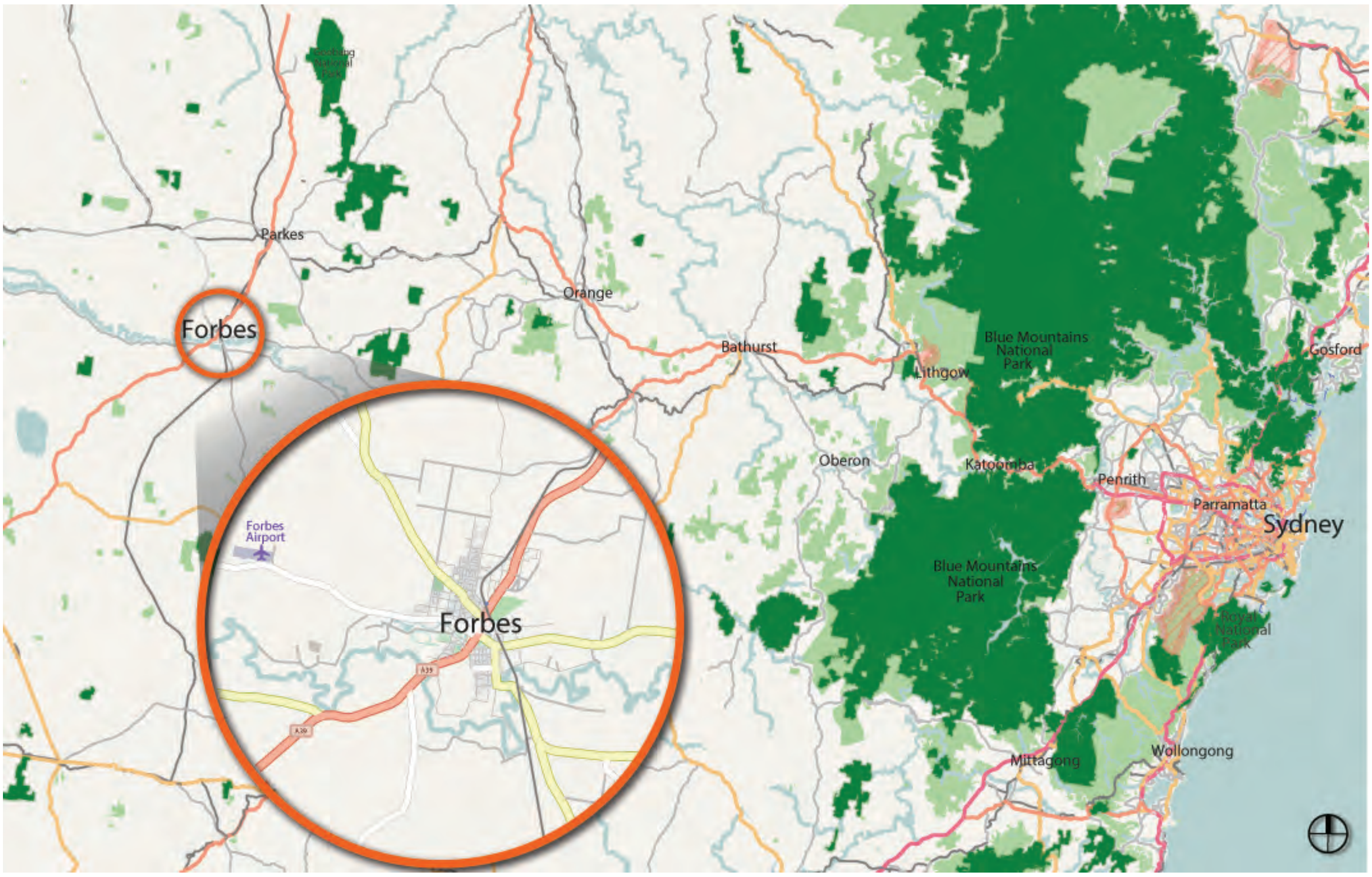


Figure 2.1 Regional context plan. Forbes is located on the Lachlan River 245M above sea-level and 374km west of Sydney via Bathurst and Orange.

2.2 NETWORK CONTEXT

The Camp Street Bridge provides a critical link between Forbes and the region to the east, allowing the bridge to act as a gateway that announces the arrival into Forbes.

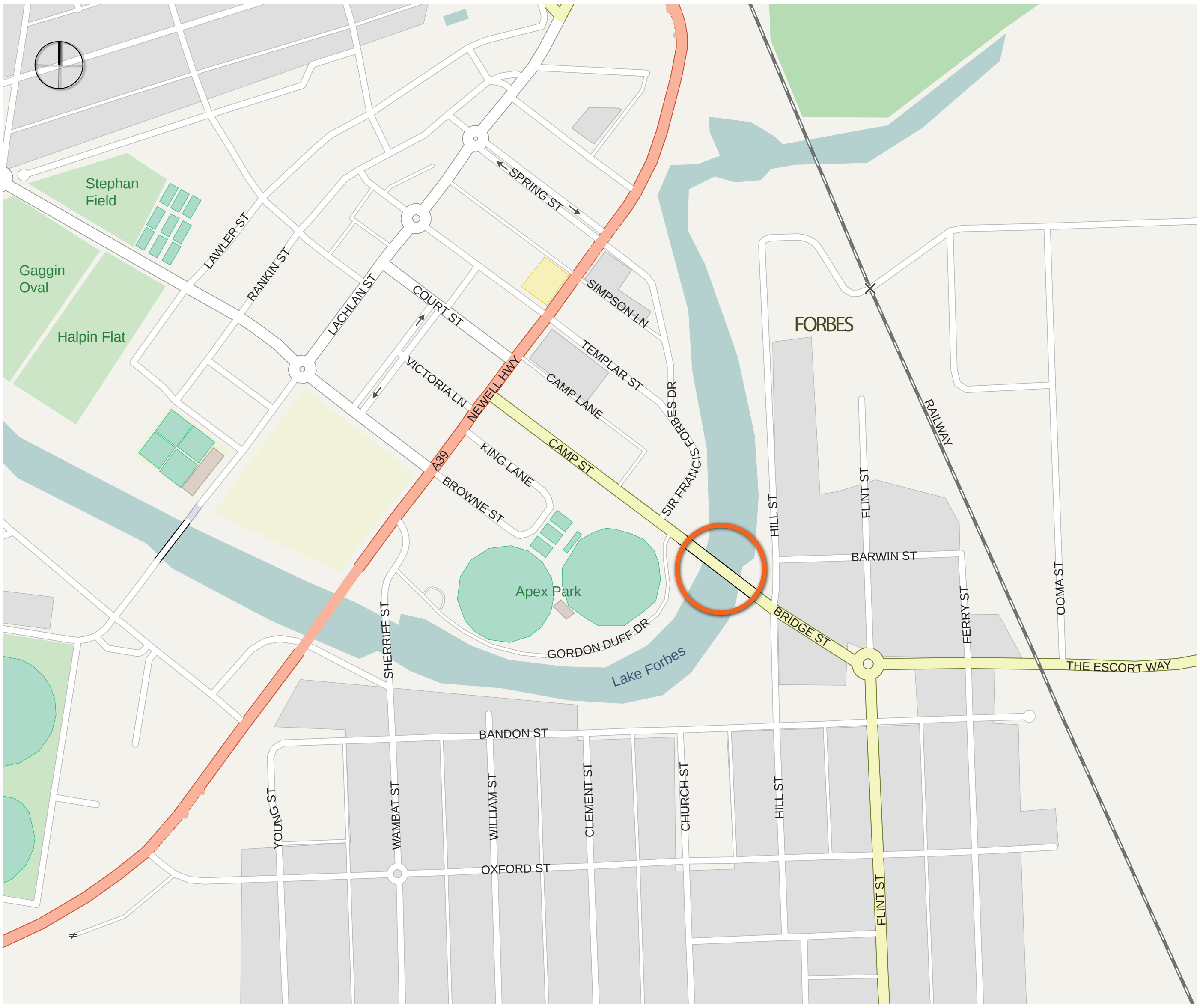


Figure 2.2 Detailed locality map illustrating the main roads and local streets of the townships. Note how Bridge and Camp Street provide a key link into the town.

The existing bridge caters for local and regional traffic which includes heavy vehicles. The bridge also performs a critical pedestrian link for the community between the town centre and the residential areas to the south of town (Camp Hill). In addition, this pedestrian link also complements the open space trail system, creating a 'loop' around Lake Forbes.

West of the bridge, Camp Street ends at a 'T' intersection with the Newell Highway at Victoria Park. The Newell Highway is a national highway and an important freight route between Queensland and Victoria and between regional centres in western New South Wales.

East of the bridge, Camp Street is also known as Bridge Street which then leads to the Escort Way in the direction towards Orange. Bridge Street intersects Flint Street which leads to Lachlan Valley Way and links to Cowra. This underpins the importance of Camp Street as part of a regional route system.

Figure 2.3 Camp Street is a arterial road that links with The Escort Way, a regional route to the east of Forbes.

Figure 2.4 A separate path provides an important link to the town centre and completes a circuit around the lake.

Figure 2.5 There is a path in the form of a circuit around the lake that provides high recreational value for residents.

2.3 HISTORY OF THE SITE AND HERITAGE

History

The area was scarcely populated by the Wiradjuri Aboriginal people prior to white settlement. Some Aboriginal heritage artefacts are displayed at the Forbes and District Historical Society Museum.

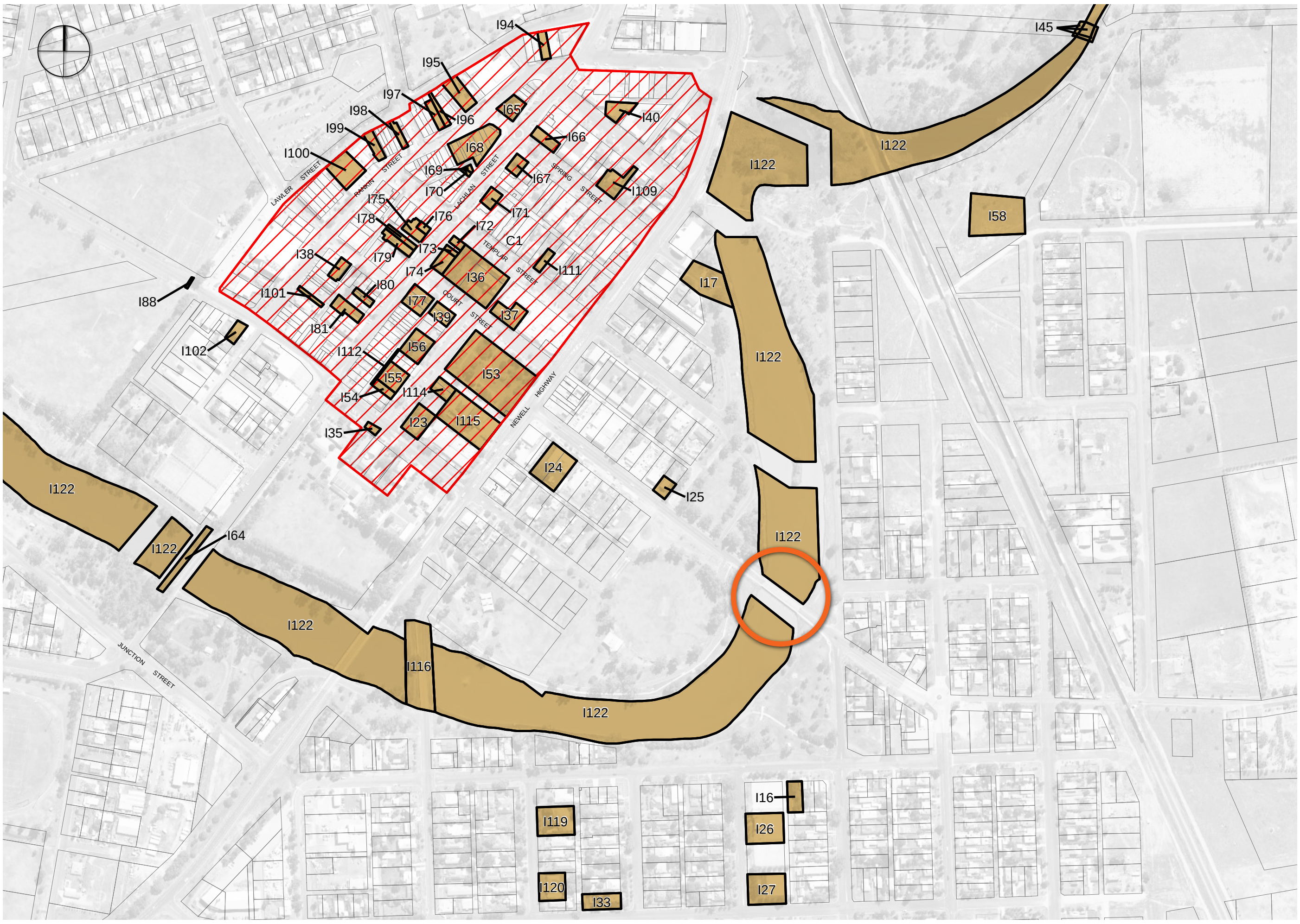
John Oxley explored part of the Lachlan Plain in 1817 and named the site Camp Hill. The area was not settled until 1834 and when gold was discovered 1861, about 30,000 people moved to the region. This was short lived as the mining conditions were difficult, leading to an exodus of the population, declining to about 3,500, in 1863. *(wikipedia)*

Oxley subsequently renamed the settlement Forbes after Francis Forbes, later Sir Francis Forbes, who became the first Chief Justice of New South Wales in the Supreme Court.

Heritage

The map below illustrates the numerous heritage items in the general area, underpinning the strong European heritage present in the township. Three items have been identified that are in the vicinity of the bridge; they include:

- Item I16 - 31 Bandon Street - White Rose Cottage
- Item I25 - 16 Camp Street - Scout Hall (former)
- Item I122 - Lake Forbes



Heritage

Conservation Area - General

Item - General

The most impacted heritage elements are considered the bridge itself and Lake Forbes. It is important to consider the shorelines of Lake Forbes in context of the proposed works and to identify opportunities that would enhance the lake.

The other two items I16 and I25 would be less impacted as there are landscape buffer zones that mitigate the overall effects of the works.

It should be noted that all identified heritage items are locally listed.

Figure 2.6 The centre of town provides a high quality urban setting with an ensemble of heritage buildings that give Forbes its unique identity.

2.4 THE BRIDGE

Although the bridge was originally built in 1927, it is considered of moderate aesthetic value, despite it being a locally listed heritage item. The light poles are the most important elements that give the bridge its character. The rest of the structure is of limited visual appeal.

The bridge is about nine metres wide with a single vehicular traffic lane in each direction. There are two narrow footpaths to either side of the carriageway and adjacent to the existing bridge is a recently completed pedestrian bridge south of the historic structure. This pedestrian bridge acts as a shared use path that runs alongside the historic bridge, partially screening it when viewed from the south.

Figure 2.7 Lake Forbes is a key feature element in the township.

Figure 2.8 The bridge was constructed in the 1927 and its light fixtures are key components that add character to the structure.

Figure 2.9 The original bridge to the left. The walkway to the right was recently added to provide better pedestrian amenity.

2.5 LAND USE

The land use in the vicinity of the bridge is public recreation which includes Lake Forbes, surrounding park lands and the town's oval. General residential use dominates the land use to the south, whilst the town centre is situated to the northwest. Note how a ribbon of open green space surrounds the town centre, delineating its historic fabric.

This green ribbon, together with Lake Forbes, is a key asset for the town and strongly contributes to its identity and the overall character of the bridge setting.

The proximity of the bridge and lake setting to the town centre, create a legible arrival sequence into the town.

This visual sequence could be exploited to enhance the overall urban quality of the township.

Land Use

Local Centre	Public Recreation
Environmental Management	Private Recreation
Light Industrial	Primary Production
General Residential	Infrastructure

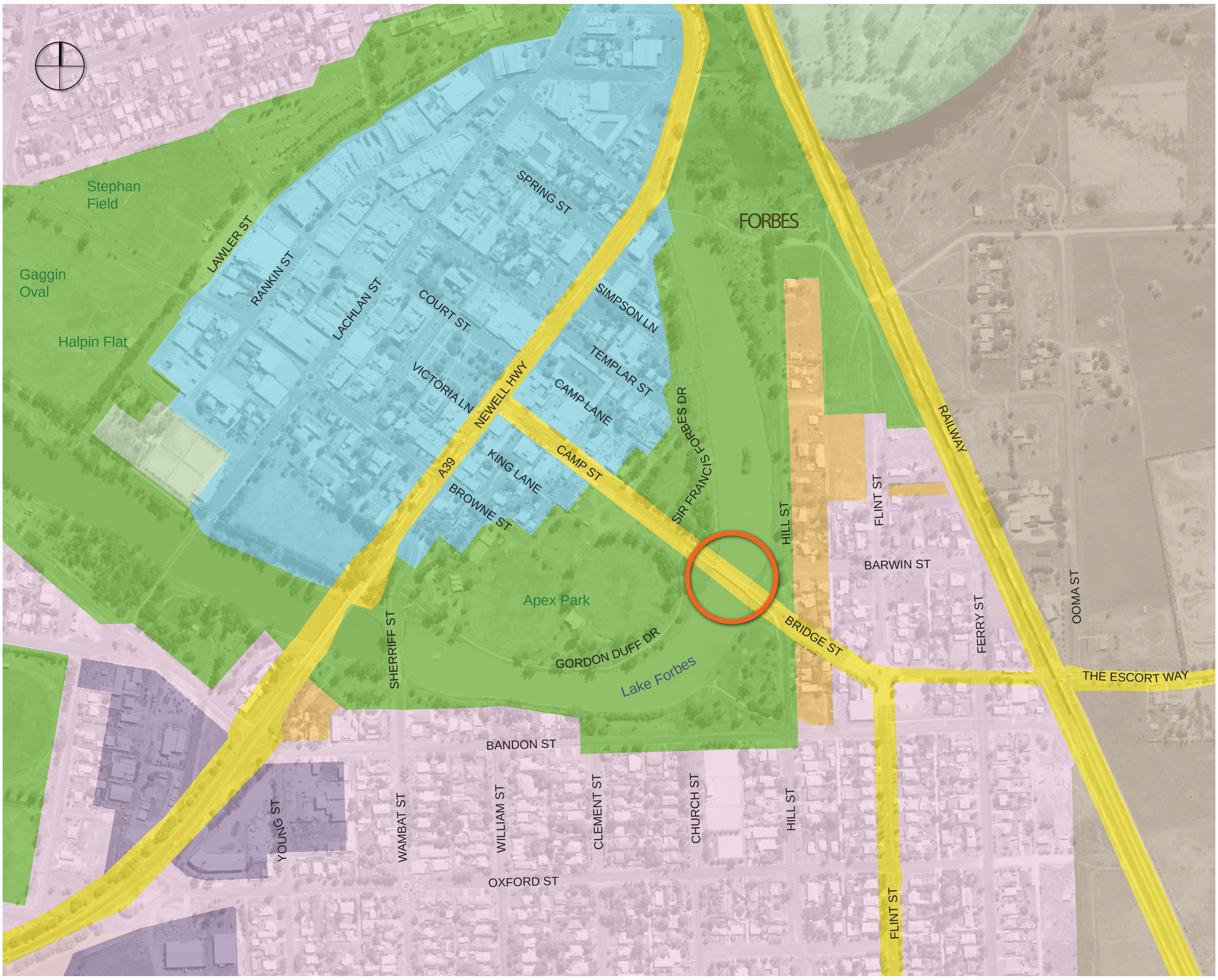


Figure 2.10 Land use map , from Council LEP map of the area.

3 URBAN DESIGN OBJECTIVES & PRINCIPLES

3.1 URBAN DESIGN OBJECTIVES

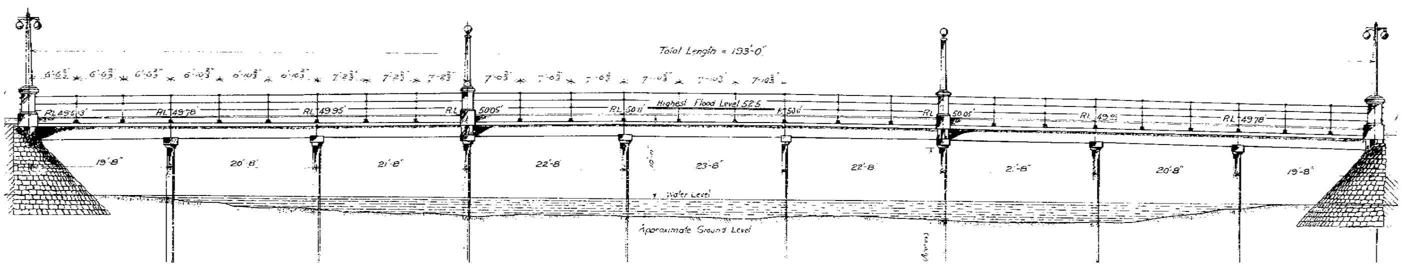
The following urban design objectives have been identified based on the site analysis of the project.

- Replace the existing bridge with a new landmark structure that celebrates the entry into Forbes
- Minimise visual impacts to the existing character of the setting
- Enhance safety where possible, particularly for pedestrian traffic
- Respect the heritage values of the existing structure
- Encourage slower speeds for vehicular traffic
- Enhance the urban connectivity and respond to the desired future character and functioning of the area
- Promote Roads and Maritime Active Transport policies to facilitate walking and cycling transport trips
- Minimise environmental impacts and improve water quality discharged into the lake
- Reinforce the entry into Forbes with a strong landscape design
- Minimise impact on the community
- Design for low maintenance
- Meet the growing and future needs of the local and travelling community.

3.2 URBAN DESIGN PRINCIPLES

Based on the urban design objectives, key design principles have been identified to further guide the design of the new bridge. These include:

- Create a structure that is elegant and understated with a distinct visual character that reinforces the horizontality of the setting
- Integrate the shared path with other pedestrian networks and desire lines. Locate the shared path along the southern side of the bridge and integrate with paths in the adjacent open spaces.
- Minimise the height of the parapet to retain a visually slender structure and open character
- Introduce feature lighting to express the structure at night time and to create a memorable experience that visually reinforces the structure as a landmark
- Introduce streetscape lighting that provides a pedestrianised character to visually de-emphasise the road
- Provide a wide pedestrian path (shared path) to create a promenade streetscape character that is pedestrian friendly
- Utilise high quality paving materials for pedestrian zones to reflect the importance of the bridge and its setting
- Integrate historic interpretation references of the existing bridge as part of a heritage interpretation strategy
- Develop a bridge design that is easy to maintain such as a concrete structure
- Introduce landscaped areas within areas of existing road pavement and adjacent the road to create a visual accent at each bridge approach that will also encourage slower vehicular speeds
- Integrate water sensitive urban design into the landscape/engineering design to provide environmental initiatives that will also add interest to the streetscape and lake foreshore
- Visually integrate bridge abutment treatments with the landscape/WSUD works to create softer transitions and edges to improve the Lake Forbes setting
- Reinforce the avenue tree planting to create a stronger visual link to the town centre
- Consider introducing accent trees to accent the bridge approach to reflect the heritage context of Forbes



4 THE CONCEPT

Figure 4.1 Abstract aerial overview of the proposed bridge.

Figure 4.2 The bridge would include a wide promenade to promote a safe crossing.

Figure 4.3 The distinct shape of the parapet contributes to the identity of the bridge and reflects the 'art nouveau' theme.

4.1 BUILT FORM ELEMENTS

The concept design is based on creating a new bridge that is a contemporary interpretation of the existing structure and aims to create a promenade across Lake Forbes, with a 4 metre wide shared use path.

Key features of the proposed design are:

Superstructure

The new bridge is based on a precast concrete plank structure to minimise the depth of the superstructure and to mitigate potential flooding issues. The plank structure echoes the existing structure, providing a similar character.

Piers

The piers have been designed as piles with a deep headstock. The headstock is partially screened by a precast element, deep enough to create the appearance of a blade pier and to provide a neat appearance devoid of clutter. To reduce construction complexities, the central portion of the headstock is devoid of the precast element, since it would be barely visible. To reinforce the overall horizontal character of the structure, horizontal reveals would be incorporated into the precast element and the ends would be rounded to echo the 'art nouveau' style of the existing bridge.

Parapets

The parapets have been design to act as a concrete traffic barrier. To keep a slender appearance the RD regular performance barrier would be truncated in height from 1300mm to 820mm. When seen in section, the parapet has a curved top and a counter-curved fascia that would help to disguise the overall height. This unusual shape, would provide a strong shadow line and complements the curved form of the piers, thereby reinforcing the 'art nouveau' theme.

Balustrade

A balustrade would be integrated on top of the barrier which would also include a rub rail for cyclists. The balustrade is based on stainless steel cables with steel supports. This would allow an open character with the unobtrusive resolution of this element.

Lighting

Pole lighting would be integrated on top of the parapet traffic barrier. The poles have been restricted in height to create a pedestrianised character and are spaced in line with the piers. The poles would be tilted and have a minimalist design with neat lines to provide a contemporary character that is unobtrusive.

Feature lighting is proposed in the form of a wall wash of the top of the parapet. The LED fixtures would be integrated within the underside of the handrail, limiting the visual exposure of these elements.

Abutments

The abutments are proposed as rock banks to create a softer appearance and visually integrate with the proposed landscape design and water sensitive design initiatives.

Figure 4.4 The balustrade has been kept as transparent as possible.

Figure 4.5 The bridge would include a wide promenade to promote a safe crossing.

Figure 4.6 Feature lighting to accentuate the parapet would be incorporated within the handrail.

Promenade

The shared use and pedestrian paths would be paved in a feature textured concrete paver with a dark grey colour. The shared use path (promenade) would be 4 metres wide and located adjacent to the westbound lane. A 2 metre wide pedestrian path would be situated adjacent to the eastbound lanes.

Carriageway

The roadway would consist of one 3.5 metre wide lane and a 2 metre shoulder in each direction. To create a legible entry into the town and to announce the bridge crossing, feature planting areas have been incorporated adjacent to the road by moving the paths away from the road edge at either abutment. This design also enhances road safety.

These landscaped areas incorporate the historic lamp posts of the existing bridge, thereby acting as legible markers and celebrating the historic crossing, whilst reinforcing the arrival sequence into Forbes. The landscaped areas would also soften the streetscape appearance and promote drivers to slow down.

A heritage interpretation in the form of signage would complement the relocated light posts and provide further context of the original bridge.

Figure 4.7 Feature pavers would be used for the shared use path and landscaped areas introduced at the approaches to the bridge.

Figure 4.8 The existing light poles would be recycled as part of the approaches to the new bridge.

Figure 4.9 The historic light poles would complement the streetscape and announce the entry into the town centre.

Figure 4.10 The parapet is terminated through a gentle transition back into the ground, creating a fluid end to the bridge.

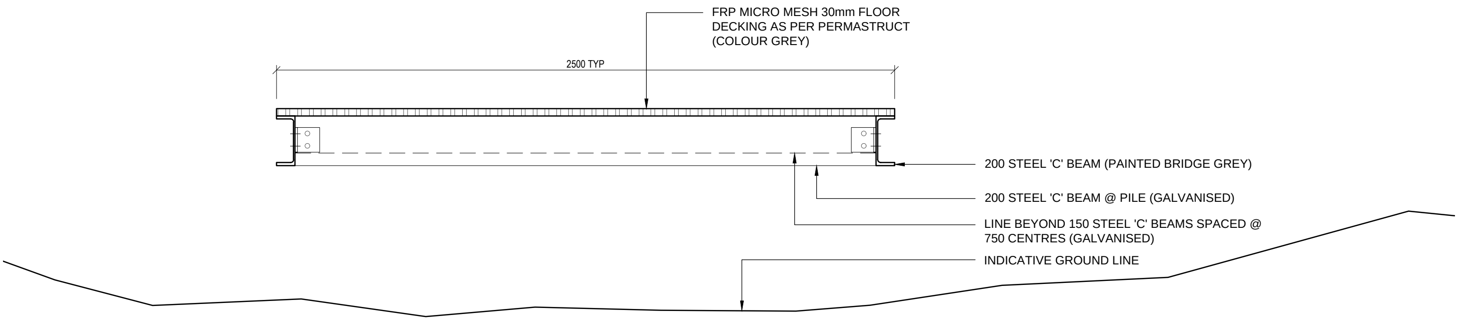


Figure 4.11 Indicative cross section of the proposed boardwalk.

Boardwalk

A boardwalk is proposed on the town side to integrate with and express the water sensitive design initiatives and add interest to the streetscape. The boardwalk consists of a steel structure painted in grey and to retain an open character, it is devoid of any railing or balustrade.

Figure 4.12 The boardwalk would express the interface with water sensitive design initiatives.

Figure 4.13 Existing situation looking towards the bridge approach with Camp Hill in the background.

Figure 4.14 Indicative proposed design, including accent planting of Canary Island Date Palms with tussock understorey

Figure 4.15 Existing situation looking east from the foreshore of Lake Forbes.

Figure 4.16 Indicative view of the new bridge. The structure reinforces the horizontality of the setting with the form of the parapet catching light and expressing the slender proportion. Water sensitive design initiatives soften and improve the Lake Forbes shoreline

4.2 LANDSCAPE DESIGN

The adjacent plan illustrates the integrated landscape and water scheme for the project. As well as enhancing the immediate setting of Lake Forbes, the design integrates the new bridge abutments and road design approaches with the surrounding landscape.

Key design elements include:

- revegetation of indigenous tree, shrub and grass layer plantings to reflect the vegetation of the area.
- water sensitive design elements including swales, biofiltration areas and wetland filter areas as described in the following pages
- introduction of feature trees- the Canary Island Date Palm that is characteristic of the older town areas in Forbes.

LEGEND

EXISTING ELEMENTS

EXISTING TREES

TREE PROTECTION ZONE

CONTOURS (EXIST.)

DESIGN CONTOURS

PLANTING & REVEGETATION

TURF

NATIVE GRASSES

LOW SHRUBS

NATIVE, INDIGENOUS TREE SPECIES

CULTURAL LANDSCAPE TREE SPECIES

WATER SENSITIVE DESIGN

VEGETATED SWALE

ROCK MULCH SWALE

WETLAND FILTER

RECLAIMED WATER EDGE

ROCK BOULDERS

OTHER DESIGN ELEMENTS

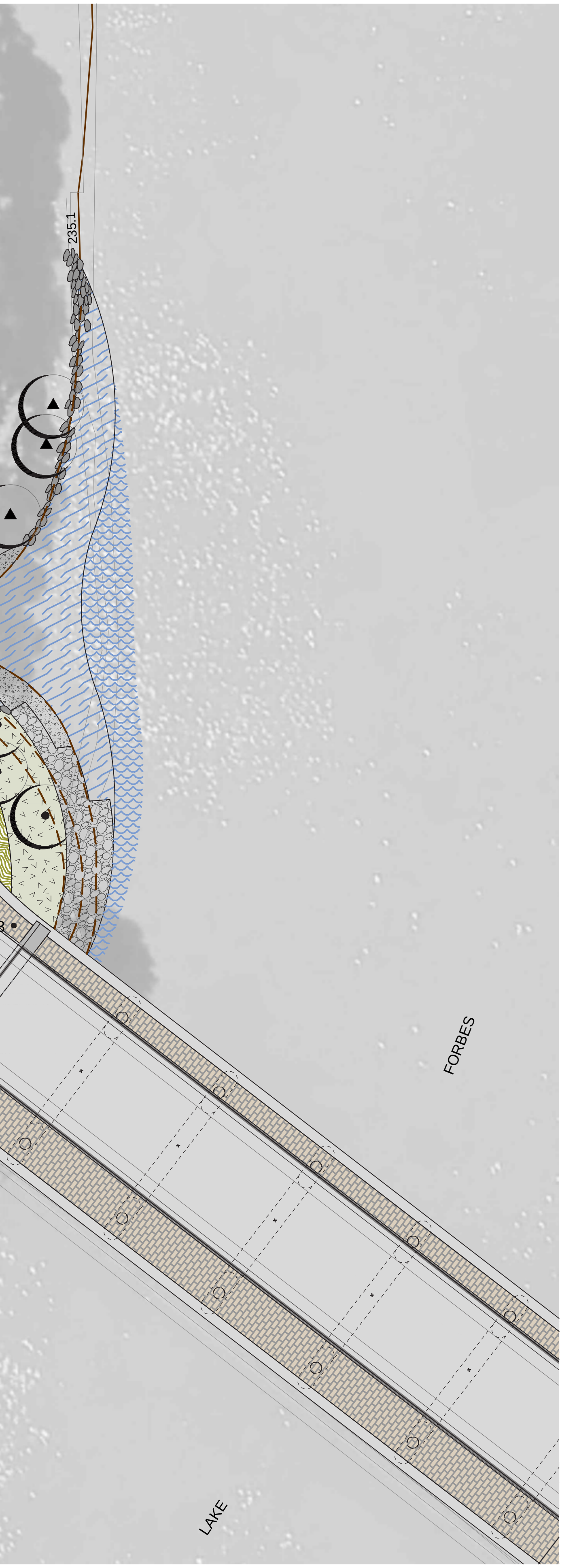
FEATURE PAVING

FOOTPATH

BOARDWALK

Figure 4.17 The proposed landscape design incorporates water sensitive design elements that soften the lake edge by curving the lake/land interface more to create more natural, organic shapes as well as improving water quality.


SIR FRANCIS FORBES DR
SIR FRANCIS
FORBES PARK
236.20
EXISTING
TELEGRAPH POLE
SLOTTED
KERB
235.80
4.00
236.0
236.3
CAMP ST
236.495
236.335
236.580
236.655
236.50
236.777
236.67
236.950
237.03
GORDON DUFF DR
236.0
236.5
236.277
235.40
235.1
235.5
SOUTH CIRCLE
OVAL
235.5



LEGEND

EXISTING ELEMENTS

TREES PROTECTED & RETAINED

236.0 CONTOURS (EXIST.)

TREE PROTECTION ZONE

CONTOURS (DESIGN)

+ 78.0 EXISTING LEVELS

• 78.0 DESIGN LEVELS

SURFACES & INCIDENTAL WORKS

PAVINGS

CONCRETE PATH

FEATURE PAVING

INCIDENTAL WORKS

BOARDWALK

CULVERT

RELOCATED HISTORIC BRIDGE LAMP

WATER SENSITIVE URBAN DESIGN

VEGETATED SWALE

ROCK MULCH SWALE

ROCK BOULDERS

ROCK MULCH EDGE

ROCK BANK

WETLAND FILTER LAKE EDGE

SLOTTED KERB

RECLAIMED WATER EDGE

PLANTING

MASS PLANTING BED 1 - NATIVE GRASSES
- 100MM TUBES PLANTED @ 6/M²
- 200MM DEPTH CULTIVATION
- 150MM DEPTH TOPSOIL (UNLESS OTHERWISE SHOWN)
- 75MM DEPTH WOODCHIP MULCH

MASS PLANTING BED 2 - LOW SHRUBS
- TUBESTOCK @ 1/M² OR AS SHOWN
- 200MM DEPTH CULTIVATION
- 150MM DEPTH TOPSOIL (UNLESS OTHERWISE SHOWN)
- 75MM DEPTH WOODCHIP MULCH

TURF
- MIN. 75MM DEPTH TOPSOIL

TREE PLANTING

Eucalyptus camaldulensis
River Red Gum

Phoenix canariensis
Canary Island Date Palm

Casuarina cunninghamiana
River Oak

Figure 4.18 The proposed landscape design for the western abutment and adjacent public parks, incorporating water sensitive design elements that also soften the lake interface.

FORBES
LAKE
BRIDGE ST
ROTARY PARK
HILL ST
SLOTTED
KERB
235.5
235.1
236.0
236.5
235.70
236.917
237.03
237.03
1 in 15.9
236.820
236.50
1 in 14
236.90
236.763
236.67
236.665
236.831
236.773
236.50
1 in 14
236.60

LEGEND

EXISTING ELEMENTS

- TREES PROTECTED & RETAINED
- TREE PROTECTION ZONE
- + 78.0 EXISTING LEVELS
- • 78.0 DESIGN LEVELS
- 236.0 CONTOURS (EXIST.)
- CONTOURS (DESIGN)

SURFACES & INCIDENTAL WORKS

PAVINGS

- CONCRETE PATH
- FEATURE PAVING

INCIDENTAL WORKS

- BOARDWALK
- CULVERT
- RELOCATED HISTORIC BRIDGE LAMP

WATER SENSITIVE URBAN DESIGN

- VEGETATED SWALE
- ROCK MULCH SWALE
- ROCK BOULDERS
- ROCK MULCH EDGE
- ROCK BANK
- WETLAND FILTER LAKE EDGE
- SLOTTED KERB
- RECLAIMED WATER EDGE

PLANTING

MASS PLANTING BED 1 - NATIVE GRASSES
- 100MM TUBES PLANTED @ 6/M²
- 200MM DEPTH CULTIVATION
- 150MM DEPTH TOPSOIL (UNLESS OTHERWISE SHOWN)
- 75MM DEPTH WOODCHIP MULCH

MASS PLANTING BED 2 - LOW SHRUBS
- TUBESTOCK @ 1/M² OR AS SHOWN
- 200MM DEPTH CULTIVATION
- 150MM DEPTH TOPSOIL (UNLESS OTHERWISE SHOWN)
- 75MM DEPTH WOODCHIP MULCH

TURF
- MIN. 75MM DEPTH TOPSOIL

TREE PLANTING

- *Eucalyptus camaldulensis* River Red Gum
- *Phoenix canariensis* Canary Island Date Palm
- *Casuarina cunninghamiana* River Oak

Figure 4.19 The proposed landscape design for the eastern abutment and adjacent public parks, incorporating water sensitive design elements that also soften the lake interface.

Water Sensitive Urban Design

Lake Forbes is known for poor water quality and occasional concerns of green-blue algae. In the water areas adjacent this project, the edges are predominantly walled or simply shaped, without wetland filter zones or rough areas. The water depth is quite shallow- being only 1500mm.

With this project, the shoreline will be modified with the new bridge which is longer than the current one, and the drainage of nearby roads and existing culverts and concrete drains (west bank) all require careful consideration.

A sustainable water scheme is proposed for the project which is well suited to the landscape setting and will greatly improve the aesthetic outcome for the project. A holistic, integrated scheme is proposed that will assist in improving the water quality of the lake through implementation of wetland filter areas. Obviously additional lake aeration would also assist if budget could be stretched.

This bridge project provides ideal opportunity for demonstrating good water sensitive design, in its application of swales, rock mulch swales, bio-filtration areas and wetland filters. Water sensitive design means minimal pipes and culverts, and open channelling of stormwater through the landscape in an integrated way. The design is well integrated with adjacent topography and elements and incorporates stormwater treatment/ cleaning functions such as the wetland filter zones , rock mulch swales and slotted kerbs leading into swales in lieu of kerbs, pipes and pits beside road pavements.

The system is a natural, gravity fed design that is durable, functional and sustainable. This approach replicates natural processes and integrated water flows and cleaning as part of the landscape, which are carefully integrated with the new earthworks to each bridge abutment.

Lake Forbes - a great asset

As mentioned in the State of the Environment Report, 2006-2007, Lake Forbes is a major geographical and aesthetic feature in the town, providing a water contrast in the urban landscape. It is an important asset, contributing a number of benefits, including passive and active recreation, wildlife habitat, historical values, tourism and related economic benefits and treatment of urban drainage.

Whilst there are constructed wetlands in other areas of the lake, there is scope to “roughen” lake edges generally by implementing more areas of wetland filter zones, as is proposed with the project. These enhancements will also minimise erosion of the banks, that is occurring in adjacent areas, and that also increases the amount of silt within the lake.

The water sensitive design elements proposed will be sensitively integrated with proposed earthworks that will settle the bridge abutments into the landscape/lake setting, as well as:

- Responsibly clean stormwater prior to releasing it into the lake
- Slow down stormwater velocities and thereby reduce flooding
- Provide habitat for water birds
- Provide natural irrigation to plants
- Provide opportunity for water conservation/ environmental interpretation and education for the town’s residents

The scheme will showcase practical, cost effective ways of implementing water sensitive design and greatly contribute to enriching Lake Forbes foreshore areas, adjacent to the new bridge. The new typology of a more organic water’s edge to the lake adds more visual interest to the area.

The project also demonstrates the advantages of applying the Transport for NSW's "Water sensitive urban design guideline".

Water sensitive design elements

Key water sensitive design elements proposed include:

- Vegetated, turfed swales or rock mulched swales (open drainage channels) rather than kerb and gutter to road drainage and adjacent areas; rock mulch swales are planted with wetland filter plants; whereas the turfed swales (in higher areas) will visually blend with adjacent grassed areas
- Wetland filter edges to the lake- these include wetland plants in bio-filter soil to clean the stormwater, using various species that grow in different water depths, with either an angular rock edge to deter weed growth or rock boulder edge where levels are steeper.
- Short sections of stormwater pipe where levels and or spaces are tight between path/boardwalk / culvert junctions
- Boardwalk to cross the open swale formation
- Rock boulders and individual rock boulders using local rock as shown

Safety and Maintenance

Consideration of public safety, risk and access to the water has been considered in the design, and the following measures have been adopted in the proposal:

- Gentle edges to wetland filter zones, with maximum slopes of 1:8-1:10;
- Use of rock boulders in areas where levels are steeper than 1:6 to the edge of wetland filter zones
- Accessible, gently sloped lawn areas to restricted areas, where the rock mulch strip to the wetland filter zones is shown
- Satisfactory vehicular maintenance if required
- Integration with rock boulders from wetland filter zone with the rock bank(sloped at maximum slope of 1:1.5) around the bridge abutment walls

Figure 4.20 The proposed water sensitive design proposal with key components illustrated below.

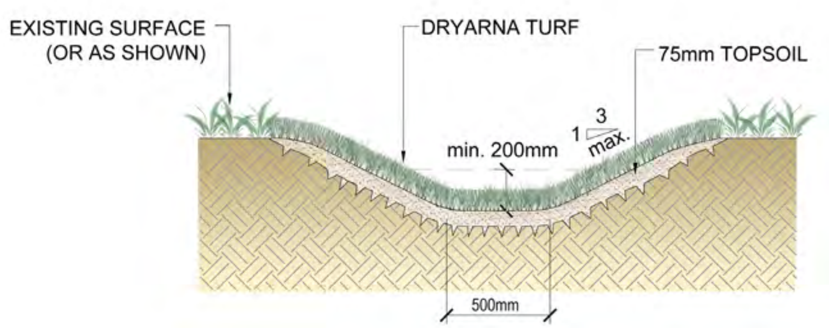


Figure 4.21 Vegetated swale-turfed

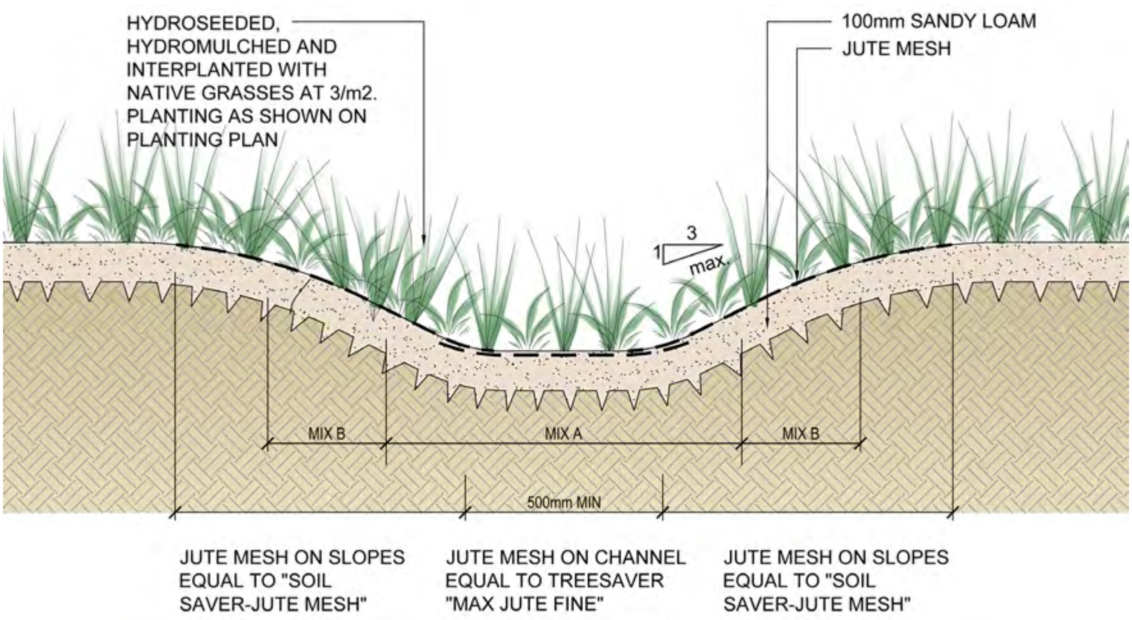


Figure 4.22 Vegetated swale-hydroseeded, hydromulched and interplanted with wetland filter plants

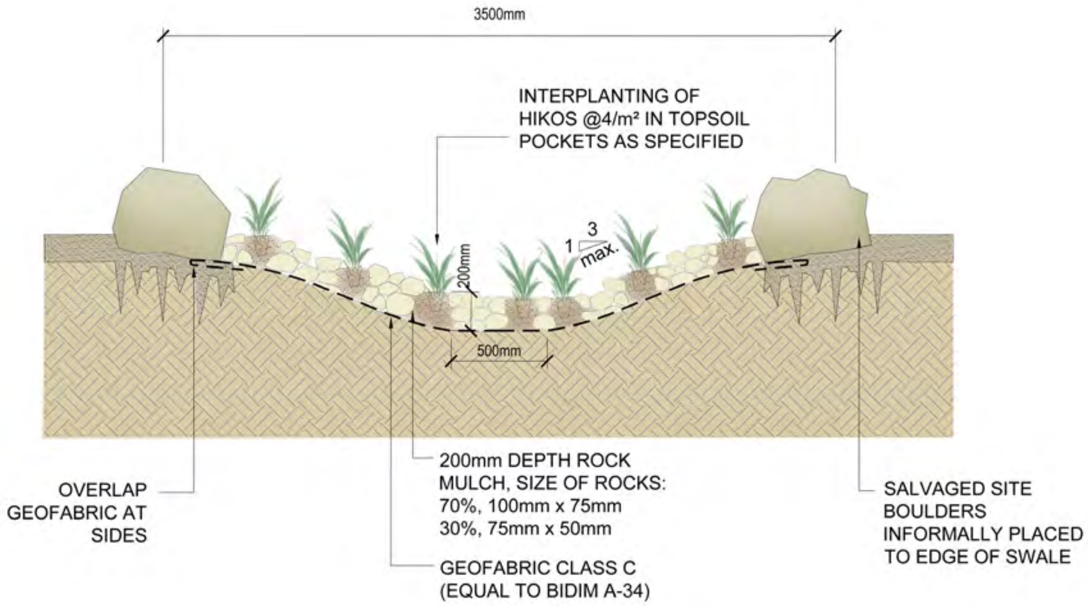


Figure 4.23 Section through a rock mulch swale-interplanted with wetland filter plants

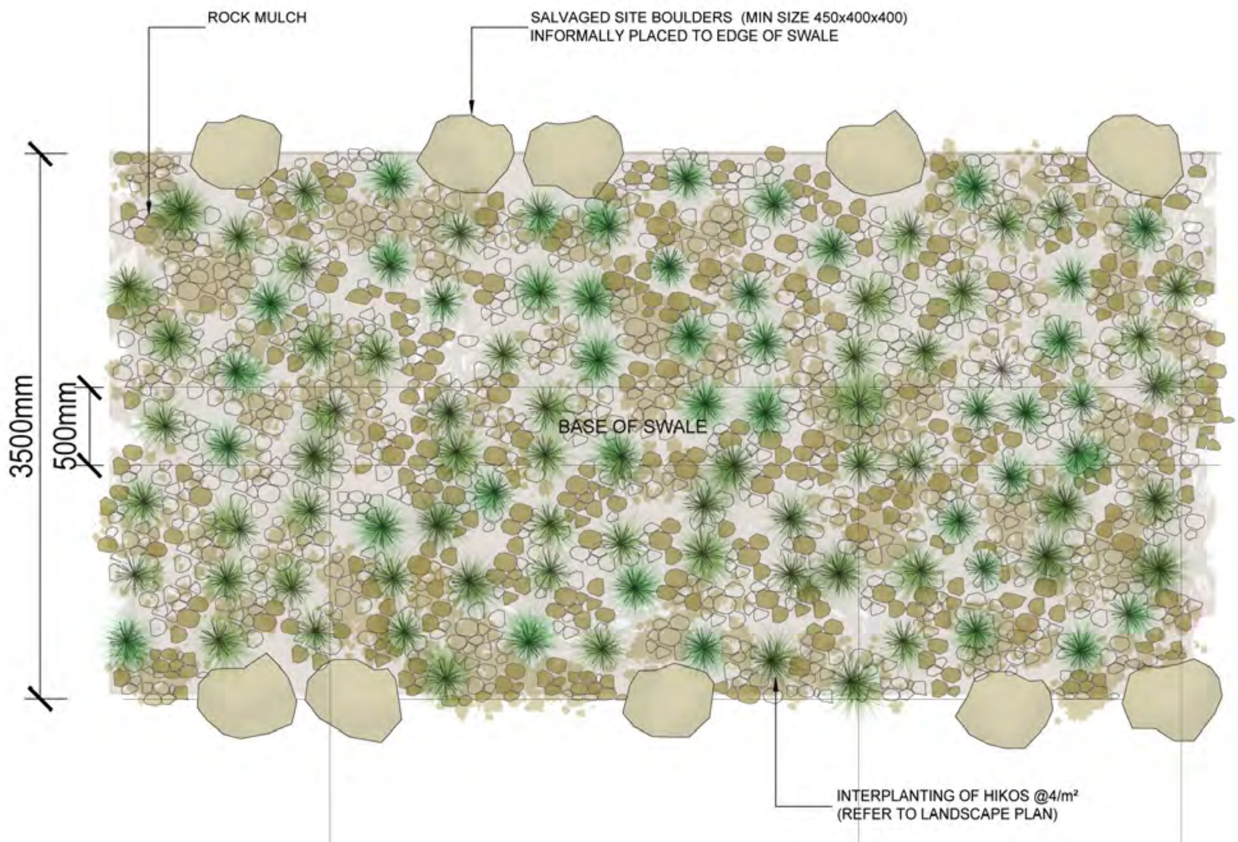


Figure 4.24 Plan of a rock mulch swale-interplanted with wetland filter plants

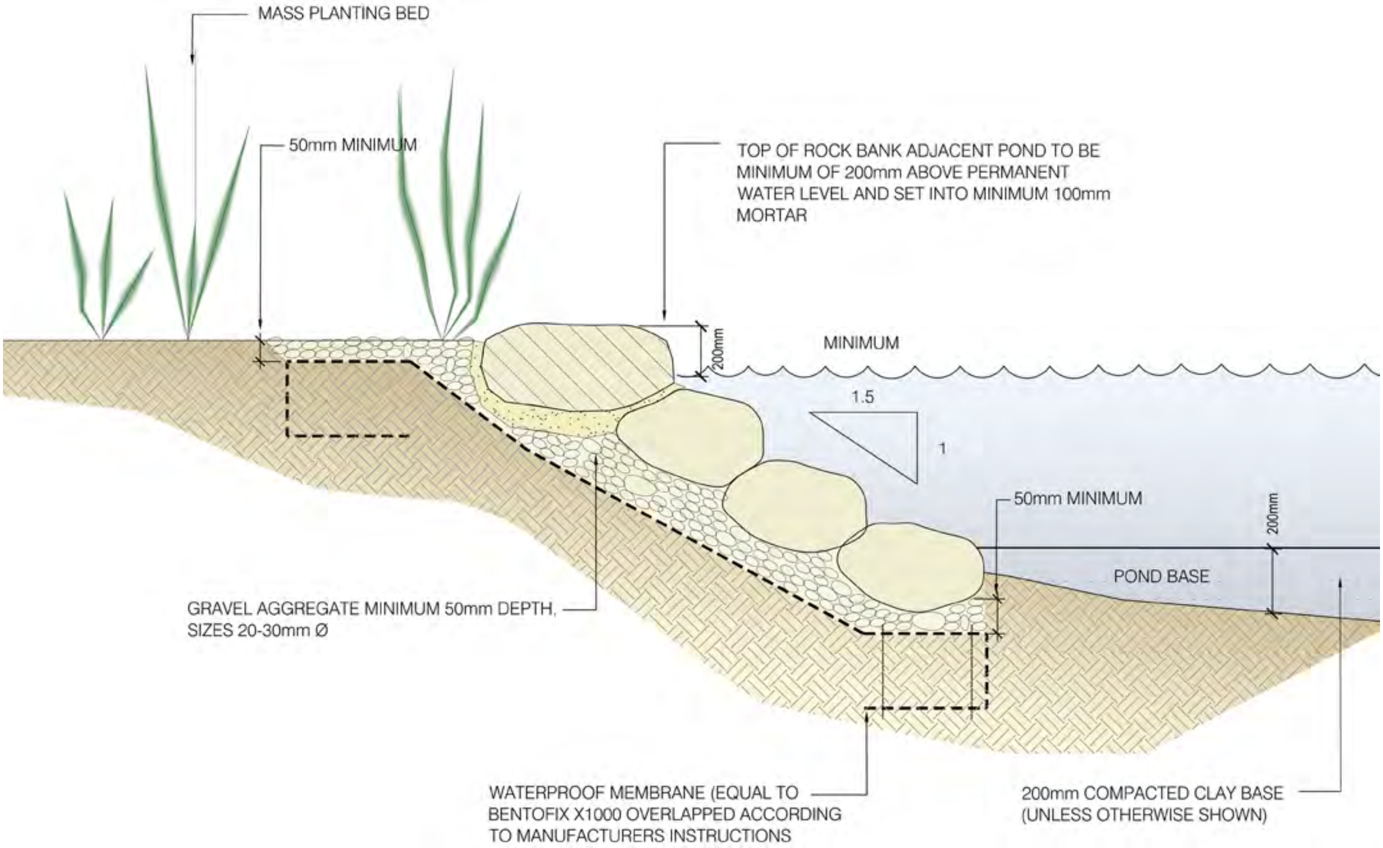


Figure 4.25 Typical rock bank- similar to treatment proposed under the bridge for the abutment

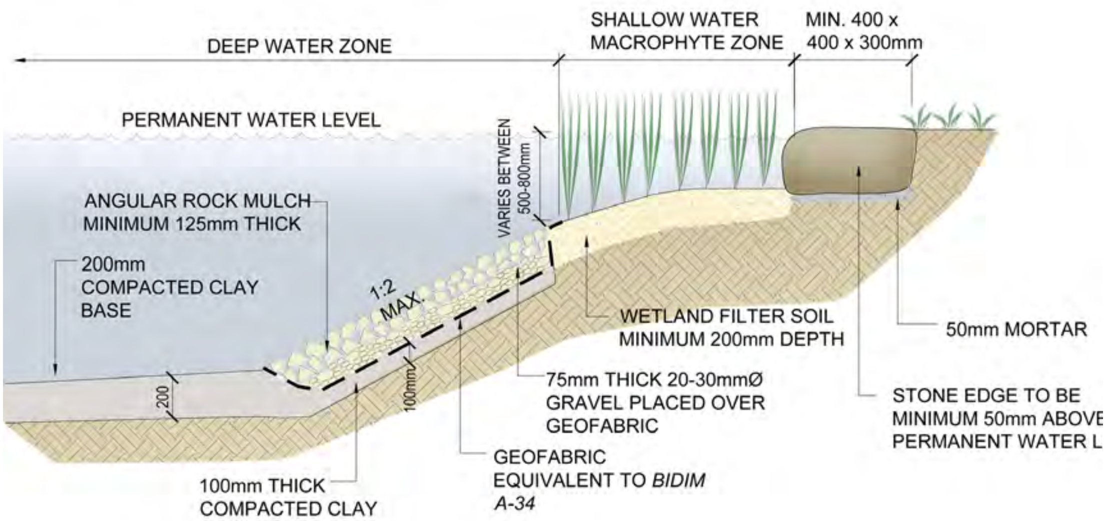


Figure 4.26 Typical narrower section of lake edge treatment, using rock boulders to define the edge

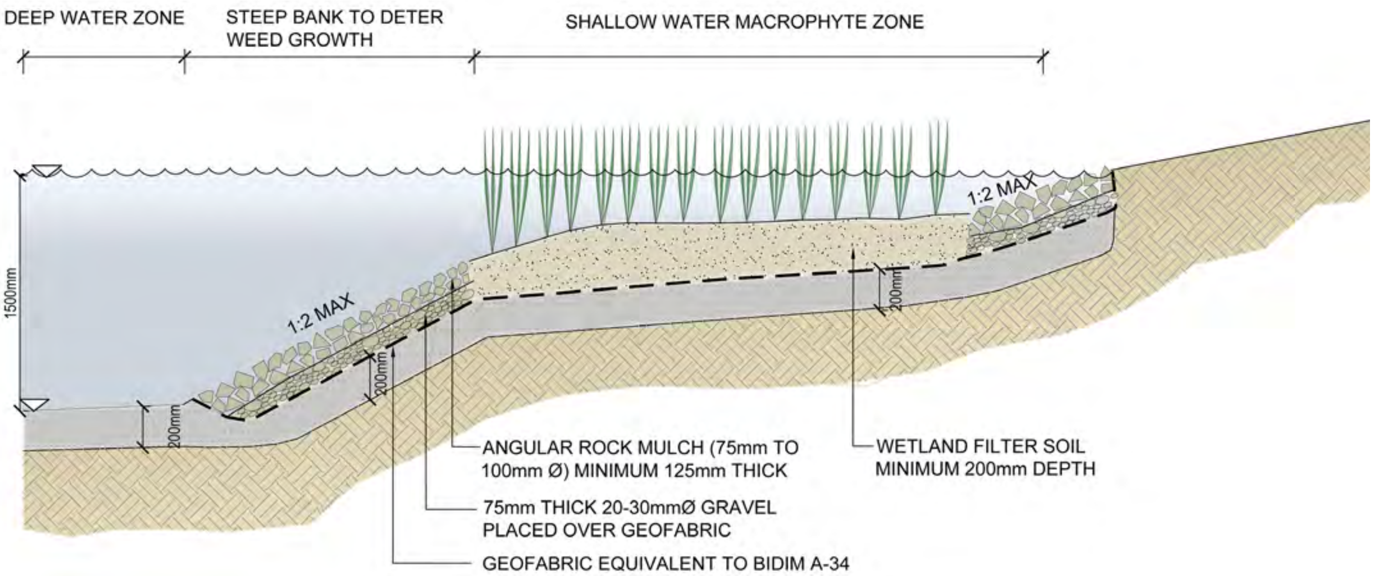


Figure 4.27 Typical wider section of lake edge treatment, using gentle slopes for the shallow water, a steep drop off to the lake to deter weed growth, and a rock mulch edge to cater for changes in water level, and to provide access to water where required

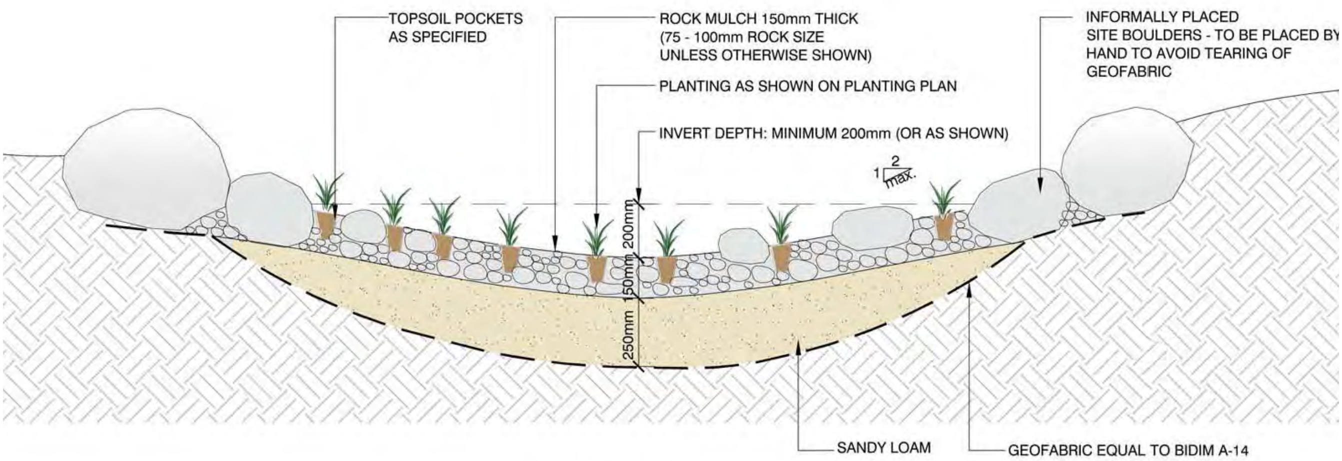


Figure 4.28 Infiltration area where wetland plants and rock mulch provide a low maintenance, practical , sustainable treatment

Figure 4.29 Water sensitive design concepts integrated as part of the landscape design works.

Figure 4.30 This view captures the area where a slotted kerb is used to capture rainwater run off and feeding it into a rock mulched sale /infiltration area where the water is cleaned and slowed down, prior to it discharging into the lake

Planting Strategy

The planting strategy reflects the indigenous trees of the area, being predominantly the River Red Gums and the River Oaks. Local, indigenous species will be reintroduced in all layers- trees, shrubs and grasses. A list of appropriate plants are illustrated in the plant images below and overleaf.

Feature planting of Canary Island Date Palms provide an effective accent to the bridge approaches and reflect the heritage character of Forbes CBD.

Figure 4.31 Plant strips to illustrate the main textures, colours, character of selected species

Figure 4.32 Planting strategy plan

Proposed Species List:

Trees

Casuarina cunninghamiana	River Oak
Eucalyptus camaldulensis	River Red Gum
Eucalyptus blakelyi	Red Gum

Shrubs

Atriplex semibaccata	Australian Saltbush
Eremophila nivea	Emu Bush- silvery leaves
Eremophila macuata	“Valentine” Emu Bush
Eremophila platycalyx	Emu Bush
Melalueca lanceolate	Dryland Tea Tree
Melaleuca uncinata	Broombush
Westringia “Wynyabbie Gem”	Coastal Rosemary hybrid

Native Grasses

Austrodanthonia setacea	Bristly Wallaby Grass
Austrostipa scabra	Rough Spear Grass
Dianella caerula	Blueberry Lily
Rytidosmerma pallidum	Silver Topped Wallaby Grass
Themeda triandra	Kangaroo Grass

Wetland Filters

Bothriochloa macra	Red Grass
Carex appressa	Tall Sedge
Juncus usitatus	Common Rush


Figure 4.33 Existing situation looking from the vicinity of Hills Street.


Figure 4.34 Proposed treatment at the north eastern abutment.

5 LANDSCAPE CHARACTER IMPACT ASSESSMENT

The purpose for identifying different landscape character zones is to assess levels of sensitivity and provide a description of each zone, giving the proposal its context and interface. This will inform the design process, particularly in the identification of impacts and mitigations measures applied as a design tool.

This chapter also discusses the landscape character impact for each landscape character zone based on the concept design. The assessment has been based on Roads and Maritime's Environmental Impact Assessment Practice Note - Guidelines for Landscape Character and Visual Impact Assessment No. EIA-N04,Version 2.0 Issue (2013).

The landscape character impact is based on the aggregate of an area's built, natural and cultural character and sense of place. In this regard, it is measured by the combination of the area's sensitivity, and the magnitude (scale, character and distance).

The sensitivity value refers to the qualities of a particular character zone, the number and type of receivers and how sensitive the existing character of the setting is to the proposed change. For example a pristine natural environment will be more sensitive to change than a built up industrial area.

The table below illustrates how the level of sensitivity and magnitude are combined to achieve an overall level of impact for both the landscape character impact and the visual impact. It should be noted that the ratings are measured relative to each other rather then assigned through an absolute scale. Hence the resulting landscape character impact rating is project specific and identifies those areas with the highest and lowest impacts.

Sensitivity \ Magnitude	high	moderate	low	negligible
high	high impact	high- moderate	moderate	negligible
moderate	high- moderate	moderate	moderate-low	negligible
low	moderate	moderate-low	low	negligible
negligible	negligible	negligible	negligible	negligible

Visual Impacts Rating Table, example illustrating the resulting impact as a combination of sensitivity and magnitude.

5.1 LANDSCAPE CHARACTER ZONES

Three landscape character zones have been identified in the immediate vicinity of the bridge.

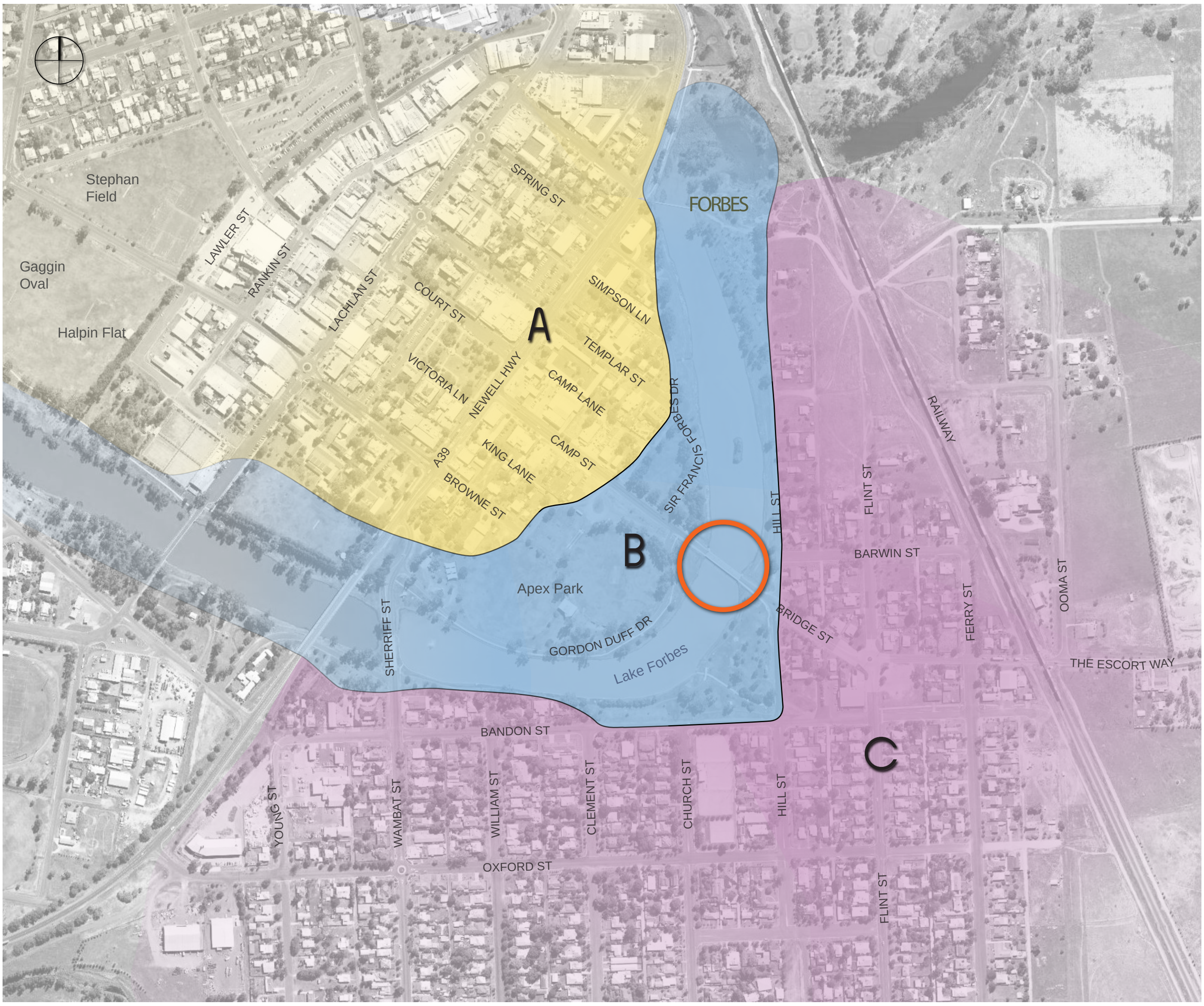


Figure 5.1 Map identifying the various landscape character zones surrounding the site.

Zone A: Town Centre
Comprises the historic buildings surrounding Victoria Park and forms the commercial hub of the town. Historic buildings and churches, combined with statues and a Victorian style central park create a distinctive identity that defines this beautiful township.

Zone B: Lake Forbes
The main parkland of the town that includes waterways and grassed parklands with mature trees and open vistas. This parkland is highly popular and provides a fitness loop, picnic benches and a playground.

Zone C: Residential
This large residential area includes an array of homes ranging from modern double storey villas to single storey weatherboard cottages. The neighbourhood has a well established character with wide streets and generous front gardens.

The sensitivity of all three zones is high either due to the historic fabric, its recreational and community value or its residential land use.

Figure 5.2 The town centre includes a Victorian style park surrounded by historic buildings, creating a cohesive ensemble that gives Forbes its identity.

Figure 5.3 The open space surrounding Lake Forbes provide open views across the lake. Established trees with a predominantly mown grassland provide an open parkland character.

Figure 5.4 The residential area to the south comprises predominantly of single storey houses and cohesive streetscapes.

5.2 LANDSCAPE CHARACTER IMPACT

The magnitude of impact would vary between each of the zones.

Town Centre

For Zone A, a negligible magnitude of impact is assessed. The existing character of the town centre would not be affected by the proposal. Its identity and character would be retained, including its historic fabric. This results in a negligible landscape character impact.

Lake Forbes

In the case of Zone B, the magnitude of impact is low. The proposed bridge would have a different character to the existing structure, yet its overall built form is similar to the existing structure, limiting its effect on the current parkland setting. The open space system and waterways would continue to operate in the same way. Hence, the low magnitude of impact, resulting in a moderate landscape character impact. It should be noted, that the proposed changes to the existing crossing would enhance the perceived arrival sequence into the town, and the interface with Lake Forbes, providing a positive contribution to the identity and character of the township.

Residential

Zone C would experience a similar negligible magnitude of impact as the town centre. The residential area to the south would retain its character and identity and it could be argued that the bridge would enhance the link between them and the town centre. A negligible landscape character impact is assessed for this zone.

Summary of Landscape Character Impacts

The table below summarises the landscape character impact for each of the identified landscape character zones. The proposal would have a very limited impact on the general area and character. It could be argued, that the proposal would have a positive contribution by enhancing the urban connectivity and arrival sequence into town and introduce an accent feature at night time through feature lighting, celebrating the bridge and the lake setting.

In addition, the landscape design and its environmental design initiatives provide an important contribution to the setting, further enhancing the character and natural systems of the area.

Character zones		Sensitivity	Magnitude	Impact
01	THE TOWN CENTRE	High	Negligible	Negligible
02	LAKE FORBES	High	Low	Moderate
03	RESIDENTIAL	High	Negligible	Negligible

KI STUDIO

6 VISUAL IMPACT ASSESSMENT

In order to assess the visual impact, a Visual Envelope Map of the project's visual catchment from the surrounding area has been prepared. The visual catchment is defined either by topographical features, built form elements or screening vegetation.

Due to the generous buffer zones and foreshore vegetation surrounding Lake Forbes, the visual exposure of the overall proposal is limited. The project would predominantly be exposed to the immediate foreshore parkland adjacent to the bridge and approach roads to the bridge.

The visual impact assessment has been based by selecting representative viewpoints from the surrounding areas.

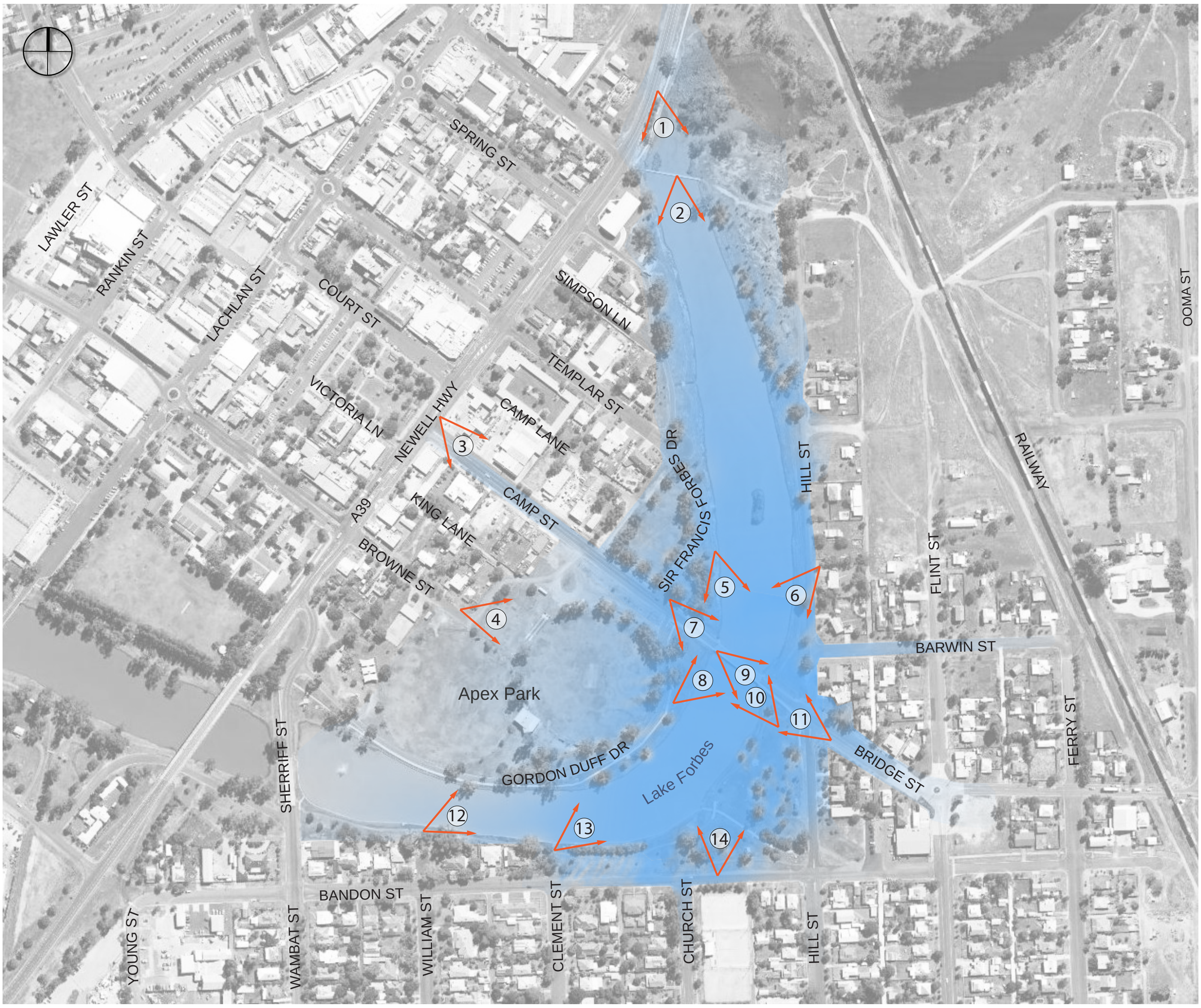


Figure 6.1 Visual envelope map illustrating the exposure of the bridge.

VIEWPOINT 1	
Description of the setting	View from the Newell Highway/Sherriff Street looking towards Lake Forbes
Element visible of the project	Camp Street Bridge in the far distance
Category of viewer	Road user
Nature of impact	Adverse
Visual sensitivity	Low due to the transient nature of the viewer. This viewpoint is visually less ceremonial coming into town compared to the Camp Street sequence
Magnitude of impact	Negligible
Overall rating of visual impact	Negligible
Comment / mitigation measures	No mitigation measures identified. The distance to the proposal limits any noteworthy visual effects from the proposal

VIEWPOINT 2	
Description of the setting	Lake view with established vegetation framing the existing bridge
Element visible of the project	Distant view of the bridge
Category of viewer	Pedestrians and park users
Nature of impact	Adverse
Visual sensitivity	High due to the visual quality and panoramic views
Magnitude of impact	Negligible. The distant views towards the bridge limit its visual effect on the overall composition and scenic value of the setting. It is likely that at night time the magnitude of impact is higher due to the feature lighting which would also be reflected on the water
Overall rating of visual impact	Negligible during day time and moderate during night time
Comment / mitigation measures	During night time, views towards the structure would be more present then during the day

VIEWPOINT 3	
Description of the setting	Camp Street, looking from the intersection with the Newell Highway/Sheriff Street looking towards Lake Forbes
Element visible of the project	Glimpses of the bridge in the distance
Category of viewer	Road users
Nature of impact	Beneficial
Visual sensitivity	Low due to the transient nature of the viewer
Magnitude of impact	Negligible. The distance to the proposal limits any visual effects
Overall rating of visual impact	Negligible
Comment / mitigation measures	Although the proposal would have a positive impact to the streetscape, its visual effect is negligible from this location

VIEWPOINT 4	
Description of the setting	View from the end of Browne Street looking towards Forbes Oval. The Camp Street Bridge is situated behind the oval
Element visible of the project	Partial views of the structure through stands of trees
Category of viewer	Oval visitors
Nature of impact	Adverse
Visual sensitivity	Moderate due to the introverted character of the viewer's activity
Magnitude of impact	Low. Filtered views through greenery limit the overall visual effect of the proposal
Overall rating of visual impact	Low to moderate
Comment / mitigation measures	Limited impact of the proposal to oval visitors. No mitigation measures identified

VIEWPOINT 5	
Description of the setting	Parkland setting adjacent to Lake Forbes
Element visible of the project	Bridge and eastern approach in the mid-distance
Category of viewer	Park users
Nature of impact	Adverse
Visual sensitivity	High due to the visual quality of the setting
Magnitude of impact	Low. The overall character of the park lands would remain. The proposed bridge would have a similar scale to the existing structure.
Overall rating of visual impact	Moderate: the proposal would introduce a contemporary structure to the setting. Yet this change can also be viewed as positive. The proposed landscape works would help settle the bridge in its setting.
Comment / mitigation measures	Pedestrians would enjoy the riverside the same way. During night time, the structure may appear different due to the lighting scheme. Care has been taken to limit the scale of light poles to retain a similar character.

VIEWPOINT 6	
Description of the setting	Front yard of one of the residential properties fronting Lake Forbes along Hill Street. The parkland and waterways provide a high quality setting.
Element visible of the project	Mid-distant views of the bridge in its setting
Category of viewer	Residents, pedestrians and park users
Nature of impact	Adverse
Visual sensitivity	High due to the visual quality of the setting
Magnitude of impact	Low. The current vistas would predominantly remain with the proposed bridge structure having a limited visual effect on the setting. The landscape design would contribute to visually settling the structure into the landscape.
Overall rating of visual impact	Moderate
Comment / mitigation measures	Night time impacts may be more noticeable due to a different lighting arrangement, including feature lighting. Some of these aspects may be considered positive.

VIEWPOINT 7	
Description of the setting	Streetscape setting adjacent to parkland
Element visible of the project	Approach to the bridge, water sensitive design measures and new vegetation visible, including accent planting
Category of viewer	Pedestrians
Nature of impact	Beneficial
Visual sensitivity	Moderate due to the transient nature of the viewer adjacent to the road
Magnitude of impact	High. The proposed landscape would create a strong streetscape feature and additional planting would enhance the streetscape setting
Overall rating of visual impact	Moderate to high. The streetscape would be improved
Comment / mitigation measures	The landscape design is a key mitigation measure incorporated into the design. This results in a higher visual impact, yet with a positive outcome

VIEWPOINT 8	
Description of the setting	Parkland along the shores of Lake Forbes
Element visible of the project	New bridge and modified approaches
Category of viewer	Pedestrians and park users
Nature of impact	Adverse on bridge / beneficial on park setting
Visual sensitivity	High due to the visual quality and significance of the setting
Magnitude of impact	Moderate. Although a new bridge would be constructed, its mass and general arrangement would be of a similar nature, limiting the magnitude of impact. The landscape design would positively contribute to the setting
Overall rating of visual impact	Moderate to high. The new bridge would have a different appearance both during the day and at night. The additional planting would visually enhance the park
Comment / mitigation measures	Pedestrians and park users would enjoy the parkland in the same way. The new bridge would celebrate the setting and feature lighting at night time would create a visual accent, complementing its gateway function. The proposed planting would define the abutments and improve the foreshore parkland.

VIEWPOINT 9	
Description of the setting	Pedestrian path on recently constructed bridge. Open vistas of Lake Forbes and surrounds.
Element visible of the project	Shared use path adjacent to carriageway
Category of viewer	Pedestrians and park users
Nature of impact	Adverse
Visual sensitivity	Moderate as a result of the combination of low sensitivity due to the transient nature of the viewer and high sensitivity due to the visual quality of the setting
Magnitude of impact	High. The proposal would provide a new crossing with a contemporary character
Overall rating of visual impact	Moderate to high as the proposal would have a different character to the existing crossing
Comment / mitigation measures	The new bridge would provide a different visual experience, still allowing a strong interaction between viewers and the setting. The existing bridge is considered safer due to the complete separation between pedestrians and vehicular traffic. This effect has been mitigated by incorporating a wider shared use path

VIEWPOINT 10	
Description of the setting	Lake Forbes foreshore near Camp Street looking towards the existing bridge
Element visible of the project	Camp Street Bridge and south eastern approach including new planting
Category of viewer	Park users and cyclists
Nature of impact	Adverse
Visual sensitivity	High due to the importance of this open space for the community
Magnitude of impact	Moderate. A new bridge would replace the existing structure somewhat changing the visual character of the structure
Overall rating of visual impact	Moderate to high. A more contemporary structure that is less cluttered would allow the landscape setting to dominate. Night time lighting is likely to have a different effect with the proposal considered more subtle.
Comment / mitigation measures	Although the new bridge would have a different character, the proposal would de-emphasise the bridge with less vertical elements. The grey finish of light poles would allow these items to recede in the background. Proposed landscape works would settle the bridge in its setting.

VIEWPOINT 11	
Description of the setting	Road users approaching Camp Street Bridge from the south east. Open vistas to lake Forbes and surrounding parklands
Element visible of the project	View of Camp Street Bridge from the road
Category of viewer	Road user
Nature of impact	Beneficial
Visual sensitivity	Moderate. Although transient in nature, this entry into town is an important visual sequence for road users as part of the travel experience
Magnitude of impact	High. The new bridge would have a different appearance, with a promenade to one side and landscape design measures that would visually reinforce the arrival sequence into Forbes
Overall rating of visual impact	Moderate to high. The proposal is considered to provide a contribution to the visual quality of the setting
Comment / mitigation measures	The design has integrated mitigation measures, such as the landscape design and water sensitive urban design to achieve an improve outcome to the existing situation.

VIEWPOINT 12	
Description of the setting	Parkland setting adjacent to Lake Forbes. Residences interface with the parkland
Element visible of the project	Minor filtered views towards the bridge
Category of viewer	Park users and some residents overlooking the lake
Nature of impact	Adverse
Visual sensitivity	High due to the visual quality and panoramic views of the setting
Magnitude of impact	Negligible. Filtered views through greenery limit the overall visual effect of the proposal
Overall rating of visual impact	Negligible
Comment / mitigation measures	No noticeable impact from this vantage point

VIEWPOINT 13	
Description of the setting	Lakes Forbes foreshore looking towards Camp Street Bridge
Element visible of the project	Camp Street Bridge in the distance including landscape measures
Category of viewer	Park users and cyclists
Nature of impact	Adverse
Visual sensitivity	High due to the importance of this open space for the community
Magnitude of impact	Low. The overall effect of the proposal would be limited as the proposal emulates the existing structure. The landscape design complements the parkland character.
Overall rating of visual impact	Moderate. The proposal would have a limited effect on the views from this vantage point
Comment / mitigation measures	Pedestrians would enjoy the riverside the same way. The general character of the structure would be retained with limited change.

	VIEWPOINT 14
Description of the setting	View looking from Bandon Street near the recently completed Waterplay park with Lake Forbes in the background
Element visible of the project	Filtered views to Camp Street Bridge in the background
Category of viewer	Pedestrians, road users, waterplay park visitors
Nature of impact	Adverse
Visual sensitivity	Low either due to the transient nature of the viewer or the introverted character of interaction at the water play park
Magnitude of impact	Negligible. No important visual effect from this vantage point
Overall rating of visual impact	Negligible
Comment / mitigation measures	No mitigation measures identified, the structure would recede in the background

7 CONCLUSION

This proposal would replace a historic bridge structure that has served the community for the last 90 years. Its original design did not consider the loading requirements and safety aspects that have become standard today.

Whilst attempting to minimise impacts to the existing character of the lake foreshore, the proposal also endeavours to improve it by celebrating the setting and the entry into Forbes. In addition, the environmental initiatives integrated into the design reflect a responsive outcome that would improve the lakes' environmental systems.

The simple, yet expressive design of the bridge marks a distinctive crossing with a contemporary character, that is aesthetically resolved for parkland users, and also respects the history of the site.

The recycling of key elements of the historic bridge and expressing these as key streetscape elements reflect the designer's consideration to integrate old with new in a successful manner.

Other components such as the boardwalk would contribute to the overall design resolution and add interest to the streetscape, particularly for pedestrians, and reinforce and improve the link to the town centre.

The limited landscape character impact that the proposal would have reflects the attention to detail and resolution of the design as a site responsive solution.

The moderate to high visual impact identified in a number of cases, reflects the fact that a new contemporary bridge is replacing the existing historic structure and even more so, that landscape design measures integrated into the design would have a profound positive change to the existing situation. In this regard, the proposal is considered to provide a positive contribution to the township and celebrates its entry from the east.

Figure 7.1 A bridge that celebrates the future of Forbes and respects it past.

Appendix D

OEH Bionet Search results 25/09/17

Data from the BioNet BioNet Atlas website, which holds records from a number of custodians. The data are only indicative and cannot be considered a comprehensive inventory, and may contain errors and omissions. Species listed under the Sensitive Species Data Policy may have their locations denatured (^ rounded to 0.1Â°; ^^ rounded to 0.01Â°). Copyright the State of NSW through the Office of Environment and Heritage. Search criteria : Public Report of all Valid Records of Entities in selected area [North: -33.34 West: 147.96 East: 148.06 South: -33.44] returned a total of 1,297 records of 461 species.

Report generated on 25/09/2017 12:46 PM

Kingdom	Class	Family	Species Code	Scientific Name	Exotic	Common Name	NSW status	Comm. status	Records	Info
Animalia	Amphibia	Myobatrachidae	3060	*Limnodynastes interioris*		Giant Banjo Frog	P		1	
Animalia	Amphibia	Myobatrachidae	3098	*Notaden bennettii*		Crucifix Frog	P		1	
Animalia	Reptilia	Gekkonidae	2138	*Underwoodisaurus milii*		Thick-tailed Gecko	P		1	
Animalia	Reptilia	Scincidae	5156	*Cryptoblepharus australis*		Inland Snake-eyed Skink	P		1	
Animalia	Reptilia	Scincidae	2519	*Menetia greyii*		Common Dwarf Skink	P		1	
Animalia	Reptilia	Typhlopidae	2603	*Anilios proximus*		Proximus Blind Snake	P		1	
Animalia	Reptilia	Typhlopidae	2606	*Anilios wiedii*		Brown-snouted Blind Snake	P		2	
Animalia	Aves	Anseranatidae	0199	*Anseranas semipalmata*		Magpie Goose	V,P		4	
Animalia	Aves	Anatidae	0210	*Anas castanea*		Chestnut Teal	P		2	
Animalia	Aves	Anatidae	0211	*Anas gracilis*		Grey Teal	P		31	
Animalia	Aves	Anatidae	0212	*Anas rhynchotis*		Australasian Shoveler	P		6	
Animalia	Aves	Anatidae	0208	*Anas superciliosa*		Pacific Black Duck	P		29	
Animalia	Aves	Anatidae	0215	*Aythya australis*		Hardhead	P		12	
Animalia	Aves	Anatidae	0217	*Biziura lobata*		Musk Duck	P		5	
Animalia	Aves	Anatidae	0202	*Chenonetta jubata*		Australian Wood Duck	P		8	
Animalia	Aves	Anatidae	0203	*Cygnus atratus*		Black Swan	P		19	
Animalia	Aves	Anatidae	0205	*Dendrocygna eytoni*		Plumed Whistling-Duck	P		2	
Animalia	Aves	Anatidae	0213	*Malacorhynchus membranaceus*		Pink-eared Duck	P		14	
Animalia	Aves	Anatidae	0216	*Oxyura australis*		Blue-billed Duck	V,P		13	
Animalia	Aves	Anatidae	0214	*Stictonetta naevosa*		Freckled Duck	V,P		12	
Animalia	Aves	Anatidae	0207	*Tadorna tadornoides*		Australian Shelduck	P		1	
Animalia	Aves	Podicipedidae	0060	*Podiceps cristatus*		Great Crested Grebe	P		2	
Animalia	Aves	Podicipedidae	0062	*Poliocephalus poliocephalus*		Hoary-headed Grebe	P		6	

Animalia	Aves	Podicipedidae	0061	*Tachybaptus novaehollandiae*		Australasian Grebe	P		16
Animalia	Aves	Columbidae	0957	*Columba livia*	*	Rock Dove			10
Animalia	Aves	Columbidae	0031	*Geopelia cuneata*		Diamond Dove	P		1
Animalia	Aves	Columbidae	9931	*Geopelia striata*		Peaceful Dove	P		4
Animalia	Aves	Columbidae	0043	*Ocyphaps lophotes*		Crested Pigeon	P		6
Animalia	Aves	Columbidae	0034	*Phaps chalcoptera*		Common Bronzewing	P		1
Animalia	Aves	Podargidae	0313	*Podargus strigoides*		Tawny Frogmouth	P		1
Animalia	Aves	Aegothelidae	0317	*Aegotheles cristatus*		Australian Owlet-nightjar	P		1
Animalia	Aves	Apodidae	0335	*Apus pacificus*		Fork-tailed Swift	P	C,J,K	1
Animalia	Aves	Anhingidae	8731	*Anhinga novaehollandiae*		Australasian Darter	P		10
Animalia	Aves	Phalacrocoracid	0100	*Microcarbo melanoleucos*		Little Pied Cormorant	P		12
Animalia	Aves	Phalacrocoracid	0096	*Phalacrocorax carbo*		Great Cormorant	P		7
Animalia	Aves	Phalacrocoracid	0097	*Phalacrocorax sulcirostris*		Little Black Cormorant	P		8
Animalia	Aves	Phalacrocoracid	0099	*Phalacrocorax varius*		Pied Cormorant	P		1
Animalia	Aves	Pelecanidae	0106	*Pelecanus conspicillatus*		Australian Pelican	P		15
Animalia	Aves	Ardeidae	0977	*Ardea ibis*		Cattle Egret	P	C,J	1
Animalia	Aves	Ardeidae	0186	*Ardea intermedia*		Intermediate Egret	P		6
Animalia	Aves	Ardeidae	8712	*Ardea modesta*		Eastern Great Egret	P		6
Animalia	Aves	Ardeidae	0189	*Ardea pacifica*		White-necked Heron	P		11
Animalia	Aves	Ardeidae	0197	*Botaurus poiciloptilus*		Australasian Bittern	E1,P	E	1
Animalia	Aves	Ardeidae	0185	*Egretta garzetta*		Little Egret	P		1
Animalia	Aves	Ardeidae	0188	*Egretta novaehollandiae*		White-faced Heron	P		10
Animalia	Aves	Ardeidae	0192	*Nycticorax caledonicus*		Nankeen Night Heron	P		4
Animalia	Aves	Threskiornithida	0182	*Platalea flavipes*		Yellow-billed Spoonbill	P		9
Animalia	Aves	Threskiornithida	0181	*Platalea regia*		Royal Spoonbill	P		4
Animalia	Aves	Threskiornithida	0178	*Plegadis falcinellus*		Glossy Ibis	P	C	2
Animalia	Aves	Threskiornithida	0179	*Threskiornis molucca*		Australian White Ibis	P		7

Animalia	Aves	Threskiornithida	0180	*Threskiornis spinicollis*	Straw-necked Ibis	P		4
Animalia	Aves	Accipitridae	0222	*Accipiter cirrocephalus*	Collared Sparrowhawk	P		1
Animalia	Aves	Accipitridae	0221	*Accipiter fasciatus*	Brown Goshawk	P		1
Animalia	Aves	Accipitridae	0219	*Circus approximans*	Swamp Harrier	P		2
Animalia	Aves	Accipitridae	0232	*Elanus axillaris*	Black-shouldered Kite	P		2
Animalia	Aves	Accipitridae	0226	*Haliaeetus leucogaster*	White-bellied Sea-Eagle	V,P	C	6
Animalia	Aves	Accipitridae	0228	*Haliastur sphenurus*	Whistling Kite	P		8
Animalia	Aves	Accipitridae	0225	*Hieraaetus morphnoides*	Little Eagle	V,P		1
Animalia	Aves	Accipitridae	0229	*Milvus migrans*	Black Kite	P		5
Animalia	Aves	Falconidae	0239	*Falco berigora*	Brown Falcon	P		7
Animalia	Aves	Falconidae	0240	*Falco cenchroides*	Nankeen Kestrel	P		13
Animalia	Aves	Falconidae	0235	*Falco longipennis*	Australian Hobby	P		2
Animalia	Aves	Falconidae	0237	*Falco peregrinus*	Peregrine Falcon	P		3
Animalia	Aves	Falconidae	0238	*Falco subniger*	Black Falcon	V,P		1
Animalia	Aves	Rallidae	0059	*Fulica atra*	Eurasian Coot	P		19
Animalia	Aves	Rallidae	0056	*Gallinula tenebrosa*	Dusky Moorhen	P		14
Animalia	Aves	Rallidae	0046	*Gallirallus philippensis*	Buff-banded Rail	P		1
Animalia	Aves	Rallidae	0058	*Porphyrio porphyrio*	Purple Swamphen	P		11
Animalia	Aves	Rallidae	0049	*Porzana fluminea*	Australian Spotted Crake	P		2
Animalia	Aves	Rallidae	0050	*Porzana pusilla*	Baillon's Crake	P		1
Animalia	Aves	Rallidae	0051	*Porzana tabuensis*	Spotless Crake	P		1
Animalia	Aves	Rallidae	0055	*Tribonyx ventralis*	Black-tailed Native-hen	P		3
Animalia	Aves	Recurvirostridae	0146	*Himantopus himantopus*	Black-winged Stilt	P		4
Animalia	Aves	Recurvirostridae	0148	*Recurvirostra novaehollandiae*	Red-necked Avocet	P		1
Animalia	Aves	Charadriidae	0144	*Elseyornis melanops*	Black-fronted Dotterel	P		5
Animalia	Aves	Charadriidae	0132	*Erythrogonys cinctus*	Red-kneed Dotterel	P		2
Animalia	Aves	Charadriidae	0133	*Vanellus miles*	Masked Lapwing	P		6
Animalia	Aves	Rostratulidae	0170	*Rostratula australis*	Australian Painted Snipe	E1,P	E	2
Animalia	Aves	Scolopacidae	0163	*Calidris acuminata*	Sharp-tailed Sandpiper	P	C,J,K	1
Animalia	Aves	Scolopacidae	0154	*Tringa glareola*	Wood Sandpiper	P	C,J,K	1
Animalia	Aves	Scolopacidae	0158	*Tringa nebularia*	Common Greenshank	P	C,J,K	1
Animalia	Aves	Scolopacidae	0159	*Tringa stagnatilis*	Marsh Sandpiper	P	C,J,K	1
Animalia	Aves	Laridae	0110	*Chlidonias hybrida*	Whiskered Tern	P		1
Animalia	Aves	Laridae	0125	*Chroicocephalus*	Silver Gull	P		2

				novaehollandiae					
Animalia	Aves	Laridae	0111	*Gelochelidon nilotica*	Gull-billed Tern	P	C	1	
Animalia	Aves	Laridae	0112	*Hydroprogne caspia*	Caspian Tern	P	C,J	1	
Animalia	Aves	Cacatuidae	0269	*Cacatua galerita*	Sulphur-crested Cockatoo	P		9	
Animalia	Aves	Cacatuidae	0273	*Eolophus roseicapillus*	Galah	P		15	
Animalia	Aves	Cacatuidae	0274	*Nymphicus hollandicus*	Cockatiel	P		10	
Animalia	Aves	Psittacidae	0310	*Melopsittacus undulatus*	Budgerigar	P		1	
Animalia	Aves	Psittacidae	0288	*Platycercus eximius*	Eastern Rosella	P		7	
Animalia	Aves	Psittacidae	0277	^^*Polytelis swainsonii*	Superb Parrot	V,P,3	V	2	
Animalia	Aves	Psittacidae	0295	*Psephotus haematonotus*	Red-rumped Parrot	P		13	
Animalia	Aves	Cuculidae	0338	*Cacomantis flabelliformis*	Fan-tailed Cuckoo	P		1	
Animalia	Aves	Cuculidae	0337	*Cacomantis pallidus*	Pallid Cuckoo	P		1	
Animalia	Aves	Cuculidae	0342	*Chalcites basalis*	Horsfield's Bronze-Cuckoo	P		2	
Animalia	Aves	Cuculidae	0343	*Chalcites lucidus*	Shining Bronze-Cuckoo	P		1	
Animalia	Aves	Strigidae	9922	*Ninox novaeseelandiae*	Southern Boobook	P		1	
Animalia	Aves	Alcedinidae	0319	*Ceyx azureus*	Azure Kingfisher	P		1	
Animalia	Aves	Alcedinidae	0322	*Dacelo novaeguineae*	Laughing Kookaburra	P		11	
Animalia	Aves	Alcedinidae	0326	*Todiramphus sanctus*	Sacred Kingfisher	P		7	
Animalia	Aves	Meropidae	0329	*Merops ornatus*	Rainbow Bee-eater	P	J	2	
Animalia	Aves	Coraciidae	0318	*Eurystomus orientalis*	Dollarbird	P		1	
Animalia	Aves	Climacteridae	8127	*Climacteris picumnus victoriae*	Brown Treecreeper (eastern subspecies)	V,P		3	
Animalia	Aves	Maluridae	0529	*Malurus cyaneus*	Superb Fairy-wren	P		2	
Animalia	Aves	Acanthizidae	0486	*Acanthiza chrysorrhoa*	Yellow-rumped Thornbill	P		1	
Animalia	Aves	Acanthizidae	0471	*Acanthiza nana*	Yellow Thornbill	P		2	
Animalia	Aves	Acanthizidae	0481	*Acanthiza uropygialis*	Chestnut-rumped Thornbill	P		1	
Animalia	Aves	Acanthizidae	0466	*Aphelocephala leucopsis*	Southern Whiteface	P		1	
Animalia	Aves	Acanthizidae	0504	*Chthonicola sagittata*	Speckled Warbler	V,P		2	
Animalia	Aves	Acanthizidae	0463	*Gerygone fusca*	Western Gerygone	P		3	
Animalia	Aves	Acanthizidae	0465	*Smicrornis brevirostris*	Weebill	P		1	
Animalia	Aves	Pardalotidae	0565	*Pardalotus punctatus*	Spotted Pardalote	P		1	
Animalia	Aves	Pardalotidae	0976	*Pardalotus striatus*	Striated Pardalote	P		5	
Animalia	Aves	Meliphagidae	0640	*Acanthagenys rufogularis*	Spiny-cheeked Honeyeater	P		1	

Animalia	Aves	Meliphagidae	0638	*Anthochaera carunculata*	Red Wattlebird	P	1
Animalia	Aves	Meliphagidae	0641	*Entomyzon cyanotis*	Blue-faced Honeyeater	P	7
Animalia	Aves	Meliphagidae	0448	*Epthianura albifrons*	White-fronted Chat	V,P	1
Animalia	Aves	Meliphagidae	0449	*Epthianura tricolor*	Crimson Chat	P	1
Animalia	Aves	Meliphagidae	0634	*Manorina melanocephala*	Noisy Miner	P	6
Animalia	Aves	Meliphagidae	0583	*Melithreptus brevirostris*	Brown-headed Honeyeater	P	1
Animalia	Aves	Meliphagidae	0646	*Philemon citreogularis*	Little Friarbird	P	8
Animalia	Aves	Meliphagidae	0645	*Philemon corniculatus*	Noisy Friarbird	P	1
Animalia	Aves	Meliphagidae	0585	*Plectorhyncha lanceolata*	Striped Honeyeater	P	4
Animalia	Aves	Meliphagidae	0625	*Ptilotula penicillatus*	White-plumed Honeyeater	P	13
Animalia	Aves	Pomatostomida	0445	*Pomatostomus superciliosus*	White-browed Babbler	P	1
Animalia	Aves	Pomatostomida	8388	*Pomatostomus temporalis temporalis*	Grey-crowned Babbler (eastern subspecies)	V,P	4
Animalia	Aves	Neosittidae	0549	*Daphoenositta chrysoptera*	Varied Sittella	V,P	1
Animalia	Aves	Campephagida	0424	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	P	7
Animalia	Aves	Campephagida	0430	*Lalage sueurii*	White-winged Triller	P	1
Animalia	Aves	Pachycephalida	0408	*Colluricincla harmonica*	Grey Shrike-thrush	P	7
Animalia	Aves	Pachycephalida	0416	*Falcunculus frontatus frontatus*	Eastern Shrike-tit	P	3
Animalia	Aves	Pachycephalida	0398	*Pachycephala pectoralis*	Golden Whistler	P	1
Animalia	Aves	Pachycephalida	0401	*Pachycephala rufiventris*	Rufous Whistler	P	3
Animalia	Aves	Oriolidae	0671	*Oriolus sagittatus*	Olive-backed Oriole	P	2
Animalia	Aves	Artamidae	0546	*Artamus cinereus*	Black-faced Woodswallow	P	2
Animalia	Aves	Artamidae	8519	*Artamus cyanopterus cyanopterus*	Dusky Woodswallow	V,P	1
Animalia	Aves	Artamidae	0543	*Artamus leucorynchus*	White-breasted Woodswallow	P	7
Animalia	Aves	Artamidae	0544	*Artamus personatus*	Masked Woodswallow	P	1

Animalia	Aves	Artamidae	0545	*Artamus superciliosus*		White-browed Woodswallow	P	2
Animalia	Aves	Artamidae	0700	*Cracticus nigrogularis*		Pied Butcherbird	P	6
Animalia	Aves	Artamidae	0705	*Cracticus tibicen*		Australian Magpie	P	10
Animalia	Aves	Artamidae	0702	*Cracticus torquatus*		Grey Butcherbird	P	1
Animalia	Aves	Artamidae	0694	*Strepera graculina*		Pied Currawong	P	1
Animalia	Aves	Rhipiduridae	0361	*Rhipidura albiscapa*		Grey Fantail	P	1
Animalia	Aves	Rhipiduridae	0364	*Rhipidura leucophrys*		Willie Wagtail	P	10
Animalia	Aves	Corvidae	0930	*Corvus coronoides*		Australian Raven	P	2
Animalia	Aves	Corvidae	0954	*Corvus mellori*		Little Raven	P	2
Animalia	Aves	Monarchidae	0415	*Grallina cyanoleuca*		Magpie-lark	P	15
Animalia	Aves	Monarchidae	9955	*Myiagra inquieta*		Restless Flycatcher	P	2
Animalia	Aves	Corcoracidae	0693	*Corcorax melanorhamphos*		White-winged Chough	P	6
Animalia	Aves	Corcoracidae	0675	*Struthidea cinerea*		Apostlebird	P	2
Animalia	Aves	Petroicidae	0392	*Eopsaltria australis*		Eastern Yellow Robin	P	1
Animalia	Aves	Petroicidae	8367	*Melanodryas cucullata cucullata*		Hooded Robin (south-eastern form)	V,P	1
Animalia	Aves	Petroicidae	0377	*Microeca fascinans*		Jacky Winter	P	1
Animalia	Aves	Petroicidae	0381	*Petroica goodenovii*		Red-capped Robin	P	1
Animalia	Aves	Acrocephalidae	0524	*Acrocephalus australis*		Australian Reed-Warbler	P	11
Animalia	Aves	Megaluridae	0508	*Cincloramphus cruralis*		Brown Songlark	P	1
Animalia	Aves	Megaluridae	0509	*Cincloramphus mathewsi*		Rufous Songlark	P	6
Animalia	Aves	Megaluridae	0522	*Megalurus gramineus*		Little Grassbird	P	3
Animalia	Aves	Timaliidae	0574	*Zosterops lateralis*		Silvereye	P	2
Animalia	Aves	Hirundinidae	0358	*Cheramoeca leucosterna*		White-backed Swallow	P	1
Animalia	Aves	Hirundinidae	0357	*Hirundo neoxena*		Welcome Swallow	P	14
Animalia	Aves	Hirundinidae	0360	*Petrochelidon ariel*		Fairy Martin	P	5
Animalia	Aves	Hirundinidae	0359	*Petrochelidon nigricans*		Tree Martin	P	7
Animalia	Aves	Turdidae	0991	*Turdus merula*	*	Eurasian Blackbird		1
Animalia	Aves	Sturnidae	0999	*Sturnus vulgaris*	*	Common Starling		9
Animalia	Aves	Nectariniidae	0564	*Dicaeum hirundinaceum*		Mistletoebird	P	2
Animalia	Aves	Estrildidae	0661	*Neochmia modesta*		Plum-headed Finch	P	2
Animalia	Aves	Estrildidae	0652	*Stagonopleura guttata*		Diamond Firetail	V,P	1

Animalia	Aves	Estrildidae	0653	*Taeniopygia guttata*		Zebra Finch	P		1
Animalia	Aves	Passeridae	0995	*Passer domesticus*	*	House Sparrow			2
Animalia	Aves	Passeridae	0994	*Passer montanus*	*	Eurasian Tree Sparrow			2
Animalia	Aves	Motacillidae	0647	*Anthus novaeseelandiae*		Australian Pipit	P		1
Animalia	Mammalia	Dasyuridae	1008	*Dasyurus maculatus*		Spotted-tailed Quoll	V,P	E	1
Animalia	Mammalia	Macropodidae	1265	*Macropus giganteus*		Eastern Grey Kangaroo	P		1
Animalia	Mammalia	Macropodidae	1266	*Macropus robustus*		Common Wallaroo	P		2
Animalia	Mammalia	Macropodidae	1242	*Wallabia bicolor*		Swamp Wallaby	P		1
Animalia	Mammalia	Pteropodidae	1281	*Pteropus scapulatus*		Little Red Flying-fox	P		2
Plantae	Flora	Aizoaceae	6381	*Glinus lotoides*		Hairy Carpet-weed			1
Plantae	Flora	Aizoaceae	7094	*Zaleya galericulata subsp. australis*					1
Plantae	Flora	Alliaceae	8963	*Nothoscordum borbonicum*	*	Onion Weed			1
Plantae	Flora	Amaranthaceae	7079	*Alternanthera nana*		Hairy Joyweed			2
Plantae	Flora	Amaranthaceae	1064	*Amaranthus viridis*	*	Green Amaranth			1
Plantae	Flora	Amaranthaceae	1079	*Ptilotus obovatus*		Smoke Bush	P		1
Plantae	Flora	Anthericaceae	3518	*Arthropodium minus*		Small Vanilla Lily			1
Plantae	Flora	Anthericaceae	3544	*Dichopogon fimbriatus*		Nodding Chocolate Lily			3
Plantae	Flora	Anthericaceae	3574	*Thysanotus tuberosus*		Common Fringe-lily			1
Plantae	Flora	Apiaceae	1151	*Trachymene cyanopetala*		Purple Parsnip			1
Plantae	Flora	Asphodelaceae	3531	*Bulbine bulbosa*		Bulbine Lily			2
Plantae	Flora	Asphodelaceae	3532	*Bulbine semibarbata*		Wild Onion			4
Plantae	Flora	Asteraceae	1253	*Actinobole uliginosum*		Flannel Cudweed			1
Plantae	Flora	Asteraceae	1273	*Arctotheca calendula*	*	Capeweed			3
Plantae	Flora	Asteraceae	1335	*Calotis anthemoides*		Cut-leaved Burr-daisy			1
Plantae	Flora	Asteraceae	1354	*Carduus pycnocephalus*	*	Slender Thistle			1
Plantae	Flora	Asteraceae	1384	*Centipeda cunninghamii*		Common Sneezeweed			1
Plantae	Flora	Asteraceae	1391	*Chondrilla juncea*	*	Skeleton Weed			5
Plantae	Flora	Asteraceae	8559	*Chrysocephalum apiculatum*		Common Everlasting			1

Plantae	Flora	Asteraceae	8562	*Chrysocephalum semipapposum*		Clustered Everlasting	1
Plantae	Flora	Asteraceae	1413	*Cotula bipinnata*	*	Ferny Cotula	1
Plantae	Flora	Asteraceae	1414	*Cotula coronopifolia*	*	Water Buttons	1
Plantae	Flora	Asteraceae	1426	*Cymbonotus lawsonianus*		Bear's Ear	1
Plantae	Flora	Asteraceae	1473	*Helianthus ciliaris*	*	Blue Weed	1
Plantae	Flora	Asteraceae	1540	*Hypochaeris glabra*	*	Smooth Catsear	1
Plantae	Flora	Asteraceae	1550	*Lactuca serriola*	*	Prickly Lettuce	2
Plantae	Flora	Asteraceae	1657	*Senecio daltonii*			1
Plantae	Flora	Asteraceae	1689	*Sonchus asper*	*	Prickly Sowthistle	1
Plantae	Flora	Asteraceae	1690	*Sonchus oleraceus*	*	Common Sowthistle	1
Plantae	Flora	Asteraceae	10164	*Verbesina encelioides subsp. encelioides*	*	Crownbeard	1
Plantae	Flora	Asteraceae	1711	*Vittadinia cuneata*		A Fuzzweed	3
Plantae	Flora	Asteraceae	9446	*Vittadinia cuneata var. cuneata f. cuneata*			1
Plantae	Flora	Asteraceae	1714	*Vittadinia gracilis*		Woolly New Holland Daisy	1
Plantae	Flora	Asteraceae	1716	*Vittadinia muelleri*		A Fuzzweed	1
Plantae	Flora	Asteraceae	1717	*Vittadinia pterochaeta*		Rough Fuzzweed	3
Plantae	Flora	Asteraceae	7130	*Xanthium occidentale*	*	Noogoora Burr	1
Plantae	Flora	Asteraceae	1729	*Xanthium spinosum*	*	Bathurst Burr	1
Plantae	Flora	Azollaceae	8049	*Azolla pinnata*			1
Plantae	Flora	Boraginaceae	1744	*Amsinckia lycopsoides*	*		1
Plantae	Flora	Boraginaceae	1747	*Cynoglossum australe*			1
Plantae	Flora	Boraginaceae	1749	*Cynoglossum suaveolens*		Sweet Hound's-tongue	1
Plantae	Flora	Boraginaceae	1751	*Echium plantagineum*	*	Patterson's Curse	6
Plantae	Flora	Boraginaceae	1755	*Halgania cyanea*		Rough Halgania	1
Plantae	Flora	Boraginaceae	1761	*Heliotropium europaeum*	*	Potato Weed	2
Plantae	Flora	Boraginaceae	1762	*Heliotropium supinum*	*	Prostrate Heliotrope	1
Plantae	Flora	Brassicaceae	1815	*Lepidium africanum*	*	Common Peppercress	1
Plantae	Flora	Brassicaceae	1820	*Lepidium fasciculatum*		Bundled Peppercress	1
Plantae	Flora	Brassicaceae	1841	*Rapistrum rugosum*	*	Turnip Weed	1
Plantae	Flora	Brassicaceae	1853	*Sisymbrium irio*	*	London Rocket	2
Plantae	Flora	Cactaceae	12439	*Opuntia sp. sensu I.Telford (1984)*	*		1

Plantae	Flora	Campanulaceae	1929	*Wahlenbergia communis*		Tufted Bluebell	1
Plantae	Flora	Campanulaceae	1933	*Wahlenbergia gracilenta*		Annual Bluebell	1
Plantae	Flora	Campanulaceae	7314	*Wahlenbergia luteola*		Bluebell	2
Plantae	Flora	Caryophyllaceae	7584	*Petrorhagia nanteuilii*	*	Proliferous Pink	1
Plantae	Flora	Caryophyllaceae	1980	*Sagina apetala*	*	Annual Pearlwort	1
Plantae	Flora	Casuarinaceae	2019	*Casuarina cristata*		Belah	1
Plantae	Flora	Chenopodiacea	2071	*Atriplex spinibractea*		Spiny-fruit Saltbush	1
Plantae	Flora	Chenopodiacea	ATRI	*Atriplex spp.*		A Saltbush	1
Plantae	Flora	Chenopodiacea	2095	*Chenopodium melanocarpum*		Black Crumbweed	1
Plantae	Flora	Chenopodiacea	2111	*Einadia nutans*		Climbing Saltbush	3
Plantae	Flora	Chenopodiacea	2122	*Maireana brevifolia*			1
Plantae	Flora	Chenopodiacea	2127	*Maireana decalvans*		Black Cotton Bush	1
Plantae	Flora	Chenopodiacea	2128	*Maireana enchylaenoides*		Wingless Fissure-weed	4
Plantae	Flora	Chenopodiacea	2133	*Maireana humillima*			1
Plantae	Flora	Chenopodiacea	2138	*Maireana microphylla*		Small-leaf Bluebush	4
Plantae	Flora	Chenopodiacea	MAIR	*Maireana spp.*		Cotton Bush, Bluebush, Fissure-weed	1
Plantae	Flora	Chenopodiacea	2161	*Rhagodia spinescens*		Thorny Saltbush	1
Plantae	Flora	Chenopodiacea	11152	*Salsola tragus*		Buckbush,Soft Rolpoly, Saltwort	1
Plantae	Flora	Chenopodiacea	2177	*Sclerolaena diacantha*		Grey Copperburr	1
Plantae	Flora	Chenopodiacea	2185	*Sclerolaena muricata*		Black Rolypoly	4

Plantae	Flora	Chenopodiacea	7656	*Sclerolaena muricata var. semiglabra*		Black Rolypoly	2
Plantae	Flora	Clusiaceae	7240	*Hypericum gramineum*		Small St John's Wort	1
Plantae	Flora	Convolvulaceae	11405	*Convolvulus angustissimus subsp. angustissimus*			2
Plantae	Flora	Convolvulaceae	2220	*Convolvulus erubescens*		Pink Bindweed	2
Plantae	Flora	Convolvulaceae	2287	*Cuscuta campestris*	*	Golden Dodder	1
Plantae	Flora	Cupressaceae	2279	*Callitris endlicheri*		Black Cypress Pine	1
Plantae	Flora	Cupressaceae	6379	*Callitris glaucophylla*		White Cypress Pine	4
Plantae	Flora	Cyperaceae	2310	*Carex appressa*		Tall Sedge	1
Plantae	Flora	Cyperaceae	2311	*Carex bichenoviana*			2
Plantae	Flora	Cyperaceae	2322	*Carex gaudichaudiana*			1
Plantae	Flora	Cyperaceae	2327	*Carex inversa*		Knob Sedge	3
Plantae	Flora	Cyperaceae	2364	*Cyperus eragrostis*	*	Umbrella Sedge	1
Plantae	Flora	Cyperaceae	2382	*Cyperus lhotskyanus*			1
Plantae	Flora	Cyperaceae	2393	*Cyperus rotundus*	*	Nutgrass	1
Plantae	Flora	Cyperaceae	2421	*Eleocharis plana*		Flat Spike-sedge	1
Plantae	Flora	Cyperaceae	2464	*Isolepis victoriensis*			1
Plantae	Flora	Dilleniaceae	HIBB	*Hibbertia spp.*			2
Plantae	Flora	Euphorbiaceae	2681	*Bertya cunninghamii*		Gooma Bush, Wallaby Bush	1
Plantae	Flora	Euphorbiaceae	2694	*Beyeria viscosa*		Sticky Wallaby Bush	1
Plantae	Flora	Euphorbiaceae	8560	*Chamaesyce drummondii*		Caustic Weed	2
Plantae	Flora	Euphorbiaceae	CHAM	*Chamaesyce spp.*			1
Plantae	Flora	Fabaceae (Caesalpinioide	6644	*Senna barclayana*		Smooth Senna	1
Plantae	Flora	Fabaceae (Faboideae)	2774	*Astragalus hamosus*	*	Yellow Milk-vetch	2
Plantae	Flora	Fabaceae (Faboideae)	10668	*Cullen cinereum*		Annual Verbine	1
Plantae	Flora	Fabaceae (Faboideae)	2860	*Glycine clandestina*		Twining glycine	3

Plantae	Flora	Fabaceae (Faboideae)	2861	*Glycine tabacina*		Variable Glycine	1
Plantae	Flora	Fabaceae (Faboideae)	2862	*Glycyrrhiza acanthocarpa*		Native Liquorice	1
Plantae	Flora	Fabaceae (Faboideae)	12243	*Lessertia frutescens*	*	Cancer Bush	1
Plantae	Flora	Fabaceae (Faboideae)	2920	*Medicago minima*	*	Woolly Burr Medic	1
Plantae	Flora	Fabaceae (Faboideae)	2926	*Medicago truncatula*	*	Barrel Medic	2
Plantae	Flora	Fabaceae (Faboideae)	10069	*Swainsona bracteata*			1
Plantae	Flora	Fabaceae (Faboideae)	3072	*Trifolium angustifolium*	*	Narrow-leaved Clover	8
Plantae	Flora	Fabaceae (Faboideae)	3073	*Trifolium arvense*	*	Haresfoot Clover	2
Plantae	Flora	Fabaceae (Faboideae)	3074	*Trifolium campestre*	*	Hop Clover	1
Plantae	Flora	Fabaceae (Faboideae)	3079	*Trifolium glomeratum*	*	Clustered Clover	1
Plantae	Flora	Fabaceae (Faboideae)	3089	*Trifolium subterraneum*	*	Subterranean Clover	1
Plantae	Flora	Fabaceae (Faboideae)	3091	*Trifolium tomentosum*	*	Woolly Clover	1
Plantae	Flora	Fabaceae (Faboideae)	8794	*Vicia sativa subsp. sativa*	*	Common Vetch	1
Plantae	Flora	Fabaceae (Mimosoideae)	3703	*Acacia amblygona*		Fan Wattle	1
Plantae	Flora	Fabaceae (Mimosoideae)	3759	*Acacia deanei*		Green Wattle	1
Plantae	Flora	Fabaceae (Mimosoideae)	7482	*Acacia deanei subsp. paucijuga*		Green Wattle	2
Plantae	Flora	Fabaceae (Mimosoideae)	3761	*Acacia decora*		Western Silver Wattle	2
Plantae	Flora	Fabaceae (Mimosoideae)	3765	*Acacia doratoxylon*		Currawang	2
Plantae	Flora	Fabaceae (Mimosoideae)	3786	*Acacia hakeoides*		Hakea Wattle	1

Plantae	Flora	Fabaceae (Mimosoideae)	12032	*Acacia homalophylla <--> melvillei*			2
Plantae	Flora	Fabaceae (Mimosoideae)	7852	*Acacia leucoclada subsp. leucoclada*			1
Plantae	Flora	Fabaceae (Mimosoideae)	3813	*Acacia lineata*		Streaked Wattle	1
Plantae	Flora	Fabaceae (Mimosoideae)	3825	*Acacia melvillei*		Yarran	1
Plantae	Flora	Fabaceae (Mimosoideae)	3843	*Acacia oswaldii*		Miljee	1
Plantae	Flora	Fabaceae (Mimosoideae)	3848	*Acacia pendula*		Weeping Myall, Boree	5
Plantae	Flora	Fabaceae (Mimosoideae)	10922	*Acacia penninervis var. penninervis*		Mountain Hickory	1
Plantae	Flora	Fabaceae (Mimosoideae)	3872	*Acacia salicina*		Cooba	1
Plantae	Flora	Fabaceae (Mimosoideae)	ACAC	*Acacia spp.*		Wattle	1
Plantae	Flora	Fabaceae (Mimosoideae)	3891	*Acacia trineura*		Three-nerved Wattle	1
Plantae	Flora	Gentianaceae	3133	*Centaurium tenuiflorum*	*	Branched Centaury, Slender centaury	1
Plantae	Flora	Geraniaceae	3145	*Erodium moschatum*	*	Musky Crowfoot	1
Plantae	Flora	Geraniaceae	3156	*Geranium solanderi*		Native Geranium	1
Plantae	Flora	Goodeniaceae	3182	*Goodenia glabra*		Smooth Goodenia	1
Plantae	Flora	Goodeniaceae	3188	*Goodenia hederacea*		Ivy Goodenia	1
Plantae	Flora	Goodeniaceae	9279	*Goodenia hederacea subsp. hederacea*			1
Plantae	Flora	Haloragaceae	3249	*Haloragis aspera*		Rough Raspwort	2
Plantae	Flora	Hydrocharitacea	14246	*Vallisneria australis*		Eelweed	4
Plantae	Flora	Hypoxidaceae	7493	*Hypoxis glabella var. glabella*		Tiny Star	1
Plantae	Flora	Juncaceae	9311	*Juncus acutus subsp. acutus*	*	Sharp Rush	1
Plantae	Flora	Juncaceae	3330	*Juncus flavidus*			1
Plantae	Flora	Juncaceae	8521	*Juncus remotiflorus*			1
Plantae	Flora	Juncaceae	3348	*Juncus subsecundus*		Finger Rush	2

Plantae	Flora	Lamiaceae	3381	*Marrubium vulgare*	*	White Horehound	5
Plantae	Flora	Lamiaceae	3383	*Mentha australis*		River Mint	1
Plantae	Flora	Lamiaceae	3386	*Mentha pulegium*	*	Pennyroyal	1
Plantae	Flora	Lamiaceae	3445	*Salvia reflexa*	*	Mintweed	1
Plantae	Flora	Lamiaceae	3446	*Salvia verbenaca*	*	Vervain	7
Plantae	Flora	Lemnaceae	7689	*Spirodela punctata*			2
Plantae	Flora	Linaceae	3583	*Linum marginale*		Native Flax	1
Plantae	Flora	Lobeliaceae	1922	*Pratia concolor*		Poison Pratia	3
Plantae	Flora	Lomandraceae	6302	*Lomandra filiformis*		Wattle Matt-rush	2
Plantae	Flora	Lomandraceae	LOMA	*Lomandra spp.*		Mat-rush	1
Plantae	Flora	Malvaceae	3660	*Modiola caroliniana*	*	Red-flowered Mallow	1
Plantae	Flora	Malvaceae	3664	*Sida corrugata*		Corrugated Sida	7
Plantae	Flora	Marsileaceae	8138	*Marsilea hirsuta*		Short-fruited Nardoo	1
Plantae	Flora	Martyniaceae	4654	*Proboscidea louisianica*	*	Purple-flowered Devil's Claw	1
Plantae	Flora	Meliaceae	3680	*Melia azedarach*		White Cedar	1
Plantae	Flora	Moraceae	3929	*Maclura pomifera*	*	Osage Orange	2
Plantae	Flora	Myoporaceae	8602	*Eremophila debilis*		Amulla	3
Plantae	Flora	Myoporaceae	7252	*Eremophila deserti*		Turkeybush	1
Plantae	Flora	Myoporaceae	3942	*Eremophila longifolia*		Emubush	1
Plantae	Flora	Myoporaceae	3944	*Eremophila mitchellii*		Budda	1
Plantae	Flora	Myoporaceae	9442	*Myoporum platycarpum subsp. platycarpum*			1
Plantae	Flora	Myoporaceae	MYOP	*Myoporum spp.*		Boobialla	1
Plantae	Flora	Myrsinaceae	14614	*Lysimachia arvensis*	*	Scarlet Pimpernel	1
Plantae	Flora	Myrtaceae	4039	*Eucalyptus albens*		White Box	1
Plantae	Flora	Myrtaceae	6360	*Eucalyptus camaldulensis*		River Red Gum	8
Plantae	Flora	Myrtaceae	4072	*Eucalyptus conica*		Fuzzy Box	8
Plantae	Flora	Myrtaceae	4078	*Eucalyptus dealbata*		Tumbledown Red Gum	1
Plantae	Flora	Myrtaceae	4085	*Eucalyptus dwyeri*		Dwyer's Red Gum	4
Plantae	Flora	Myrtaceae	4125	*Eucalyptus melliodora*		Yellow Box	5
Plantae	Flora	Myrtaceae	4127	*Eucalyptus microcarpa*		Western Grey Box	6
Plantae	Flora	Myrtaceae	4181	*Eucalyptus sideroxylon*		Mugga Ironbark	1
Plantae	Flora	Myrtaceae	4272	*Micromyrtus ciliata*		Fringed Heath-myrtle	1
Plantae	Flora	Nyctaginaceae	6841	*Boerhavia dominii*		Tarvine	3
Plantae	Flora	Onagraceae	7952	*Epilobium billardierianum subsp. cinereum*			1

Plantae	Flora	Orchidaceae	4380	*Caladenia filamentosa*		Daddy Longlegs	P	1
Plantae	Flora	Orchidaceae	4457	*^Diuris tricolor*		Pine Donkey Orchid	V,P,2	1
Plantae	Flora	Oxalidaceae	4610	*Oxalis bowiei*	*			1
Plantae	Flora	Oxalidaceae	4612	*Oxalis chnoodes*				1
Plantae	Flora	Oxalidaceae	4613	*Oxalis corniculata*	*	Creeping Oxalis		1
Plantae	Flora	Oxalidaceae	4621	*Oxalis perennans*				4
Plantae	Flora	Oxalidaceae	4622	*Oxalis pes-caprae*	*	Soursob		1
Plantae	Flora	Phormiaceae	3569	*Stypandra glauca*		Nodding Blue Lily		1
Plantae	Flora	Pittosporaceae	11202	*Pittosporum angustifolium*		Butterbush		3
Plantae	Flora	Poaceae	4735	*Alopecurus geniculatus*	*	Marsh Foxtail		1
Plantae	Flora	Poaceae	6842	*Amphibromus nervosus*		Swamp Wallaby Grass		1
Plantae	Flora	Poaceae	4754	*Aristida behriana*		Bunch Wiregrass		4
Plantae	Flora	Poaceae	9334	*Aristida calycina var. calycina*				1
Plantae	Flora	Poaceae	6933	*Aristida jerichoensis var. subspinulifera*		Jericho Wiregrass		1
Plantae	Flora	Poaceae	4770	*Aristida ramosa*		Purple Wiregrass		4
Plantae	Flora	Poaceae	ARIS	*Aristida spp.*		A Wiregrass		3
Plantae	Flora	Poaceae	10384	*Austrostipa aristiglumis*		Plains Grass		6
Plantae	Flora	Poaceae	10386	*Austrostipa bigeniculata*		Yanganbil		1
Plantae	Flora	Poaceae	10383	*Austrostipa blackii*				1
Plantae	Flora	Poaceae	10395	*Austrostipa densiflora*		Foxtail Speargrass		1
Plantae	Flora	Poaceae	10376	*Austrostipa nodosa*		A Speargrass		1
Plantae	Flora	Poaceae	10377	*Austrostipa scabra*		Speargrass		4
Plantae	Flora	Poaceae	10382	*Austrostipa setacea*		Corkscrew Grass		3
Plantae	Flora	Poaceae	AUSO	*Austrostipa spp.*		A Speargrass		1
Plantae	Flora	Poaceae	10371	*Austrostipa verticillata*		Slender Bamboo Grass		1
Plantae	Flora	Poaceae	4781	*Avena ludoviciana*	*	Ludo Wild Oats		2
Plantae	Flora	Poaceae	AVEN	*Avena spp.*	*	Oats		2
Plantae	Flora	Poaceae	4790	*Bothriochloa macra*		Red Grass		4
Plantae	Flora	Poaceae	10328	*Bromus alopecuros*	*			2
Plantae	Flora	Poaceae	7813	*Bromus catharticus*	*	Praire Grass		3
Plantae	Flora	Poaceae	4806	*Bromus diandrus*	*	Great Brome		6
Plantae	Flora	Poaceae	4811	*Bromus molliformis*	*	Soft Brome		2
Plantae	Flora	Poaceae	4825	*Cenchrus longispinus*	*	Innocent Weed		3
Plantae	Flora	Poaceae	9134	*Chloris divaricata var.*		Slender Chloris		2

				divaricata			
Plantae	Flora	Poaceae	4833	*Chloris truncata*		Windmill Grass	2
Plantae	Flora	Poaceae	6540	*Cynodon dactylon*		Common Couch	4
Plantae	Flora	Poaceae	7178	*Dactyloctenium radulans*		Button Grass	1
Plantae	Flora	Poaceae	7485	*Dichanthium sericeum*		Queensland Bluegrass	1
Plantae	Flora	Poaceae	7645	*Dichanthium sericeum subsp. sericeum*		Queensland Bluegrass	1
Plantae	Flora	Poaceae	4898	*Dichelachne micrantha*		Shorthair Plumegrass	1
Plantae	Flora	Poaceae	4907	*Digitaria divaricatissima*		Umbrella Grass	1
Plantae	Flora	Poaceae	4938	*Ehrharta longiflora*	*	Annual Veldtgrass	2
Plantae	Flora	Poaceae	8796	*Elymus scaber*		Common Wheatgrass	4
Plantae	Flora	Poaceae	6721	*Enteropogon acicularis*		Curly Windmill Grass	1
Plantae	Flora	Poaceae	6722	*Enteropogon ramosus*		Curly Windmill Grass	2
Plantae	Flora	Poaceae	7921	*Eragrostis brownii*		Brown's Lovegrass	1
Plantae	Flora	Poaceae	6387	*Eragrostis cilianensis*	*	Stinkgrass	3
Plantae	Flora	Poaceae	4958	*Eragrostis lacunaria*		Purple Lovegrass	1
Plantae	Flora	Poaceae	7335	*Eriochloa pseudoacrotricha*		Early Spring Grass	2
Plantae	Flora	Poaceae	5000	*Hainardia cylindrica*	*	Common Barbgrass	1
Plantae	Flora	Poaceae	5012	*Hordeum leporinum*	*	Barley Grass	3
Plantae	Flora	Poaceae	5019	*Iseilema membranaceum*		Small Flinders Grass	1
Plantae	Flora	Poaceae	11388	*Lachnagrostis filiformis*			1
Plantae	Flora	Poaceae	5032	*Lolium perenne*	*	Perennial Ryegrass	2
Plantae	Flora	Poaceae	5033	*Lolium rigidum*	*	Wimmera Ryegrass	1
Plantae	Flora	Poaceae	LOLI	*Lolium spp.*	*	A Ryegrass	1
Plantae	Flora	Poaceae	5037	*Microlaena stipoides*		Weeping Grass	1
Plantae	Flora	Poaceae	5054	*Panicum coloratum*	*	Coolah Grass	1
Plantae	Flora	Poaceae	5073	*Paspalidium aversum*		Bent Summer Grass	1
Plantae	Flora	Poaceae	5082	*Paspalidium jubiflorum*		Warrego Grass	2
Plantae	Flora	Poaceae	5086	*Paspalum dilatatum*	*	Paspalum	4
Plantae	Flora	Poaceae	5111	*Phalaris paradoxa*	*	Paradoxa Grass	1
Plantae	Flora	Poaceae	5129	*Poa fordeana*		Sweet Swamp-grass	1
Plantae	Flora	Poaceae	11196	*Poa labillardierei var. labillardierei*		Tussock	1
Plantae	Flora	Poaceae	POAC	*Poaceae indeterminate*	*	Grasses, reeds and bamboos	1

Plantae	Flora	Poaceae	7878	*Rostraria cristata*	*	Annual Cat's Tail	1
Plantae	Flora	Poaceae	14304	*Rytidosperma bipartitum*		Wallaby Grass	2
Plantae	Flora	Poaceae	14305	*Rytidosperma caespitosum*		Ringed Wallaby Grass	2
Plantae	Flora	Poaceae	14320	*Rytidosperma richardsonii*		Straw Wallaby-grass	2
Plantae	Flora	Poaceae	14322	*Rytidosperma setaceum*		Small-flowered Wallaby-grass	4
Plantae	Flora	Poaceae	RYTI	*Rytidosperma spp.*			3
Plantae	Flora	Poaceae	5177	*Sporobolus caroli*		Fairy Grass	1
Plantae	Flora	Poaceae	5179	*Sporobolus creber*		Slender Rat's Tail Grass	1
Plantae	Flora	Poaceae	7774	*Urochloa subquadripara*		Green Summer Grass	1
Plantae	Flora	Poaceae	5239	*Vulpia bromoides*	*	Squirrel Tail Fesque	4
Plantae	Flora	Poaceae	5242	*Vulpia myuros*	*	Rat's Tail Fescue	2
Plantae	Flora	Poaceae	VULP	*Vulpia spp.*	*	Rat's-tail Fescue	1
Plantae	Flora	Poaceae	12112	*Walwhalleya subxerophila*		Gilgai Grass	1
Plantae	Flora	Polygonaceae	5285	*Persicaria prostrata*		Creeping Knotweed	2
Plantae	Flora	Polygonaceae	5296	*Rumex brownii*		Swamp Dock	4
Plantae	Flora	Polygonaceae	5298	*Rumex crispus*	*	Curled Dock	1
Plantae	Flora	Polygonaceae	5304	*Rumex tenax*		Shiny Dock	1
Plantae	Flora	Potamogetonac	5330	*Potamogeton crispus*		Curly Pondweed	1
Plantae	Flora	Proteaceae	10956	*Grevillea floribunda subsp. floribunda*		Seven Dwarfs Grevillea	1
Plantae	Flora	Proteaceae	5426	*Hakea tephrosperma*		Hooked Needlewood	2
Plantae	Flora	Pteridaceae	8005	*Cheilanthes austrotenuifolia*		Rock Fern	1
Plantae	Flora	Pteridaceae	10439	*Cheilanthes sieberi*		Rock Fern	1
Plantae	Flora	Pteridaceae	8007	*Cheilanthes sieberi subsp. sieberi*		Rock Fern	2
Plantae	Flora	Ranunculaceae	5524	*Ranunculus sceleratus*	*	Celery Buttercup	2
Plantae	Flora	Rhamnaceae	5554	*Cryptandra amara*		Bitter Cryptandra	2
Plantae	Flora	Rubiaceae	5653	*Asperula conferta*		Common Woodruff	1
Plantae	Flora	Rutaceae	5800	*Geijera parviflora*		Wilga	1
Plantae	Flora	Sapindaceae	5913	*Dodonaea viscosa*		Sticky Hop-bush	1

Plantae	Flora	Sapindaceae	7011	*Dodonaea viscosa subsp. cuneata*		Wedge-leaf Hop-bush	1
Plantae	Flora	Sapindaceae	7068	*Dodonaea viscosa subsp. spatulata*		Broad-leaf Hopbush	1
Plantae	Flora	Scrophulariacea	5969	*Kickxia elatine*	*	Pointed Toadflax	1
Plantae	Flora	Scrophulariacea	5982	*Mimulus gracilis*		Slender Monkey-flower	1
Plantae	Flora	Solanaceae	6030	*Datura ferox*	*	Fierce Thornapple	1
Plantae	Flora	Solanaceae	6061	*Salpichroa origanifolia*	*	Pampas Lily-of-the-valley	2
Plantae	Flora	Solanaceae	6078	*Solanum elaeagnifolium*	*	Silver-leaved Nightshade	1
Plantae	Flora	Solanaceae	6995	*Solanum eremophilum*			1
Plantae	Flora	Solanaceae	6081	*Solanum esuriale*		Quena	1
Plantae	Flora	Solanaceae	6103	*Solanum rostratum*	*	Pincushion Nightshade	1
Plantae	Flora	Solanaceae	6106	*Solanum simile*		Oondoroo	1
Plantae	Flora	Typhaceae	TYPH	*Typha spp.*	*		1
Plantae	Flora	Valerianaceae	12057	*Centranthus macrosiphon*	*		1
Plantae	Flora	Verbenaceae	11134	*Phyla canescens*	*	Lippia	1
Plantae	Flora	Verbenaceae	6256	*Verbena bonariensis*	*	Purpletop	1
Plantae	Flora	Verbenaceae	10717	*Verbena gaudichaudii*		Verbena	8
Plantae	Flora	Verbenaceae	10718	*Verbena incompta*	*		3
Plantae	Flora	Verbenaceae	6259	*Verbena officinalis*	*	Common Verbena	2

Appendix E

EPBC Act Protected Matters Report 25/09/17

EPBC Act Protected Matters Report

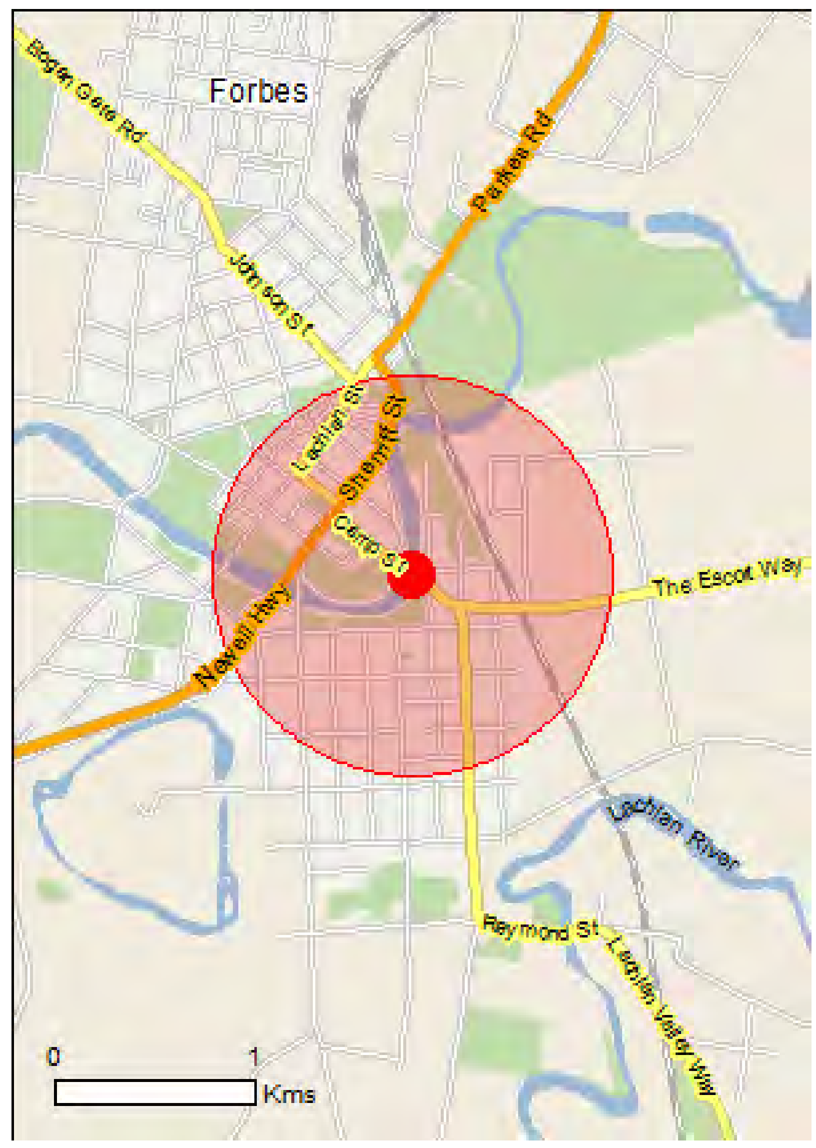
This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 25/09/17 13:03:22

- Summary
- Details
  - Matters of NES
  - Other Matters Protected by the EPBC Act
  - Extra Information
- Caveat
- Acknowledgements



Coordinates
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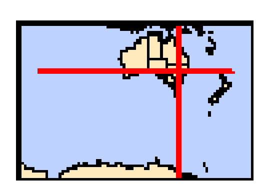

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	4
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	3
Listed Threatened Species:	20
Listed Migratory Species:	11

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	1
Listed Marine Species:	17
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	22
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Banrock station wetland complex	700 - 800km upstream
Hattah-kulkyne lakes	500 - 600km upstream
Riverland	600 - 700km upstream
The coorong, and lakes alexandrina and albert wetland	800 - 900km upstream

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Grey Box (Eucalyptus microcarpa) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia	Endangered	Community likely to occur within area
Weeping Myall Woodlands	Endangered	Community may occur within area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Species or species habitat may occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat likely to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Polytelis swainsonii Superb Parrot [738]	Vulnerable	Species or species habitat known to occur within area

Name	Status	Type of Presence
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Fish		
Maccullochella peelii Murray Cod [66633]	Vulnerable	Species or species habitat may occur within area
Macquaria australasica Macquarie Perch [66632]	Endangered	Species or species habitat may occur within area
Mammals		
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat known to occur within area
Nyctophilus corbeni Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat likely to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Plants		
Austrostipa metatoris [66704]	Vulnerable	Species or species habitat may occur within area
Austrostipa wakoolica [66623]	Endangered	Species or species habitat likely to occur within area
Philotheca ericifolia [64942]	Vulnerable	Species or species habitat may occur within area
Tylophora linearis [55231]	Endangered	Species or species habitat may occur within area
Reptiles		
Aprasia parapulchella Pink-tailed Worm-lizard, Pink-tailed Legless Lizard [1665]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species

[Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Historic		
Forbes Post Office	NSW	Listed place

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat may occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area

Extra Information

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Alauda arvensis Skylark [656]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Nassella trichotoma Serrated Tussock, Yass River Tussock, Yass		Species or species

Name	Status	Type of Presence
Tussock, Nassella Tussock (NZ) [18884]		habitat likely to occur within area
Rubus fruticosus aggregate		
Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Solanum elaeagnifolium		
Silver Nightshade, Silver-leaved Nightshade, White Horse Nettle, Silver-leaf Nightshade, Tomato Weed, White Nightshade, Bull-nettle, Prairie-berry, Satansbos, Silver-leaf Bitter-apple, Silverleaf-nettle, Trompillo [12323]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-33.38903 148.01278

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- -Office of Environment and Heritage, New South Wales
- -Department of Environment and Primary Industries, Victoria
- -Department of Primary Industries, Parks, Water and Environment, Tasmania
- -Department of Environment, Water and Natural Resources, South Australia
- -Department of Land and Resource Management, Northern Territory
- -Department of Environmental and Heritage Protection, Queensland
- -Department of Parks and Wildlife, Western Australia
- -Environment and Planning Directorate, ACT
- -Birdlife Australia
- -Australian Bird and Bat Banding Scheme
- -Australian National Wildlife Collection
- -Natural history museums of Australia
- -Museum Victoria
- -Australian Museum
- -South Australian Museum
- -Queensland Museum
- -Online Zoological Collections of Australian Museums
- -Queensland Herbarium
- -National Herbarium of NSW
- -Royal Botanic Gardens and National Herbarium of Victoria
- -Tasmanian Herbarium
- -State Herbarium of South Australia
- -Northern Territory Herbarium
- -Western Australian Herbarium
- -Australian National Herbarium, Canberra
- -University of New England
- -Ocean Biogeographic Information System
- -Australian Government, Department of Defence
- Forestry Corporation, NSW
- -Geoscience Australia
- -CSIRO
- -Australian Tropical Herbarium, Cairns
- -eBird Australia
- -Australian Government – Australian Antarctic Data Centre
- -Museum and Art Gallery of the Northern Territory
- -Australian Government National Environmental Science Program
- -Australian Institute of Marine Science
- -Reef Life Survey Australia
- -American Museum of Natural History
- -Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
- -Tasmanian Museum and Art Gallery, Hobart, Tasmania
- -Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

Department of the Environment
GPO Box 787
Canberra ACT 2601 Australia
+61 2 6274 1111

Appendix F

Statement of Heritage Impact

Roads and Maritime Services

Camp Street Bridge BN4286 at Forbes, NSW

Statement of Heritage Impact for the Proposed Bridge Replacement

Revision 0

February 2018

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Appendices

Appendix A – Durability assessment results summary

Appendix B – Landscape design

Appendix C – Visualisations

1. Introduction

Focus Bridge Engineering (FBE) has been engaged by Roads and Maritime Services to complete a Statement of Heritage Impact (SOHI) for the proposed replacement of Camp Street Bridge BN4286.

1.1 General

The Bridge over Lake Forbes on MR56 Lachlan Valley Way at Forbes, NSW is also known as Camp Street Bridge and was built in 1927 (see Figure 1-1 and 2-1).

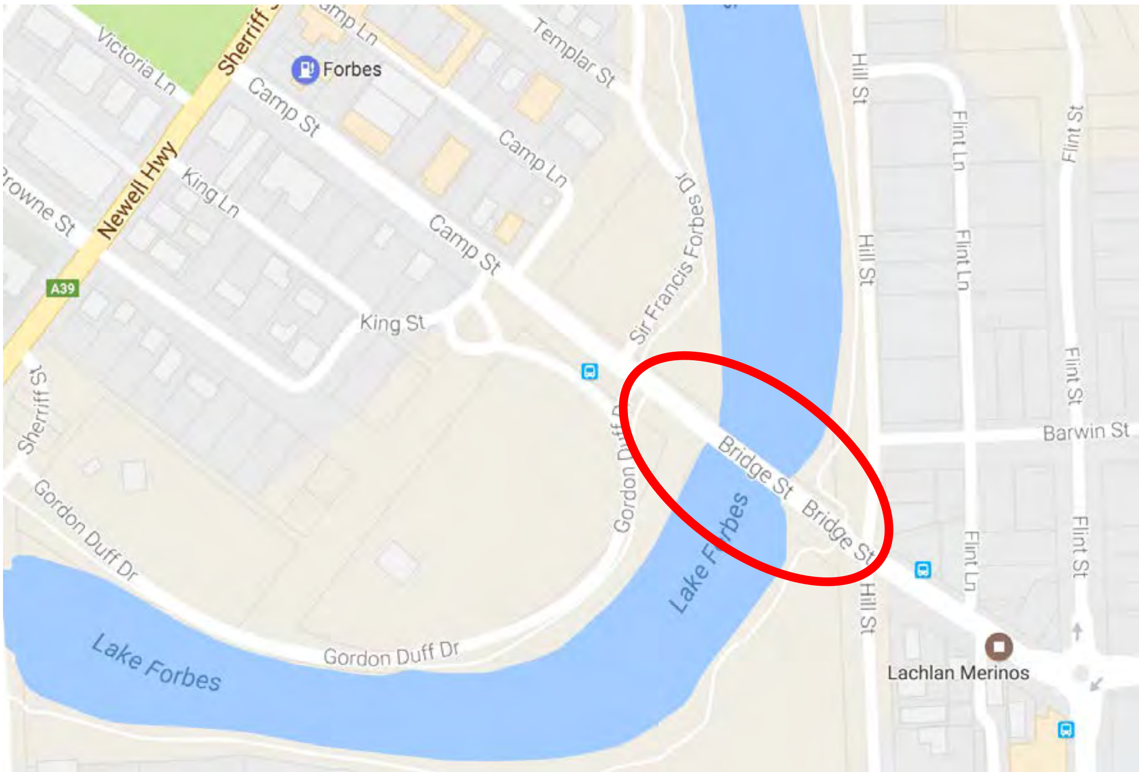


Figure 1-1 Camp Street Bridge location plan (Source: FBE)

Forbes is a town in the Central West region of New South Wales located on the Newell Highway between Parkes and West Wyalong. At the 2011 census Forbes had a population of 7,560.

Located on the banks of the Lachlan River, Forbes is 245 m above sea-level and about 380 km west of Sydney. Forbes is subject to a pattern of flooding, generally occurring to a significant level once every seven years, including 2016.

The annual average daily traffic (AADT) count in 2011 at the bridge was approximately 1280 vehicles per day with around 17 % heavy vehicles using the two lane carriageway.

1.2 Project background

Roads and Maritime Services is in the preliminary stages of developing strategic options to maintain or replace the existing bridge. FBE was engaged to complete a strategic options and engineering heritage assessment options report in May 2017, which reviewed the bridges condition and developed strategic maintenance and replacement options. This report concluded that:

- Camp Street Bridge is considered to be in poor condition and appears to require considerable expenditure to maintain the bridge in either the medium or long term.

- The cost to replace the bridge appears to be more economical than costly and difficult maintenance. Furthermore, from an operational perspective a new bridge is a considerably more viable prospect for the current Higher Mass Limit (HML) route, the local community and in terms of sustainable use of resources and mitigating future asset management risk.

The bridge is listed on both the State Heritage Inventory and the Roads and Maritime Services Section 170 register as being of local heritage significance. Therefore, preparation of a SOHI is required to determine the potential impact of the proposed works on the bridge's heritage significance.

1.3 Project scope

Focus Bridge Engineering has been engaged by Roads and Maritime to undertake a site inspection with key staff to confirm the physical scope of works and take photographs of key bridge elements for inclusion in this report, and prepare a statement of heritage impact (SOHI) for the proposed works covering:

- History and significance of Camp Street Bridge.
- Brief history of reinforced concrete beam bridges in NSW.
- Brief summary of examples of decorative lamp post designs on concrete bridges in NSW.
- Assessment of the proposed works on the heritage significance of the bridge.
- Statement of Heritage Impact to the NSW Heritage Manual requirements.
- Conclusions and recommendations.

1.4 Supplied information

The information supplied by Roads and Maritime Services is shown in Table 1-1.

Table 1-1 Roads and Maritime supplied documents (Source: Roads and Maritime)

Document or reference	Date
WAE drawings sheet 1 to 5	19 July 1926
RMS Level 2 inspection reports	2008, 2010, 2012, 2014, 2015
Gilbert Diving underwater inspection	29 October 2009
Commercial Diving Solutions underwater inspection	13 & 14 November 2013
CTI Consultants Concrete Durability Assessment Report	11 March 2015
Project Brief A/80045	29 October 2015
Project Team Meeting Presentation	13 February 2017
FBE Strategic Options and Engineering Heritage Report	June 2017

1.5 Project limitations

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information provided by Roads and Maritime at the date of preparation of the report. FBE has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

1.6 Glossary

Table 1-2 provides a basic glossary of engineering terms used in the main body of this report.

Table 1-2 Glossary (Source: FBE)

Term	Definition
Anode	An anode is an electrode through which conventional current flows into a polarized electrical device
Axial	Pertaining to, or nature of an axis.
Bending moment	The moment which produces or tends to produce bending in a beam or other member of a structure.
Carbonation	Is the rate of carbon monoxide or dioxide that penetrates the concrete over time making the concrete porous and making the reinforcement vulnerable to corrosion.
Cathode	A cathode is the electrode from which a conventional current leaves a polarized electrical device.
Cathodic protection (CP)	Technique used to control the rate of corrosion of a metal by making it the cathode of an electrochemical cell.
Chloride gradient	Penetration of chlorides from the atmosphere or due to poor selection of admixtures in the concrete corroding the reinforcement.
Compressive strength	The capacity to resist compression in units of force over area.
Drummy	The hollow drum like sound heard when a concrete surface is hit with a hammer.
Galvanic anode	Main component of SCP system made from a metal alloy with more potential and hence active protective voltage.
Half-cell potential survey	The measurement of the potential difference in mV across the reinforcement where more negative results indicate higher rates of corrosion
Impressed current CP	ICCP is a system used to control (slow) the rate of corrosion using anodes connected to a DC power source.
Flexure/flexural	Bending.
Moment	The tendency of a force to produce rotation or of a stress or mass-inertia to resist rotation.

Table 1-2 continued

Term	Definition
Reinforced concrete cracking performance	Ability of concrete to resist cracking due to adequate steel reinforcement usually restricted to less than 0.3 mm.
Sacrificial CP	SCP is the application of a passive sacrificial galvanic anode to slow the rate of corrosion of the main metal elements.
Shear	To slide one part of a body upon an adjacent part. The stress set up in opposition to a shearing action.
Spall	Sections of concrete material broken away as the result of corrosion of the reinforcement.

2. Bridge description BN4286

The Bridge over Lake Forbes on MR56 Lachlan Valley Way at Forbes, NSW is also known as Camp Street Bridge and was built in 1927 (see Figure 2-1 and Figure 2-2).

The bridge is on a 25/26 m long B-double Restricted Access Vehicle (RAV) and Higher Mass Limit (HML) route.

Figure 2-1 Camp Street Bridge (Source: FBE)

The reinforced concrete beam bridge has nine spans with a total length of around 58.826 m. The reinforced concrete deck and five integral girders are supported by reinforced concrete headstock and piers founded on driven timber piles.

The piers of the bridge consist of five square piles with a concrete headstock. The abutments are of simple construction similar to the piers and the original stone pitched facing on each abutment has been modified by the addition of concrete filled revetment mattresses to protect from further erosion.

The deck carries two lanes of traffic and is 6.096 m wide between kerbs with a footway on either side. Protecting the edge of the bridge is a three rail pipe pedestrian balustrade spanning between four lamp standards. The reinforced concrete lamp posts have art-deco features with single luminaires on the central posts and double luminaires suspended from a concrete cross-arm on the end posts. The lamp posts are painted which enhances their architectural features.

The bridge appears to be in fair to poor condition.

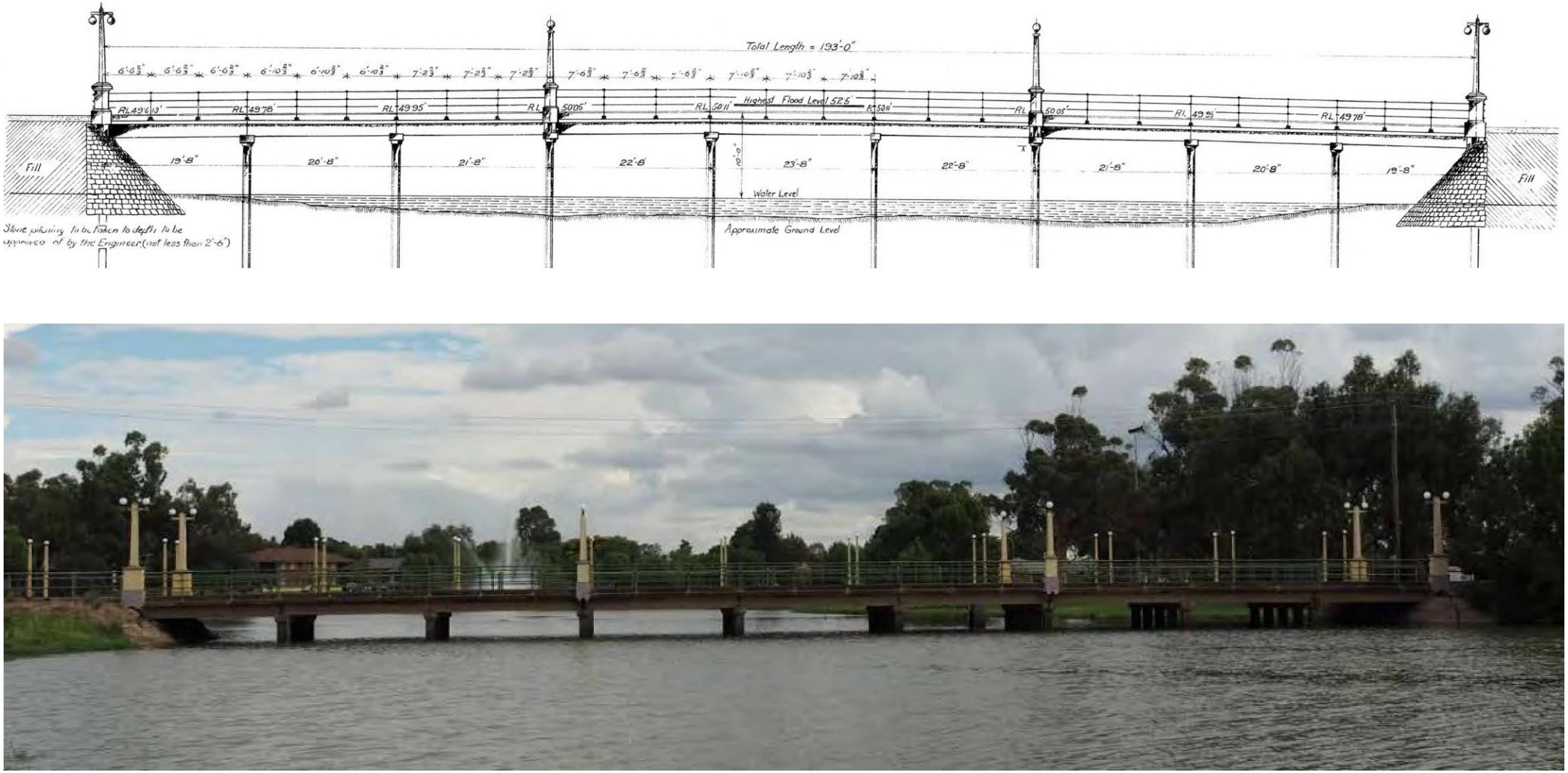


Figure 2-2 Camp Street Bridge elevation (Source: DMR WAE drawings and FBE)

3. Bridge condition

3.1 Level 2 inspections

Roads and Maritime undertake Level 2 visual inspections every 2 years. The last Level 2 inspection was completed on 17 November 2015 and is summarised in Table 3-1.

Table 3-1 Level 2 inspection condition summary (Source: RMS)

BN4286	**Camp Street Bridge over Lake Forbes**				**Quantities: RMS**			
Inspection Date: 17/11/2015					**Inspector: Bill Walker**			
Element Code	**Element Description**	**Health Rating**	**Total Qty***	**Unit**	**Estimated quantity or percentage of total in Condition State**			
					1	**2**	**3**	**4**
CABW	Concrete-Abutment and Wingwalls	Good	18	m^2	15	3	0	0
CDSL	Concrete-Deck Slab	Poor	566	m^2	425	120	20	1
CPHS	Concrete-Pier Headstock	Fair	180	m^2	50	122	8	0
CPIL	Concrete-Pile	Poor	72	m^2	0	40	32	0
CRBM	Concrete-Reinforced Beam	Fair	420	m^2	126	284	10	0
JNOS	Joint – No Seal	Good	77	m	42	35	0	0
MAPP	Approach Carriageway	As-built	2	ea	2	0	0	0
MATT	Miscellaneous Attachments	As-built	8	item	8	0	0	0
MBAT	Batter Protection	Good	28	m^2	25	3	0	0
MWWY	Waterway	As-built	1	ea	1	0	0	0
RMIS	Miscellaneous Railing including Guardfence	As-built	120	m	120	0	0	0
RPNT	Railing Paint Work	As-built	120	m	120	0	0	0
UCPL	Underwater CPIL – Concrete-Pile	Good	69	m^2	0	69	0	0
* Estimated quantities								

The condition state ratings of elements are similar but not identical for concrete, steel, protective coatings, etc, as can be referenced in the Roads and Maritime Bridge Inspection Manual. However, in general the ratings are as follows:

- Condition State 1: None or minimal damage.
- Condition State 2: Minor damage that should not affect performance of the bridge.
- Condition State 3: Average damage that may potentially affect the bridge operation.
- Condition State 4: Significant damage that is likely to affect the bridge performance.

The Level 2 inspection rates the following elements as:

3.1.1 Poor condition

- Deck.
- Piles.

The deck and piles are main load carrying members.

3.1.2 Fair condition

- Headstock.
- Beam.

The headstock and beams are main load carrying members.

3.1.3 Good condition

- Abutment and wingwalls.
- Joints.
- Batter protection.
- Underwater piles.

3.2 Underwater inspection

Roads and Maritime have had a number of concerns about the bridge piles and two recent underwater inspections have been completed by Gilbert Diving in 2009 and Commercial Diving Services in 2013.

The last inspection found that 23 out of the 40 piles had defects:

3.2.1 Below normal water level

- 3 piles were in condition state 3 (7.5%).
- 37 remaining piles were in condition state 2.
- The pile cap was in condition state 1.
- The timber piles were not observable (below bed level).

3.2.2 Around normal water level

- 20 piles were in condition state 3 (50%).
- 20 remaining piles were in condition state 2.

The piles are generally considered to be in poor condition.

3.3 Durability assessment

In 2015 CTI Consultants were engaged by Roads and Maritime to complete a comprehensive durability assessment of the overall condition of the bridges concrete. Consequently, CTI completed a field inspection along with a suite of site and laboratory testing including a defect survey, concrete and steel reinforcement assessment.

The durability assessment report condensed findings can be found in Appendix A and can be summarised as follows:

- Defects to a large number of piles.
- Significant concrete carbonation.
- High chloride contents in the concrete, particularly the piles.
- Less than the specified design cover to the reinforcement.
- High potential for corrosion in the lower half of the piles.
- No continuity in the reinforcement between the piles and headstocks.

In summary, the concrete piles were in poor condition and the headstocks and in poor/fair condition and the girders were in fair condition.

CTI suggested a range of potential maintenance strategies:

1. Patch repairs.
2. Re-casting the piers/columns.
3. Installation of ICCP system.

Their recommendations were made on the basis that the cracks in the piles, headstocks and girders were not the result of structural damage due to overloading.

4. History of reinforced concrete beam bridges in NSW

Burns, Roe and Worley (BRW) and Heritage Assessment and History (HAH) completed the *"Study of Heritage Significance of Pre-1948 RTA Controlled Concrete Beam Road Bridges for Northern, Hunter and Western Regions"* Report 3 in 2006. The following is an extract from their historical review which can found on the Roads and Maritime website:

http://www.rms.nsw.gov.au/documents/about/environment/bridge-types-historical-overviews-2006-concretebeam.pdf

The objectives of the heritage study of pre-1948 concrete beam bridges for Northern, Hunter and Western Regions (from now on referred to as the BRW report) were as follows:

- Assess individual bridges against the significance criteria including a rating of each bridge as being of either State, Local or No heritage significance.
- Prepare a statement of heritage significance for each bridge.
- Provide a ranking of the bridges in order of heritage significance.
- On this basis establish the heritage significance of the Northern, Hunter and Western group of pre-1948 RTA controlled concrete beam road bridges in NSW.
- Provide entry information on each of the bridges into the RTA's heritage and conservation register.

The study ranked Camp Street Bridge as of LOCAL significance. The following section provides the key relevant extracts from their report.

4.1 The Colonial Period

Concrete saw its first role in bridges in New South Wales through the "back door". It was found to be a suitable material for filling the insides of cast iron pier caissons and the like, providing a filling which was not only strong and stable but also protected the iron from corrosion due to its alkalinity. It also began to make cameo appearances in the form of mass concrete for abutments. This actually revived a role concrete had filled for the Romans two thousand years earlier.

With the dominance of German speakers in the commercialisation of reinforced concrete bridges in the late nineteenth century it is not surprising that this link brought the technology to Australia. W J Baltzer, a German immigrant working for the New South Wales Public Works Department maintained contact with his brother in Germany, and through that link, awareness of the emerging technology. In 1890 he travelled to Germany to gather information on this new form of bridge building. However, on his return he was unsuccessful in interesting his superiors in the technique and ultimately joined several businessmen to obtain licences through Wayss to cover the Australian Colonies.

Their company, Carter Gummow & Co, built several small trial structures, one of these being a culvert under Parramatta Road at Burwood in 1894. Unfortunately, it appears that this structure is no longer extant. The current main crossing has a flat soffit and the semi-arched connection to an upstream circular pipe is of rough construction unlikely of a trial structure built to impress potential users.

4.2 Developments in the twentieth century

In support of the move to use reinforced concrete for local structures, Professor W.H. Warren, Challis Professor of Engineering at Sydney University and President of the Royal Society of NSW undertook research into the strength and elasticity of reinforced concrete utilizing local materials. Results of these investigations were published in the Journal of the Royal Society of NSW in 1902, 1904 and 1905. Despite this supportive work, the number and scale of concrete bridges built in New South Wales over the next decade was small.

The first concrete beam bridge built in New South Wales was reputed to be a small bridge over Muddy Creek on the Princes Highway at Rockdale in 1907. However, during the current study, an examination of the drawings for this bridge, RTA Bridge No 28, has indicated that this deck appears to have been of steel beams and buckled plates, possibly with a mass concrete deck (This deck was replaced and widened with reinforced concrete beams in 1953). The abutments were of mass concrete on timber piles and topped with sandstone copings. These abutments and supporting piles, as part of the widened beam bridge, continue to serve one of the most heavily loaded Highways in NSW.

The oldest extant reinforced concrete slab bridge is over Muttama Creek at Cootamundra (RTA Bridge No 6438), built in 1914 (see Figure 4-1). Another crossing, over American Creek near Figtree, also built in 1914, has been replaced.

The oldest surviving beam bridge in NSW is thus the bridge over Mummulgum Creek (RTA Bridge No. 2258), built in 1915 (see Figure 4-1). Although it has been strengthened and widened, it remains in service. Other beam bridges, all now gone, were built in 1916 at Mullet Creek, Dapto Throsby Creek, Wickham and Shark Creek, Maclean. Extant also from 1916 is the slab bridge over Surveyors Creek at Walcha (RTA Bridge No. 3485).

Figure 4-1 Muttama Creek Bridge and Mummulgum Bridge (Source: BRW)

These structures, with deck geometries having either flat soffits or beams cast monolithically with the deck, represented a logical step forward in the use of reinforced concrete from the first spate of arch bridges, and actually reverted to the style used by Monier in his first bridge. The concrete arch did not in fact, efficiently utilise the freedom of geometry that reinforced concrete was able to offer. In the traditional masonry arch, avoidance of collapse was achieved by keeping the line of compression within the curved masonry. With a reinforced arch the same thinking initially applied, but with the advantage that the reinforcement could accommodate some local bending effects (such as from concentrated loads from heavy wheels) by using the tensile capability of the reinforcing in the concrete. However, these structures still required the placement of filling on top of the arch to build an almost level surface for traffic, and this meant an overall heavy (and thus somewhat inefficient) structure. Once designers of reinforced concrete began to use the material in a manner which took advantage of its tensile capabilities, lifting the underside of the superstructure close to the top of the deck, design efficiency began to *improve. Up to a span of several metres, flat slabs were efficient. Beyond that, by having a thin deck to carry the local wheel loads across to beams in which steel reinforcement was concentrated near the bottom, deck structures of up to 15 m were ultimately achieved.*

The next step was to make the composite beam systems continuous over their supports. By making the deck continuous at the piers, adjacent spans effectively assisted each other by spreading a load on any one span along the bridge. In a typical span, by changing from simply supported to continuous, the bending moment due to self-weight at mid-span drops from M to M/3, whilst the moments at the supports go up from zero to -2M/3. There is thus a 33% net reduction in the bending moment to be designed for, and the peak occurs at the piers where extra beam depth can be provided efficiently and aesthetically. Placing the reinforcing steel predominantly in the bottom of the slab at mid-span, and bending it up into the top over supports (where the bending effect is reversed) designers were able to place the steel effectively where the tension forces occurred. The bridge described as "the first true continuous girder reinforced concrete bridge" was Fullers Bridge across Lane Cove River (see Figure 5-2), completed in 1918 (RTA Bridge No. 105). This has spans of 9.14 m. It is interesting that this continuous bridge has outlived most of the simply supported span beam bridges erected before it. The conceptual logic contained in these early bridges was to persist with relatively modest changes until the introduction of prestressing in the 1950s.

By the end of World War I there was the prospect of a substantial increase in both bridge building in general and in reinforced concrete in particular. In 1914 the Director General of Public Works stated that "the increasing cost and difficulty in obtaining timber of suitable quality and dimensions for the large highway bridges determined me to adopt steel and ferro-concrete construction wherever practicable". In contrast with timber, the raw materials for reinforced concrete bridges: coarse aggregate, sand, cement and steel bars were becoming readily available.

Figure 4-2 Fullers Bridge across Lane Cove River (Source: BRW)

The other driver was the explosion of private car ownership and the dramatic growth in truck transport of goods, with the weight of trucks growing continuously.

The style of roads and bridges which had sufficed during the nineteenth century, wherein the road alignment and surface was subservient to the surroundings, was no longer acceptable for the higher vehicle speeds now emerging. Road design became a science in which the design speed dictated the minimum radius of vertical curves as well as the horizontal ones (see Figure 4-3). These were predicated on principles of safe stopping sight distances, and on limiting the lateral forces on vehicles. Previous rules, such as that mandated by the railways, that all overbridges must be at right angles to the rail line (to minimise soot effects from steam trains) began to be overturned, as were rules of thumb such as minimising the cost of bridges by making them straight and of minimum length (for example over rivers).

Figure 4-3 Croobyar Creek Bridge curved deck (Source: BRW)

Other parameters to evolve progressively during the Twentieth Century included the design weight of vehicles, the width of lanes, the provision of width to provide continuity with the shoulders of the roadway, and rules for impact resistance of railings. All of these have had their impact, not only on the design of new bridges but also on the continued appropriateness of existing structures and the need to modify them to maintain their level of service.

4.3 Discussion on study group

The following provides an extract on the findings for Northern, Hunter and Western Region with some pertinent cross references to Camp Street Bridge in Section 3.3.3.

4.3.1 Introduction to beam bridges

This study has addressed the beam bridge which was the commonest form of concrete bridge deck during the period up to 1948. They are also referred to as concrete girder bridges or T-beam decks. In this deck form, the slab carries the local wheel loads across to the beams which acted as T shaped sections to carry the loads to the piers and abutments. Variations on this theme include intermediate cross beams which help stiffen the deck and assist load transfer, decks with edge beams only, and whether the deck is composite with the piers and/or abutments. Simply supported girder decks were considered economic for spans up to 15.24m (50 feet), after which the dead weight of the girders began to increase rapidly and impair efficiency. The design methods used for the deck included those of M.Pigeaude for non-square panels, and H. Marcus for approximately square panels. Most of the simply supported girder bridges were of single or two span configuration although some longer structures were built.

Figure 4-4 Manilla Bridge in Western Region curved deck (Source: BRW)

Based on both their numbers and their generally well developed aesthetics, the class of beam bridges has a high value to the community as infrastructure and also as significant heritage *items. Because their form lent itself to longer spans they were generally sited over more prominent crossings than the slab bridges which crossed more modest streams. Despite these pluses, they were a product of the same era as the slabs, and have consequently been subjected to the same processes of widening, re-kerbing etc when they have been assessed as falling short of changing community expectations of bridges. Of the total of some 160 beam bridges built during the period and still extant, approximately half are included in this study group, the remainder having been covered in previous studies.*

The following Tables 4-1 and 4-2 summarises the salient features of the bridges in the study group, ordered by year of construction.

Table 4-1 Concrete beam bridges in Northern, Hunter & Western Regions (Source: BRW)

RTA No	SHI No	Description	Year Built	Spans	Abutment Continuity	Deck Continuity	Soffit
2258	4306085	Mummulgum Creek Bridge	1915	3	AC	DC	NH
1782	4306067	Graham Bridge	1916	7	AS	DS	NH
2706	4306094	Severn River Bridge	1927	3	AS	DS	NH
4286	4306123	Camp Street Bridge	1928	9	AS	DS	NH
1626	4306065	Chinamans Hollow Bridge	1930	3	ACT	DC	TH
1030	4306059	Crossley Bridge	1930	4	AS	DS	TH
2585	4306092	Federation Bridge	1930	5	ACT	DS	NH
4317	4306126	Mandagery Creek Bridge	1930	6	AS	DS	NH
1846	4306071	Ravenswood Bridge	1930	3	AC	DC	TH
1354	4306063	Bangalow Creek Bridge	1931	2	AS	DS	NH
4052	4306113	Belubula River Bridge	1932	1	AC	DC	TH
4061	4306115	Mandurama Creek Bridge	1932	2	AC	DC	TH
4060	4306114	Coombing Creek Bridge	1933	2	AS	DS	NH
4062	4306116	Grubbenbun Creek Bridge	1933	1	AC	DC	CH
2183	4306081	Brunswick River Bridge	1934	7	AC	DC	TH
2945	4306100	Halls Creek Bridge (1)	1934	4	AS	DS	TH
1010	4306055	Rocks Creek Bridge (2)	1934	2	AC	DC	CH
3537	4306109	Wallumburrawang Crk Bridge	1934	2	AC	DS	TH
1654	4306066	Bellbird Creek Bridge	1935	1	AC	DC	NH
1027	4306057	Clear Creek Bridge	1935	3	AC	DC	TH
3637	4306110	Collaroy Bridge	1935	5	AS	DS	NH
4312	4306125	Boree Creek Bridge	1935	3	AC	DC	CH
1843	4306070	Smiths Creek Bridge	1935	3	AC	DC	CH
1028	4306058	Cheshire Creek Bridge	1936	3	AS	DS	NH
2947	4306102	Halls Creek Bridge (2)	1936	3	AC	DC	TH
2777	4306099	Mia Mia Creek	1936	3	AS	DS	NH
2703	4306093	Hogues Creek Bridge	1937	3	AC	DC	CH
2957	4306103	Kellys Gully Creek Bridge	1937	4	AS	DC	CH
2095	4306073	Reedys Creek Bridge	1937	1	AC	DC	TH
2255	4306083	Rileys Creek Bridge	1937	1	AC	DC	CH
2776	4306098	Slaughterhouse Creek Bridge	1937	2	AC	DS	TH
2139	4306077	Alipou Creek Bridge	1938	2	AS	DS	NH
4104	4306118	Gosling Creek Bridge	1938	7	AS	DC	NH
2140	4306078	Musk Valley Creek Bridge	1938	2	AS	DS	NH
2257	4306084	Reids Creek Bridge	1938	1	AC	DC	CH
1815	4306068	Stoney Creek Bridge	1938	1	AC	DC	CH
1373	4306064	Throsby Ck Storm Water Ch	1938	2	AS	DS	NH
3087	4306104	Yarrawa Bridge	1938	5	ACT	DS	NH
2253	4306082	Black Gully Bridge	1939	4	AS	DS	NH

RTA No	SHI No	Description	Year Built	Spans	Abutment Continuity	Deck Continuity	Soffit
4085	4306117	Brundah Creek Bridge	1939	5	AS	DS	NH
4230	4306121	Fiddlers Creek Bridge	1939	2	AS	DS	NH
4234	4306122	Mountain Creek Bridge	1939	1	AC	DC	TH
1009	4306054	Rocks Creek Bridge (1)	1939	2	AC	DS	TH
3445	4306108	Rocky Gully Creek	1939	2	AC	DS	CH
3412	4306106	Swamp Creek Bridge	1939	3	AC	DC	TH
2263	4306089	Tabulam Rivulet Bridge	1939	3	AC	DC	CH
2759	4306096	Warialda Creek Bridge	1939	6	AS	DC	CH
4131	4306120	Blathery Creek Bridge	1940	3	AC	DC	TH
4309	4306124	Boree Creek Bridge	1940	2	AC	DS	TH
4562	4306127	Boree Creek Bridge	1940	3	AC	DC	CH
2265	4306090	Captains Creek Bridge	1940	1	AC	DC	TH
2259	4306086	Deep Creek Bridge (1)	1940	2	AC	DS	TH
2261	4306087	Deep Creek Bridge (2)	1940	1	AC	DC	CH
2133	4306076	Halfway Creek Bridge	1940	3	AS	DS	NH
1820	4306069	Herons Creek Bridge	1940	2	AC	DC	CH
4119	4306119	Molong Creek Bridge	1940	3	AC	DC	CH
2105	4306074	Newports Creek Bridge	1940	2	AC	DS	CH
1011	4306056	Rocks Creek Bridge (3)	1940	1	AS	DS	TH
1031	4306060	Two Mile Creek Bridge	1940	2	AC	DC	TH
2163	4306079	McDonalds Creek Bridge	1941	1	AC	DC	NH
4571	4306128	Mandagery Creek Bridge	1942	3	AS	DS	NH
3427	4306107	Burkes Loders Gully Ck	1943	1	AC	DC	TH
3656	4306111	Manilla River Bridge	1943	6	AS	DC	CH
3408	4306105	Quirindi Creek Bridge	1943	3	AC	DC	TH
2277	4306091	Springvale Bridge	1943	3	AS	DC	CH
999	4306053	Boyd Creek Bridge	1944	1	AC	DC	TH
2946	4306101	Dinoga Bridge	1944	2	AC	DC	CH
2757	4306095	RTA Bridge No.2757	1944	1	AC	DC	TH
1072	4306062	Wyaldra Creek Bridge	1944	3	AS	DC	CH
1865	4306072	Allgomera Creek Bridge	1946	4	AS	DS	NH
1066	4306061	Macdonalds Creek Bridge	1946	4	AC	DC	CH
2106	4306075	Coffs Creek Bridge	1947	3	AS	DS	NH
28	4306052	Skidmores Bridge	1953	1	AS	DS	NH
2170	4306138	Fishery Creek Bridge	1955	5	ACT	DS	NH
2171	4306080	North Creek Canal Bridge	1955	5	ACT	DS	NH

Table 4-2 Concrete beam bridges in Northern, Hunter & Western Regions (Source: BRW)

Feature	Nomenclature	Spans					
		1	2	3	4	5	>=6
Continuity of Deck with Abutments	Continuous with abutments - AC	14	11	13	1	0	1
	Simply supported at abutments - AS	2	6	8	5	2	6
	Cantilever approaches - ACT			1		4	
Deck continuity	Deck simply supported - DS	2	13	16	4	6	3
	Deck continuous - DC	14	4	6	2	0	4
Line of Beam Soffits	Tapered haunches - TH	8	6	7	2	0	1
	Curved haunches – CH	5	5	8	2	0	2
	No haunch - NH	3	6	7	2	6	4
Total		16	17	22	6	6	7

4.3.2 Single span bridges

As can be seen from the summary Table 4-2, the single span crossings predominantly use the deck to connect the two abutments which thus support each other, with only two being simply supported. This form is often referred to as a rigid framed bridge, and results in improved efficiency in abutment design as well as improving the deck by giving end fixity. When this is used, the deck beams are usually deepened as they approach the abutment to give greater bending strength at these points of fixity. There is a fairly even split between this being done in the form of a straight taper or haunch, or alternatively using a curve, either circular or parabolic.

During the study period the spans achieved by this bridge form were extended by steps of optimisation and development. This pattern can be seen in Figure 4-5 below which charts span length for all single span rigid framed beam bridges against construction year. Two of the bridges in the current study, Belubula River Bridge (RTA Bridge No 4052) built in 1932 and Grubbenbun Creek Bridge (RTA Bridge No 4062) built in 1933 were in the vanguard of this development, in combination pushing the span limit by more than 40% over a five-year period.

As may be seen, the span peaks in 1937 at less than 20 m (Backhouse Creek Bridge (RTA Bridge No 742) and assessed in a previous study), and then drops back to the 10 to 15 m range, indicating that the optimum economic span for this form was found to be in this zone.

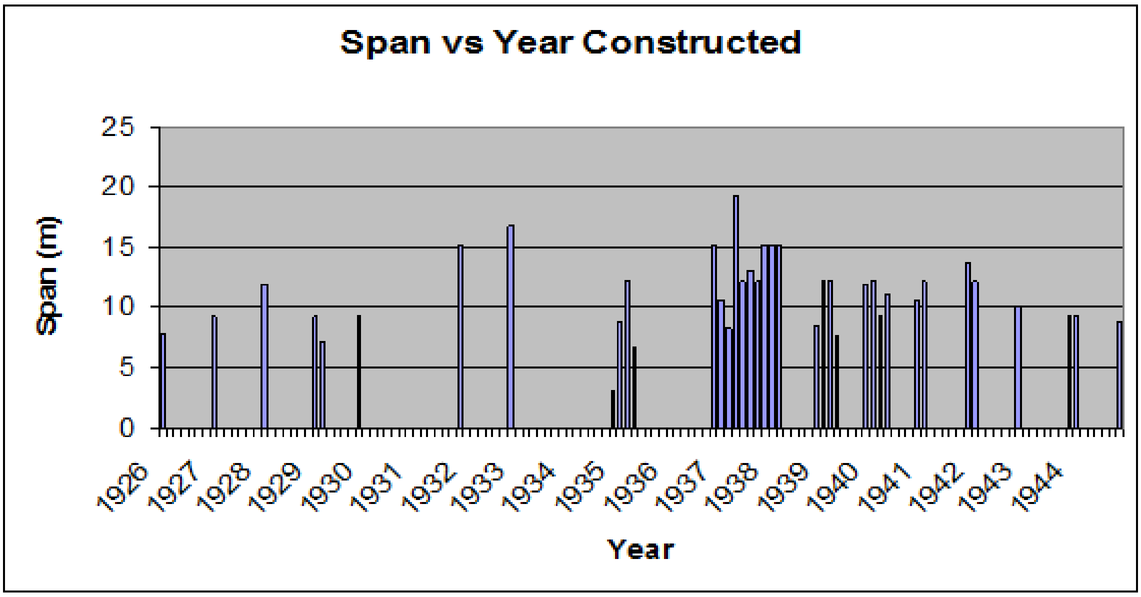


Figure 4-5 Plot of span versus construction year for single span rigid frame beam bridges (Source: BRW)

4.3.3 Multi span bridges

Of the 19 bridges with 4 or more spans, approximately two thirds have simply supported decks, with the remainder being either fully continuous or partly so. With these longer bridges the issue of thermal expansion becomes progressively more important, and simple sliding plates are often inadequate to cope with the design demands of high lateral load resistance, low friction etc. Consequently, a number of these bridges have cast steel bearings of pin and rocker or double rocker type. These are often hidden behind pier upstands to avoid the appearance of discontinuity in the structure.

The bridge with most spans is the Camp Street Bridge at Forbes (RTA Bridge No 4286). It has nine spans which are simply supported and set low over Lake Forbes with flat soffit beams.

With 7 spans each, the Graham Bridge and the Brunswick River Bridge are both notable structures in their respective landscapes. Whilst the Graham Bridge uses flat soffit beams, the Brunswick River structure has continuous beams with tapered soffits giving an elegant line across its major waterway.

5. History and significance of the bridge

The history of the bridge is an extract from the NSW Office of Environment and Heritage (OEH) State Heritage Inventory listing for Camp Street Bridge (database number 4306123).

5.1 History

The Camp Street Bridge crosses Lake Forbes at the south-eastern end of Forbes township on the road that becomes the Lachlan Valley Way linking Forbes and Cowra. At the time of European settlement, the area was inhabited by groups of the Wiradjuri Aboriginal peoples. Surveyor John Oxley was the first European to explore the area and when he passed the site of Forbes in 1817 he named it Camp Hill. Early squatters arrived in the 1830s and knew it by the name of the largest run, "Bogabigal", while later it was known as Black Ridge.

Forbes, like many towns in the Lachlan River area, owed its development to the gold rush, which began in Forbes in 1861 with the discovery of gold in what is now King George V Park. Miners who flocked to the district named the town "Forbes" after Sir Frances Forbes, the first Chief Justice of New South Wales, who insisted that all free men were entitled to normal privileges regardless of previous status, an idea that is likely to have appealed to those on the goldfields. The population leapt from 124 to 30,000 in 1861 but by 1863 most had deserted to seek their fortunes elsewhere, especially New Zealand, reducing the population to 3,500.

Mining did not completely cease, and even in 1915 eight mining companies operated in Forbes. By the 1870s, however, the town's wealth rested primarily on sheep. Wheat was processed at local flour mills from 1872 and transported to the railway station from 1893. Fruit and vines were later added to the area's primary products. By the mid-twentieth century Forbes had become the centre of an important agricultural and pastoral area with secondary industries related to the primary products, including meat works, butter factory, flour mill and winery. (Reader's Digest Illustrated Guide to Australian Places, 2003, p. 198; Beckett (ed.), 1948, p. 251).
The route from the Hume Highway near Yass, to Cowra was proclaimed a secondary main road under the amended Local Government Act of 1923, and passed into State management with the institution of the Main Roads Board in 1924. In 1928 this route was amalgamated with the route from the Mid Western Highway near Cowra through Gooloogong to Forbes to form the Lachlan Valley Way, classified as a 'trunk route'. It closely follows the Lachlan River from Cowra through to Forbes, then through Condobolin and Lake Cargelligo and on to Booligal, where it joins the Cobb Highway. The route from Forbes developed from an earlier stock route and a road connecting with the River, which was also used to transport goods before the advent of the railway and main road system. (DMR, 1976, p. 82 and maps opposite pp. 80, 112; Goldney & Bowie (eds.), 1987, pp. 193-194).

Prior to the 1930s, Lake Forbes was called The Lagoon and was often dry and unpleasant as it was a natural billabong and the water level was regulated by overflow from the Lachlan River. From the 1930s onwards, however, the lagoon has been beautified and kept full of water. (Forbes History Book Committee, 1997, p. 35) The Camp Street Bridge was constructed in 1927/8. It replaced a timber bridge over the lagoon between Camp and Bridge Streets, which was over 46 years old and in a dangerous condition. The bridge's location on the main road from Cowra to Forbes meant that it carried a lot of heavy traffic. It was also in a flood-prone area and there was a danger that the whole structure would be washed away; and so, it became urgent that the bridge be replaced by a concrete structure. As the town was fast expanding on the southern side of the lagoon it was necessary to incorporate footways into the new bridge's design. During the bridge's construction a temporary crossing was erected at Woods' Crossing in Wombat Street. The contract for the new bridge's construction was let to the State Monier

Pipe and Reinforced Concrete Works. The cost was met jointly by the Main Roads Board and Forbes Municipal Council and a plaque with the names of the Aldermen and Town Clerk was affixed to one of the bridge's end posts. Some difficulties were encountered during construction as remains of an old stone crossing were discovered. The bridge was officially opened on 24 January 1928 with the official switching on ceremony of the bridge's lighting taking place on the same evening followed by a banquet at the Town Hall. Newspaper reports noted the impressive image the nine-span bridge created, especially with the willow trees at the edge of the lagoon and, with its "handsome lighting arrangements", it "added to the beauty of that section of Lake Forbes". (Supplement to the Forbes Advocate, 25 January, 1928; Material supplied by Forbes Family History Group; RTA SDC File: 157.15)

Between 1925 and 1940 more than 1,000 bridges were built or under construction by the department of Main Roads. This was a period in which the department's engineers were adapting existing standards of bridge design to meet the requirements of improved motor vehicle performance - they were generally wider than bridges built previously, with an improved load capacity. Three principal types of bridges were constructed in this period: concrete slab; reinforced concrete beam; steel truss on concrete piers; and timber beam bridges. (DMR, 1976, p. 169) Such bridges on the state's main roads and highways, constructed to replace high-maintenance and aged timber bridges or open crossings, along with other road improvements, ushered in the age of comfortable motor transport and efficient road transport of goods and produce to which we are accustomed today.

In 1950 and 1952 Forbes experienced severe floods. In October 1950 the top iron railing of the Camp Street Bridge was practically submerged. In 1952 concerns were raised re the impact that structures including the Camp Street Bridge, Bates Bridge (Lachlan Street) and causeways at Wombat Street and the showground were having on raising flood levels in the town. Forbes Council suggested that the Camp Street Bridge be raised above high flood level, however this was rejected as the height of the embankment would cause further obstruction to the waterway. An alternative was to regrade the approaches to the bridge to a lower level. (RTA General File: 157.129).

In the 1960s the local council expressed concern for pedestrian safety at the Camp Street Bridge, particularly with the trend to faster and heavier traffic. The traffic lanes were 20 feet wide in total and the 4' 6" footways on either side were separated from the roadway by a kerb only. Council wanted a safety fence or Armco guard rail to be erected on the kerb line. The DMR did not agree, however, but recommended that the approaches to the bridge, where the footpath was not properly formed, posed a greater danger to pedestrians and should be kerbed and guttered, and guide posts erected. (RTA General File: 157.129).

5.2 Integrity

Integrity can exist on a number of levels in terms of heritage significance. For example, the heritage bridge maybe an intact example of a particular architectural style or period and consequently have a high degree of significance for its ability to illustrate this style or period. Equally, the heritage significance of a bridge may arise from a lack of integrity where the significance lies in its ability to provide information of a significant evolution or change in use.

The 1927 Camp Street Bridge displays a high degree of integrity. All the information held in the Roads and Maritimes archives, OEH database and as indicated in this report highlight that there are only minor changes to the lamp posts globe orientation.

The existing bridge provides an integral approach to Forbes town centre and is visible from the surrounding parkland and makes a gateway statement entering the town.

5.3 Comparative analysis

Comparative analysis can assist in the determination of whether a place is rare or representative and also aid in locating it within patterns of history or activity. The level of integrity may also impact upon how it compares to other bridges.

The BRW report highlights that:

- *The bridge over Lake Forbes is a nine span bridge providing an impressive entry to the town and consequently being part of its identity.*
- *State Monier Pipe and Reinforced Concrete Works, a state owned enterprise built the bridge.*
- *The bridge had the most spans of any structure in the Northern, Hunter and Western Region study.*

5.4 Contribution to surrounding landscape

Camp Street Bridge is a prominent element as approaching and departing Forbes on the Lachlan Valley Way (MR56). It also plays a central structural feature in the surrounding parkland and lake. The bridge handrail and art-deco lamp posts also provide a strong visual entrance onto the bridge.

Although the bridge is low lying it still contributes significantly to the surrounding landscape and the BRW report highlighted that:

- *Lake Forbes Bridge at Forbes, the Crossley Bridge at Sofala, the Federation Bridge at Mullumbimby and the Mandagery Creek Bridge at Eugowra all are dominant structures in their respective townships.*

5.5 Significance to local community

It has been recognised by Roads and Maritime Services that the bridge plays an important part in the local community and has engaged in extensive community consultation and presentations to the local council. In addition, the BRW report noted that:

- *The set of bridges has a wide range of linkages with communities. This ranges from childhood memories of rambling along creeks, picnics and bushwalks to matters of life and death including crossing bridges to escape floodwaters and the like. Each local bridge fits within its own microcosm, tying farms together, linking families to schools, transporting goods and services.*
- *Some are known as gateways to towns, such as Mandagery Creek Bridge in Eugowra and Lake Forbes Bridges on the eastern approaches to Forbes.*

5.6 Adjacent items

There are no apparent heritage items in the immediate vicinity of the bridge.

5.7 Heritage listings

The most relevant statutory listings for conducting future works on the bridges are the State Heritage Register, LEP and s170. The statutory listings for each bridge have been recorded within the inventory sheets as shown in Table 5-1.

Table 5-1 Statutory and non-statutory listings (Source: see Table)

Heritage Listing	Status
Australian Heritage Database	Not listed
OEH Heritage Division State Heritage Inventory	Listed (database number 4306123)
Local Environment Plan	Not listed
NSW National Trust Register	Not listed
RMS S170 Heritage and Conservation Register	Listed (but not on RMS website)

The statutory listings that are relevant to the proposed works are the Roads and Maritime Section 170 register. As the bridge is not listed on the State Heritage Register a Section 60 application to the Office of Environment and Heritage will not be required for the proposed works.

5.8 Section 170 register

The Roads and Maritime Services Heritage and Conservation Register was established in accordance with Section 170 of the Heritage Act, 1977 to record all the heritage items in the ownership or under the control of Roads and Maritime Services.

The Heritage and Conservation Register has two main roles:

1. To meet Roads and Maritime Services' statutory requirements.
2. As an essential tool in total asset management, by listing and providing information on those Roads and Maritime Services assets which have heritage significance.

Information in the Register has been prepared according to OEH Heritage Division guidelines and corresponds with information in the State Heritage Inventory, maintained by the OEH Heritage Division.

6. Heritage assessment

Heritage assessments are the process by which heritage items are assessed to determine their value or importance to the community, local and wider. The ICOMOS Burra Charter has been developed as expressing a broad community view of what such significance and values may be and what responsibilities they impose on us as a community. To make such values explicit the former NSW Heritage Office developed a set of criteria to guide significance assessments.

6.1 NSW heritage assessment criteria

The Heritage Assessment document in the *NSW Heritage Manual* update (NSW Heritage Office 2001) suggests that an item will be considered to be of State (or local) heritage significance if, in the opinion of the Heritage Council of NSW, it meets one or more of the following criteria:

Criterion (a) – an item is important in the course, or pattern, of NSW's cultural or natural history (or the cultural or natural history of the local area);

Criterion (b) – an item has strong or special association with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history (or the cultural or natural history of the local area);

Criterion (c) – an item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW (or the local area);

Criterion (d) – an item has strong or special association with a particular community or cultural group in NSW (or the local area) for social, cultural or spiritual reasons;

Criterion (e) – an item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history (or the cultural or natural history of the local area);

Criterion (f) – an item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history (or the cultural or natural history of the local area);

Criterion (g) – an item is important in demonstrating the principal characteristics of a class of NSW's

- cultural or natural places; or
- cultural or natural environments.

(or a class of the local area's

- cultural or natural places; or
- cultural or natural environments.)

Heritage significance is an expression of the cultural (or heritage) value afforded a place or item.

The following assessment and statement of significance are extracts from the NSW Office of Environment and Heritage (OEH) State Heritage Inventory listing for Camp Street Bridge (database number 4306123).

6.2 Assessment of significance

Items assessed against the SHR criteria are shown in Table 6-1 and can be found on the OEH website:

http://www.environment.nsw.gov.au/heritageapp/ViewHeritageItemDetails.aspx?ID=4306123

Table 6-1 OEH inventory assessment (Source: OEH)

Criteria a	*Historical significance*	*The bridge is located on an important and historically significant transport route developed from the earliest days of European settlement and which provides evidence of the evolution of the road system in the region. Located at the gateway to Forbes township, the site has served as a crossing point over a long period, replacing earlier stone, then timber crossings. The bridge continues to serve both local road and pedestrian traffic as well as through traffic, including heavy goods vehicles on this busy route stretching from Yass through Cowra and Forbes to Condobolin and further west. It is thus associated with the state historical themes of agriculture, pastoralism, mining, industry, commerce and transport and the national theme of developing local, regional and national economies.*
Criteria c	*Aesthetic significance*	*The bridge is a long, impressive structure situated in a pleasant parkland setting within Forbes township. Its original lighting and handrailing evoke the art-deco styling of its era and the lamp posts are painted in colours which enhance their architectural features, all of which contributes to its aesthetic appeal.*
Criteria d	*Social significance*	*The bridge's opening in 1928 was greeted with much fanfare, including a 'switching on' ceremony, indicating that the opening of the new bridge was considered a major event and esteemed by the local community. Comments in the press at the time also indicate that the bridge was valued for its aesthetic qualities, which, when viewed with the willow trees along lagoon, made an attractive view to town, enhanced at night by its lighting. The fact that the bridge retains many of its original features and continues to be heavily used by pedestrian and vehicular traffic suggests that it would contribute to the local community's sense of place.*
Criteria e	*Research potential*	*Not assessed.*
Criteria f	*Rarity*	*Not assessed.*
Criteria g	*Representativeness*	*Not assessed.*
	Integrity/Intactness	*Reasonably high.*
	Assessed significance	*Not assessed.*

6.3 Statement of significance

The Camp Street Bridge has heritage significance at a local level. Located at the gateway to Forbes township, it has some historical significance at a site that has served as an important crossing point over a long period, on a major road - the Lachlan Valley Way - serving both local *road and pedestrian traffic as well as through traffic, including heavy goods vehicles on this busy route stretching from Yass through Cowra and Forbes to Condobolin and further west.*

The development of the simple, economical and effective beam bridge form in the mid-1920s grew from the aim of providing efficient road transport over thousands of kilometres over the State, and facilitated the achievement of that aim. It is thus associated with the state historical themes of agriculture, pastoralism, mining, industry, commerce and transport and the national theme of developing local, regional and national economies.

The bridge is particularly significant for its aesthetic qualities as it retains many of its original features, especially its railing and lamp posts, the latter evoking the art-deco styling of its era.

The bridge also has considerable social significance, its construction having been greeted with much fanfare and comment on its contribution to the aesthetics of the town due to its siting over the tree-lined lagoon, within pleasant parkland and its appealing lighting. Its location near the park and its continued use by pedestrians mean that it is likely to be observed and valued by locals, thus contributing to their sense of place.

7. Schedule of significant forms and fabric

7.1 Criteria for assigning levels of significance to bridge elements

To facilitate a better understanding of the manner in which each of the elements of a bridge contributes to its overall significance, it is a useful management tool to separate a bridge into its components and examine the heritage significance of each. This process allows for more informed analysis of what constitutes significant form and fabric, or what fabric is of little significance, or intrusive.

Table 7-1 Grading system used for heritage significance (Source: OEH)

Grading	Justification	Status
EXCEPTIONAL	Rare or outstanding element directly contributing to an item's local or State significance.	Fulfils criteria for local or State listing.
HIGH	High degree of original fabric. Demonstrates a key element of the item's significance. Alterations do not detract from significance.	Fulfils criteria for local or State listing.
MODERATE	Altered or modified elements. Elements with little heritage value, but which contribute to the overall significance of the item.	Fulfils criteria for local or State listing.
LOW	Alterations detract from significance. Difficult to interpret.	Does not fulfil criteria for local or State listing.
INTRUSIVE	Damaging to the item's heritage significance.	Does not fulfil criteria for local or State listing.

Table 7-1 above provides a guide to the grading of significance of items or places of heritage value and is directly derived from the OEH Heritage Division *NSW Heritage Manual* (revised 2001).

7.2 Schedule of significant forms and fabric Camp Street Bridge

7.2.1 Abutment A and B

The form and fabric of Abutment A and B is INTRUSIVE.

The existing abutments are of similar construction to the piers comprising of reinforced concrete headstock with a curtain wall supported by square columns.

The abutments are protected from scour in the original drawings by 8" x 6" x15" stone pitching which appears to have been removed and replaced by conventional concrete filled revetment scour protection mattresses (see Figure 7-1).

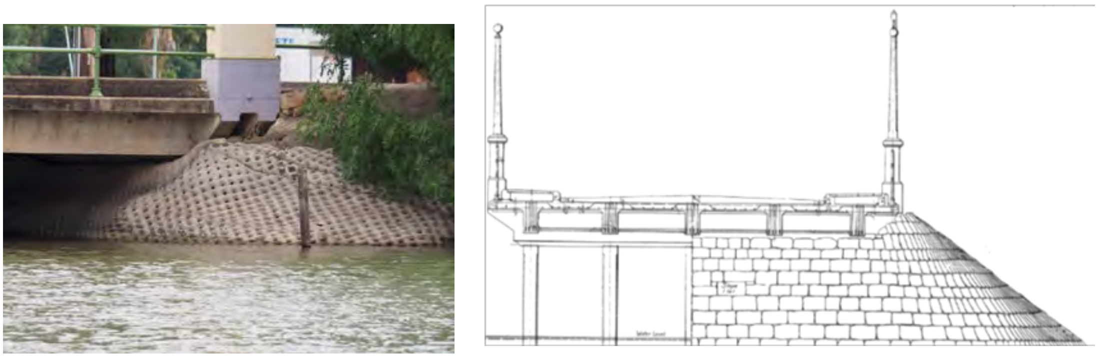


Figure 7-1 Abutment section (Source: FBE)

The abutments have no technical or aesthetic significance.

7.2.2 Piers 1 to 8

The form and fabric of Piers 1 to 8 is of LOW significance.

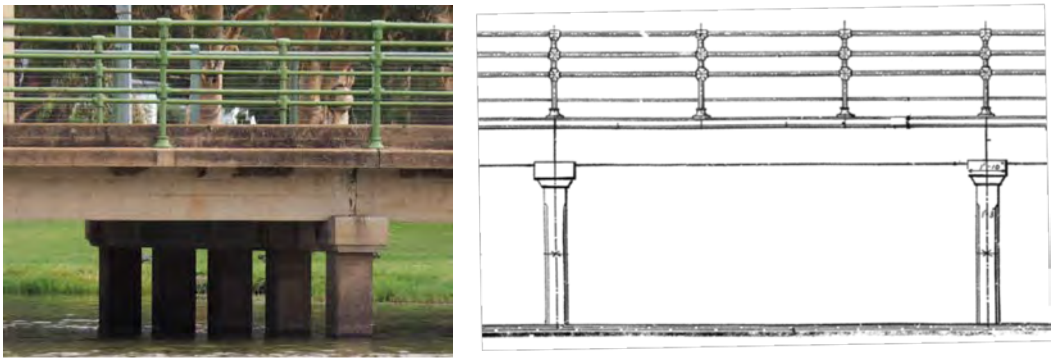


Figure 7-2 Pier and deck elevation (Source: FBE)

The piers comprise of reinforced concrete headstocks supported by square piers, without the chamfered corners shown in the original design and have no technical or aesthetic significance.

7.2.3 Approach spans 1 to 9

The form and fabric of the approach Spans 4 is of MODERATE significance.

The approach spans are constructed of simply supported reinforced concrete girders with a composite concrete deck. The girders sit on tar paper and there are end diaphragms between the girders. The integration of the small cantilevered deck, kerbing and pedestrian balustrade is aesthetically pleasing providing a shadow line for the superstructure profile (see Figure 2-2 and Figure 7-2). The concrete deck is cast integrally with the girders (see Figure 7-3).

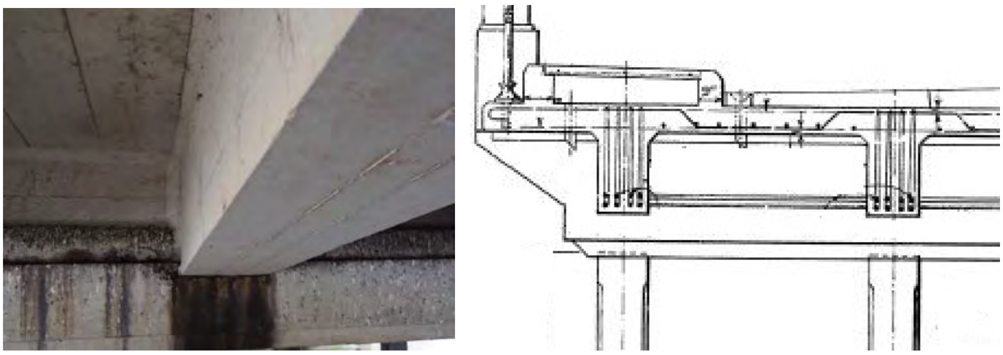


Figure 7-3 Deck span section (Source: FBE)

7.2.4 Pedestrian balustrade railing

The form and fabric of the pedestrian balustrade railing is of HIGH significance.

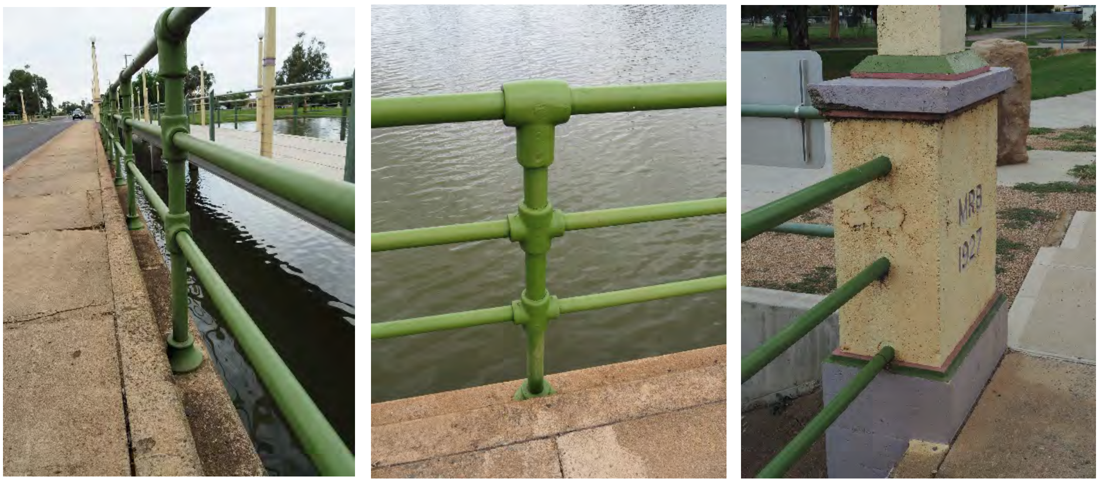


Figure 7-4 Pedestrian balustrade railing (Source: FBE)

The pedestrian balustrade is made up of a 2” diameter top rail and 1” diameter mid and bottom rails, with 1$^{1}/_{2}$” diameter vertical posts spaced at varying distances depending on the changing span lengths. The posts are anchored into the cantilevered section of the deck and the railing terminates in the lamp post bases (see Figure 7-4).

7.2.5 Art-deco lamp posts

The form and fabric of the art-deco lamp posts is of EXCEPTIONAL significance.

There are two types of lamp posts with either a single luminaire (see Figure 7-5) or double luminaires (see Figure 7-6).

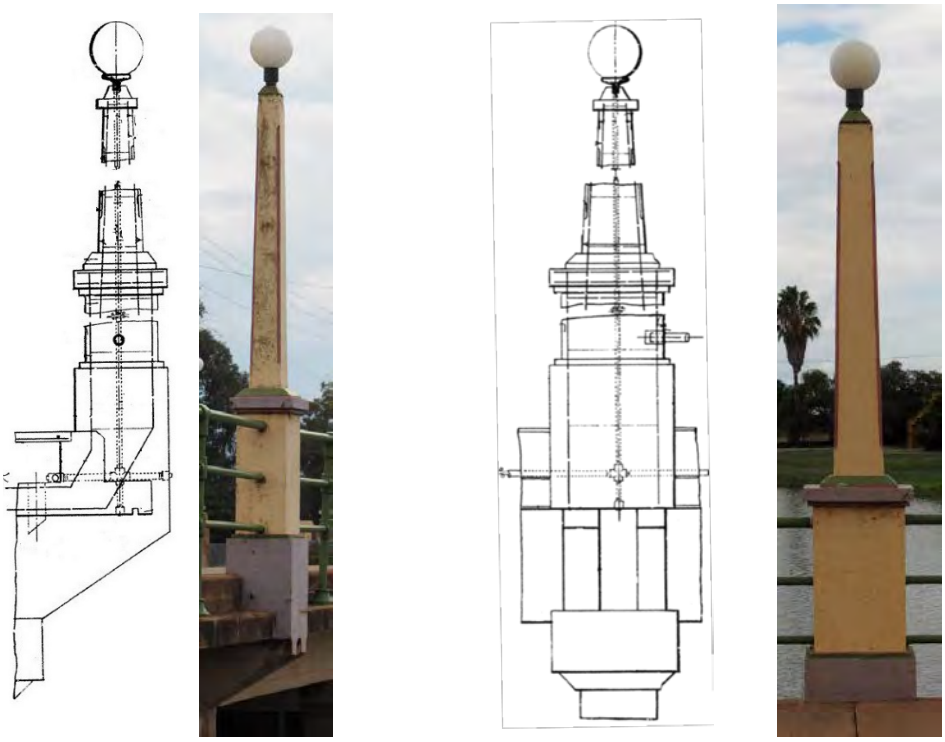


Figure 7-5 Single luminaire lamp post (Source: FBE)

There are four (4) single luminaire lamp posts which appear to be intact and as per the original 1926 design drawings. However, the four (4) double luminaire lamp posts appear to have been altered with modified cross arms and luminaire orientation.

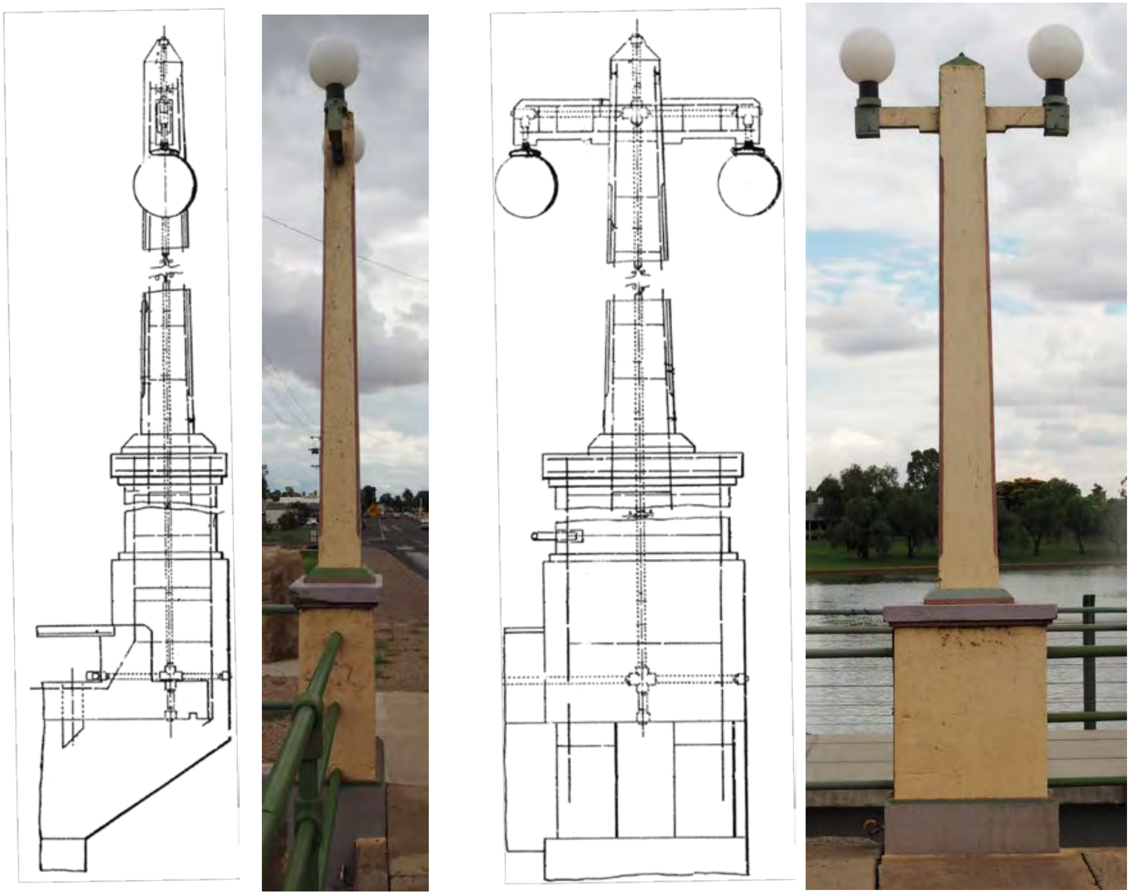


Figure 7-6 Double luminaire lamp posts (Source: FBE)

The original design shows the luminaire on the underside of the concrete cross arms, whereas the site photographs show a modified cross arm and the luminaires inverted and on top of new steel mountings (see Figure 7-7).

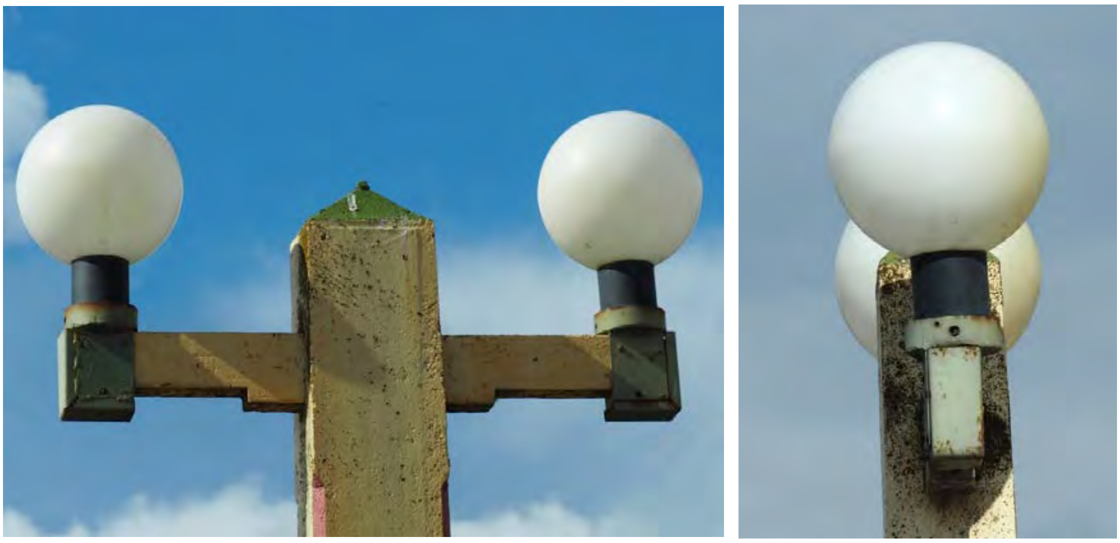


Figure 7-7 Modified double luminaires (Source: FBE)

The lamp posts and luminaires are good examples of art-deco bridge features of that era and are painted in colours which enhance their architectural features.

Unfortunately, modifications to the double luminaires is not ideal and contributes to the downgrading of their significance. Furthermore, the new pedestrian bridge also contributes to lessening the visual and aesthetic impact of the original art-deco lamp posts by adding twenty-two (22) replica single luminaire lamp posts. This leads to the original fabric being lost amongst a forest of newly painted lamp posts; see the next section for more commentary.

The lamp posts appear to have some graffiti, localised concrete cracking and spall but are otherwise in fair condition.

The lamp posts and luminaires have technical merit and aesthetic significance.

7.2.6 New pedestrian bridge

The form and fabric of the adjacent new pedestrian bridge is INTRUSIVE.

The new pedestrian bridge intrudes significantly upon the overall aesthetic of the original bridge. Unfortunately, the twenty-two new bridge lamp posts obstruct and hide the eight existing 1927 lamp posts which are of interest. The new lamp posts appear to replicate the existing single luminaire lamp posts in terms of colour, taper and luminaire globe shape and orientation.

Figure 7-8 New pedestrian bridge (Source: FBE)

Figure 7-9 New pedestrian bridge lamp posts (Source: FBE)

The original bridge aesthetics would have been served much better by the new pedestrian bridge providing a similar or shallower deck profile, with street lighting at balustrade level and not trying to replicate the existing bridge lamp posts and luminaires.

7.3 Summary of heritage significance

The significance of each bridge element or section has been summarised in Table 7-2:

Table 7-2 Summary of heritage significance (Source: FBE)

Bridge component	Significance grading
Abutment A and B	Intrusive
Piers 1 to 8	Low
Approach spans 1 to 9	Moderate
Pedestrian balustrade railing	High
Lamp posts	Exceptional
New pedestrian bridge	Intrusive
Overall significance	Moderate

The new pedestrian bridge has significantly impacted upon the visual aesthetic of the original bridge, in particular the more significant elements including the pedestrian balustrade railing and lamp posts.

Consequently, Camp Street Bridge is assessed as being of MODERATE overall significance at a LOCAL level.

The 2006/7 heritage study of pre-1948 concrete beam road bridges for Northern, Hunter and Western Regions by Burns and Roe Worley found the bridge to be of LOCAL significance.

8. The proposed works

8.1 Background

The internal Roads and Maritime brief for the project number A/80045 was issued by the Bridge Maintenance Planner on the 29 October 2015. The project objective was to replace the existing bridge over Lake Forbes with a new reinforced concrete bridge. However, before committing to replacing this heritage structure Roads and Maritime wished to:

- Establish the bridge condition, including existing durability.
- Explore and confirm maintenance strategies and their viability.
- Develop and confirm bridge replacement feasibility.

Consequently, FBE in conjunction with Roads and Maritime Services completed a strategic options report.

8.2 Strategic options summary

The strategic options considered:

1. Maintenance strategies.
   - 1A. Medium term to 2035.
   - 1B. Long term to 2070.
2. Replacement strategy.

Consequently, the most cost effective approach confirms Roads and Maritime Services preference to replace the bridge subject to heritage approvals. The strategic cost estimates are summarised in Table 8-1.

Table 8-1 Strategic options cost estimates (Source: FBE)

Option	Description	Contingency included	Cost estimate (excluding GST)
1. Maintenance options			
1A	Medium term to 2035	50%	$3,090,000
1B	Long term to 2070	50%	$16,517,000
2. Bridge replacement option			
2	Demolish and replace	50%	$7,500,000

The following Section 10 for maintenance strategies and Section 11 for replacement strategies provides the key extracts and supporting decision making aspects from that report.

9. Option 1 - maintenance options

The viability, risk and strategic cost to maintain the bridge in the medium and long term was assessed as follows. Furthermore, each maintenance strategy will have to cater for rehabilitating and/or upgrading the bridge to cater for HML vehicles.

9.1 Option 1A: Medium term - bridge replaced by 2035

The medium term scope of works is slightly harder to establish as the life of the bridge is now extended beyond the usually anticipated 100 years. However, early and more direct intervention of the current bridge maintenance issues may extend the bridge's life:

9.1.1 Inspections

- Level 2 inspections every 2 years.
- Level 3 inspections every 10 years.
- Underwater inspections every 4 years.

9.1.2 Routine maintenance

Annual activities:

- Clean bridge scuppers and remove vegetation.
- Graffiti removal.
- Minor repairs pedestrian balustrade.
- Street lighting checks, replace bulbs and fuses, etc.
- Replace damaged signs.

9.1.3 Minor maintenance

- Patch repair all concrete spalls annual allowance.
- Patch paint repairs to the steel pedestrian balustrades.
- Replace small movement joints to all concrete spans.

9.1.4 Major maintenance

- Concrete repairs to all damaged areas and apply sacrificial cathodic protection (SCP) system for 3 m length of the pile above mid-water level. It is expected this would extend the life by 10 to 15 years.
- Mill off deck seal, apply water proof membrane to the deck and re-asphalt.

9.2 Option 1B: Long term - bridge retained until at least 2070

The long term scope of works would require more significant major maintenance and earlier intervention to extend the bridge life for another 50 years:

9.2.1 Inspections

- Level 2 inspections every 2 years.
- Level 3 inspections every 10 years.
- Underwater inspections every 4 years.

9.2.2 Routine maintenance

Annual activities:

- Clean bridge scuppers and remove vegetation.
- Graffiti removal.
- Minor repairs to pedestrian balustrades.
- Street lighting checks, replace bulbs and fuses, etc.
- Replace damaged signs.

9.2.3 Minor maintenance

- Replace small movement joints every 20 years.
- Maintain concrete annual allowance.

9.2.4 Major maintenance

Pier rehabilitation or replacement

At this stage it is possible to either rehabilitate or replace the existing piers:

1. Rehabilitate piers

This technique would involve substantial demolition of the damaged piers and re-casting the existing pier columns. It may be possible to strengthen the piers by the application of additional reinforcement.

However, the main concern on rehabilitation projects is the unknown scope of work which may increase as corroded reinforcement is exposed resulting in significant time and cost penalties. The bridge may also need to be load limited or closed during the works.

In addition, rehabilitation would almost certainly require the application of an impressed current cathode protection (ICCP) system to prevent further corrosion. The CTI report highlighted that there was no electrical continuity between the piers and superstructure making any ICCP applied to the piers less efficient and therefore less cost-effective.

Advantages

- Less expensive than replacement.
- Reasonable durability and 25-year design life should be achievable.

Disadvantages

- Not possible to strengthen all the piers to cater for HML loads.
- Working at heights over water to install, with limited access and headroom.
- Long term durability unlikely to meet 50 years.

2. Replace piers

This option would involve completely demolishing the existing piers and replacing insitu. The new piers would require extensive temporary falsework either side of the existing piers whilst the new piers are constructed with limited headroom and side access due to temporary supports.

The cost to re-cast and apply ICCP is likely to be less expensive than underpinning the bridge with new piers. However, the piers that are rehabilitated would still have very high levels of carbonation, high chloride levels and lack of cover generally. It is also impossible to improve the structural capacity of the existing piers.

Therefore, for the purposes of this report we have adopted the option to replace the piers.

Advantages

- Possible to strengthen all the piers to cater for HML loads.
- Good durability.
- 50-year plus design life should be achievable.

Disadvantages

- More expensive than rehabilitation.
- Working at heights over water to install, with limited access and headroom.

Temporary works

To either rehabilitate or replace the existing piers would require significant temporary works. The typical temporary works arrangement that could be used to undertake this work is shown in Figure 9-1.

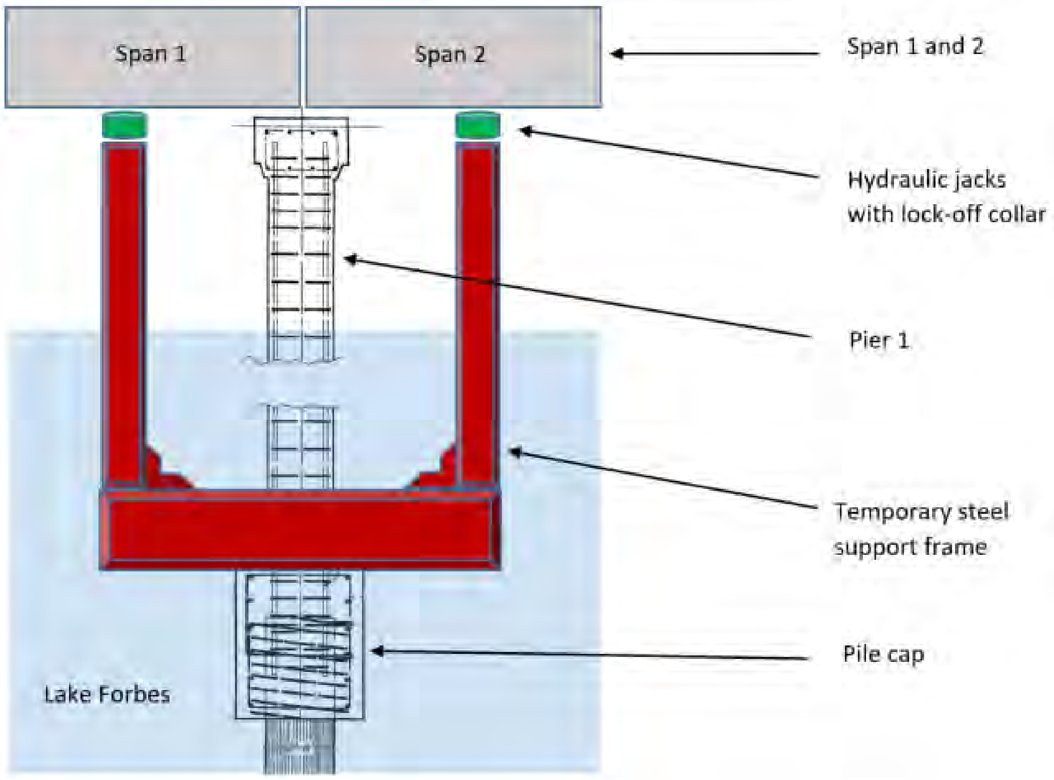


Figure 9-1 Typical temporary support frame to rehabilitate or replace piers (Source: FBE)

Superstructure strengthening

There are two predominant external strengthening option types to the main span reinforced concrete girders:

1. Active strengthening by the application of post tensioning

The use of external prestressing as a means of strengthening or rehabilitating existing bridges has been used in many countries and has been found to provide an efficient and economical solution for a wide range of bridge types and conditions.

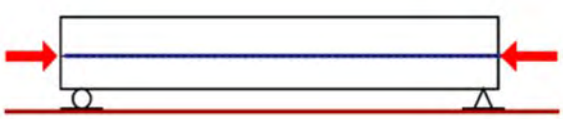



Figure 9-2 Typical post tensioing using stressbars (Source: FBE)

The technique has been relatively popular due to the speed of installation and minimal disruption to traffic (see Figure 9-2).

The principle of external post tensioning is the same as that of prestressing, i.e. the application of an axial load combined with a hogging bending moment to increase the flexural capacity of a beam and improve the reinforced concrete cracking performance. It can also have a beneficial capacity on shear capacity.

Post tensioning as a means of strengthening existing bridges has been in use since the 1950's and there are many examples of its use throughout the world. In general, the prestress is applied through prestressing cables that are either single or grouped strand or alternately the stress can be applied through high tensile bars. In a few cases the stress has been applied using more unconventional techniques, for example the stress in a tendon can be developed by anchoring a straight tendon in place and imposing a deflection at mid-span.

Advantages

- Relatively quick installation and inexpensive solution.
- Proven technology.
- Reasonable durability.
- 25-year plus design life should be achievable.

Disadvantages

- Visual impact on the bridge.
- Working at heights over water to install, with limited access and headroom.
- Drilling and installing of deviators and anchorages.
- Long term durability unknown.
- Regular monitoring of adequate stresses in the post tensioning system required.
- Regular monitoring of bridge performance recommended.

It is also likely additional maintenance would be required to ensure the concretes long term durability including a cathodic protection system and/or coating.

2. Passive strengthening by the application of fibre reinforced polymer (FRP)

Fibre reinforced polymer (FRP) can be used to improve flexural, shear or axial strength or a combination of these. The main methods of strengthening using FRP include:

- External bonding of FRP composite sheets and strips to beams and slabs.
- Wrapping with FRP composites, for example in the external confinement of piers or columns.

FRP strengthening has been used on a number of bridges in Australia, but has probably not been used as extensively as external post tensioning using strand or stressbars.

The most common fibres used in strengthening materials for external repairs and strengthening are carbon, aramid and glass. The selection for particular applications depends on many factors including material properties, type of component to be strengthened, loading history, temperature, moisture and environmental constraints.

In addition, the type of FRP to be used is also dependent on chemical, impact, fire and ultraviolet light resistance, strength, elastic modulus, electrical conductivity, etc.

There are three main types of commercially available externally bonded FRP systems; wet lay-up, prepreg and precured systems.

Advantages

- No active stresses applied to the structure.
- May improve concretes long term durability.
- Potentially effective and light weight installation.
- Likely to significantly improve shear capacity.

Disadvantages

- Working at heights over water to install, with limited access and headroom.
- Complex installation.
- Insitu performance unknown.
- Shear or tension delamination of the concrete cover.
- Potential localised FRP failures due to localised high stresses.
- Reliance on effective bond strength to concrete surface.
- Durability performance unknown.

For the purposes of this report we have adopted the FRP prepreg solution (see Figure 10-3) as this can be applied globally to the beams to improve both the shear and flexural capacity.

It is likely that shear capacity would be an issue for the beams and post tensioning does not so readily solve this.

There may also be some advantage in the application of FRP in improving the overall long term durability performance of the concrete and prevent further carbonation and effectively improve the concretes cover.

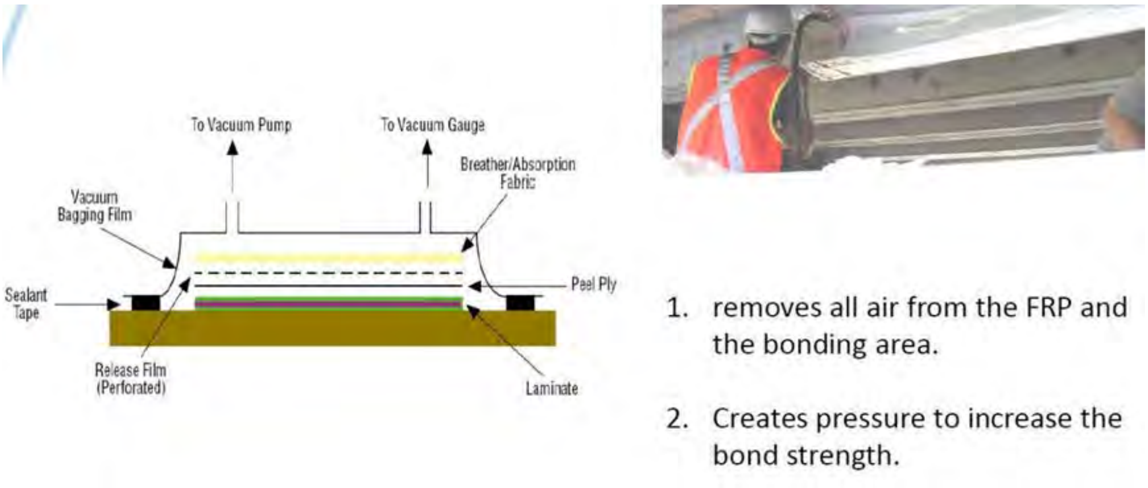


Figure 9-3 Typical prepreg FRP system (Source: FBE)

10. Option 2 - bridge replacement

At this preliminary strategic options stage Roads and Maritime Services has advised it is considering an on-line bridge replacement (see Figure 10-1).

Figure 10-1 Strategic concept bridge layout (Source: RMS)

The new bridge structure would be designed in accordance with Australian Standard AS5100: Bridge Design and have a 100 year design life. The new bridge would be designed in accordance with the specified design loading of SM1600 and HLP400 vehicles with load factors to AS5100.2. This would adequately cater for any current RAV or HML route requirements.

Roads and Maritime Services current preference is to use shallow spaced prestressed concrete planks which is a standard bridge design typically favoured by State Road Authorities. The proposed bridge would be built on the current road alignment after the existing bridge is demolished and new bridge constructed. During this period a local detour would be in place.

10.1 New bridge aesthetics

Roads and Maritime Services has set a number of urban design objectives during the early consideration of bridge replacement options as shown in Figure 10-2 and 10-3.

Items specific to the bridge that may need to be considered to suit any bridge aesthetics objectives include:

- Local context and adjacent parkland features.
- Symmetry, proportion, parapet profile and external shape.
- Pier shape, profile, orientation and spacing.
- Joints, connections and drainage.
- Signage, lighting and surface finishes.

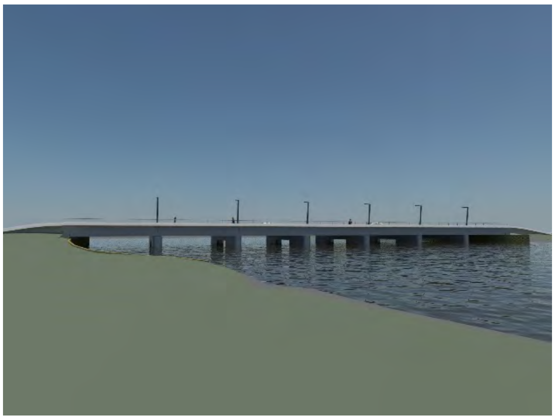


Figure 10-2 Preliminary bridge aethetics (Source: RMS)

Figure 10-3 New bridge photomontage (Source: RMS)

The Roads and Maritime team has recognised that this is a “gateway” bridge into Forbes.

10.2 New bridge geometry

Roads and Maritime Services requires the following cross section for the new bridge:

- Number of lanes: Two (2).
- Lane width: 3.500 m.
- Shoulder width: 1.000 m.
- Bridge width between traffic barrier kerbs: 9.000 m.
- Cross fall: Two way cross-fall at 3%.
- Number of footways: One (1) on upstream side.
- Width of shared footway: > 2.500 m.

Any new bridge geometry would be designed in accordance with Clause 9 Geometric requirements of AS5100.1.

10.3 New bridge lighting

At this early stage Roads and Maritime have allowed for street lighting on the upstream shared footpath side of the new bridge (see Figure 10-4).

Figure 10-4 Proposed bridge lighting (Source: RMS)

11. Statement of Heritage Impact

The following questions are presented in the NSW Heritage Manual document "Statements of Heritage Impact" as the minimum response required to properly address proposals on heritage items which would result in the removal of original fabric.

11.1 Brief description of the proposal

Roads and Maritime Services preferred and proposed solution is to:

- Demolish the existing bridge.
- Replace the existing bridge on the current alignment.
- Design new reinforced concrete bridge to be sympathetic with the surrounding urban and park landscape.
- Existing art-deco lamp posts to be removed, repaired and relocated to the road approaches and/or parkland.
- Develop heritage interpretation plan and signage.

Roads and Maritime is currently undertaking the landscape design (Appendix B), bridge visualisations (Appendix C) and bridge concept designs. In conjunction with this development process Roads and Maritime are undertaking community and local government consultation.

The new bridge will be able to cater for the HML vehicles whilst providing a gateway bridge with visual impact and providing aesthetic appeal to pedestrians and park users.

11.2 What aspects of the proposal respect or enhance the heritage significance of the bridge?

The new bridge is of a similar form as follows:

- Concrete bridge.
- Multiple short spans.
- Shallow deck depth.
- Low level.
- Retain street lighting.
- Retaining walkways.

Additional features and enhancements:

- Wider promenade boulevard type walkways on both sides.
- Gateway feature street lighting.
- Additional feature lighting including handrailing, span soffit and piers.
- Integrated blade piers for improved capacity, durability and remove flood debris build up.

Consequently, the proposed new bridge would provide an up to date and modern structure that will be well detailed and potentially enhance the appearance of the bridge as a gateway entrance into Forbes.

11.3 What aspects of the proposal could have a detrimental effect on the heritage of the bridge?

The bridge replacement means the complete demolition of the existing bridge. The assessment contained in this report has attributed a LOCAL (i.e. minor) level of significance to this bridge. It therefore follows that the demolition of the bridge will have an impact. Again, the reasons for the replacement have been detailed throughout this report.

However, before demolition the existing art-deco lamp posts from the old bridge shall be carefully removed and retained for use elsewhere.

From a conservation perspective the long term maintenance strategies to replace the piers and strengthen the girders would be visually intrusive and would compromise the overall heritage value of the bridge. The high heritage balustrade railing is found commonly on Roads and Maritime concrete and steel bridges and is not proposed to be re-used.

Consequently, replacing the bridge with a sympathetic structure whilst adaptively re-using the exceptional value art-deco lamp posts appears less detrimental to the overall and key items of significance.

11.4 Have more sympathetic solutions been considered and discounted? Why?

This report details the where the following options have been considered:

1. **Option 1: Maintenance**

   Section 10 details the maintenance strategies including the medium and long term options. This included the scoping and cost estimates to maintain, repair, rehabilitate, strengthen and upgrade.

2. **Option 2: Replacement**

   Section 11 details the bridge replacement strategic options and visualisations.

3. **Option 3: Do nothing**

   The do nothing option is not considered feasible.

From the outset Roads and Maritime Services has been conscious of establishing and reviewing all feasible options. Furthermore, Roads and Maritime has recognised the heritage significance and gateway landmark the existing bridge provides when entering or leaving the township of Forbes.

The existing bridge is in poor condition and damaged in sections. In addition, the bridge requires significant, costly and difficult maintenance that is unlikely to prolong the bridges remaining life in the medium term.

In the long term significant and fabric altering maintenance, rehabilitation and capacity upgrade work would be required including underpinning with new piers and visually intrusive strengthening works to the superstructure.

11.5 Is the alteration sympathetic to the bridge? In what way?

Roads and Maritime has expended considerable bridge engineering, architectural and urban landscape design resources to ensure the new bridge is a worthy gateway replacement structure.

The aim has been to ensure that the new bridge is sympathetic to the old bridge design in terms of location, form, fabric and functionality, whilst also considering the surrounding landscape.

The following items have been considered key in achieving the aesthetic objectives to ensure a sympathetic replacement structure:

- Local context and adjacent parkland features to be retained or enhanced.
- Symmetry, proportion, parapet profile and external shape to closely match or improve on the existing.
- Pier shape, profile, orientation and spacing to closely match the existing bridge.
- Joints, connections and drainage.
- Signage, lighting and surface finishes improved to enhance the quality of this gateway entry bridge into Forbes.

In addition, Roads and Maritime intend to repair and adaptively re-use the four art-deco lamp posts in the parkland on the approaches to the new bridge.

12. Examples of decorative lamps posts on concrete bridges in NSW

FBE has reviewed over 4000 images from the four reinforced concrete beam bridge studies completed by BRW. Additional bridge examples have also been included, but the following examples of decorative lamp posts is not meant to be exhaustive but provide background to the recommendations made in this report.

12.1 From Northern, Hunter and Western Region study

There are two examples; one from northern region (see Figure 12-1) and one from western region (see Figure 12-2).

Figure 12-1 Federation Bridge BN2585, Mullumbimby (Source: RMS)

Figure 12-2 Mandagery Creek 2 Bridge BN4571, Eugowra (Source: RMS)

12.2 From Sydney, Southern and South West Region study

There are four examples; two from south west region (see Figure 12-3 and 12-4) and two examples from Sydney Region (see Figure 12-5 and 12-6).

Figure 12-3 Ten Mile Creek Bridge BN5444, Holbrook (Source: RMS)

Figure 12-4 Burrangong Creek Bridge BN6427, Young (Source: RMS)

Figure 12-5 Long Gully Bridge BN172, Northbridge (Source: RMS)

Figure 12-6 Lennox Bridge, Parramatta (Source: RMS)

12.3 Other examples

The example below is not a Roads and Maritime Services owned bridge but a Council structure.

Figure 12-7 Hanlon Bridge, Young (Source: RMS)

12.4 Brief comparative analysis

The following Table 12-1 provides a basic comparison of these examples against Camp Street Bridge.

Table 12-1 Comparative analysis of decorative lamp posts (Source: FBE)

Bridge, location	Age	Number of Luminaire per post	Luminaire arms per post	Total number of posts	Apparent style and condition
Long Gully Bridge, Northbridge	1892 & 1939	1	Cantilever	8	Romanesque revival? Original
Camp Street Bridge, Forbes	1927	3 or 1	Double arm or n/a	4	Art-deco, modified double arm luminaires
Federation Bridge, Mullumbimby	1930	2	Double arm	4	Art-deco, modified luminaires?
Burrangong Creek, Young	1932	2	Double arm	4	Art-deco, original luminaires
Hanlon Bridge, Young	Unk.	2	Double arm	4	Art-deco, original luminaires
Lennox Bridge, Parramatta	1839 & 1934	3	Double arm	4	Art-deco, original luminaires
Ten Nile Creek Bridge, Holbrook	1941	1	n/a	4	Art-deco, original luminaires
Mandagery Creek Bridge, Eugowra	1942	1	n/a	4	Art-deco, original luminaires

From the initial brief comparative analysis, it appears that Camp Street Bridge has the following attributes:

- Potentially the first example of art-deco lamp posts.
- Only example with both single luminaire and double arm triple luminaire posts on the same bridge.
- One of only two bridges with 3 luminaires per post.

To confirm the above further study of the NSW concrete bridge stock would be required and this is currently outside the scope of this engagement.

13. Conclusions

Camp Street Bridge is considered to be in poor condition and appears to require considerable expenditure to maintain in either the medium or long term.

The cost to replace the bridge appears to be more economical than costly and difficult maintenance. Furthermore, from an operational perspective a new bridge is a considerably more viable prospect for the current HML route, the local community and in terms of sustainable use of resources and mitigating future asset management risk.

Camp Street Bridge has been found to be of moderate overall heritage significance at a local level. The majority of the individual components appear to be of low or intrusive significance, although the pedestrian balustrades are of high significance and the art deco lamp posts are considered to be exceptional. Consequently, if a bridge replacement strategy is adopted it is suggested some appropriate recognition of the art-deco features be given either by incorporation into the new bridge design or developed as a standalone aspect as part of a heritage interpretation strategy.

14. Recommendations

Camp Street Bridge has reached the end of its useful life and the proposed bridge replacement is being completed appropriately with respect to the old bridge and the future usage requirements.

As noted in Section 8 Camp Street Bridge has been assessed as being of MODERATE overall significance at a LOCAL level. However, the separate components of Camp Street Bridge are of varying levels of significance with the majority having been assessed of INTRUSIVE, LOW or MODERATE significance. The balustrade railing and art-deco lamp posts have been assessed of HIGH or EXCEPTIONAL significance respectively.

Consequently, we make the following recommendations:

1. Detailed quality photographic recording of the bridge be completed prior to the work commencing. Any images taken would be placed on the Roads and Maritime Services bridge files and could be utilised in any heritage interpretive signage. Copies would also be provided to the State Library of NSW as a heritage resource for future researchers.
2. Develop and implement a heritage interpretation plan.
3. S170 register be amended to reflect the changes.
4. All necessary precautions are to be taken during the proposed works to avoid where possible damage to the art-deco lamp posts. To achieve this a works methodology should be prepared to ensure this prior to commencement.
5. Ensure continued safe usage and access to the Forbes lake and parkland and bridges users at all times, including temporary fencing to any of the proposed work areas.

15. References

Focus Bridge Engineering Camp Street Bridge Strategic Options and Engineering Heritage Assessment Report dated June 2017.

Burns, Roe and Worley (BRW) and Heritage Assessment and History (HAH) Study of Heritage Significance of Pre-1948 RTA Controlled Concrete Beam Road Bridges for Northern, Hunter and Western Regions, Report 3 in 2006.

Some Notes on the History of Concrete Bridges in N.S.W. by L.H. Evans Unpublished manuscript, stamped March 1986, held by RTA library, Parramatta.

Early Reinforced Concrete in New South Wales (1895-1915) by D. J. Fraser Engineering Transactions of the Institution of Engineers Australia, 1985.

John Monash Engineering Enterprise Prior to World War I- Introduction of Monier concrete to Victoria, Australia http://home.vicnet.net.au/~aholgate/welcome.html

How to Look at Bridges, A Guide to the study of Australian Historic Bridges by Colin O'Connor, Institution of Engineers Australia 1985.

W.H. Warren, " Investigations in regard to the comparative strength and elasticity of Portland Cement Mortar and Concrete when reinforced with Steel Rods and when not reinforced'. *Journal of the Royal Society of NSW*, Vol. XXXVI, 1902, pp.290-313; "Further Experiments on the Strength and Elasticity of Reinforced Concrete", *Journal of the Royal Society of NSW*, Vol. XXXViiI, 1904, pp.140-189; "Reinforced Concrete, Paper III', *Journal of the Royal Society of NSW*, Vol. XXXIX, 1905, pp.49-64.

Appendices

Appendix A – Durability assessment results summary

BRIDGE DURABILITY ASSESSMENT SUMMARY

In 2015 CTI Consultants were engaged by Roads and Maritime to complete a comprehensive durability assessment of the overall condition of the bridges concrete. Consequently, CTI completed a field inspection along with a suite of site and laboratory testing including a defect survey, concrete and steel reinforcement assessment.

1.1 Defect survey

The defect survey generally aligns with the Level 2 and underwater pile inspection records.

1.1.1 Piers

Table 1 shows a summary of the pier defects found by CTI Consultants.

Table 1 Pier defect survey (Source: CTI)

Pier	Pile					
	1	2	3	4	5	% Damage
1	None	None	None	Cracks	None	20%
2	None	None	None	None	None	0%
3	Drummy	None	Cracks	None	Cracks	60%
4	None	None	None	Cracks	Spalling and cracks	40%
5	Cracks	Cracks	Spalling and cracks	Cracks	Cracks	100%
6	Cracks	Cracks and spalling	Cracks and spalling	Cracks and spall	Cracks and spalling	100%
7	None	None	None	Cracks	None	20%
8	Cracks	Spalling and cracks	Cracks and drummy	Fine cracks	None	80%

There is significant damage recorded to approximately 50% of the 40 piles. This equates accurately with Commercial Diving Services observations with 20 pile defects at condition state 3 at or above water level. We can conclude that the pier piles are in poor condition.

1.1.2 Headstocks

CTI noted that damage to the headstocks and diaphragms was less frequent.

1.1.3 Girders

CTI noted that the girders were mostly free from obvious defects apart from hair line cracks and end spall over the piers.

1.2 Concrete assessment

The concrete condition was assessed as follows:

1.2.1 Compressive strength

Using the CTI core results, the worst credible compressive strength has been calculated by FBE at 45 MPa as follows:

W.C.S = $\sum f_c/100n\ (100-16/(n)^{1/2})$

where:

- n = number of cores (8).
- $\sum f_c$ = sum of estimated in situ concrete core strength (381 MPa).

The drawings specify class A concrete which should be around 17 MPa, so the insitu concrete has significantly higher compressive strength than that catered for in the design.

1.2.2 Carbonation

The extent and depth of carbonation is quite high (see Table 2).

Table 2 Depth of carbonation (Source: CTI)

Location	Depth of carbonation (mm)	Depth of carbonation (as % of design cover)
Pier 2 Col 2	9-12	27%
Pier 2 H/stock	54	85%
Pier 2 Col 3	31-37	83%
Pier 5 Col 3	24	54%
Pier 5 H/stock	35-45	71%
Pier 5 Col 4	17-20	45%
Pier 8 Col 3	35	79%
Pier 8 H/stock	20-30	47%
Pier 8 Col 4	0-9	20%
Beam 3 Span 8	24-33	87%
Deck Span 1	20-26	102%

It is generally accepted that the rate of the carbonation reaction is inversely proportional to the square root of the age of the structure. However, the rate of carbonation varies with age, exposure, quality of concrete and location on the bridge.

Therefore, the depth of carbonation for good quality concrete should not exceed (Age years)$^{1/2}$, so a 100 year design life should result in 10 mm depth of carbonation. Consequently, Camp Street Bridge is 90 years old and carbonation depths should not have exceeded 9.5 mm.

1.2.3 Chloride gradients

Standards Australia HB 84: Guide to concrete repair and protection refers to 0.4% bwoc as the accepted threshold before corrosion is considered dangerous and above 1.0% bwoc as very dangerous (see Figure 1 as an example).

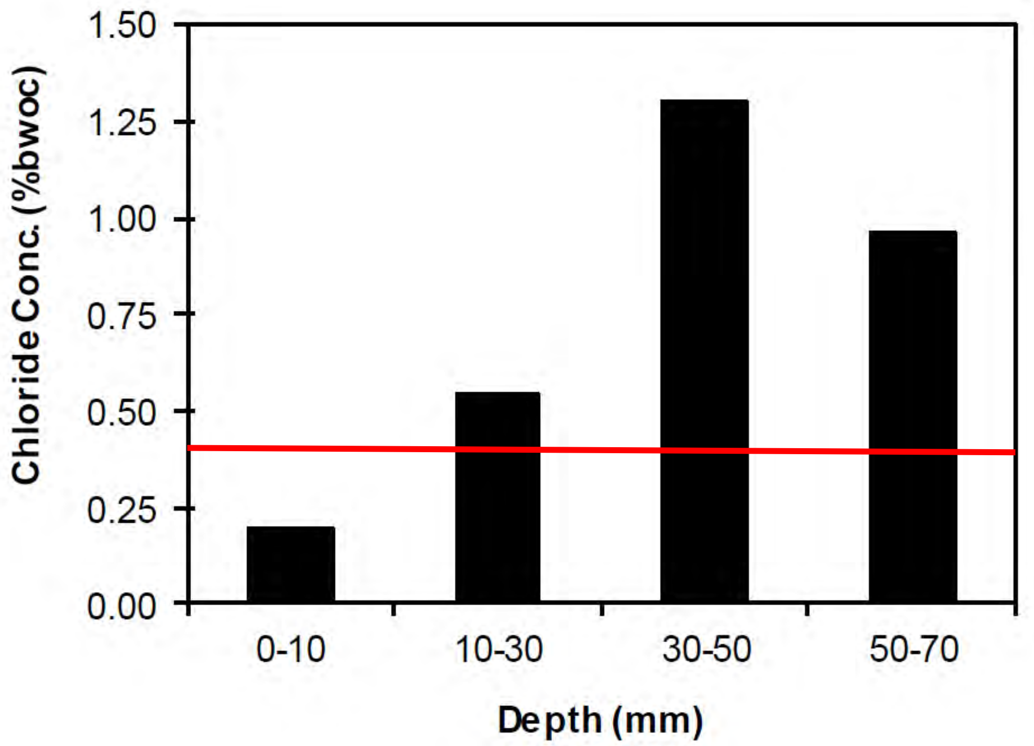


Figure 1 Pier 5 Column 4 at mid-height (Source: CTI)

In this instance the bridge was found to have high chloride contents against depth in the piers indicating calcium chloride accelerating admixtures.

1.3 Steel reinforcement assessment

The steel reinforcement condition was assessed as follows:

1.3.1 Half-cell potential survey

Whilst care has to be taken in the splash zone the CTI results showed that the highest corrosion potentials were lower sections of the piles, however corrosion was observed as occurring some distance above the water level.

1.3.2 Reinforcement continuity

There is no electrical continuity between the piles and headstocks. This may make the installation of an Impressed Current Cathodic Protection (ICCP) system troublesome.

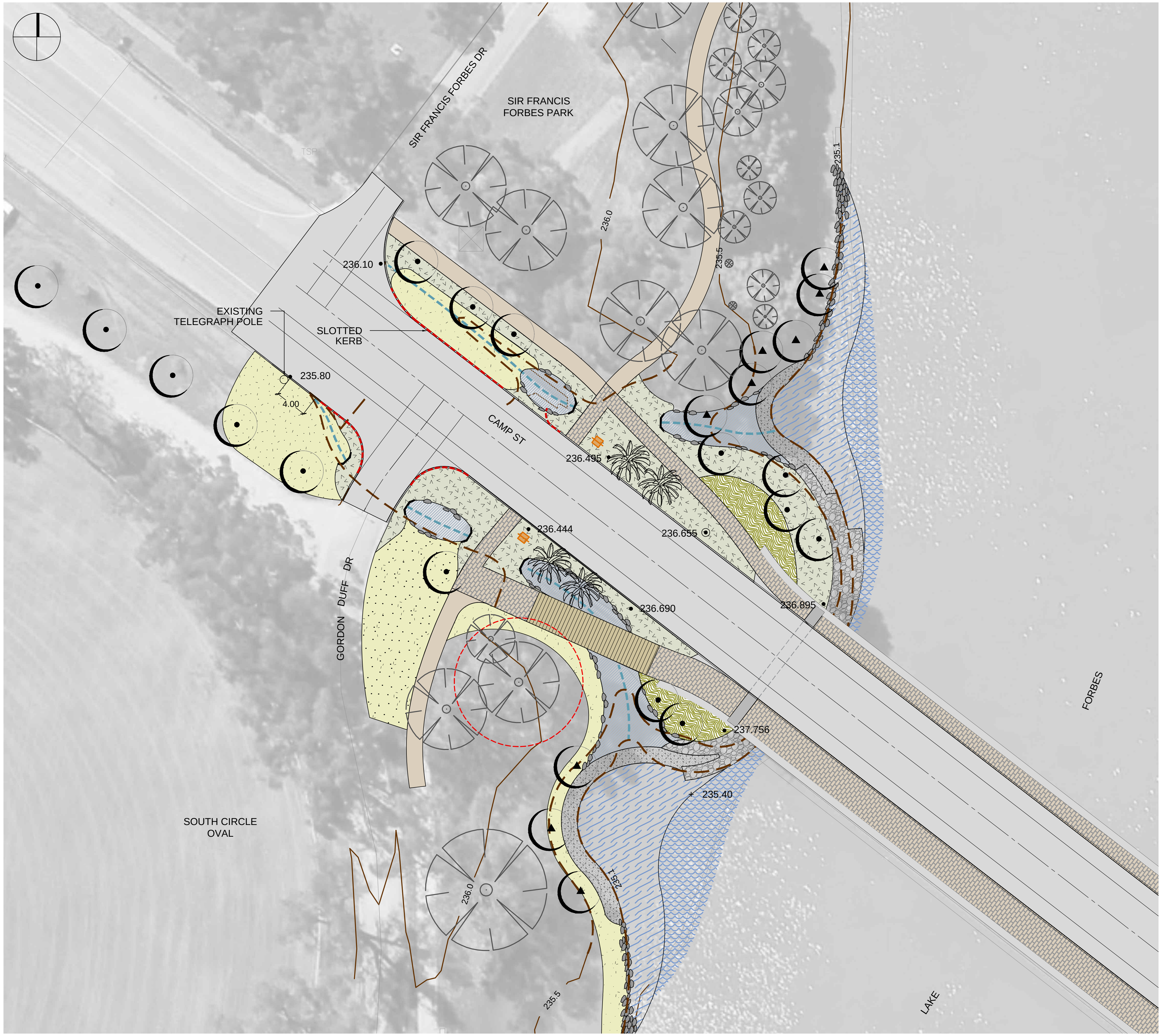
1.3.3 Cover survey

The results from the CTI cover survey have been summarised in Table 3 which appears to shows the bridge was generally built with less than the specified design cover. Furthermore, there were four instances where corrosion was observed.

Table 1 Steel reinforcement cover and condition (Source: CTI)

Location	Actual cover (mm)	Design cover (mm)	Difference (mm)	Condition
Pier 2 Col 2	39	44	-5	Clean
Pier 2 H/stock	75	64	9	Clean
Pier 2 Col 3	39	44	-5	Clean
Pier 5 Col 3	41	44	-3	Corroding
Pier 5 H/stock	60	64	-4	Clean
Pier 5 Col 4	41	44	-3	Heavy corrosion
Pier 8 Col 3	36	44	-8	Partly corroded
Pier 8 H/stock	53	64	-11	Clean
Pier 8 Col 4	32	44	-12	Partly corroded
Beam 3 Span 8	35	38	-3	Clean
Deck Span 1	70	74	-4	Clean

Appendix B – Landscape design



LEGEND

EXISTING ELEMENTS

- TREES PROTECTED & RETAINED
- TREE PROTECTION ZONE
- + 78.0 EXISTING LEVELS
- • 78.0 DESIGN LEVELS
- 236.0 CONTOURS (EXIST.)
- CONTOURS (DESIGN)

SURFACES & INCIDENTAL WORKS

PAVINGS

- CONCRETE PATH
- FEATURE PAVING

INCIDENTAL WORKS

- BOARDWALK
- CULVERT
- RELOCATED HISTORIC BRIDGE LAMP

WATER SENSITIVE URBAN DESIGN

- VEGETATED SWALE
- ROCK MULCH SWALE
- ROCK BOULDERS
- ROCK MULCH EDGE
- ROCK BANK
- WETLAND FILTER LAKE EDGE
- SLOTTED KERB
- RECLAIMED WATER EDGE

PLANTING

MASS PLANTING BED 1 - NATIVE GRASSES
- 100MM TUBES PLANTED @ 6/M²
- 200MM DEPTH CULTIVATION
- 150MM DEPTH TOPSOIL (UNLESS OTHERWISE SHOWN)
- 75MM DEPTH WOODCHIP MULCH

MASS PLANTING BED 2 - LOW SHRUBS
- TUBESTOCK @ 1/M² OR AS SHOWN
- 200MM DEPTH CULTIVATION
- 150MM DEPTH TOPSOIL (UNLESS OTHERWISE SHOWN)
- 75MM DEPTH WOODCHIP MULCH

TURF
- MIN. 75MM DEPTH TOPSOIL

TREE PLANTING

- *Eucalyptus camaldulensis* River Red Gum
- *Phoenix canariensis* Canary Island Date Palm
- *Casuarina cunninghamiana* River Oak

No.	Amendment Description	Initials	Date
02			
01	FOR INFORMATION	VO	20/07/2017

A3 original | This sheet may be prepared using colour and may be incomplete if copied

SCALES
0 5 10 15 20 25
SCALE 1:500m

Co-ordinate System: MGA Zone 56 | Height Datum: A.H.D.

level 3 studio 3 the cooperage
56 bowman street
pyrmont nsw 2009 australia
t +61 2 9571 7900
e info@kistudio.com.au
www.kistudio.com.au

DESIGNED JVG / VO
REVIEWED MW

ROADS AND MARITIME SERVICES
Forbes, NSW
CAMP ST BRIDGE
Landscape Design - West Foreshore
Surfaces, Incidental Works & Planting

FILE No.	DRAWING	PRINTED DATE	SHEET No.
16_32	DWG_LD_103	20/07/2017	02

REGISTRATION NUMBER
KIS-1632-DWG-LD

LEGEND

EXISTING ELEMENTS

- TREES PROTECTED & RETAINED
- TREE PROTECTION ZONE
- + 78.0 EXISTING LEVELS
- • 78.0 DESIGN LEVELS
- 236.0 CONTOURS (EXIST.)
- CONTOURS (DESIGN)

SURFACES & INCIDENTAL WORKS

PAVINGS

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- FEATURE PAVING

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level 3 studio 3 the cooperage
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pyrmont nsw 2009 australia
t +61 2 9571 7900
e info@kistudio.com.au
www.kistudio.com.au

DESIGNED. JVG / VO
REVIEWED. MW

ROADS AND MARITIME SERVICES

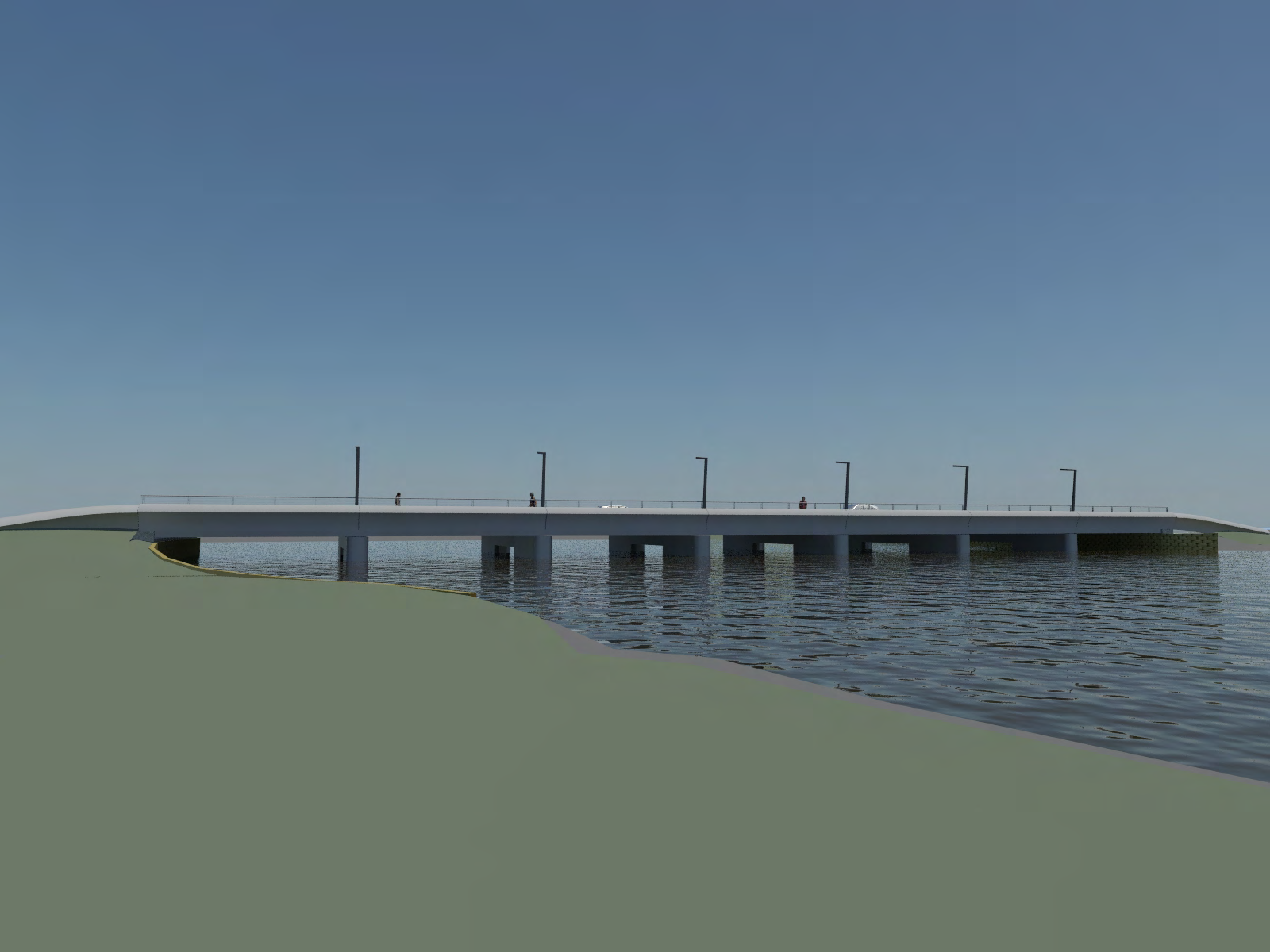
Forbes, NSW
CAMP ST BRIDGE

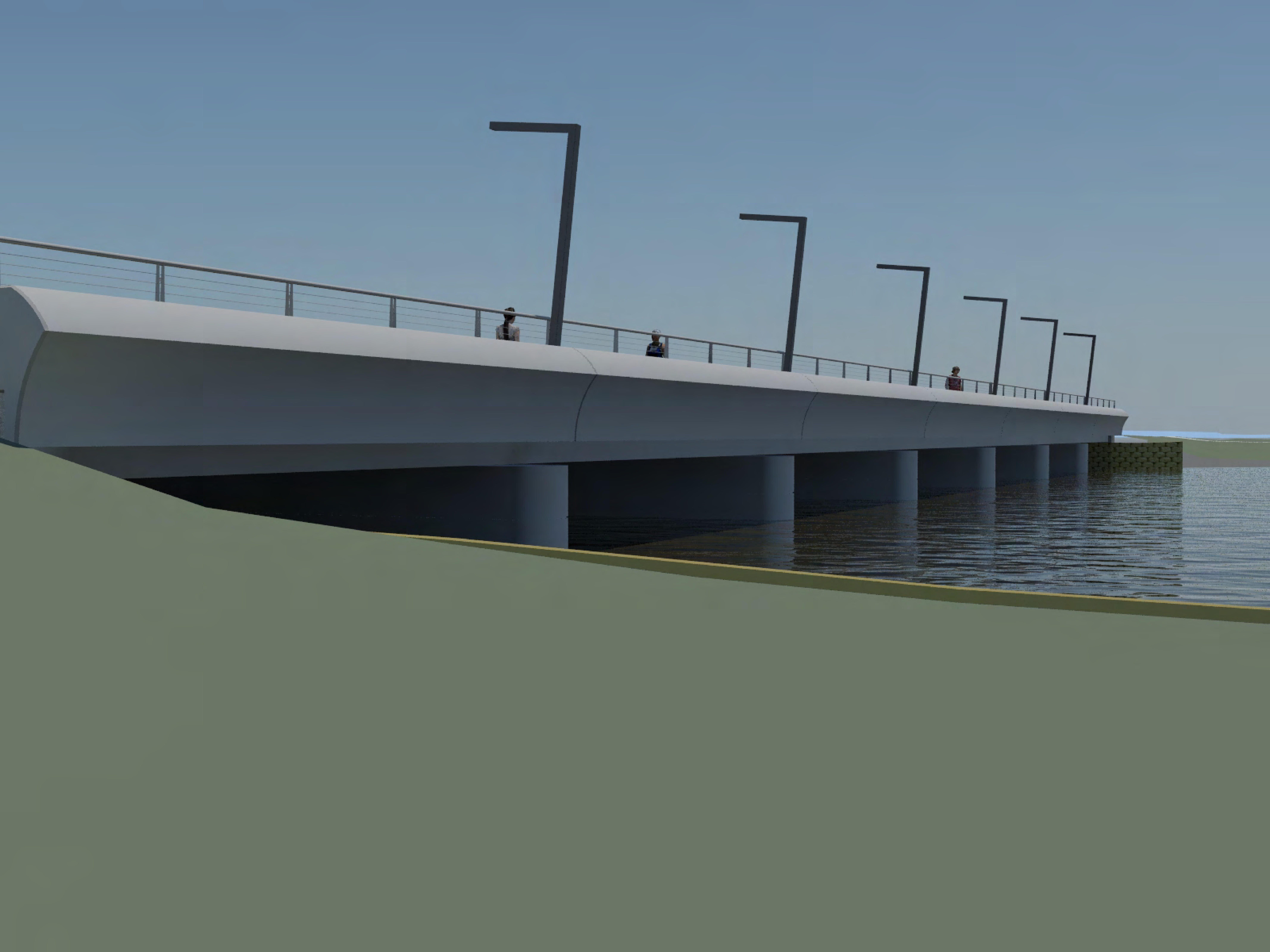
Landscape Design - East Foreshore
Surfaces, Incidental Works & Planting

FILE No.	DRAWING	PRINTED DATE	SHEET No.
16_32	DWG_LD_103	20/07/2017	03

REGISTRATION NUMBER
KIS-1632-DWG-LD

Appendix C – Visualisations





Focus Bridge Engineering Pty Ltd

Link Business Hub, 271 Brunker Road, Adamstown, NSW 2289
E: mail@focusbridges.com W: www.focusbridges.com

Job number: 220052

Rev No.	Authors	Reviewed		Authorised		
		Name	Signature	Name	Signature	Date
0	M Tilley	C Everett		M Tilley		23/02/18
A	M Tilley	C Everett	On file	M Tilley	On file	30/08/17

www.focusbridges.com

Appendix G

Stage 1 Aboriginal heritage assessment

02/02/2018

Peter Hamilton
28 Hampden Street
DUBBO NSW 2830

Roads and Maritime Services

Dear Peter

Preliminary assessment results for Camp Street Bridge Replacement Forbes Based on Stage 1 of the *Procedure for Aboriginal cultural heritage consultation and investigation* (PACHCI).

The project, based on the information provided was assessed as being unlikely to have an impact on Aboriginal cultural heritage.

The assessment is based on the following due diligence considerations:

- The project is unlikely to harm known Aboriginal objects or places.
- The AHIMS search **did not** indicate any concentrations of Aboriginal objects and places **outside** the study area.
- The study area **does** contain landscape features that indicate the presence of Aboriginal objects, based on the Office of Environment and Heritage's *Due diligence Code of Practice for the Protection of Aboriginal objects in NSW* and the Roads and Maritime Services' procedure.
- The cultural heritage potential of the study area appears to be reduced due to past disturbance. (Bridge Construction, compound site and side tracks)
- The cultural heritage potential of the study area appears to be reduced due to past disturbance.
- After reviewing the REF and associated documents

Safe Guards: The works is to be restricted to the Conditions stated in the Applicable Safeguards from the REF and associated documents.

Please be vigilant for further potential Aboriginal objects when construction commences.

Your project may proceed in accordance with the environmental impact assessment process, as relevant, and all other relevant approvals.

If the scope of your project changes, you must contact me and your regional environmental staff to reassess any potential impacts on Aboriginal cultural heritage.

If any potential Aboriginal objects (including skeletal remains) are discovered during the course of the project, all works in the vicinity of the find must cease. Follow the steps outlined in the Roads and Maritime Services' **Unexpected Heritage Item Procedure**.

.

Yours sincerely

Mark Hartwig
(Act) Aboriginal Cultural Heritage Advisor – Western Region

Appendix H

Aboriginal heritage information management system search results

AHIMS Web Services (AWS)
Search Result

Purchase Order/Reference : CAMPSTREET_1

Client Service ID : 303493

Jack Turner

17 Warabrook Boulevard
Warabrook New South Wales 2304

Attention: Jack Turner

Email: jack.turner@aecom.com

Date: 25 September 2017

Dear Sir or Madam:

AHIMS Web Service search for the following area at Lat, Long From : -33.3917, 148.0081 - Lat, Long To : -33.3862, 148.0168 with a Buffer of 50 meters, conducted by Jack Turner on 25 September 2017.

The context area of your search is shown in the map below. Please note that the map does not accurately display the exact boundaries of the search as defined in the paragraph above. The map is to be used for general reference purposes only.

A search of the Office of the Environment and Heritage AHIMS Web Services (Aboriginal Heritage Information Management System) has shown that:

0	**Aboriginal sites are recorded in or near the above location.**
0	**Aboriginal places have been declared in or near the above location. ***

If your search shows Aboriginal sites or places what should you do?

- You must do an extensive search if AHIMS has shown that there are Aboriginal sites or places recorded in the search area.
- If you are checking AHIMS as a part of your due diligence, refer to the next steps of the Due Diligence Code of practice.
- You can get further information about Aboriginal places by looking at the gazettal notice that declared it. Aboriginal places gazetted after 2001 are available on the NSW Government Gazette (http://www.nsw.gov.au/gazette) website. Gazettal notices published prior to 2001 can be obtained from Office of Environment and Heritage's Aboriginal Heritage Information Unit upon request

Important information about your AHIMS search

- The information derived from the AHIMS search is only to be used for the purpose for which it was requested. It is not be made available to the public.
- AHIMS records information about Aboriginal sites that have been provided to Office of Environment and Heritage and Aboriginal places that have been declared by the Minister;
- Information recorded on AHIMS may vary in its accuracy and may not be up to date .Location details are recorded as grid references and it is important to note that there may be errors or omissions in these recordings,
- Some parts of New South Wales have not been investigated in detail and there may be fewer records of Aboriginal sites in those areas. These areas may contain Aboriginal sites which are not recorded on AHIMS.
- Aboriginal objects are protected under the National Parks and Wildlife Act 1974 even if they are not recorded as a site on AHIMS.
- This search can form part of your due diligence and remains valid for 12 months.

Appendix I

Flood impact assessment

Level 7, 177 Pacific Highway
North Sydney NSW 2060 Australia
PO Box 632 North Sydney
NSW 2059 Australia
T +61 2 9928 2100
F +61 2 9928 2500
www.jacobs.com

11 July 2017

Phanta Khamphounvong
Bridge Waterway Engineer
Level 5, Octagon Building
110 George Street
PARRAMATTA NSW 2150

Flood Impact Assessment for Replacement of Camp Street Bridge over Lake Forbes

Dear Phanta,

1. Introduction

The existing Camp Street Bridge over Lake Forbes is a concrete bridge which was constructed in 1926, providing the primary access route between the Forbes town centre and areas to the east. Roads and Maritime Services proposes to replace the existing bridge with a longer, wider and deeper structure. The existing Camp Street Bridge and the foot bridge located immediately downstream of Camp Street Bridge would be demolished for construction of the replacement bridge.

Roads and Maritime Services requires a flood impact assessment for the proposed replacement bridge. Roads and Maritime Services engaged Jacobs to undertake a flood impact assessment for the replacement bridge for the 1% annual exceedance probability (AEP) event using the MIKE11 hydraulic model for Forbes developed by Jacobs (formerly Sinclair Knight Merz) in 2001 as part of the Forbes Flood Study (SKM 2001).

Details on the existing and the proposed bridges and outcomes from the flood impact assessment for the 1% AEP event are presented in the following sections.

2. Existing Bridge and the Proposed Replacement Bridge

A comparison of key features for the existing bridge and the proposed bridge presented in Table 1 shows that the proposed bridge is 11.2 m longer than the existing bridge. A comparison of bridge waterway area under the bridge deck for the two bridges is shown in Figure 1. Figure 1 shows that the proposed bridge provides a similar waterway area as the existing bridge up to the underside of the deck of the existing bridge. The underside of the proposed bridge is approximately 0.26 to 0.46m higher than the existing bridge, providing significantly more (approximately 30%) waterway area under bridge deck than the existing bridge.

Table 1 : Comparison of key features between the existing and the proposed bridge

Key Feature	Existing Camp St Bridge	Proposed Bridge
Deck Level (m AHD)	237.155	237.389 to 237.197
Soffit Level (m AHD)	236.203	236.659 to 236.467
Number of Spans	9	7
Number of Piers	8	6
Pier Thickness (m)	0.381	1.1
Depth of Super Structure (m)	0.952	1.55*
Bridge Length (m)	58.8	70

* The superstructure of the proposed bridge includes a concrete barrier that sits 0.82m above the deck level

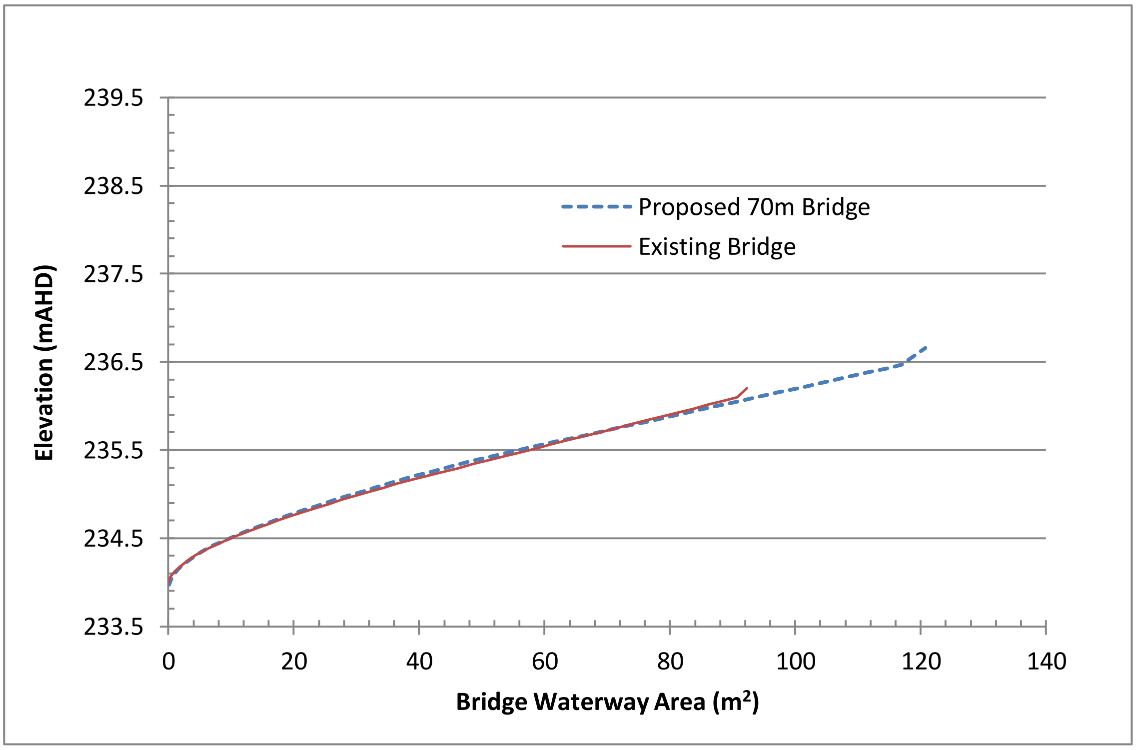


Figure 1 : Comparison of Bridge Waterway Areas

3. Flood Behaviour

3.1 Forbes

The flood behaviour in Forbes is complex and varies significantly during major and minor floods. Recorded peak gauge heights at two gauges located on the Lachlan River, just south of Forbes are shown in Table 1. The flood event of June 1952 is the highest flood on record in Forbes and is the flood adopted by Forbes Shire Council for flood planning within the Forbes local government area. The June 1952 flood reached peak levels of 238.86 mAHD at the Iron

Bridge gauge and 239.06 mAHD at the Municipal Baths situated on the Battye Street runner (SKM 2001).

Table 1 : Recorded Gauge Heights (m) in Forbes for Major Flood Events

Flood Event	Lachlan River @ Forbes Iron Bridge	Lachlan River @ Cottons Weir
Jun 1952	10.79	7.57
Sep 2016[1]	10.65	7.17
Aug 1990	10.64	7.30
Sep 1974	10.62	7.27
Apr 1990	10.61	7.17
Mar 2012	10.55	7.07
Oct 1976	10.46	6.96
Oct 1996	10.46	6.42

[1] source: http://www.bom.gov.au/waterdata/

In major flood events, such as that experienced in 1952 and 1990, the behaviour of flood waters can be characterised as follows (SKM 2001):

- Major outbreaks at the Southern Cross Breakout, located approximately 16 kilometres upstream of Forbes, contributing significant flow into Lake Forbes;
- Breaching of the 'neck' adjacent to the College bend;
- Deep flow over the floodplain at College Road in generally west direction rejoining the Lachlan River upstream of Fitzgerald Bridge;
- Significant flow between Lake Forbes and the Lachlan River in the vicinity of Young Street;
- Significant breakouts from Lake Forbes and flow down the Battye Street Runner.

Minor floods tend to follow the defined floodplain routes more directly. Minor floods usually entail a breakout of the Lachlan River at the Southern Cross and thus result in flooding of Lake Forbes. Minor floods tend to break out near College Road and Reymond Street and flow south or south west and re-enter the Lachlan River shortly after the College Bend. Overbank flow from the Lachlan is limited and to the peripheral areas and there is diminished cross flow between Lake Forbes and the Lachlan River upstream of the Newell Highway.

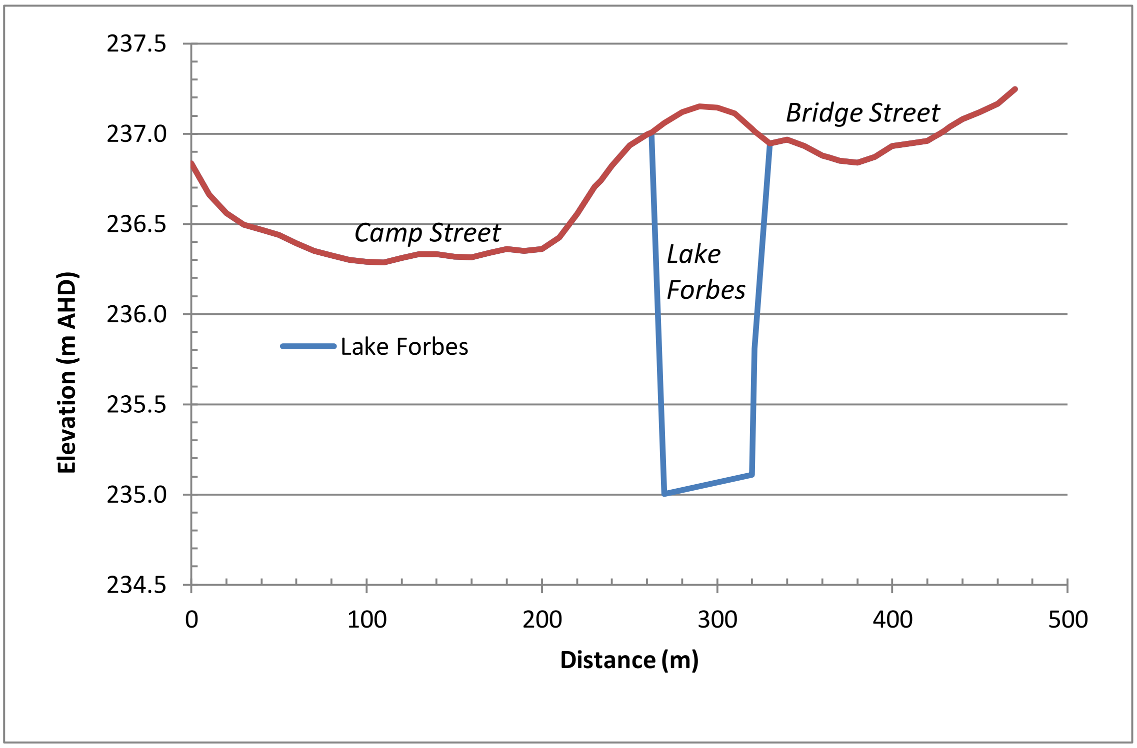
3.2 Camp Street Bridge over Lake Forbes

Lake Forbes has a catchment area of approximately 260 square kilometres. In addition, during significant floods in the Lachlan River, water flows into Lake Forbes via the 'Southern Cross' breakout resulting in frequent flooding in Lake Forbes. The nature of flooding (shown in blue) in Lake Forbes in the vicinity of Camp Street Bridge during the flood event of March 2012 is shown in Appendix A.

A long section profile along Camp Street Bridge and its approaches is shown in Figure 2. Figure 2 shows that the lowest invert of the eastern approach is located at approximately RL

236.3 m and the lowest invert of the western approach is located approximately at RL 236.85 m. As a result, the eastern approach is flooded first followed by the western approach and the bridge deck.

Figure 2 : Long Section Profile along Camp and Bridge Streets



4. Flood Impact Assessment

A hydrodynamic model was formulated as part of Forbes Flood Study (SKM 2001) using the MIKE11 (version 1999b) modelling system. Topographic data utilised to develop the model were sourced from: a previous MIKE11 model for Forbes; detailed topographic survey for the township; additional topographic survey undertaken for the 2001 study; and the 1936 compilation irrigation maps. The MIKE11 model was calibrated against the flood events of August 1990 and June 1952. The calibrated model was updated to represent the year 2000 (then current) topography and the model was run with the 1952 inflow hydrographs to define flood levels, flood extents and flood hazards. An extreme flood (equivalent to 2 times 1952 flood) with 2000 topography was also assessed in the 2001 Flood Study.

The MIKE11 model was updated for a flood impact assessment entitled "*Flood Assessment for Rezoning of Three Areas in Forbes*". The flood assessment was undertaken by SKM (currently Jacobs) for Forbes Shire Council in February 2013. The baseline model from the SKM 2013 study was adopted for this flood impact assessment for the proposed replacement for Camp Street Bridge. The representation of the existing Camp Street Bridge in the MIKE11 model was refined based on the general arrangement drawing for the existing bridge and the long section profile along Camp Street and Bridge Street provided by Roads and Maritime Services for this flood impact assessment. The refined MIKE11 model was run with the 1952 inflow hydrographs and refinement of the model did not result in any discernible changes in peak flood levels, discharges and velocities at model cross sections.

The existing Camp Street Bridge was replaced with the proposed bridge in the MIKE11 model and the model was run with the 1952 inflow hydrographs. A comparison of modelled peak flood levels, discharges and velocities shows no adverse changes in peak flood levels, discharges and velocities with the proposed replacement bridge. The proposed replacement bridge provides more waterway area under the bridge deck than the existing bridge which reduces peak flood levels in Lake Forbes upstream of the bridge up to a maximum of 0.01m just upstream of the bridge and increases peak flood levels downstream of the bridge up to a maximum of 0.01m. A maximum change in peak flood level up to 0.01m is considered negligible and beyond the confidence limit (ie. +/-0.01m) of the MIKE11 model (SKM 2001).

Detailed impacts on peak flood levels at modelled cross sections for Lake Forbes (ie. LAKEF flow path) in the vicinity of Camp Street Bridge are presented in Appendix A. The peak flood level just upstream of the replacement bridge is 239.01 mAHD and peak discharge conveyed by Lake Forbes with the 1955 inflow hydrographs in the vicinity of the proposed bridge is 1,283 m^3/s. The average peak flow velocity under the proposed bridge with the 1952 inflow hydrograph is 1.3 m/s.

The MIKE11 model was run with the proposed 70m bridge for an extreme flood (2 X 1952 inflow) event and the modelled flood level just upstream of the proposed bridge (MIKE11 cross section LAKEF 3704) was estimated at 240.15m AHD and the averaged peak flow velocity at the proposed bridge was estimated 2.2 m/s. The SKM 2001 study reported a flood level 240.09 mAHD at MIKE11 cross section LAKEF 3704.

5. Conclusions

The existing Camp Street Bridge over Lake Forbes is a concrete bridge which was constructed in 1926 and Roads and Maritime Services proposes to replace the existing bridge with a longer, wider and deeper structure. The existing Camp Street Bridge and the foot bridge located immediately downstream of Camp Street Bridge would be demolished for construction of the replacement bridge. The proposed replacement bridge provides more waterway area than the existing Camp Street Bridge.

An available MIKE11 hydrodynamic model for Forbes was utilised to assess hydraulic impacts due to proposed replacement bridge. Modelling results indicate negligible hydraulic impacts due to the proposed replacement bridge with the 1952 inflow hydrographs.

Yours sincerely

MHossain

Akhter Hossain B Sc (Ag Eng), M Sc (Hydrology), MIEAust, CPEng, NER
Principal Water Resources Engineer
+61 2 9928 2256
Akhter.Hossain@jacobs.com

Encl

Appendix A Location of MIKE11 Cross Sections and March 2012 Flood Extent

Figure A-1 Location of MIKE11 Cross Sections

Jacobs does not warrant that this document is definitive nor free of error and does not accept liability for any loss caused or arising from reliance upon information provided herein.

SPOT5 Image Captured on 7 March 2012 shows the extent of flooding close to the peak of the flood in Forbes. The Image was provided by NSW Office of Environment & Heritage

22 July 2015
Prepared by : LC
Checked by : AH

Appendix B Modelling Results

Table B-1 Modelled Peak Water Levels (PWL)

MIKE11 Cross Section	Modelled PWL (mAHD)		Difference in PWL (m)	Remarks
	Base Case	Proposed Camp Street Bridge		
LAKEF 0.00	239.411	239.405	-0.006	
LAKEF 0.00	239.411	239.405	-0.006	
LAKEF 24.56	239.409	239.403	-0.006	
LAKEF 49.13	239.407	239.401	-0.006	
LAKEF 73.69	239.405	239.399	-0.006	
LAKEF 98.25	239.403	239.397	-0.006	
LAKEF 122.82	239.402	239.395	-0.007	
LAKEF 147.38	239.400	239.393	-0.007	
LAKEF 171.95	239.398	239.391	-0.007	
LAKEF 196.51	239.396	239.390	-0.006	
LAKEF 221.07	239.394	239.388	-0.006	
LAKEF 245.64	239.392	239.386	-0.006	
LAKEF 270.20	239.390	239.384	-0.006	
LAKEF 294.76	239.389	239.382	-0.007	
LAKEF 319.33	239.387	239.380	-0.007	
LAKEF 343.89	239.385	239.378	-0.007	
LAKEF 368.45	239.383	239.376	-0.007	
LAKEF 393.02	239.381	239.375	-0.006	
LAKEF 417.58	239.379	239.373	-0.006	
LAKEF 442.14	239.378	239.371	-0.007	
LAKEF 466.71	239.376	239.369	-0.007	
LAKEF 491.27	239.374	239.367	-0.007	
LAKEF 515.84	239.372	239.365	-0.007	
LAKEF 540.40	239.370	239.363	-0.007	
LAKEF 564.96	239.368	239.362	-0.006	
LAKEF 589.53	239.367	239.360	-0.007	
LAKEF 614.09	239.365	239.358	-0.007	
LAKEF 638.66	239.363	239.356	-0.007	
LAKEF 663.22	239.361	239.354	-0.007	
LAKEF 687.78	239.359	239.352	-0.007	
LAKEF 712.34	239.357	239.350	-0.007	
LAKEF 736.91	239.356	239.349	-0.007	
LAKEF 761.47	239.354	239.347	-0.007	
LAKEF 786.04	239.352	239.345	-0.007	
LAKEF 810.60	239.350	239.343	-0.007	
LAKEF 835.16	239.348	239.341	-0.007	
LAKEF 859.73	239.347	239.339	-0.008	
LAKEF 884.29	239.345	239.338	-0.007	
LAKEF 908.85	239.343	239.336	-0.007	
LAKEF 933.42	239.341	239.334	-0.007	
LAKEF 957.98	239.339	239.332	-0.007	
LAKEF 982.54	239.337	239.330	-0.007	

MIKE11 Cross Section	Modelled PWL (mAHD)		Difference in PWL (m)	Remarks
	Base Case	Proposed Camp Street Bridge		
LAKEF 1007.11	239.336	239.329	-0.007	
LAKEF 1031.67	239.334	239.327	-0.007	
LAKEF 1056.24	239.332	239.325	-0.007	
LAKEF 1080.80	239.330	239.323	-0.007	
LAKEF 1105.36	239.329	239.321	-0.008	
LAKEF 1129.93	239.327	239.319	-0.008	
LAKEF 1154.49	239.325	239.318	-0.007	
LAKEF 1179.06	239.323	239.316	-0.007	
LAKEF 1203.62	239.321	239.314	-0.007	
LAKEF 1228.18	239.320	239.312	-0.008	
LAKEF 1252.74	239.318	239.310	-0.008	
LAKEF 1277.31	239.316	239.309	-0.007	
LAKEF 1301.87	239.314	239.307	-0.007	
LAKEF 1326.44	239.312	239.305	-0.007	
LAKEF 1351.00	239.311	239.303	-0.008	
LAKEF 1351.00	239.311	239.303	-0.008	
LAKEF 1375.66	239.309	239.301	-0.008	
LAKEF 1400.32	239.307	239.299	-0.008	
LAKEF 1424.98	239.305	239.298	-0.007	
LAKEF 1449.64	239.303	239.296	-0.007	
LAKEF 1474.30	239.301	239.294	-0.007	
LAKEF 1498.95	239.300	239.292	-0.008	
LAKEF 1523.61	239.298	239.290	-0.008	
LAKEF 1548.27	239.296	239.288	-0.008	
LAKEF 1572.93	239.294	239.287	-0.007	
LAKEF 1597.59	239.293	239.285	-0.008	
LAKEF 1622.25	239.291	239.283	-0.008	
LAKEF 1646.91	239.289	239.281	-0.008	
LAKEF 1671.57	239.287	239.279	-0.008	
LAKEF 1696.23	239.286	239.278	-0.008	
LAKEF 1720.89	239.284	239.276	-0.008	
LAKEF 1745.55	239.282	239.274	-0.008	
LAKEF 1770.20	239.280	239.272	-0.008	
LAKEF 1794.86	239.279	239.271	-0.008	
LAKEF 1819.52	239.277	239.269	-0.008	
LAKEF 1844.18	239.275	239.267	-0.008	
LAKEF 1868.84	239.273	239.265	-0.008	
LAKEF 1893.50	239.271	239.263	-0.008	
LAKEF 1918.16	239.270	239.262	-0.008	
LAKEF 1942.82	239.268	239.260	-0.008	
LAKEF 1967.48	239.266	239.258	-0.008	
LAKEF 1992.14	239.264	239.256	-0.008	
LAKEF 2016.80	239.263	239.254	-0.009	
LAKEF 2041.45	239.261	239.253	-0.008	
LAKEF 2066.11	239.259	239.251	-0.008	
LAKEF 2090.77	239.257	239.249	-0.008	
LAKEF 2115.43	239.255	239.247	-0.008	

MIKE11 Cross Section	Modelled PWL (mAHD)		Difference in PWL (m)	Remarks
	Base Case	Proposed Camp Street Bridge		
LAKEF 2140.09	239.254	239.245	-0.009	
LAKEF 2164.75	239.252	239.244	-0.008	
LAKEF 2189.41	239.250	239.242	-0.008	
LAKEF 2214.07	239.249	239.240	-0.009	
LAKEF 2238.73	239.247	239.239	-0.008	
LAKEF 2263.39	239.245	239.237	-0.008	
LAKEF 2288.04	239.244	239.235	-0.009	
LAKEF 2312.71	239.242	239.234	-0.008	
LAKEF 2337.36	239.240	239.232	-0.008	
LAKEF 2362.02	239.239	239.230	-0.009	
LAKEF 2386.68	239.237	239.228	-0.009	
LAKEF 2411.34	239.235	239.227	-0.008	
LAKEF 2436.00	239.234	239.225	-0.009	
LAKEF 2436.00	239.234	239.225	-0.009	
LAKEF 2460.47	239.233	239.225	-0.008	
LAKEF 2484.94	239.233	239.224	-0.009	
LAKEF 2509.41	239.232	239.224	-0.008	
LAKEF 2533.88	239.232	239.223	-0.009	
LAKEF 2558.35	239.231	239.222	-0.009	
LAKEF 2582.82	239.230	239.222	-0.008	
LAKEF 2607.29	239.230	239.221	-0.009	
LAKEF 2631.76	239.229	239.220	-0.009	
LAKEF 2656.24	239.228	239.219	-0.009	
LAKEF 2680.71	239.227	239.218	-0.009	
LAKEF 2705.18	239.226	239.217	-0.009	
LAKEF 2729.65	239.225	239.216	-0.009	
LAKEF 2754.12	239.223	239.214	-0.009	
LAKEF 2778.59	239.221	239.212	-0.009	
LAKEF 2803.06	239.219	239.210	-0.009	
LAKEF 2827.53	239.215	239.207	-0.008	
LAKEF 2852.00	239.211	239.202	-0.009	
LAKEF 2869.00	239.214	239.205	-0.009	
LAKEF 2875.00	239.139	239.130	-0.009	
LAKEF 2892.00	239.135	239.126	-0.009	
LAKEF 3089.00	239.101	239.090	-0.011	
LAKEF 3089.00	239.101	239.090	-0.011	
LAKEF 3240.00	239.101	239.090	-0.011	
LAKEF 3245.00	239.097	239.087	-0.010	
LAKEF 3374.00	239.094	239.083	-0.011	
LAKEF 3374.00	239.094	239.083	-0.011	
LAKEF 3569.00	239.058	239.046	-0.012	
LAKEF 3569.00	239.058	239.046	-0.012	
LAKEF 3704.00	239.023	239.009	-0.014	U/S Camp St Bridge
LAKEF 3724.00	238.944	238.954	0.010	D/S Camp St Bridge
LAKEF 3866.00	238.946	238.956	0.010	
LAKEF 3866.00	238.946	238.956	0.010	
LAKEF 4061.00	238.864	238.873	0.009	

MIKE11 Cross Section	Modelled PWL (mAHD)		Difference in PWL (m)	Remarks
	Base Case	Proposed Camp Street Bridge		
LAKEF 4265.00	238.579	238.587	0.008	
LAKEF 4285.00	238.283	238.291	0.008	
LAKEF 4285.00	238.283	238.291	0.008	
LAKEF 4352.00	237.948	237.954	0.006	
LAKEF 4369.00	237.842	237.848	0.006	
LAKEF 4392.00	237.920	237.924	0.004	
LAKEF 4560.00	237.876	237.880	0.004	
LAKEF 4560.00	237.876	237.880	0.004	
LAKEF 4574.00	237.876	237.880	0.004	
LAKEF 4589.00	237.867	237.871	0.004	
LAKEF 4614.00	237.749	237.751	0.002	
LAKEF 4614.00	237.749	237.751	0.002	
LAKEF 4950.00	237.601	237.605	0.004	
LAKEF 4950.00	237.601	237.605	0.004	
LAKEF 5044.00	237.554	237.552	-0.002	
LAKEF 5064.00	237.540	237.541	0.001	
LAKEF 5777.00	237.060	237.060	0.000	
LAKEF 5777.00	237.060	237.060	0.000	
LAKEF 6896.00	236.569	236.570	0.001	
LAKEF 7660.00	236.121	236.122	0.001	
LAKEF 7700.00	236.087	236.088	0.001	
LAKEF 7776.00	236.067	236.068	0.001	
LAKEF 8552.00	235.876	235.876	0.000	

Appendix J

Statutory consultation checklists

Infrastructure SEPP

Council related infrastructure or services

Issue	Potential impact	Yes / No	If 'yes' consult with	ISEPP clause
Stormwater	Are the works likely to have a *substantial* impact on the stormwater management services which are provided by council?	Yes	Forbes Shire council	ISEPP cl.13(1)(a)
Traffic	Are the works likely to generate traffic to an extent that will *strain* the existing road system in a local government area?	No	Forbes Shire Council	ISEPP cl.13(1)(b)
Sewerage system	Will the works involve connection to a council owned sewerage system? If so, will this connection have a *substantial* impact on the capacity of any part of the system?	No		ISEPP cl.13(1)(c)
Water usage	Will the works involve connection to a council owned water supply system? If so, will this require the use of a *substantial* volume of water?	No		ISEPP cl.13(1)(d)
Temporary structures	Will the works involve the installation of a temporary structure on, or the enclosing of, a public place which is under local council management or control? If so, will this cause more than a *minor* or *inconsequential* disruption to pedestrian or vehicular flow?	Yes	Forbes Shire Council	ISEPP cl.13(1)(e)
Road & footpath excavation	Will the works involve more than *minor* or *inconsequential* excavation of a road or adjacent footpath for which council is the roads authority and responsible for maintenance?	Yes	Forbes Shire Council	ISEPP cl.13(1)(f)

Local heritage items

Issue	Potential impact	Yes / No	If 'yes' consult with	ISEPP clause
Local heritage	Is there is a local heritage item (that is not also a State heritage item) or a heritage conservation area in the study area for the works? If yes, does a heritage assessment indicate that the potential impacts to the item/area are more than *minor* or *inconsequential*?	Yes	Forbes Shire Council	ISEPP cl.14

Flood liable land

Issue	Potential impact	Yes / No	If 'yes' consult with	ISEPP clause
Flood liable land	Are the works located on flood liable land? If so, will the works change flood patterns to more than a *minor* extent?	Yes	Forbes Shire Council	ISEPP cl.15

Public authorities other than councils

Issue	Potential impact	Yes / No	If 'yes' consult with	ISEPP clause
National parks and reserves	Are the works adjacent to a national park or nature reserve, or other area reserved under the *National Parks and Wildlife Act 1974*?	No	Office of Environment and Heritage	ISEPP cl.16(2)(a)
Marine parks	Are the works adjacent to a declared marine park under the *Marine Parks Act 1997*?	No	Department of Planning and Environment	ISEPP cl.16(2)(b)
Aquatic reserves	Are the works adjacent to a declared aquatic reserve under the *Fisheries Management Act 1994*?	No	Office of Environment and Heritage	ISEPP cl.16(2)(c)
Sydney Harbour foreshore	Are the works in the Sydney Harbour Foreshore Area as defined by the *Sydney Harbour Foreshore Authority Act 1998*?	No	Department of Planning and Environment	ISEPP cl.16(2)(d)
Bush fire prone land	Are the works for the purpose of residential development, an educational establishment, a health services facility, a correctional centre or group home in bush fire prone land?	No	Rural Fire Service	ISEPP cl.16(2)(f)

Appendix K

Agency consultation letters

Transport
Roads & Maritime Services

27 October 2017

SF2016/169507
A15371

Mr Evan Knoll
Project Officer
Aquatic Environment Branch/Fisheries
Department of Primary Industries
4 Marsden Park Road
Calala NSW 2340

Dear Evan

Invitation to comment - Proposed Bridge Replacement at Camp Street (MR56), Lake Forbes

Roads and Maritime Services are proposing to replace the bridge at Camp Street (MR56) over Lake Forbes with a new concrete plank structure. A review of environmental factors (REF) is currently being prepared to assess the likely impacts of the proposal under Part 5 of the *Environmental Planning and Assessment Act 1979*. Roads and Maritime Services invites your organisation to comment and advise of any interests, concerns or statutory requirements relating to the proposal. Comments received will be considered in the REF.

The objectives of the proposal are to replace the current structure, which is in poor condition, with a new wider reinforced concrete bridge capable of carrying higher mass traffic loads.

To assist in your response, please find attached details of the proposal and concept drawings of the proposed bridge and road approaches.

To enable consideration of your comments in the REF, a written response would be appreciated by Wednesday 15 November 2017. Roads and Maritime Services would be pleased to provide further information if required. The project manager may be contacted on 0419 995 212 or by email peter.hamilton@rms.nsw.gov.au.

Yours sincerely,

Peter Hamilton
Project/Contract Manager

Transport Roads & Maritime Services

27 October 2017

SF2016/169507
A15371

Mr Tim Baker
Senior Water Regulation Officer
NSW Department of Primary Industries - Water
PO Box 717
Dubbo NSW 2830

Dear Tim

Invitation to comment - Proposed Bridge Replacement at Camp Street (MR56), Lake Forbes

Roads and Maritime Services are proposing to replace the bridge at Camp Street (MR56) over Lake Forbes with a new concrete plank structure. A review of environmental factors (REF) is currently being prepared to assess the likely impacts of the proposal under Part 5 of the *Environmental Planning and Assessment Act 1979*. Roads and Maritime Services invites your organisation to comment and advise of any interests, concerns or statutory requirements relating to the proposal. Comments received will be considered in the REF.

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Yours sincerely,

Peter Hamilton
Project/Contract Manager

Transport
Roads & Maritime Services

16 March 2018

SF2016/169507
A15371

Mr Tim Baker
Senior Water Regulation Officer
NSW Department of Industry – Water
PO Box 717
Dubbo NSW2830

Dear Tim

Invitation to comment - Proposed Camp Street Bridge Replacement (MR56), Lake Forbes

Roads and Maritime Services are proposing to replace the Camp Street Bridge on Lake Forbes with a new reinforced concrete bridge. A new bridge is required due to the poor condition of the bridge and the high costs of maintaining the current bridge to continue carrying traffic loads.

The proposal includes the lowering of Lake Forbes upstream of the Johnny Woods crossing. This is essential to enable the bridge demolition and construction of the new bridge. The levels in Lake Forbes will be lowered by approximately 0.5 m for a period of up to 40 weeks subject to weather.

Roads and Maritime Services have previously consulted with the Department of Industries - Water on the 27th October 2017. We are in the process of preparing a Review of Environmental Factors (REF) addressing the DoI-Water comments received 20th November 2017.

As part of the REF assessment we have undertaken a review of surface water licenses around the Lake and commenced consultation with license holders, notably Forbes Shire Council. Our consultation with council has indicated that a temporary decrease in water levels will not impact on Council's extraction. A copy of the licenses identified and figure showing locations near the Lake are attached.

We have reviewed the Water Sharing rules Lake Forbes and Back Yamma Creek water source. We note the Cease to Pump rule that "pumping is not permitted when the water level in Lake Forbes is 50% below the Lake' full capacity" (https://www.water.nsw.gov.au/__data/assets/pdf_file/0010/659890/Lake-Forbes-and-Back-Yamma.pdf) The reference point for the CTP is in "Lake Forbes. A height gauge or equivalent will be established on the Lake within the life of the plan." Our understanding is that there is a potential risk that CTP may be inadvertently triggered by the temporary reduction of water levels in the Lake. In order to evaluate this risk further we would appreciate the location and height of the gauge used to assess the 50% capacity.

We will consult further with DoI-Water and potentially affected surface water license holders should this risk emerge.

To enable consideration of your comments in the REF, a written response would be appreciated by Monday 9 April 2018. Roads and Maritime Services would be pleased to provide further information if required. Please contact myself on 0419 995 212 or by email on peter.hamilton@rms.nsw.gov.au.

Yours sincerely,

Peter Hamilton
Project/Contract Manager
RMD Project Management Western

Attachments (2)

- Table of surface water license – Lake Forbes.
- Figure of surface water license - Lake Forbes

Table -1: Water Access License (WAL) – Lake Forbes

WAL	Allocation (ML)	Work approval	LOT/DP	Work Type	Use purpose	Use location
31795	6	70CA611117	Lot 9, DP 739034	Diversion Works - Pumps	Irrigation	Lot 9, DP 739034
31798	18	70CA611123	Lot 1633, DP 750158	Diversion Works - Pumps	Irrigation	Lot 822, DP 750158
31793	4	70CA611126	Lot 1564, DP 750158 Lot 1611, DP 750158 Lot 734, DP 750158 Lot 16, DP 1178669 Lot 17, DP 1178669 Lot 1564, DP 750158 Lot 734, DP 750158	Diversion Works – Pumps Storages	Recreation - Low Security	Lot 1564, DP 750158 Lot 1611, DP 750158 Lot 734, DP 750158 Lot 16, DP 1178669 Lot 17, DP 1178669
31794	142	70CA611129	Lot 150, DP 750146	Diversion Works - Pumps	Irrigation	Lot 150, DP 750146 Lot 171, DP 750146 Lot 172, DP 750146 Lot 182, DP 750146 Lot 183, DP 750146

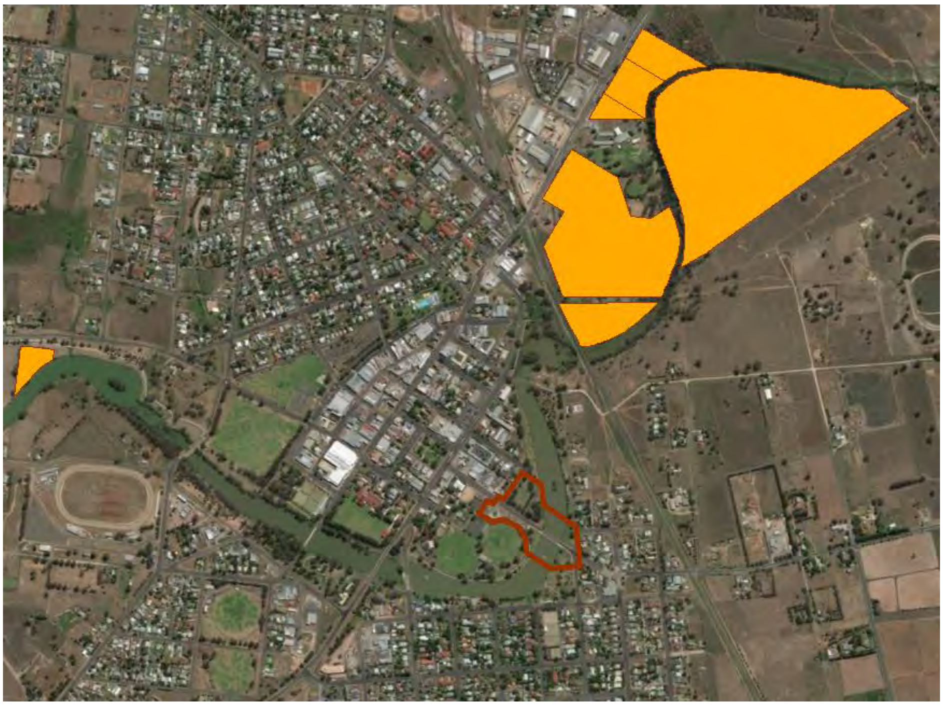

Figure -1: Location of land parcels with surface water entitlements (orange shaded areas).

Transport
Roads & Maritime Services

Pauline McKenzie
Executive Director
Heritage Division
Office of Environment and Heritage
Locked Bag 5020
Parramatta NSW 2124

Dear Ms McKenzie

Removal of Camp Street Bridge from the RMS Section 170 register

Roads and Maritime Services wishes to advise in accordance with section 170A(1)(a) of the *Heritage Act 1977* (NSW), that the item **Camp Street Bridge** (Item No 4306123) will be removed from the RMS' Section 170 (Heritage and Conservation) Register.

Camp Street Bridge is a reinforced concrete beam bridge, constructed in 1928, located within the town of Forbes on the Lachlan Valley Way over Lake Forbes. It was assessed as being of local significance in a study of concrete beam bridges in 2006 and also in a statement of heritage impact (SOHI) by Focus Bridge Engineering Consultants in 2018 (attached).

The Camp Street Bridge is narrow, in poor condition and nearing the end of its life. A new bridge is needed to meet current design standards and improve safety for motorists and pedestrians into the future. The project involves replacing the existing bridge with a new, wider concrete spaced plank bridge across Lake Forbes with wider travel lanes and pedestrian / cyclist paths. The new bridge is of a similar form as follows:

- concrete bridge
- multiple short spans
- shallow deck depth
- low level
- retain street lighting
- retaining walkways

Additional features and enhancements will be incorporated in the design:

- wider promenade boulevard type walkways on both sides
- gateway feature street lighting
- additional feature lighting including hand-railing, span soffit and piers
- integrated blade piers for improved capacity, durability and remove flood debris build up

While demolition of the existing bridge would impact its significance, the Statement of Heritage Impact for the proposal concludes:

> *The existing bridge is in poor condition and damaged in sections. In addition, the bridge requires significant, costly and difficult maintenance that is unlikely to prolong the bridges remaining life in the medium term. In the long term significant and fabric altering maintenance, rehabilitation and capacity upgrade work would be required including underpinning with new piers and visually intrusive strengthening works to the superstructure.*

To manage the heritage impacts, the following measures will be adopted:

- Reinstating the art deco lamps in the landscaping on the approach roadworks to the new bridge and a heritage interpretation/picnic area which will view the downstream side of the new bridge.
- A photographic archival recording.

Please find attached for your information:

- The RMS Section 170 Register entry for Camp Street Bridge.
- The Statement of Heritage Impact for the proposed removal.
- A letter from Forbes Shire Council (NSW) advising it has no objection to removal.

Should you require further information please contact the Senior Environmental Specialist, Heritage Mr Denis Gojak on 02 8843 3053 or Denis.Gojak@rms.nsw.gov.au.

It would be greatly appreciated if an acknowledgement of your receipt of this letter could be sent to Rachel.McMullan@rms.nsw.gov.au.

Yours sincerely

Denis Gojak
Senior Environmental Specialist (Heritage)

FORBES SHIRE COUNCIL

ABN 86 023 614 567
Administration Centre:
2 Court St Forbes NSW 2871
All mail to:
General Manager
PO Box 333
Forbes NSW 2871
General Enquiries:
T 02 68 502 300
F 02 68 502 399
Mayor and
General Manager:
T 02 68 502 304
F 02 68 502 399
Engineering Services:
137 Lachlan St
Forbes NSW 2871
T 02 68 502 874
F 02 68 502 899
Environmental Services:
T 02 68 502 344
F 02 68 502 398
Email & Web:
forbes@forbes.nsw.gov.au
www.forbes.nsw.gov.au

DETS

4 December 2017

Regional Manager - Western
Roads & Maritime Services
PO Box 334
PARKES NSW 2870

Attention : Mr Peter Hamilton – Project Management Western
Subject : Camp Street Bridge (MR56) Replacement

Dear Peter

Council refers to the proposed replacement of the Camp Street Bridge (MR56) and advises that Council at its 21 September 2017 Council Meeting considered a report from the Director Engineering and Technical Services in relation to the project. Council on the advice of that report resolved to write to the Roads and Maritime Services with the following:

1. Confirming Forbes Shire Council's support for the replacement of the Camp Street Bridge in accordance with the proposed design as presented to the Council on 4 September 2017.

2. Confirming Forbes Shire Council's intent to support the project up to the value of $250,000 for landscaping works.

3. Indicating that from a heritage perspective Forbes Shire Council supports the proposed design and the use of heritage lighting on the approaches to the bridge as per the proposed design as presented to the Council on 4 September 2017

4. Indicating that Forbes Shire Council will work with the Roads and Maritime Services on the project including assistance with constructing the road approaches, managing the detour route, and an interest in undertaking the landscaping of the project.

Please do not hesitate to contact the undersigned if you require clarification in relation to this matter.

Yours sincerely

John Zannes
DIRECTOR
ENGINEERING & TECHNICAL SERVICES

OUR REF: C17/453

31 October 2017

Mr Peter Hamilton
Project/Contract Manager
Roads and Maritime Services
28 Hampden Street
DUBBO NSW 2830
Via email: peter.hamilton@rms.nsw.gov.au

Dear Mr Hamilton

Re: DPI Fisheries Review of Environmental Factors (REF) inclusions into proposed Camp Street Bridge replacement, Lake Forbes, Forbes LGA.

Reference is made to Roads and Maritime Services referral seeking REF comments associated with the above mentioned project forwarded to DPI Fisheries on 27 October 2017.

DPI Fisheries is responsible for ensuring that fish stocks are conserved and that there is no net loss of Key Fish Habitat upon which they depend. To achieve this, DPI Fisheries ensures that developments comply with the requirements of the Fisheries Management Act 1994 (FM Act), and the associated Policy and Guidelines for Fish Habitat Conservation and Management (2013). In addition, DPI Fisheries is responsible for ensuring the sustainable management of commercial, recreational and Aboriginal cultural fishing, aquaculture and marine protected areas within NSW.

Section 199 of the Fisheries Management Act 1994 pertains to dredging and reclamation works undertaken or approved by public authorities such as Roads and Maritime Services. Section 199 requires the proposal (including final construction plans and completed REF) be referred to the Minster for Primary Industries. The section also requires that Roads and Maritime Services consider any matters concerning the proposed works that are raised by the Minister.

Specifically, DPI Fisheries requests that the following issues are addressed in the REF;

1. **Blockages to fish Passage -** DPI Fisheries requests that the REF consider whether any temporary dams, construction pads, sidetracks, etc. are likely to be used that may result in the blockage of fish passage within Key Fish Habitat. If so, details on proposed design and construction methods, likely duration of installation or removal methods should be outlined within the REF.
2. **Damage to Riparian Vegetation -** DPI Fisheries seeks information on any damage to riparian vegetation such as river red gums that may occur, noting that Degradation of Riparian Vegetation along Watercourses is listed as a Key Threatening Process under the FM Act.
3. **Removal, realignment of snags -** DPI Fisheries requests information on any proposal to remove, realign or relocate snags (large woody debris). Proposed works should be outlined within the REF. Snags should not be removed, realigned or relocated without first contacting DPI Fisheries. Note: that the removal of large woody debris is listed as a Key Threatening Process under the FM Act.

NSW GOVERNMENT | Department of Primary Industries

4. **Bank Stabilisation and Rehabilitation** – DPI Fisheries seeks information on any destabilisation of the banks with heavy machinery or damage to the bed or banks. DPI Fisheries requests that any bed and bank rehabilitation works be completed immediately after the completion of works. Proposals to ensure replacement of aquatic and riparian vegetation with native/endemic species are encouraged.
5. **Threatened species, populations, and ecological communities** –Threatened species provisions are listed within the Fisheries Management Act 1994. The REF must address the threatened species provisions of the Act; for species, populations or communities listed under schedules 4 and 5 whose historical geographical distribution extends to within the waterway adjacent the works. The proposal should address whether there are likely to be any significant impacts on the listed species, know or expected populations or ecological communities within the project area. Threatened species distributions available at; https://www.dpi.nsw.gov.au/fishing/species-protection/threatened-species-distributions-in-nsw/freshwater-threatened-species-distribution-maps.

Should you wish for further information please contact me on 0418 204 207 or via email at evan.knoll@dpi.nsw.gov.au

Yours Sincerely

Evan Knoll
Fisheries Manager, Aquatic Environment
Department of Primary Industries

Heritage Council of New South Wales

Level 6, 10 Valentine Avenue
Parramatta NSW 2150
Locked Bag 5020
Parramatta NSW 2124
DX 8225 PARRAMATTA

Telephone: 61 2 9873 8500
Facsimile: 61 2 9873 8599
heritagemailbox@environment.nsw.gov.au
www.heritage.nsw.gov.au

Our Ref: DOC 18/137728

Mr Denis Gojak
Senior Environmental Specialist (Heritage)
Roads and Maritime
Locked Bag 928
NORTH SYDNEY NSW 2059

By email: denis.gojak@rms.nsw.gov.au

Dear Mr Gojak

RE: S170A NOTIFICATION OF INTENTION TO DEMOLISH CAMP STREET BRIDGE AT FORBES

The Heritage Division, Office of Environment and Heritage, has considered this notification and provides the following response to the proposed demolition of the Camp Street Bridge at Forbes.

Under Section 170A(1)(c) of the *NSW Heritage Act 1977*, a government instrumentality must give the Heritage Council 14 days notice before it demolishes any place entered in its register.

The submitted information is considered to meet the requirements of Section 170A(1)(c) of the *NSW Heritage Act 1977*. The proposed mitigation measures identified in the Statement of Heritage Impact (Focus Bridge Engineering, February 2018) including the archival photographic recording and reuse of art deco lamps within the place are considered appropriate.

If you have any questions regarding the above matter please contact Gary Estcourt, Heritage Officer at the Heritage Division, Office of Environment and Heritage, on (02) 9895 6409 or at gary.estcourt@environment.nsw.gov.au.

Yours sincerely

Sarah Jane Brazil
Senior Team Leader Major Projects
Heritage Division, Office of Environment & Heritage
As Delegate of the Heritage Council of NSW

28 March 2018

Appendix L

Water License Search results, Lake Forbes

Information about a water source

Use this tool to search for information about a particular water source in relation to water access licences, approvals and water usage.

Search for:

- Water access licences (including conditions) for a water source
- Total number of water access licences and water usage for a water source

Water Source	Lake Forbes and Black Yamma Creek Water Source
Licence Category	All
Period (Financial Year)	2016/2017

Notes:

The calculation of 'Water Made Available' in the search results may be affected by water access licences that have been cancelled or created part way through the selected financial year.

Information on licences issued under the Water Act 1912 is not available via this search.

- Status of approvals (including conditions) for a water source or region

« Previous Search Print Export

Search Results

Access Licence Category	No. of WAL's	Total Share Component	Share Component Unit	Cumulative AWD	Cumulative AWD Unit	Water made Available (ML)	Usage YTD (ML)
DOMESTIC AND STOCK [STOCK]	0	0	% of Share Component	1	100	0	0
UNREGULATED RIVER	4	170	ML per share	1	1	170	0

Information about a water source

Use this tool to search for information about a particular water source in relation to water access licences, approvals and water usage.

Search for:

- (selected) Water access licences (including conditions) for a water source

Licence Category: All

Water Source: Lake Forbes and Black Yamma Creek Water Source

Note:

Information on licences under the Water Act 1912 is not available via this search.

- Total number of water access licences and water usage for a water source
- Status of approvals (including conditions) for a water source or region

« Previous Search Print Export

Search Results

« ‹ 1 to 4 of 4 rows › »

WAL No.	Water Source	Share Components
31795	Lake Forbes And Back Yamma Creek Water Source	6.00

Category [Subcategory]	Status	Water Source	Tenure Type	Management Zone	Share Components (units or ML)
Unregulated River	Current	Lake Forbes And Back Yamma Creek Water Source	Continuing		6.00

Extraction Times or Rates

Subject to conditions water may be taken at any time or rate

Nominated Work Approval(s)

70CA611117

- Conditions

Plan Conditions

Water sharing plan	Lachlan Unregulated and Alluvial Water Sources
	Take of water
MW0010-00007	The maximum water allocation that may be carried over in the account for this access licence from one water year to the next water year is 1 ML/unit share of the share component of the licence.
MW0036-00001	The volume of water taken in any three (3) consecutive water years from 1 July 2013 must be recorded in the logbook at the end of those three water years. The maximum volume of water permitted to be taken in those years must also be recorded in the logbook.
MW0010-00001	The maximum water allocation that may be carried over in the account for this access licence from one water year to the next water year is 2 ML/unit share of the share component of the licence.
MW0004-00001	From 1 July 2013, the total volume of water taken in any three (3) consecutive water years under this access licence must not exceed a volume which is equal to the lesser of either: A. the sum of: i. water in the account from the available water determinations in those 3 consecutive water years, plus ii. water in the account carried over from the water year prior to those 3 consecutive water years, plus iii. any net amount of water assigned to or from this account under a water allocation assignment in those 3 consecutive water years, plus iv. any water re-credited by the Minister to the account in those 3 consecutive water years, or B. the sum of: i. the share component of this licence at the beginning of the first year in those 3 consecutive water years, plus ii. the share component of this licence at the beginning of the second year in those 3 consecutive water years, plus iii. the share component of this licence at the beginning of the third year in those 3 consecutive water years, plus iv. any net amount of water assigned to or from this account under a water allocation assignment in those 3 consecutive water years, plus v. any water re-credited by the Minister to the account in those 3 consecutive water years.
MW0548-00001	If water is taken from an in-river pool, then water must only be taken from the pool when the volume of water in the pool exceeds the full capacity of that pool.
	Monitoring and recording
MW0027-00001	The volume of water taken from 14 September 2012 until 30 June 2015 must be recorded in the logbook at the end of 30 June 2015. The

maximum volume of water permitted to be taken in those water years must also be recorded in the logbook. The first water year is from 14 September 2012 until 30 June 2013.

MW2338-00001	The completed logbook must be retained for five (5) years from the last date recorded in the logbook.
MW2336-00001	The purpose or purposes for which water is taken, as well as details of the type of crop, area cropped, and dates of planting and harvesting, must be recorded in the logbook each time water is taken.
MW2337-00001	The following information must be recorded in the logbook for each period of time that water is taken: A. date, volume of water, start and end time when water was taken as well as the pump capacity per unit of time, and B. the access licence number under which the water is taken, and C. the approval number under which the water is taken, and D. the volume of water taken for domestic consumption and/or stock watering.
MW2339-00001	A logbook must be kept, unless the work is metered and fitted with a data logger. The logbook must be produced for inspection when requested by the relevant licensor.
	Reporting
MW0051-00002	Once the licence holder becomes aware of a breach of any condition on this access licence, the licence holder must notify the Minister as soon as practicable. The Minister must be notified by: A. email: water.enquiries@dpi.nsw.gov.au, or B. telephone: 1800 353 104. Any notification by telephone must also be confirmed in writing within seven (7) business days of the telephone call.

Other Conditions

NIL

31798 Lake Forbes And Back Yamma Creek Water Source 18.00

Category [Subcategory]	Status	Water Source	Tenure Type	Management Zone	Share Components (units or ML)
Unregulated River	Current	Lake Forbes And Back Yamma Creek Water Source	Continuing		18.00

Extraction Times or Rates

Subject to conditions water may be taken at any time or rate

Nominated Work Approval(s)

70CA611123

- Conditions

Plan Conditions

Water sharing plan	Lachlan Unregulated and Alluvial Water Sources

Take of water

MW0010-00007	The maximum water allocation that may be carried over in the account for this access licence from one water year to the next water year is 1 ML/unit share of the share component of the licence.
MW0036-00001	The volume of water taken in any three (3) consecutive water years from 1 July 2013 must be recorded in the logbook at the end of those three water years. The maximum volume of water permitted to be taken in those years must also be recorded in the logbook.
MW0010-00001	The maximum water allocation that may be carried over in the account for this access licence from one water year to the next water year is 2 ML/unit share of the share component of the licence.
MW0548-00001	If water is taken from an in-river pool, then water must only be taken from the pool when the volume of water in the pool exceeds the full capacity of that pool.
MW0004-00001	From 1 July 2013, the total volume of water taken in any three (3) consecutive water years under this access licence must not exceed a volume which is equal to the lesser of either: A. the sum of: i. water in the account from the available water determinations in those 3 consecutive water years, plus ii. water in the account carried over from the water year prior to those 3 consecutive water years, plus iii. any net amount of water assigned to or from this account under a water allocation assignment in those 3 consecutive water years, plus iv. any water re-credited by the Minister to the account in those 3 consecutive water years, or B. the sum of: i. the share component of this licence at the beginning of the first year in those 3 consecutive water years, plus ii. the share component of this licence at the beginning of the second year in those 3 consecutive water years, plus iii. the share component of this licence at the beginning of the third year in those 3 consecutive water years, plus iv. any net amount of water assigned to or from this account under a water allocation assignment in those 3 consecutive water years, plus v. any water re-credited by the Minister to the account in those 3 consecutive water years.

Monitoring and recording

MW0027-00001	The volume of water taken from 14 September 2012 until 30 June 2015 must be recorded in the logbook at the end of 30 June 2015. The maximum volume of water permitted to be taken in those water years must also be recorded in the logbook. The first water year is from 14 September 2012 until 30 June 2013.
MW2338-00001	The completed logbook must be retained for five (5) years from the last date recorded in the logbook.

MW2336-00001	The purpose or purposes for which water is taken, as well as details of the type of crop, area cropped, and dates of planting and harvesting, must be recorded in the logbook each time water is taken.
MW2337-00001	The following information must be recorded in the logbook for each period of time that water is taken: A. date, volume of water, start and end time when water was taken as well as the pump capacity per unit of time, and B. the access licence number under which the water is taken, and C. the approval number under which the water is taken, and D. the volume of water taken for domestic consumption and/or stock watering.
MW2339-00001	A logbook must be kept, unless the work is metered and fitted with a data logger. The logbook must be produced for inspection when requested by the relevant licensor.
	Reporting
MW0051-00002	Once the licence holder becomes aware of a breach of any condition on this access licence, the licence holder must notify the Minister as soon as practicable. The Minister must be notified by: A. email: water.enquiries@dpi.nsw.gov.au, or B. telephone: 1800 353 104. Any notification by telephone must also be confirmed in writing within seven (7) business days of the telephone call.

Other Conditions

NIL

31793 Lake Forbes And Back Yamma Creek Water Source 4.00

Category [Subcategory]	Status	Water Source	Tenure Type	Management Zone	Share Components (units or ML)
Unregulated River	Current	Lake Forbes And Back Yamma Creek Water Source	Continuing		4.00

Extraction Times or Rates

Subject to conditions water may be taken at any time or rate

Nominated Work Approval(s)

70CA611126

\- Conditions

Plan Conditions

Water sharing plan	Lachlan Unregulated and Alluvial Water Sources

Take of water

MW0010-00007	The maximum water allocation that may be carried over in the account for this access licence from one water year to the next water year is 1 ML/unit share of the share component of the licence.
MW0036-00001	The volume of water taken in any three (3) consecutive water years from 1 July 2013 must be recorded in the logbook at the end of those three water years. The maximum volume of water permitted to be taken in those years must also be recorded in the logbook.
MW0010-00001	The maximum water allocation that may be carried over in the account for this access licence from one water year to the next water year is 2 ML/unit share of the share component of the licence.
MW0004-00001	From 1 July 2013, the total volume of water taken in any three (3) consecutive water years under this access licence must not exceed a volume which is equal to the lesser of either: A. the sum of: i. water in the account from the available water determinations in those 3 consecutive water years, plus ii. water in the account carried over from the water year prior to those 3 consecutive water years, plus iii. any net amount of water assigned to or from this account under a water allocation assignment in those 3 consecutive water years, plus iv. any water re-credited by the Minister to the account in those 3 consecutive water years, or B. the sum of: i. the share component of this licence at the beginning of the first year in those 3 consecutive water years, plus ii. the share component of this licence at the beginning of the second year in those 3 consecutive water years, plus iii. the share component of this licence at the beginning of the third year in those 3 consecutive water years, plus iv. any net amount of water assigned to or from this account under a water allocation assignment in those 3 consecutive water years, plus v. any water re-credited by the Minister to the account in those 3 consecutive water years.
MW0548-00001	If water is taken from an in-river pool, then water must only be taken from the pool when the volume of water in the pool exceeds the full capacity of that pool.

Monitoring and recording

MW0027-00001	The volume of water taken from 14 September 2012 until 30 June 2015 must be recorded in the logbook at the end of 30 June 2015. The maximum volume of water permitted to be taken in those water years must also be recorded in the logbook. The first water year is from 14 September 2012 until 30 June 2013.
MW2338-00001	The completed logbook must be retained for five (5) years from the last date recorded in the logbook.
MW2336-00001	The purpose or purposes for which water is taken, as well as details of the type of crop, area cropped, and dates of planting and harvesting, must be recorded in the logbook each time water is taken.

MW2337-00001	The following information must be recorded in the logbook for each period of time that water is taken: A. date, volume of water, start and end time when water was taken as well as the pump capacity per unit of time, and B. the access licence number under which the water is taken, and C. the approval number under which the water is taken, and D. the volume of water taken for domestic consumption and/or stock watering.
MW2339-00001	A logbook must be kept, unless the work is metered and fitted with a data logger. The logbook must be produced for inspection when requested by the relevant licensor.

Reporting

MW0051-00002	Once the licence holder becomes aware of a breach of any condition on this access licence, the licence holder must notify the Minister as soon as practicable. The Minister must be notified by: A. email: water.enquiries@dpi.nsw.gov.au, or B. telephone: 1800 353 104. Any notification by telephone must also be confirmed in writing within seven (7) business days of the telephone call.

Other Conditions

NIL

31794 Lake Forbes And Back Yamma Creek Water Source 142.00

Category [Subcategory]	Status	Water Source	Tenure Type	Management Zone	Share Components (units or ML)
Unregulated River	Current	Lake Forbes And Back Yamma Creek Water Source	Continuing		142.00

Extraction Times or Rates

Subject to conditions water may be taken at any time or rate

Nominated Work Approval(s)

70CA611129

- Conditions

Plan Conditions

Water sharing plan	Lachlan Unregulated and Alluvial Water Sources

Take of water

MW0494-00001	Water must only be taken if there is visible flow in the water source at the location where water is to be taken. This restriction does not apply if water is to be taken from an off-river pool, an in-river pool, a runoff harvesting dam or an in-river dam pool.
MW0010-00007	The maximum water allocation that may be carried over in the account for this access licence from one water year to the next water year is 1 ML/unit share of the share component of the licence.
MW0036-00001	The volume of water taken in any three (3) consecutive water years from 1 July 2013 must be recorded in the logbook at the end of those three water years. The maximum volume of water permitted to be taken in those years must also be recorded in the logbook.
MW0658-00001	If water is taken from an off-river pool, then water must only be taken from the pool when the volume of water in the pool exceeds the full capacity of that pool.
MW0010-00001	The maximum water allocation that may be carried over in the account for this access licence from one water year to the next water year is 2 ML/unit share of the share component of the licence.
MW0004-00001	From 1 July 2013, the total volume of water taken in any three (3) consecutive water years under this access licence must not exceed a volume which is equal to the lesser of either: A. the sum of: i. water in the account from the available water determinations in those 3 consecutive water years, plus ii. water in the account carried over from the water year prior to those 3 consecutive water years, plus iii. any net amount of water assigned to or from this account under a water allocation assignment in those 3 consecutive water years, plus iv. any water re-credited by the Minister to the account in those 3 consecutive water years, or B. the sum of: i. the share component of this licence at the beginning of the first year in those 3 consecutive water years, plus ii. the share component of this licence at the beginning of the second year in those 3 consecutive water years, plus iii. the share component of this licence at the beginning of the third year in those 3 consecutive water years, plus iv. any net amount of water assigned to or from this account under a water allocation assignment in those 3 consecutive water years, plus v. any water re-credited by the Minister to the account in those 3 consecutive water years.
MW0548-00001	If water is taken from an in-river pool, then water must only be taken from the pool when the volume of water in the pool exceeds the full capacity of that pool.

Monitoring and recording

MW0027-00001	The volume of water taken from 14 September 2012 until 30 June 2015 must be recorded in the logbook at the end of 30 June 2015. The maximum volume of water permitted to be taken in those water years must also be recorded in the logbook. The first water year is from 14 September 2012 until 30 June 2013.
MW2338-00001	The completed logbook must be retained for five (5) years from the last date recorded in the logbook.

MW2336-00001	The purpose or purposes for which water is taken, as well as details of the type of crop, area cropped, and dates of planting and harvesting, must be recorded in the logbook each time water is taken.
MW2337-00001	The following information must be recorded in the logbook for each period of time that water is taken: A. date, volume of water, start and end time when water was taken as well as the pump capacity per unit of time, and B. the access licence number under which the water is taken, and C. the approval number under which the water is taken, and D. the volume of water taken for domestic consumption and/or stock watering.
MW2339-00001	A logbook must be kept, unless the work is metered and fitted with a data logger. The logbook must be produced for inspection when requested by the relevant licensor.
	Reporting
MW0051-00002	Once the licence holder becomes aware of a breach of any condition on this access licence, the licence holder must notify the Minister as soon as practicable. The Minister must be notified by: A. email: water.enquiries@dpi.nsw.gov.au, or B. telephone: 1800 353 104. Any notification by telephone must also be confirmed in writing within seven (7) business days of the telephone call.

Other Conditions

NIL

Appendix M

Hazardous Materials Survey

Report

HAZARDOUS MATERIALS SURVEY

MR56 Camp Street Bridge - Lachlan Valley Way, Forbes

Prepared for:
RMS Western Regional Office

Project No.
38371

Date:
08-12-17

AIRSAFE

Report

HAZARDOUS MATERIALS SURVEY

MR56 Camp Street Bridge - Lachlan Valley Way, Forbes

Prepared for:
RMS Western Regional Office

Project No.
38371

Date:
08-12-17

AIRSAFE

93 Beattie Street
Balmain NSW 2041 Australia
T. 02 9555 9034
F. 02 9555 9035
info@airsafe.net.au
www.airsafe.net.au

ABN 85 143 863 496

DISTRIBUTION

Copies	Recipient
2	**Peter Hamilton** **RMS Western Regional Office** 51-55 Currajong Street PARKES NSW 2870

Prepared By:

Joshua Martin
Licensed Asbestos Assessor
[SafeWork NSW Licence No LAA 001313]

Reviewed By:

Benjamin Willetts
Manager

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- Guide to Lead Paint Management Part 2: Residential and Commercial Buildings [AS 4361.2 - 1998].
- Schedule B (7a) Guideline on Health-Based Investigation Levels [National Environment Protection (Assessment of Site Contamination) Measure 1999].
- Synthetic Mineral Fibres (SMF) – Information Sheet [Workers Health Centre, 2002].
- National Code of Practice for the Safe Use of Synthetic Mineral Fibres [NOHSC: 2006 (1990)].
- Work Health and Safety Act 2011.
- Work Health and Safety Regulation 2017.

TERMS AND DEFINITIONS

AC	-	Asbestos Cement
ACM	-	Asbestos-Containing Material
EPA	-	Environment Protection Agency
HEPA	-	High Efficiency Particulate Air
NATA	-	National Association of Testing Authorities, Australia
NES	-	National Exposure Standard
PPE	-	Personal Protective Equipment
CCA	-	Copper, Chrome, Arsenic

1 INTRODUCTION

1.1 AUTHORISATION

This inspection and report was authorized by Peter Hamilton of RMS Western Regional Office on the 1st of December, 2017.

1.2 SCOPE OF WORK

The scope of work involved a survey of the site to determine the location, extent and condition of hazardous materials on site including asbestos, lead, SMF,PCBs, Copper, Chromate, and Arsenic.

1.3 SITE DESCRIPTION

The site is located at MR56 Camp Street Bridge - Lachlan Valley Way, Forbes [refer to Figure 1]. The site currently consists of a timber bridge with Metal joining covered by an asphalt and tar road.

Figure 1: Site Location of the MR56 Camp Street Bridge - Lachlan Valley Way, Forbes

1.4 METHODOLOGY

1.4.1 Asbestos

An inspection of the premises has been carried out in order to identify, as far as practicable, all ACM in the workplace in accordance with the *Code of Practice: How to Manage and Control Asbestos in the Workplace [December 2017] Safe Work Australia.*

Representative samples of materials suspected of containing asbestos have been taken by competent personnel and inaccessible areas presumed to contain asbestos. Once such a presumption has been made, the material must be treated as an ACM, with work practices and disposal criteria as required for the presence of asbestos, until the material is removed or testing has confirmed that it does not, in fact, contain asbestos.

Samples have been analysed in accordance with AS 4964 – 2004 *Method for the qualitative identification of asbestos in bulk samples*.

A risk assessment has been carried out to ensure the associated risks of the identified ACM are assessed. The risk assessment takes account of the condition of the ACM (e.g whether they are friable or bonded and stable, and whether they liable to damage or deterioration), the likelihood of exposure, and whether the nature or location of any work to be carried out is likely to disturb the ACM. Decisions about control measures to protect workers have been made depending on the assessed risks to health.

The locations of all ACM and any inaccessible areas, as well as the types and condition of asbestos have been recorded in the asbestos register.

1.4.2 Lead

Representative samples of paint systems suspected of containing lead have been taken in accordance with *Guide to Lead Paint Management Part 2: Residential and Commercial Buildings* [AS 4361.2 - 1998].

Samples have been analysed for lead content by Envirolab Services Pty Ltd [NATA Accredited Laboratory 2901].

1.4.3 CCA

Representative samples of timber suspected of being treated with CCA have been taken analysed for copper chrome and arsenic content by Envirolab Services Pty Ltd [NATA Accredited Laboratory 2901].

1.6 LIMITATIONS

This report has been prepared to meet the requirements outlined in the scope of work. It does not include evaluation of any other issues. Airsafe performed the services in a professional manner, in accordance with relevant guidelines and standards, and generally accepted industry practices. Airsafe does not make any other warranty, expressed or implied, as to the professional advice contained in this report.

The survey was based on a visual inspection of the specified areas. It should be noted that this assessment is reflective of the current site conditions and cannot be regarded as absolute without extensive invasion of structures. Only materials that were physically accessible at the time of inspection were sampled. Consequently, without substantial demolition of the building, it is not possible to guarantee that every hazardous material has been located. Care should be taken during the course of normal site works, refurbishment or demolition works when entering any previously inaccessible areas. If suspect materials are encountered, works should cease in the area until samples have been collected and analysed by competent personnel.

The presence of any residual hazardous materials from prior removal works cannot always be ascertained without extensive intrusive investigation, which has not been undertaken as part of this survey.

It should be noted that the sampling program was limited to the collection of representative samples of suspect materials for analysis. Other materials of similar appearance are assumed to have a similar content.

The report does not cover any inaccessible areas identified during the inspection. These may include wall cavities, ceiling voids, height restricted areas, service shafts, ducts, internal areas of equipment and machinery, areas concealed within the building structure, or energised services. Hazardous materials should be presumed to be present in all inaccessible areas until removed or confirmed through testing that it does not, in fact, contain asbestos.

Where information has been supplied to Airsafe for the purpose of preparing this report, the information is assumed to be both adequate and accurate. The information provided, therefore, has not been verified or audited. Airsafe will not be liable in relation to incorrect conclusions should any information be incorrect, misrepresented or otherwise not fully disclosed.

Limitations apply to analytical methods used in the identifications of some asbestos containing materials. These limitations may be due to samples collected from non-homogenous materials not being representative, the presence of masking agents, and low concentrations of asbestos fibres. As such, sample analysis results should be considered indicative only.

This report was prepared for the sole use of the client identified on the cover page and only for the purpose for which it was prepared. Any reliance on this report by third parties shall be at their own risk and may not contain sufficient information for purposes of other parties or for other uses.

This report is not intended to be used for the purposes of tendering, programming of works, refurbishment works or demolition works unless used in conjunction with a specification detailing the extent of the works. This report must be read in its entirety and must not be copied, distributed or referred to in part only. The report must not be reproduced without the written approval of Airsafe.

2 GENERAL INFORMATION

2.1 ASBESTOS

2.1.1 Effects on Health

Asbestos is formed in fibre bundles and, as it is further processed or disturbed, the fibre bundles become progressively finer and more hazardous to health. The small fibres are the most dangerous. They are invisible to the naked eye and, when inhaled, penetrate the deepest part of the lungs (respirable fibres).

Significant health risks may arise from the inhalation of airborne asbestos fibres. Compared with straight amphibole fibres, such as amosite and crocidolite, chrysotile fibres are curly and less likely to penetrate the deepest parts of the lung.

Breathing in fibres brings a risk of asbestosis, lung cancer and mesothelioma. Evidence suggests that asbestos causes gastrointestinal and laryngeal cancers in humans, but to a far lesser extent than lung cancer. Usually, asbestos related diseases have a delay or latency period of 20 to 40 years between first exposure and the onset of symptoms and detection of the disease. Asbestos-related diseases can appear or progress even after a person is no longer exposed.

Asbestosis is the scarring of lung tissue that can result from the inhalation of substantial amounts of asbestos over a period of years. It results in breathlessness that may lead to disability and, in some cases, death. Minor changes in X-ray images may be detected for many years without any symptoms of asbestosis or progression of the disease.

Lung cancer is related to the amount of fibre that is breathed in and the risk of lung cancer is greatly increased in those who also smoke tobacco.

Mesothelioma is a cancer of the pleura (outer lung lining) or the peritoneum (the lining of the abdominal cavity). The risk of mesothelioma is less with chrysotile than with other types of asbestos. Both pleural and peritoneal mesothelioma can result from exposure to amosite and crocidolite. Exposure of humans to chrysotile alone has caused few pleural mesotheliomas, and has never produced peritoneal mesothelioma without exposure to either amosite or crocidolite. Mesothelioma rarely occurs in less than 15 years from first exposure, and most cases occur over 30 years after first exposure.

As for many cancer-causing substances, no safe level of exposure for lung cancer or mesothelioma has been identified. However, the amount of asbestos fibre in the air that people inhale is the important factor in determining the level of health risk. The highest risks involve inhaling air that contains a high concentration of asbestos fibre.

Asbestos fibres may be released into the air whenever they are disturbed, and especially during the following activities:

- any direct action on ACM, such as drilling, boring, cutting, filing, brushing, grinding, sanding, breaking, smashing or blowing with compressed air (State legislation prohibits most of these actions);
- the inspection or removal of ACM from workplaces (including vehicles, plant and equipment);
- the maintenance or servicing of materials from vehicles, plant, equipment or workplaces;
- the renovation or demolition of buildings containing ACM.

Non-friable ACM that has been subjected to extensive weathering or deterioration also has a higher potential to release asbestos fibres into the air.

2.1.2 Asbestos Classification

Under NSW OHS legislation, material that contains asbestos is referred to as friable or bonded.

2.1.2.1 Bonded Asbestos Material

Bonded asbestos material is any material that contains asbestos in a bonded matrix. It may consist of Portland cement or various resins/binders, and cannot be crushed by hand when dry. Asbestos cement (AC) products and electrical meter boards in good condition are examples of bonded asbestos material.

A large number of products made from bonded asbestos material are still found in Australian buildings, motor vehicles and plant components. These products include:

- flat (fibro), corrugated or compressed asbestos cement sheeting
- asbestos cement pipes such as electrical, water, drainage and flue pipes
- brake and clutch linings.

2.1.2.2 Friable Asbestos Material

Friable asbestos material is any material that contains asbestos and is in the form of a powder, or can be crumbled, pulverized or reduced to powder by hand pressure when dry. Examples of friable asbestos include:

- sprayed limpet
- asbestos cloth and rope
- millboard
- pipe lagging
- boiler lagging.

Any asbestos cement products that have been subjected to weathering, or damaged by hail, fire or water blasting, are considered to be friable asbestos and an asbestos removal contractor with a WorkCover licence for friable asbestos is required for its removal.

2.1.3 Control Measures

The ultimate goal is for all workplaces to be free of ACM. Where practicable, consideration should be given to the removal of ACM during renovation, refurbishment, and maintenance, rather than other control measures such as enclosure, encapsulation or sealing.

The control measures required for identified and presumed ACM should be determined from the risk assessment and should follow the following principles:

Control Measure 1 -	If the ACM are friable and not in a stable condition, and there is a risk to health from exposure, they should be removed by an asbestos removalist as soon as practicable.
Control Measure 2 -	If the ACM are friable but are in a stable condition and are accessible, serious consideration should be given to their removal. If the removal is not immediately practicable, short-term control measures, such as sealing and enclosure, may be able to be used until removal is possible.
Control Measure 3 -	If the ACM are not friable and are in a good, stable condition, minimising disturbance and encapsulation may be appropriate controls.
Control Measure 4 -	Any remaining ACM should be clearly labelled, where possible, and regularly inspected to ensure they are not deteriorating or otherwise contributing to an unacceptable health risk.

These control measures reflect the following hierarchy of controls:

1 - Elimination/removal (most preferred);

2 - Isolation/enclosure/sealing;

3 - Engineering controls;

4 - Safe Work Practices (administrative controls); and

5 - Personal Protective Equipment (PPE) (least preferred).

ACM need to be removed before demolition, partial demolition, renovation or refurbishment if they are likely to be disturbed by those works in accordance with the Code of Practice: How to Safely Remove Asbestos [December 2011] Safe Work Australia.

2.2 LEAD

Lead in any form is toxic to humans when ingested and inhaled. Repeated inhalation or ingestion of lead dust or paint particles may produce the cumulative effects of lead poisoning.

2.2.1 Lead Paint

White lead (lead carbonate) was once the principle white pigment in paints for houses and public buildings.

Lead paint, as defined by the *Guide to Lead Paint Management – Part 2: Residential and Commercial Buildings* [AS 4361.2 – 1998], is that which contains in excess of 1% lead by weight.

Many older homes and buildings still contain lead paint, even though it may be covered with layers of more recent paint. It was used mainly on exterior surfaces and to a lesser extent on interior doors and architraves, especially in undercoats and primers where concentrations of up to 20% lead were commonly used. Interior walls were not commonly painted with paint with paint containing white lead, but some colours did contain red, yellow or orange lead-chrome pigments.

Although all paints manufactured for Australian dwellings from the 1980s onwards will have contained less than 1% lead, it is possible that industrial paints, having higher concentrations of lead, may have been applied to housing and commercial buildings.

Lead paint removal methods give rise to two potential health problems, i.e. inhalation or ingestion of lead paint by the workers and public in the vicinity of the structure and the deposition of lead paint on nearby footpaths, streets or soil where they may be resuspended, tracked into houses or buildings where it can be inhaled or ingested.

2.3 CCA

2.3.1 Overview

CCA (Copper, Chrome, Arsenic) Treated Timber is timber saturated with a mixture of copper, chrome and arsenic, to effectively preserve the wood and is highly resistant to leaching. The resulting composition is 8 to 12 per cent copper, 13 to 16 per cent chromium and 11 to 24 per cent arsenic.

Timber treated with CCA is generally identifiable by its green appearance, but weathering, timber species and formulation differences will sometimes make the identification difficult.

CCA Treated Timber has been widely used for many years to preserve timber for outdoor uses such as decking, fences and playground equipment.

In 2004, the Australian Pesticides and Veterinary Medicines Authority (APVMA, formerly the National Registration Authority) reviewed CCA Treated Timber and announced an intention to phase out the use of such products for certain domestic uses in Australia. This follows similar decisions in the US, EU and a review of this product in NZ. Recently, similarly effective, but less toxic products, have become available.

2.3.2 Health Effects

Arsenic is a known toxic chemical. The general population is exposed to naturally occurring trace amounts in the environment, in foods and in drinking water. In relation to treated timber products, arsenic could be absorbed via the skin, inhaled when wood is burnt or ingested via small fragments of wood.

There is no evidence of adverse human effects associated with normal product use.

The greatest risk of adverse health effects arises from:

- occupational exposure during the actual treatment of the wood.
- burning of treated wood.

There are no reports of adverse health effects in children using playground equipment constructed from CCA Treated Timber.

There is no need for existing CCA Treated Timber structures in good condition to be removed on the basis of concerns about toxicity.

liver and the nervous system, with the possibility of causing cancer.

3 RESULTS

Site: MR56 Camp Street Bridge - Lachlan Valley Way, Forbes
Client: RMS Western Regional Office
Inspection Date: November 31, 2017
Inspected By: Joshua Martin

3.1 ASBESTOS REGISTER

Location	Material	Sample ID	Sample Status	Photo No.	Asbestos Classification	Condition	Accessibility	Control Measure	Comments
MR56 Camp Street Bridge									
Soil from Camp Street; Bridge end near river bank	Soil, rocks and debris	38371-1	Negative	-	-	-	-	-	-
Soil from Bridge Street end near river bank	Soil, rocks and debris	38371-2	Negative	-	-	-	-	-	-
Debris under concrete slab; near pipe on the eastern end of the bridge	Soil, rocks and debris	38371-3	Negative	-	-	-	-	-	-
Soil around eastern pipe end	Soil, rocks and debris	38371-4	Negative	-	-	-	-	-	-
Debris around western	Soil, rocks	38371-5	Negative	-	-	-	-	-	-

Location	Material	Sample ID	Sample Status	Photo No.	Asbestos Classification	Condition	Accessibility	Control Measure	Comments
MR56 Camp Street Bridge									
Soil on western end pipe	Soil, rocks and debris	38371-7	Negative	-	-	-	-	-	-
Western end pipe	1g PVA material	38371-8	Negative	-	-	-	-	-	-
Western end pipe	1g PVA material	38371-9	Negative	-	-	-	-	-	-
Dust and debris on top of concrete ledge and around eastern end pipe	**Chrysotile Asbestos**	**38371-10**	**Positive**	**1**	***Friable**	**Unstable**	**Low**	**2**	**Limit access, removal as soon as practice, engage an ASA classed licenced asbestos removalist**
Woven material on soil bank, under bridge	Fibrous cement sheeting	38371-11	Negative	-	-	-	-	-	-
Pipe under hanging the bridge	Metal	38371-12	Negative	-	-	-	-	-	-
Road Flap marking strip	Rubber	38371-13	Negative	-	-	-	-	-	-

NOTES:
* Friable Asbestos detected in a small fragment of dust located between the top sections of the PVA pipe underneath the concrete slap on the eastern section of the bridge. Pipe section sampled was from the photo supplied, marked with yellow marking paint.

3.2 LEAD

3.2.1 Lead Paint

Location	Sample ID	Sample Status	Photo No.	Condition	Control Recommendation
Yellow and mixed color paint from concrete columns at the eastern side of the bridge street end of the Camp street bridge	38371-1	< 0.05 %w/w	-	Average	Lead content less than the 1% parameter, which defines “Lead Paint”. Over-paint with non-lead based product. If paint is to be disturbed during refurbishment, minimise dust production.
Green paint from beams	38371-2	0.72 %w/w	-	Average	Lead content less than the 1% parameter, which defines “Lead Paint”. Over-paint with non-lead based product. If paint is to be disturbed during refurbishment, minimise dust production.
White marking paint from the centre strip on the road	38371-3	< 0.05 %w/w	-	Average	Lead content less than the 1% parameter, which defines “Lead Paint”. Over-paint with non-lead based product. If paint is to be disturbed during refurbishment, minimise dust production.
Green hand rail paint on both sides of the walking bridge, flaking in some areas	38371-4	< 0.05 %w/w	-	Poor	Lead content less than the 1% parameter, which defines “Lead Paint”. Over-paint with non-lead based product. If paint is to be disturbed during refurbishment, minimise dust production.
Multicolor paint from columns on bridge	38371-5	< 0.05 %w/w		Average	Lead content less than the 1% parameter, which defines “Lead Paint”. Over-paint with non-lead based product. If paint is to be disturbed during refurbishment, minimise dust production.
Yellow column paint from side path	38371-6	< 0.05 %w/w		Average	Lead content less than the 1% parameter, which defines “Lead Paint”. Over-paint with non-lead based product. If paint is to be disturbed during refurbishment, minimise dust production.
Grey paint under bridge	38371-7	< 0.05 %w/w		Average	Lead content less than the 1% parameter, which defines “Lead Paint”. Over-paint with non-lead based product. If paint is to be disturbed during refurbishment, minimise dust production.

NOTES:

Note 1: Lead paint as defined by AS4361.2:1998 as having a lead content of >1%. See Appendix F for Laboratory Certificate of Analysis Report.

3.3 CCA

Location	Sample ID	Sample Status			Photo No.	Condition	Control Recommendation
		Arsenic	Chromium	Copper			
Wooden telegraph pole located on the western bank of the bridge,	38371-1	<4	<1	3	-	Stable	-

Notes:

The NSW EPA Waste Classification Guidelines Part 1: Classifying waste [November 2014] lists the maximum values under general solid waste. for Arsenic and Chromium as 100mg/kg. Copper is not list under Table 1.

4 RECOMMENDATIONS

All hazardous materials identified in the areas included in the refurbishment works should be removed in accordance with the following recommendations.

4.1 ASBESTOS

4.1.2 Site Preparation

Preparation activities include minimising the number of people present and gathering the correct tools, PPE, decontamination materials, barricades, warning signs, etc at the workplace before any work commences.

The responsible person should ensure the security and safety of the asbestos removal site and asbestos work area at all times, particularly if the removal process is to take place over several days or an extended period of time.

The asbestos removal site should be clearly defined to ensure that non-essential people do not enter and to clearly delineate the removal site and warn persons that asbestos removal work is being carried out (e.g. through the placement of barriers and signs or other warning devices). All barriers and warning signs should remain in place until a clearance to re-occupy has been granted.

Before removal tasks commence plastic sheeting (for containment) may need to be placed on the floor or other surfaces that may be contaminated with asbestos dust. If the removal work is not being carried out in an enclosure, the surfaces to be worked on should be cleaned, by either wet wiping or vacuuming, to minimise exposure from the disturbance of asbestos fibres that might be on the surfaces prior to the commencement of removal tasks.

4.1.3 General Requirements for Asbestos Removal

Asbestos removal works should be carried out in accordance with the requirements of the Code of Practice: How to Safely Remove Asbestos [December 2017] Safe Work Australia.

Wherever possible, dry ACM should not be worked on.

Techniques that prevent the generation of airborne asbestos fibres should be used.

4.1.4 Asbestos Removal Equipment

Care should be taken in selecting tools for asbestos removal tasks.

In addition to having to be suitable for these tasks, all tools should prevent or minimise the generation and dispersion of airborne asbestos fibres as much as possible.

The use of power tools in asbestos removal work should be avoided because of the possibility of internal contamination, which commonly occurs with such devices.

In general, manually operated hand tools are preferred.

3 RESULTS

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Woven material on soil bank, under bridge	Fibrous cement sheeting	38371-11	Negative	-	-	-	-	-	-
Pipe under hanging the bridge	Metal	38371-12	Negative	-	-	-	-	-	-
Road Flap marking strip	Rubber	38371-13	Negative	-	-	-	-	-	-

NOTES:
* Friable Asbestos detected in a small fragment of dust located between the top sections of the PVA pipe underneath the concrete slap on the eastern section of the bridge. Pipe section sampled was from the photo supplied, marked with yellow marking paint.

3.2 LEAD

3.2.1 Lead Paint

Location	Sample ID	Sample Status	Photo No.	Condition	Control Recommendation
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Green paint from beams	38371-2	0.72 %w/w	-	Average	Lead content less than the 1% parameter, which defines “Lead Paint”. Over-paint with non-lead based product. If paint is to be disturbed during refurbishment, minimise dust production.
White marking paint from the centre strip on the road	38371-3	< 0.05 %w/w	-	Average	Lead content less than the 1% parameter, which defines “Lead Paint”. Over-paint with non-lead based product. If paint is to be disturbed during refurbishment, minimise dust production.
Green hand rail paint on both sides of the walking bridge, flaking in some areas	38371-4	< 0.05 %w/w	-	Poor	Lead content less than the 1% parameter, which defines “Lead Paint”. Over-paint with non-lead based product. If paint is to be disturbed during refurbishment, minimise dust production.
Multicolor paint from columns on bridge	38371-5	< 0.05 %w/w		Average	Lead content less than the 1% parameter, which defines “Lead Paint”. Over-paint with non-lead based product. If paint is to be disturbed during refurbishment, minimise dust production.
Yellow column paint from side path	38371-6	< 0.05 %w/w		Average	Lead content less than the 1% parameter, which defines “Lead Paint”. Over-paint with non-lead based product. If paint is to be disturbed during refurbishment, minimise dust production.
Grey paint under bridge	38371-7	< 0.05 %w/w		Average	Lead content less than the 1% parameter, which defines “Lead Paint”. Over-paint with non-lead based product. If paint is to be disturbed during refurbishment, minimise dust production.

NOTES:

Note 1: Lead paint as defined by AS4361.2:1998 as having a lead content of >1%. See Appendix F for Laboratory Certificate of Analysis Report.

3.3 CCA

Location	Sample ID	Sample Status			Photo No.	Condition	Control Recommendation
		Arsenic	Chromium	Copper			
Wooden telegraph pole located on the western bank of the bridge,	38371-1	<4	<1	3	-	Stable	-

Notes:

The NSW EPA Waste Classification Guidelines Part 1: Classifying waste [November 2014] lists the maximum values under general solid waste. for Arsenic and Chromium as 100mg/kg. Copper is not list under Table 1.

4 RECOMMENDATIONS

All hazardous materials identified in the areas included in the refurbishment works should be removed in accordance with the following recommendations.

4.1 ASBESTOS

4.1.2 Site Preparation

Preparation activities include minimising the number of people present and gathering the correct tools, PPE, decontamination materials, barricades, warning signs, etc at the workplace before any work commences.

The responsible person should ensure the security and safety of the asbestos removal site and asbestos work area at all times, particularly if the removal process is to take place over several days or an extended period of time.

The asbestos removal site should be clearly defined to ensure that non-essential people do not enter and to clearly delineate the removal site and warn persons that asbestos removal work is being carried out (e.g. through the placement of barriers and signs or other warning devices). All barriers and warning signs should remain in place until a clearance to re-occupy has been granted.

Before removal tasks commence plastic sheeting (for containment) may need to be placed on the floor or other surfaces that may be contaminated with asbestos dust. If the removal work is not being carried out in an enclosure, the surfaces to be worked on should be cleaned, by either wet wiping or vacuuming, to minimise exposure from the disturbance of asbestos fibres that might be on the surfaces prior to the commencement of removal tasks.

4.1.3 General Requirements for Asbestos Removal

Asbestos removal works should be carried out in accordance with the requirements of the Code of Practice: How to Safely Remove Asbestos [December 2017] Safe Work Australia.

Wherever possible, dry ACM should not be worked on.

Techniques that prevent the generation of airborne asbestos fibres should be used.

4.1.4 Asbestos Removal Equipment

Care should be taken in selecting tools for asbestos removal tasks.

In addition to having to be suitable for these tasks, all tools should prevent or minimise the generation and dispersion of airborne asbestos fibres as much as possible.

The use of power tools in asbestos removal work should be avoided because of the possibility of internal contamination, which commonly occurs with such devices.

In general, manually operated hand tools are preferred.

A constant low-pressure water supply is required for wetting down asbestos. This can be achieved with a mains-supplied garden hose fitted with a pistol grip. If no water supply is readily available, a portable pressurised vessel, such as a pump-up garden sprayer, may be able to be used.

Asbestos vacuum cleaners should only be used for collecting small pieces of asbestos dust and debris. Larger pieces should never be broken into smaller sizes so they can be vacuumed. 4.1.5 Personal Protective Equipment (PPE)

All persons engaged in asbestos removal work should wear respiratory protective equipment (RPE) conforming with the requirements of AS/NZS1716-2003 *Respiratory Protective Devices*.

The selection, use and maintenance of respirators should be in accordance with AS/NZS1715-1994 *Selection Use and Maintenance of Respiratory Protective Devices*.

Protective clothing should be provided and worn at all times during all work in the asbestos work area prior to the final clearance inspection.

Protective clothing should be made from materials, which provide adequate protection against fibre penetration. Coveralls should not have external pockets or Velcro fastenings because these features are easily contaminated and difficult to decontaminate.

Disposable coveralls are preferred. They should never be reused, and must be disposed of as asbestos waste.

4.1.6 Decontamination

The type of decontamination required will depend on the type of asbestos (i.e. friable or non-friable); the work method used, and site conditions.

Decontamination must include the asbestos work area, all tools and equipment and personal decontamination.

All contaminated materials, including cleaning rags, plastic sheeting and PPE etc, must be disposed of as asbestos waste.

Some asbestos removal work necessitates the use of decontamination units.

4.1.7 Waste Removal

Loose asbestos waste should not be allowed to accumulate within the asbestos work area.

Asbestos waste should be collected in heavy-duty 200 μm (minimum thickness) polythene bags that are no more than 1200 mm long and 900 mm wide.

The bags should be labelled with an appropriate warning, clearly stating that they contain asbestos and that dust creation and inhalation should be avoided.

If it is not feasible to use asbestos waste bags, drums or bins, because of the volume or size of the asbestos wastes, a waste skip, vehicle tray or similar container that has been double lined with heavy-duty plastic sheeting (200 μm minimum thickness) may be used. Once the skip is full, its contents should be completely sealed with the plastic sheeting.

4.1.8 Disposal of Asbestos Waste

All asbestos waste should be removed from the workplace by a competent person and transported and disposed of in accordance with all relevant State legislation and guidelines for the transport and disposal of asbestos waste.

All asbestos waste must be transported in a covered leak-proof vehicle and:

- not mixed with general building waste;

- not taken to a waste facility for recycling.

Only vehicles licensed by the DECC can transport friable asbestos waste in the metropolitan area.

Asbestos in any form must be disposed of in a manner approved by the DECC and at a waste facility licensed by the DECC to accept asbestos waste.

NSW licensed landfills that accept asbestos waste from the public are listed by region on the DECC website.

Vehicles and their containers must be cleaned before leaving the waste facility.

Contact the DECC and/or the local council for details of waste facilities that can accept asbestos waste.

To demonstrate proof of proper disposal, copies of asbestos waste disposal receipts are to be kept for inspection by WorkCover, the DECC or the local council.

4.1.9 Air Monitoring

Air monitoring should be performed whenever ACM are being removed, to ensure the control measures are effective.

Air monitoring should be performed in accordance with the *Guidance Note on the Membrane Filter Method for Estimating Airborne Asbestos Fibres* [NOHSC: 3003 (2005)].

4.1.10 Clearance to Reoccupy

A visual inspection involving an examination of the asbestos work area should be carried out, prior to the resumption of normal work in the area by unprotected personnel, to confirm that the asbestos removal work has been completed and there is no visual evidence of dust and debris.

Particular attention should be paid to ledges, the tops of air-conditioning ducts, cracks in the floor, folds in plastic sheeting and crevices or other areas which may have been overlooked during the initial clean-up.

The clearance inspection must be conducted by a competent person who is independent from the person responsible for the removal work.

4.2 LEAD

4.2.1 Responsibilities

4.2.1.1 Notification

The contractor must notify WorkCover of proposed lead risk work for each work site, 60 days before the work is commenced.

4.2.1.2 Compliance Program

Contractors should develop and implement a written compliance plan prior to the commencement of the job where employee exposure to lead, without respect to respiratory protection, may be in excess of the NES.

4.2.2 Protection of Personnel

All workers who may be exposed to lead on the project should be protected to avoid personal injury or harm, as well as to prevent lead dust or debris from being carried off the work site to potentially affect others.

4.2.2.1 Training

All contractors who undertake lead management work for buildings should ensure that employees have the required level of specialized training for that class of work.

4.2.2.2 Exposure

The employer is required to assure that no employee is exposed to lead at concentrations in excess of the NES of 0.15 mg/m^3 as determined by air monitoring.

4.2.2.3 Protective Clothing

Operatives involved in the lead management work should wear protective clothing suitable for the particular process adopted and observe the following:

(a) Wear a properly fitted particulate respirator when preparing lead paint management work. If using a disposable type, only those with double head straps are suitable. Respirators should meet the requirements of AS 1716.
(b) Maintain respirator filters in accordance with AS 1715 and ensure that all protective equipment is cleaned and stored properly.
(c) Wear overalls and a head covering to prevent dust accumulation in clothing and hair. Contaminated overalls should not be worn offsite as this can spread lead contamination and put family members and the public at risk.
(d) Wear disposable booties and gloves.

The employer is required to provide protective clothing and equipment appropriate to the hazard. Lead contaminated clothing should not be removed from the work site by the employee. Clean work clothing is to be provided daily to the employees whose exposure levels are above the NES. The employer is required to provide for the cleaning, laundering, or disposal of protective clothing and equipment, and is to repair or replace required protective clothing and equipment as needed to maintain effectiveness. The employer should ensure that all protective clothing is removed at the completion of a work shift.

4.2.2.4 Personal Hygiene

Operatives involved in paint removal work are to observe the following:

(a) Do not smoke while removing paint, as hand to mouth contact may increase the risk of swallowing or inhaling lead paint dust.
(b) Wash hands before eating, drinking, personal hygiene or smoking. Do not eat or smoke in the work area.
(c) Place contaminated overalls in clean polyethylene bags before removing them from the work area, as they are a significant source of contamination to others.
(d) All work clothes worn underneath disposable overalls should be changed daily and laundered separately from other domestic clothing and linen. When laundering contaminated clothes, store them away from other clothes. Do not shake prior to laundering. Disposable overalls provide a simple and safe method of protection.
(e) Clean equipment thoroughly of dust and paint fragments before it leaves the work area. A HEPA filter vacuum clean followed by a wet wipe is normally sufficient.
(f) HEPA filter vacuum then wash or wet wipe clean boots and gloves with a damp cloth at the end of each work day.

4.2.2.5 Responsible Person

A responsible person should be on-site at all times during lead exposure producing operations to implement and maintain the compliance program.

4.2.2.6 Medical Surveillance

Employees who are exposed to lead concentrations should receive medical examinations by an authorized medical practitioner in accordance with Guidelines for Health Surveillance [NOHSC: 7039 (1995)]. The employee’s blood lead level should be examined prior to commencement, within the first month of being engaged, again one month later, and then at intervals relevant to the lead level achieved.

4.2.3.1 Regulated Area

A regulated area should be established at the work site to identify areas, outside of which airborne concentrations of lead can reasonably be expected not to exceed the NES. The regulated area should be identified by appropriate signs and barriers, such as rope, tape, or other visual or physical means.

Workers within the regulated area should be required to wear nominated protective clothing and equipment and will be subject to lead exposure assessment.

Residents, members of the public and other workers should not be allowed access to areas undergoing lead management work until completion of the work and all necessary clean-up procedures.

4.2.3.2 Signs

Sign posting should be erected to adequately inform employees and the public of the presence of lead and the possible need to utilize respirators and other appropriate protective equipment. Signs should be in accordance with AS 1319, be clearly visible during all hours and be maintained in a clean and legible condition.

Phrases to be placed on the sign may include 'Warning', 'Lead Work Area', 'Authorized Personnel Only', and 'Respirators and Protective Clothing Required in this Area'.

4.2.3.3 Containment of Lead Bearing Dust and Debris

Measures that will ensure that lead dust, fumes and debris will be contained within the area include the following:

(a) Place ground sheets below the work area, ensuring they are large enough to contain all the dust generated. Disposable polyethylene sheeting should be used and the edges sealed using heavy duty tape. The plastic ground sheets should be maintained so that as soon as a tear is detected, the ground sheet is repaired or replaced.

(b) Work in such a way as to minimize dust and fume generation and the transfer of debris away from the immediate work area. Avoid working when wind or draughts could cause debris to be blown away from the work area.

(c) Remove accumulated dust frequently to prevent it spreading from the immediate work area. As a minimum, do this on a daily basis using a vacuum cleaner fitted with a HEPA filter for dust and particulate removal.

(d) Wipe down all surfaces. After vacuum removal, there are still likely to be dust traces remaining. Remove these by wiping surfaces with a damp cloth, which is disposed of after use. It is important to use a detergent in the water as this improves cleaning efficiency.

4.2.4 Procedures for Removal

4.2.5.1 Waste Collection

Collection of lead containing waste from the work area should be performed at least once per day. The removal of debris from the work area to storage containers should be performed without releasing lead or other potentially hazardous materials into the environment. The preferred method of collection is a vacuuming system that provides a completely closed pathway for conveyance of debris. If it cannot be avoided, shoveling or sweeping should be minimized and performed with care.

Consumable supplies such as disposable clothing, rags and brushes, as well as worn out reusable items, such as tarpaulins and air filters contaminated with lead should collected and disposed of accordingly.

4.2.5.2 Wastewater

All wastewater from equipment decontamination and worker hygiene practices such as showers and laundry facilities should be collected and send to a liquid waste treatment plant.

4.2.5.3 Waste Containers

All waste containing lead should be stored in a manner to prevent the entry of any hazardous material into the environment. Leak-proof drums, bins and skips are generally acceptable. Drum lids or bin covers should be firmly secured on the containers and the containers should be clearly marked to identify its contents.

4.2.5.4 Waste Storage

Waste storage sites should be located on well-drained ground which is away from areas where water run-off may occur. Waste storage sites should be adequately protected and displayed with warning signs.

Waste should not be stored at temporary storage areas for long periods of time. Waste should be disposed of appropriately as soon as practically possible.

4.2.5.5 Waste Transport

During waste moving operations, precautions should be taken to prevent damage to containers that could result in the spillage of the contents, or entry into waters, air or land.

Movement of waste from the job site is to be performed by a properly licensed carrier. The carrier should ensure that the waste received is properly packaged and meets all transportation regulations. Transporters should also ensure that the manifest/dockets are properly completed and the containers labelled as to their contents.

4.2.5.6 Waste Disposal

In accordance with the *Waste Classification Guidelines Part 1: Classifying Waste* [DECC, 2008], waste contaminated with lead (including lead paint waste) from residential premises or educational or child care institutions has been pre-classified as General Solid Waste (Non-Putrescible).

4.2.6 Air Monitoring

Air monitoring for lead should be conducted during all lead works. Calculated concentrations for lead should be less than the time-weighted average exposure standard of 0.15 mg/m^3 for lead as stated in the *Adopted National Exposure Standard for Atmospheric Contaminants in the Occupational Environment* [NOHSC: 1003 (1995)].

4.2.7 Clearance Testing

After completion of all work and after appropriate clean-up of all relevant areas both inside and outside the building, a clearance inspection should be carried out to determine if there has been a significant impact on the property and surrounding areas from the work and if the building is safe for normal use.

4.4 CCA

4.4.1 Preparation

Do your research and choose the right treated timber for the job – preferably arsenic-free.

Make sure you have the correct personal protective equipment (PPE) to work with treated timber. You should use a mask, gloves and goggles.

Cover any recent cuts or abrasions to avoid exposure to treated timber or treated timber sawdust.

Make sure you have the right screws, nails, bolts, brackets or other fastening hardware for the job. Some timber treatments (particularly copper based treatments) can corrode steel fasteners. Fasteners in contact with preservative treated pine should be hot-dipped galvanised, monel, silicone bronze or stainless steel. Electroplated fasteners are not suitable due to early break down of the plating.

4.4.2 Existing structures

The APVMA also advised that existing structures made from CCA treated timber do not need to be removed. If you are worried about children having contact with the arsenic in CCA, paint the surfaces with an oil-based polyurethane product or paint.

CCA vegetable planters can be lined with plastic.

4.4.3 Labelling

CCA treated timber in Australia must be marked with the words ‘Treated with copper chrome arsenate’ either in the form of individual labels fixed to the ends of wood, or as brands along its length. Individual items of CCA treated timber such as fence palings, battens, droppers, pieces less than 15mm thick or with a cross section below 1500mm^2 do not need to be individually labelled, but the packaging must be marked.

4.4.4 Personal Hygiene

Operatives involved in CCA work are to observe the following:

(a) Do not smoke while removing paint, as hand to mouth contact may increase the risk of swallowing or inhaling CCA dust.
(b) Wash hands before eating, drinking, personal hygiene or smoking. Do not eat or smoke in the work area.
(c) Place contaminated overalls in clean polyethylene bags before removing them from the work area, as they are a significant source of contamination to others.
(d) All work clothes worn underneath disposable overalls should be changed daily and laundered separately from other domestic clothing and linen. When laundering contaminated clothes, store them away from other clothes. Do not shake prior to laundering. Disposable overalls provide a simple and safe method of protection.
(e) Clean equipment thoroughly of dust and paint fragments before it leaves the work area. A HEPA filter vacuum clean followed by a wet wipe is normally sufficient.
(f) HEPA filter vacuum then wash or wet wipe clean boots and gloves with a damp cloth at the end of each work day.

The protection offered by some types of respirators may be affected by personal characteristics such as beards and the wearing of glasses or goggles. Appropriate respirators to ensure protection should be used. All respirators shall comply with the provisions of *Selection, Use and Maintenance of Respiratory Protective Devices* [AS 1715 – 1994] and *Respiratory Protective Devices* [AS 1716 – 2003].

4.4.5 Protective Clothing

Disposable coveralls or long sleeve, loose fitting clothing and gloves should be used by all personnel directly involved in the removal work to minimise skin irritation. To avoid undue heat stress and general discomfort to the wearer, consideration should be given to the type of material chosen for this clothing. Launderable clothing should be washed regularly, separate from other laundry to avoid cross-contamination and subsequent skin irritation of non-workers.

Where overhead work is involved, goggles and head covering should be worn to avoid eye irritation or injury.

APPENDIX A – TEST REPORTS

93 Beattie Street Balmain NSW 2041 Australia
T. 02 9555 9034 | F. 02 9555 9035
info@airsafe.net.au | www.airsafe.net.au
ABN 38 609 424 946

TEST REPORT

December 5, 2017

RMS Western Regional Office
51-55 Currajong Street
PARKES NSW 2870

Your Reference:	MR – 56 Camp Street Bridge, Forbes
Job Number:	38371
Attention:	Peter Hamidler

Dear Peter,

In accordance with your instructions, Airsafe tested samples from the above site for asbestos content.

The following samples were processed on the dates indicated.

Samples:	12 Samples
Date of Sample Receipt:	01/12/17
Date of Sample Analysis:	01/12/17
Date of Preliminary Report Sent:	Not Issued

The results are contained in the following pages of this report.

Should you have any queries regarding this report please contact the undersigned.

Yours faithfully
AIRSAFE OHC PTY LTD

M. Shaw

Matthew Shaw
Approved Identifier and Signatory

PROJECT: MR – 56 Camp Street Bridge, Forbes **JOB NO: 38371**

Sample No	Location/Reference	Sample Description	Asbestos ID - Soil	Trace Analysis
38371-1	Soil from Camp Street; Bridge end	35g soil, rocks and debris	No asbestos found at reporting limit of 0.1 g/kg Organic fibres detected	Respirable fibres not detected
38371-2	Soil from Bridge Street end	67g soil and rocks	No asbestos found at reporting limit of 0.1 g/kg Organic fibres detected	Respirable fibres not detected
38371-3	Debris under concrete slab; near pipe	93g sand, soil and rocks	No asbestos found at reporting limit of 0.1 g/kg Organic fibres detected	Respirable fibres not detected
38371-4	Soil and debris under pipe; east end	109g soil and rocks	No asbestos found at reporting limit of 0.1 g/kg Organic fibres detected	Respirable fibres not detected
38371-5	Soil around eastern pipe end	30g sand and rocks	No asbestos found at reporting limit of 0.1 g/kg Organic fibres detected	Respirable fibres not detected
38371-6	Debris on western end pipe	104g soil and rocks	No asbestos found at reporting limit of 0.1 g/kg Organic fibres detected	Respirable fibres not detected
38371-7	Soil on western end pipe	1g soil and rocks	No asbestos found at reporting limit of 0.1 g/kg Organic fibres detected	Respirable fibres not detected
38371-8	Western end pipe	1g fibrous material	No asbestos detected	N/A
38371-9	Western end pipe	1g PVA material	No asbestos detected	N/A
38371-10	Eastern end pipe debris	1g dust and debris	Chrysotile asbestos detected Organic fibres detected	N/A
38371-11	Woven material on soil bank, under bridge	1g fibrous woven material	No asbestos detected Organic fibres detected	N/A
38371-12	Pipe under the bridge	10x5x2mm metallic fragments	No asbestos detected	N/A
38371-13	Road flap marking strip	10x5x3mm paint fragments	No asbestos detected	N/A

Method: Samples have been analysed using polarised light microscopy including dispersion staining in accordance with the Method for the qualitative identification of asbestos in bulk samples [AS 4964 – 2004] and in-house method AS102 - Method for the Qualitative Identification of Asbestos in Bulk Samples.

Sampling: Samples have been analysed on an "as received" basis.

Accredited for compliance with ISO/IEC 17025 – Testing.
NATA accredited laboratory 2959.
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Note: The results relate only to the samples tested.

Comment: Even after disintegration of certain bulk samples (vinyl tiles and bituminous type materials), the detection of fibres may be difficult when using Polarised Light Microscopy and Dispersion Staining Techniques. This may be due to the matrix of the sample (uneven distribution), or fine fibres that are difficult to detect and positively identify.

APPENDIX B – PHOTOGRAPHS

Photo: 1 Friable asbestos detected within a loose fibre bundle within the underside of the concrete slab.

APPENDIX C – ANALYSIS RESULT

AIRSAFE

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 181273

Client Details

Client	Airsafe Laboratories
Attention	Simon Gorham
Address	93 Beattie St, Balmain, NSW, 2041

Sample Details

Your Reference	**38371, MR 56 Camp Street Bridge, Forbes**
Number of Samples	7 Paint, 1 Wood
Date samples received	04/12/2017
Date completed instructions received	04/12/2017

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	11/12/2017
Date of Issue	07/12/2017

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Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Long Pham, Team Leader, Metals

Authorised By

David Springer, General Manager

Envirolab Reference: 181273
Revision No: R00

Client Reference: 38371, MR 56 Camp Street Bridge, Forbes

Lead in Paint						
Our Reference		181273-1	181273-2	181273-3	181273-4	181273-5
Your Reference	UNITS	38371-1	38371-2	38371-3	38371-4	38371-5
Date Sampled		01/12/2017	01/12/2017	01/12/2017	01/12/2017	01/12/2017
Type of sample		Paint	Paint	Paint	Paint	Paint
Date prepared	-	05/12/2017	05/12/2017	05/12/2017	05/12/2017	05/12/2017
Date analysed	-	06/12/2017	06/12/2017	06/12/2017	06/12/2017	06/12/2017
Lead in paint	%w/w	<0.05	0.72	<0.05	<0.05	<0.05

Lead in Paint			
Our Reference		181273-6	181273-7
Your Reference	UNITS	38371-6	38371-7
Date Sampled		01/12/2017	01/12/2017
Type of sample		Paint	Paint
Date prepared	-	05/12/2017	05/12/2017
Date analysed	-	06/12/2017	06/12/2017
Lead in paint	%w/w	<0.05	<0.05

Client Reference: 38371, MR 56 Camp Street Bridge, Forbes

Acid Extractable metals in soil		
Our Reference		181273-8
Your Reference	UNITS	38371-8
Date Sampled		01/12/2017
Type of sample		Wood
Date prepared	-	05/12/2017
Date analysed	-	05/12/2017
Arsenic	mg/kg	<4
Chromium	mg/kg	<1
Copper	mg/kg	3

Client Reference: 38371, MR 56 Camp Street Bridge, Forbes

Method ID	Methodology Summary
Metals-004	Digestion of Paint chips/scrapings/liquids for Metals determination by ICP-AES/MS and or CV/AAS.
Metals-020	Determination of various metals by ICP-AES.

Client Reference: 38371, MR 56 Camp Street Bridge, Forbes

QUALITY CONTROL: Lead in Paint					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-5	[NT]
Date prepared	-			05/12/2017	5	05/12/2017	05/12/2017		05/12/2017	[NT]
Date analysed	-			06/12/2017	5	06/12/2017	06/12/2017		06/12/2017	[NT]
Lead in paint	%w/w	0.05	Metals-004	<0.05	5	<0.05	<0.05	0	113	[NT]

Client Reference: 38371, MR 56 Camp Street Bridge, Forbes

QUALITY CONTROL: Acid Extractable metals in soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-9	[NT]
Date prepared	-			05/12/2017	[NT]	[NT]	[NT]	[NT]	05/12/2017	[NT]
Date analysed	-			05/12/2017	[NT]	[NT]	[NT]	[NT]	05/12/2017	[NT]
Arsenic	mg/kg	4	Metals-020	<4	[NT]	[NT]	[NT]	[NT]	123	[NT]
Chromium	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	119	[NT]
Copper	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	123	[NT]

Client Reference: 38371, MR 56 Camp Street Bridge, Forbes

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Client Reference: 38371, MR 56 Camp Street Bridge, Forbes

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Report Comments

Acid Extractable Metals in Paint: Minimal sample was supplied for sample #3 (<0.01g).
This may have implications in terms of how representative the sample is of the area sampled.

Acid Extractable Metals in Wood: The results are reported on the sample as received i.e. no moisture correction has been applied.

Appendix N

Traffic and Transport Assessment

Roads and Maritime Services
12-Jun-2018
60555121

Camp Street Bridge Replacement Review of Environmental Factors

Traffic and Transport Assessment

Camp Street Bridge Replacement Review of Environmental Factors

Traffic and Transport Assessment

Client: Roads and Maritime Services

ABN: 76 236 371 088

Prepared by

AECOM Australia Pty Ltd
Level 21, 420 George Street, Sydney NSW 2000, PO Box Q410, QVB Post Office NSW 1230, Australia
T +61 2 8934 0000 F +61 2 8934 0001 www.aecom.com
ABN 20 093 846 925

12-Jun-2018

Job No.: 60555121

AECOM in Australia and New Zealand is certified to ISO9001, ISO14001 AS/NZS4801 and OHSAS18001.

Quality Information

Document Camp Street Bridge Replacement Review of Environmental Factors

Ref 60555121

Date 12-Jun-2018

Prepared by Ernest Wong

Reviewed by Andy McGregor

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
A	27-Nov-2017	Draft for issue to client		
B	1-Dec-2017	Draft for issue to client		
C	15-Jan-2018	Draft for issue to client		
D	08-May-2018	Final Draft	Simon Murphy IAP Team Lead	
0	12-Jun-2018	Final Report	Simon Murphy IAP Team Lead	

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1.0 Introduction

1.1 Project Background

Roads and Maritime Services has engaged AECOM Australia Pty Ltd (AECOM) to undertake a traffic and transport assessment to accompany its proposal to replace the existing bridge over Lake Forbes (B4286) with a new reinforced concrete bridge (B11707).

The site is located on Camp Street Bridge B4286m and is located over Lake Forbes on MR56 Lachlan Valley Way at Forbes as shown in **Figure 1**. The site is located in the local government area of Forbes Shire Council and in the state electorate of Dubbo.

The Camp Street Bridge was built in 1927 and is narrow, in poor condition and nearing the end of its life. A new bridge is needed to meet current design standards and improve safety for motorists and pedestrians into the future.

A new bridge across Lake Forbes will improve safety for motorists, pedestrians and reduce future maintenance requirements. The project involves building a new, wider bridge across Lake Forbes with wider travel lanes and pedestrian/cyclist paths. The design includes landscaping suitable to the surrounding lakeside environment. The lamp posts from the existing bridge will be incorporated in the design to complement the town's heritage aesthetics.

The benefits of the project are:

- Providing a value for money solution to replace the aging bridge and secure access for local and through traffic on the Escort and Lachlan Valley Way;
- Provide for Higher Mass Limit (HML) loads;
- Improving road user safety through wider travel lanes, improved road approaches and pedestrian/cyclist paths across the new bridge;
- Improving connections for pedestrians and cyclists between both sides of Lake Forbes;
- Reduced ongoing maintenance costs;
- Improved environmental outcomes by managing stormwater runoff from the road into Lake Forbes;
- Retaining the lamp posts in the landscape design on the approach to bridge, to reference the past and link the bridge to the heritage aesthetic of the town; and
- A unique design to provide an iconic structure for the Forbes community for the future.

The features or the proposal include:

- Relocation of utilities from the current Camp Street Bridge;
- Demolition of the existing Camp Street Bridge and adjacent footbridge;
- Placement of a temporary in stream pad in Lake Forbes to facilitate demolition of the current bridge and construction of a new bridge;
- Construction of a new bridge on the same road alignment as the old bridge;
- A bridge with a minimum of two-lane, two-way carriageway with 3.5m lanes and 1.5m clear shoulders with improved access for wide vehicles and provision of shared footpaths for cyclists and pedestrians;
- Design traffic speed to match existing (50km/h horizontal and vertical design speed);
- Earthworks and roadworks;
- Landscaping and drainage works;

- A temporary construction compound site, temporary stockpile and laydown area on the western side of Lake Forbes in open space either side of Camp Street;
- Ancillary works area including temporary stockpile and material laydown on the eastern side of Lake Forbes in open space either side of Bridge Street;
- Temporary heavy vehicle detour route for heavy vehicles to and from Orange on the Escort Way, and to and from Cowra on the Lachlan Valley Way. The detour from the intersection of Newell Highway and Camp Street across the Fitzgerald Bridge then onto Wirrinya Road, Red Bend Road, onto Wongajong Road and then onto Lachlan Valley Way as shown in **Figure 5**, **Table 10** and **Table 11**; and
- Temporary light vehicle detour for light vehicles travelling to and from the east and western sides of Lake Forbes. There are various alternative local routes available for light vehicles. It is expected that most light vehicles will use Flint Street, from the intersection at Bridge Street, and then either Bandon or Oxford Street to the intersection the Newell Highway with either Oxford Street or Sheriff Street depending on the direction of traffic as shown in **Figure 5, Table 8** and **Table 9**.

1.2 Study Objectives

This traffic and transport assessment forms part of the Review of Environmental Factors (REF). The purpose of this traffic and transport assessment is to determine the potential traffic and transport impacts during the construction of the new bridge. In particular, the following elements are assessed:

- A review of existing traffic and transport conditions, including existing operational performance of the key intersections along the detour routes;
- Operational performance of key intersections along detour routes considering the cumulative impacts of existing traffic, detour traffic and additional traffic generated by construction activities;
- Operational impact of queueing on the Iron Bridge from the operation of a single lane traffic light control during the construction period; and
- Operational impacts to public transport, pedestrian and cyclists.

1.3 Report Structure

This report has been structured into the following sections:

- **Section 2** of this report provides an overview of existing traffic and transport conditions, including existing operational performance of the key intersections along the detour routes.
- **Section 3** describes the traffic impact during the construction period and management measures that have been developed to mitigate the impact of the traffic and transport issues.
- **Section 4** summarises the key outcomes of the traffic and transport assessment.

2.0 Existing Traffic and Transport Conditions

2.1 Route Environment

Camp Street Bridge is a two-lane, two-way bridge linking Lachlan Valley Way from the south-east to Newell Highway and Forbes Town Centre. The bridge at present is narrow with a posted speed limit of 50km/h with provision for pedestrian and cycling facilities.

Camp Street is a designated B-Double truck route for trucks up to 25m in length with connections to other B-Double routes in the area including Newell Highway to the west, The Escort Way to the east, Henry Lawson Way to the south and Lachlan Valley Way to the south-east.

2.2 Study Area

The study area associated with the proposed Camp Street Bridge Replacement project is outlined in **Figure 1**. The study area encompasses key intersections identified along the proposed detour routes:

- 1: Newell Highway and Camp Street;
- 2: Flint Street and Bridge Street;
- 3: Flint Street and Bandon Street;
- 4: Newell Highway and Sheriff Street;
- 5: Newell Highway and Oxford Street;
- 6: Lachlan Valley Way and Wongajong Road; and
- 7: Newell Highway and Wirrinya Road.

All of these intersections are priority give-way intersections with the exception of a roundabout at Flint Street and Bridge Street.

The key intersections identified have been surveyed and modelled using SIDRA for this assessment. Additionally two mid-block traffic surveys were conducted at Camp Street Bridge (M-1) and Iron Bridge (M-2).

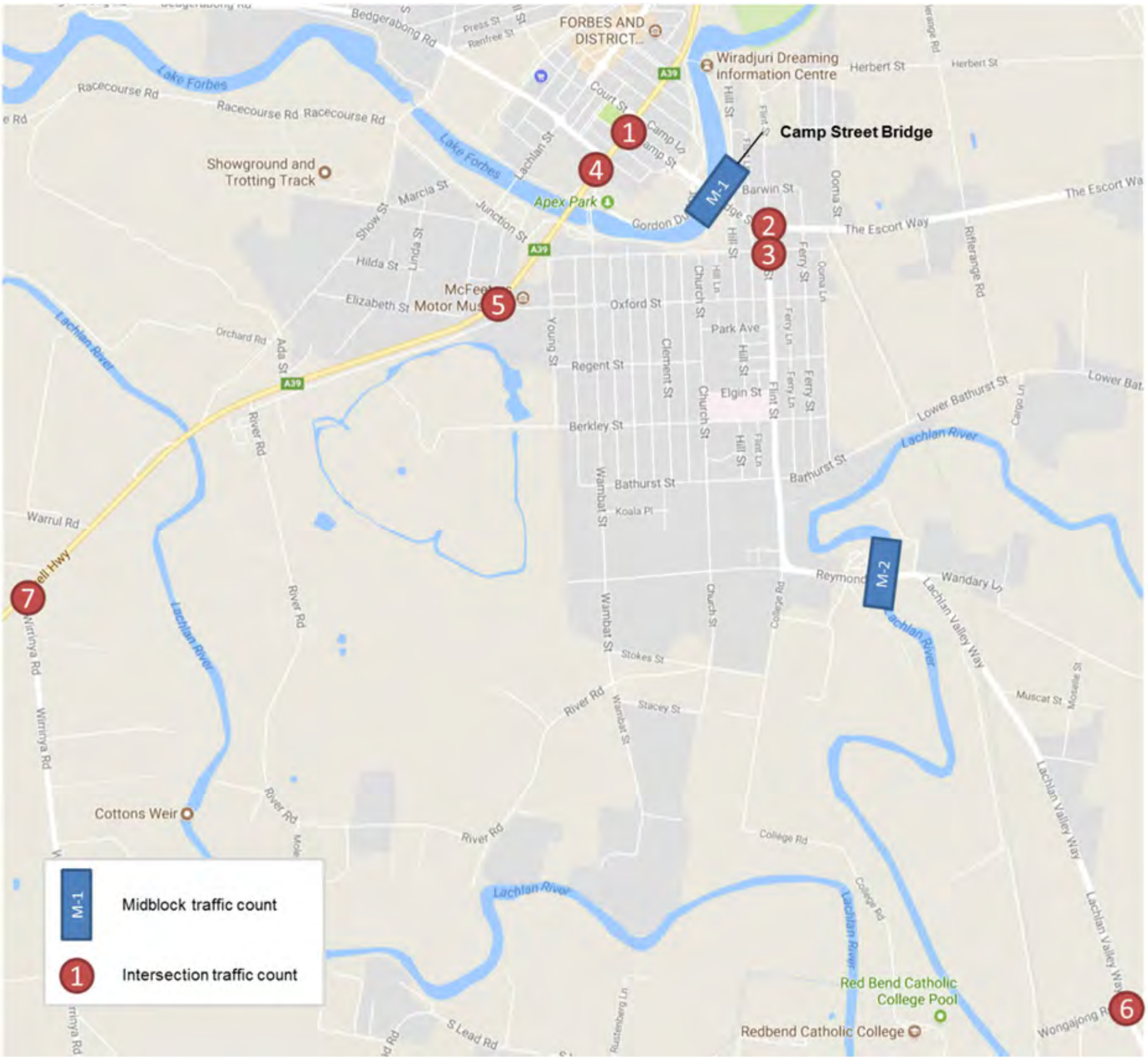


Figure 1 Proposal Study Area

2.3 Surrounding Land uses

Camp Street Bridge provides access to Forbes Town Centre, Forbes Public School, TAFE Western Forbes College and mainly low density residential areas and agricultural rural lands to the south and west of Lake Forbes. Forbes Hospital is located off Flint Street, south of Camp Street. Red Bend Catholic College is located to the south of the Camp Street.

There are some retail and commercial developments along Camp Street and Newell Highway, west of Lake Forbes, with a service station located on the corner of Camp Street and Newell Highway.

There are a few holiday parks along the proposed detour route, with Apex Riverside Tourist Park and Lachlan View Holiday Park, located west of Iron Bridge on Reymond Street and Flint Street and Forbes River Meadows Caravan Park located along Newell Highway north of Wirrinya Road.

2.4 Modes of Travel

2.4.1 Private Transport

Private vehicles are the predominant mode of transport utilised in the study area. This could be attributed to the rural nature of the area. The 2016 Census data provides details of mode share in Forbes and is summarised in **Table 1**.

Table 1 Travel to work in Forbes (Urban Centres and Localities) (2016)

Mode	Forbes	NSW
Vehicle driver	72%	58%
Vehicle passenger	7%	4%
Walked only	4%	4%
Worked at home	4%	5%
Public Transport	1%	16%

Source: Census, 2016

2.4.2 Public Transport

As shown in **Table 1**, public transport accounts for around 1% of mode share in Forbes.

Currently there is limited public transport provision in the Forbes area. There are three scheduled bus routes operated by Forbes Bus Lines in the area. Route 558 currently operates along Camp Street, connecting Camp Hill/South Forbes with Forbes Town Centre, with three scheduled services daily. Two other scheduled bus routes operates in Forbes, Route 556 and 557, servicing the residential area north and west of Forbes Town Centre (North Hill) with Forbes Town Centre.

All scheduled bus services operate between the interpeak periods (after 9:00 AM and before 3:00 PM).

Additionally, Forbes Bus Lines operates a number of school bus services in the area.

Figure 2 Scheduled bus services in Forbes

Source: Forbes Bus Lines, 2017

2.4.3 Walking and Cycling

There are dedicated walking and cycling facilities around Camp Street Bridge, with a separated pedestrian bridge located to the south of Camp Street Bridge. Additionally, separated paths along both sides of Lake Forbes provide dedicated walking and cycling facilities between Camp Street Bridge and Sheriff Street.

However, the low density and open parkland nature of the area results in very little pedestrian activity, with minimal walking and cycling trips observed.

Forbes Shire Council's draft Pedestrian and Cycling Strategy identified a strategic need to brand Forbes as 'A Pedestrian and Cycling Friendly Town' and recommended the upgrade of the existing path along Camp Street between Hill Street and Sheriff Street.

2.5 Traffic Volumes

2.5.1 Mid-block Traffic Counts

Traffic surveys were conducted on 26 Oct 2017 to measure current traffic volumes at key locations along the proposed detour route. Pneumatic tube counters were installed at the following locations:

- M-1: Camp Street Bridge – Camp Street, between Hill Street and Gordon Street, and
- M-2: Iron Bridge – Reymond Street, West of Reisling Street.

Table 2 Traffic Volume Summary

Location	Two-way traffic volumes		
	Total daily traffic (veh)	AM peak hour traffic (veh/hr) (hour beginning)	PM peak hour traffic (veh/hr) (hour beginning)
M-1: Camp Street Bridge	5,623	498 (08:00)	528 (16:00)
M-2: Iron Bridge	1,943	166 (08:00)	189 (15:00)

Source: AECOM, based on traffic data collected on 26 Oct 2017

Table 2 indicates that the traffic volume on Camp Street Bridge is significantly higher compared to Iron Bridge.

2.5.2 Daily Traffic Profile

The two-way traffic profiles are shown in **Figure 3** and **Figure 4**. The traffic profiles suggest morning and afternoon peak hour durations as follows:

- AM peak between 7:00 am and 9:00 am; and
- PM peak between 3:00 pm and 6:00 pm.

The earlier start to the afternoon peak period can be attributed to proximity to local schools, with Redbend College located south of Iron Bridge and Forbes Public School located west of Camp Street Bridge.

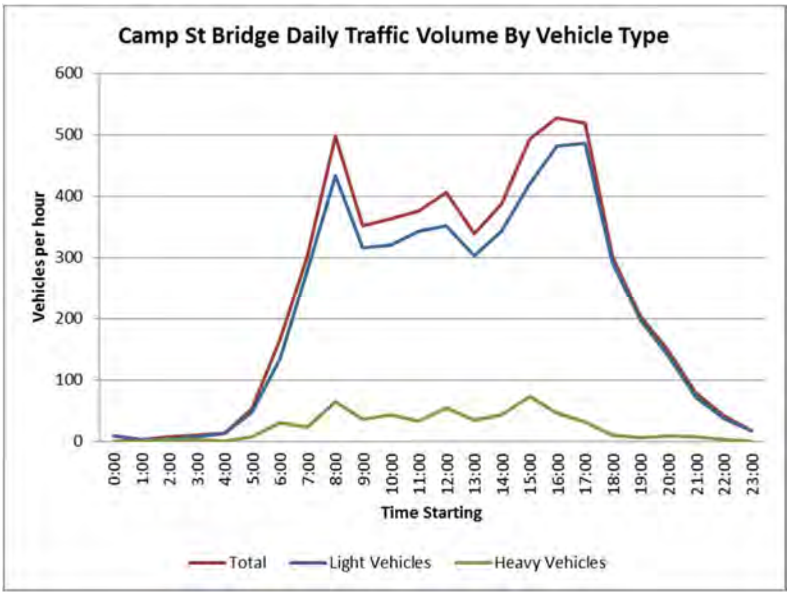


Figure 3 Daily two-way traffic volume at Camp Street Bridge, between Hill Street and Gordon Street

Source: AECOM, based on traffic data collected on 26 Oct 2017

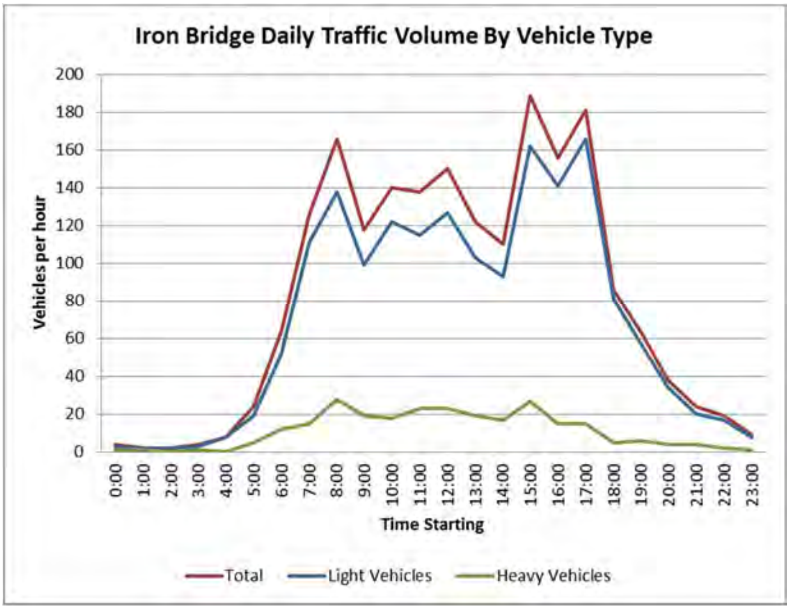


Figure 4 Daily two-way traffic volume at Iron Bridge, Reymond Street, west of Reisling Street

Source: AECOM, based on traffic data collected on 26 Oct 2017

2.5.3 Freight Transport

Both Camp Street Bridge and Iron Bridge are classified as B-Double routes. Classified mid-block pneumatic tube counts surveys were undertaken on 26 Oct 2017 to determine heavy vehicle proportions at the two locations. The proportion of heavy vehicles at Camp Street Bridge and Iron Bridge was found to be approximately 10% to 13% respectively of total traffic (**Table 3**).

Table 3 Freight volume summary

Location	Two-way traffic volumes		
	All vehicles	Heavy vehicles (B-Doubles)	% Heavy vehicles
M-1: Camp Street Bridge	5,623	567 (85)	10%
M-2: Iron Bridge	1,943	261 (61)	13%

Source: AECOM, based on traffic data collected on 26 Oct 2017

2.6 Operational Assessment

2.6.1 Mid-block Capacity

The peak hour directional traffic flows at the two surveyed location are summarised in **Table 4**. Volume capacity ratios (V/C) for the peak direction traffic volumes have also been calculated assuming a capacity of 900 vehicles per lane per hour for Camp Street Bridge and 600 vehicles per lane per hour for Iron Bridge.

Table 4 Mid-block peak hour traffic flows and capacity

Location	AM peak hour (veh/hr)		PM peak hour (veh/hr)	
	Peak direction flow (Westbound)	Volume capacity ratio	Peak direction flow (Eastbound)	Volume capacity ratio
M-1: Camp Street Bridge	247	0.27	273	0.30
M-2: Iron Bridge	113	0.19	103	0.17

Source: AECOM, based on traffic data collected on 26 Oct 2017

The results of the analysis shows that the current traffic flows at Camp Street Bridge and Iron Bridge are relatively low, and suggest there is reserve capacity on the corridor. However, the actual capacity at Iron Bridge may be additionally reduced due to constraints of the narrow bridge as it would typically operate with a one-way flow arrangement.

2.6.2 Intersection Performance

AECOM undertook the modelling of seven intersections identified in the study area using SIDRA Intersection 7 (SIDRA) modelling software package. The following specific SIDRA output metrics used in this study:

- Degree of Saturation (DoS) – a measure of the ratio between traffic volumes and capacity of the intersection. As it approaches 1.0, extensive queues and delays may be expected. DoS should be less than the nominated practical degree of saturation, usually 0.9;
- Level of Service (LoS) – a performance parameter describing of the overall performance of the intersection. It is related to the extent of delay as described in **Table 5**;
- Average Delay – the average time in seconds that vehicles wait at the intersection. At signalised intersections and roundabouts, the average intersection delay is reported. At priority controlled intersections, the average delay for the most delayed movement is reported; and
- Queue Length – the number of vehicles waiting at the give way or stop line and is typically quoted as the 95^{th} percentile back of queue. The intersection queue length is reported for the movement with the longest queue length.

Table 5 Level of Service indication table

Level of Service	Average delay per vehicle	Traffic signals, Roundabout	Priority Intersection ('Stop' and 'Give Way')
A	< 14	Good operation	Good operation
B	15 – 28	Good with acceptable delay and spare capacity	Acceptable delays and spare capacity
C	29 – 42	Satisfactory	Satisfactory, but accident study required
D	43 – 56	Operating near capacity	Near capacity and accident study required
E	57 – 70	At capacity; at signals, incidents will cause excess delays Roundabouts require other control mode	At capacity, requires other control mode
F	> 70	Extra capacity required	Unsatisfactory with excessive queuing; requires other control mode

Source: RTA Traffic Generating Development Guide, 2002

2.6.2.1 Base Model Development

Base models were created for both the AM and PM peak hours based on the peak hour traffic volumes surveyed on 26 October 2017. Due to an equipment error during the PM peak period at the intersection of Newell Highway and Sheriff Street, an additional survey was conducted on 2 November 2017 for the PM peak period at that location. It was determined that there was no significant difference in the traffic volumes between the two survey periods and they could be used as being representative of a typical weekday traffic volume.

The base model was calibrated through the use of queue length / average delay surveys and field observations. The queue lengths and average delay outputs of the SIDRA model were closely matched with the surveyed data; however the SIDRA outputs showed shorter queues and average delay on the Camp Street approach at Newell Highway, which is not representative of observed site conditions. However, with Camp Street closed during the construction of the new Camp Street Bridge, this intersection is not deemed as a critical intersection for the purposes of assessing the impact during the construction period.

2.6.2.2 Existing Intersection Performance

Table 6 and **Table 7** summarise the performance of the key intersections along the proposed detour route. The analysis was undertaken based on the traffic survey in 2017 that is representative of a typical weekday. The peak hour intersection volumes are presented in **Appendix A**.

All of the intersections within the study area currently operate at a satisfactory level of service (LoS A) during peak hours, with minimal intersection delays and queueing on all approaches.

Table 6 Existing intersection performance along proposed detour route (AM peak hour)

Intersection	Traffic volume (veh/hr)	Level of Service (LoS)	Degree of Saturation (DoS)	Average delay (s)	95% Back of Queue	
					Queue lengths (m)	Worst queueing approach
1: Newell Highway & Camp Street (priority)	934	A	0.21	7.3	4.1	Camp Street (E)
2: Flint Street & Bridge Street (roundabout)	519	A	0.15	6	6.7	Bridge Street (W)
3: Flint Street & Bandon Street (priority)	336	A	0.09	7.1	0.6	Bandon Street (W)
4: Newell Highway & Sheriff Street (priority)	599	A	0.17	6.4	3.8	Sheriff Street (E)
5: Newell Highway & Oxford Street (priority)	366	A	0.09	7.9	2.7	Oxford Street (E)
6: Lachlan Valley Way & Wongajong Road (priority)	141	A	0.04	9.1	0.4	Wongajong Road (W)
7: Newell Highway & Wirrinya Road (priority)	263	A	0.06	8.4	1.7	Wirrinya Road (E)

Source: AECOM, 2017

Table 7 Existing intersection performance along proposed detour route (PM peak hour)

Intersection	Traffic volume (veh/hr)	Level of Service (LoS)	Degree of Saturation (DoS)	Average delay (s)	95% Back of Queue	
					Queue lengths (m)	Worst queueing approach
1: Newell Highway & Camp Street (priority)	931	A	0.20	6.9	3.7	Camp Street (E)
2: Flint Street & Bridge Street (roundabout)	552	A	0.18	5.8	7.4	Bridge Street (W)
3: Flint Street & Bandon Street (priority)	352	A	0.09	7.1	0.5	Bandon Street (W)
4: Newell Highway & Sheriff Street (priority)	608	A	0.17	6.4	3.2	Sheriff Street (E)
5: Newell Highway & Oxford Street (priority)	356	A	0.08	7.6	2.2	Oxford Street (E)
6: Lachlan Valley Way & Wongajong Road (priority)	132	A	0.03	9.1	0.4	Wongajong Road (W)
7: Newell Highway & Wirrinya Road (priority)	251	A	0.06	8.5	0.9	Wirrinya Road (E)

Source: AECOM, 2017.

3.0 Traffic and Transport Assessment

This chapter provides details of the traffic impact assessment that was undertaken taking into consideration the cumulative impacts of existing traffic, detour traffic and additional traffic generated during the proposed closure of Camp Street Bridge.

3.1 Operational Assessment

During the construction of the new bridge, the existing Camp Street Bridge will be closed, requiring existing light and heavy vehicle traffic to detour on alternative routes travelling to and from the east and western sides of Lake Forbes. Two separate detour routes are proposed for light and heavy vehicles.

3.1.1 Light Vehicles

There are various alternative local routes available for light vehicles. It is expected that most vehicles would travel southbound on Flint Street from the roundabout at its intersection with Bridge Street, then following either Brandon Street or Oxford Street to reach the Newell Highway as shown in **Figure 5,** and **Table 8** and **Table 9** below.

To assess the impacts of the light vehicle detour traffic on the surrounding road network, the existing light vehicle traffic on Camp Street Bridge was redistributed based on the following general assumptions:

- No sign posted / fixed detour route for light vehicles;
- Based on existing land use and site observations, it is assumed that the majority of left turning traffic from Camp Street is destined for Forbes Town Centre (accessed via Browne Street) rather than continuing south along Newell Highway;
- Traffic generated between Oxford Street and Sheriff Street along Newell Highway is minor; and
- The majority of the detour traffic will take the shortest detour path along Sheriff Street and Bandon Street. A small percentage of traffic may filter through Oxford Street to join onto Newell Highway.

The existing light vehicle traffic was distributed depending on the direction of travel based on the existing traffic survey and the assumptions at Flint Street / Bridge Street intersection and Newell Highway / Camp Street intersection outlined in **Table 8** and **Table 9**.

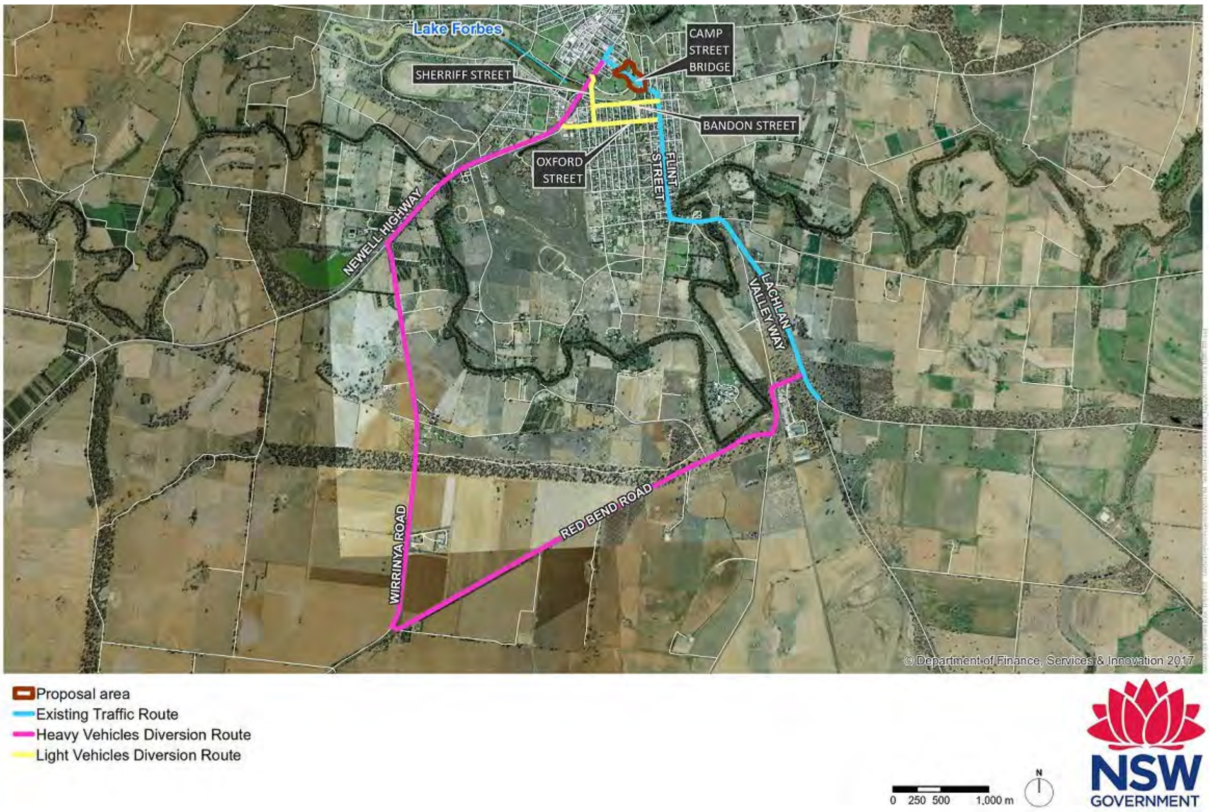


Figure 5 Proposed heavy and light vehicle diversion routes

Table 8 Light vehicle detour route assumptions for traffic originating from Flint Street & Bridge Street

<table>
<tr><th>From Bridge Street East</th><th>From Flint Street South</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Movement: Bridge Street East going straight at Flint Street:
Majority of traffic will take Sheriff Street;
Majority of traffic at Sheriff Street is heading north to Newell Highway or Forbes Town Centre;
AM/PM Peak distribution is the same based on land use – Forbes Public School in the morning and Forbes Town Centre in the afternoon; and
Remainder of the traffic is heading south on Newell Highway through Oxford Street.</td><td>Movement: Flint Street South turning left into Bridge Street:
Majority of the traffic will take existing E-W streets (Reymond Street, Bathurst Street, Berkley Street and Oxford Street) to Wambat Street / Sheriff Street rather than traveling north on Flint Street;
Majority of traffic at Sheriff Street / Newell Highway intersection is heading to Forbes Town Centre and North using the same assumption as Bridge Street East; and
Remainder of the traffic is heading south on Newell Highway through Oxford Street.</td></tr>
</table>

Table 9 Light vehicle detour route assumptions for traffic originating from Newell Highway & Camp Street

<table>
<tr><th>From Newell Highway North</th><th>From Newell Highway South</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Movement: Newell Highway North turning left into Camp Street:
Majority of traffic will take Sheriff Street;
Traffic is distributed south and east based on the surveyed distribution at Bridge Street (W) approach at Flint Street; and
Traffic heading south will filter through Wambat Street and adjacent E-W streets (Reymond Street, Bathurst Street, Berkley Street and Oxford Street).</td><td>Movement: Newell Highway South turning right into Camp Street:
Majority of the traffic will turn right at Oxford Street;
Some right turn traffic will originate from Forbes Town Centre (via Browne Street) and instead will travel south and turn left into Sheriff Street;
Traffic is distributed south and east based on the same distribution as Bridge Street (W) approach at Flint Street; and
Traffic heading south will filter through Wambat Street and adjacent E-W streets (Reymond Street, Bathurst Street, Berkley Street and Oxford Street).</td></tr>
</table>

3.1.2 Heavy Vehicles

The proposed detour route for heavy vehicles to and from Orange on The Escort Way, and to and from Cowra on the Lachlan Valley Way will be from the intersection of Newell Highway and Camp Street across the Fitzgerald Bridge then onto Wirrinya Road, Red Bend Road, onto Wongajong Road and then onto Lachlan Valley Way as shown in **Figure 5**, **Table 10** and **Table 11** below.

To assess the impacts of the heavy vehicle detour traffic on the surrounding road network, the existing heavy vehicle traffic on Camp Street Bridge was redistributed based on the following general assumptions:

- There will be a fixed detour route for the duration of the Camp Street closure;
- All heavy vehicles will use the defined detour route and no heavy vehicles will filter through Oxford Street and Sheriff Street between Newell Highway and Flint Street; and
- Based on existing land use south of Lake Forbes, there are no significant heavy vehicle generation along Newell Highway and Flint Street along the detour route.

The existing heavy vehicle traffic was distributed depending on the direction of travel based on the existing traffic survey and the assumptions at Flint Street & Bridge Street intersection and Newell Highway & Camp Street intersection outlined in **Table 10** and **Table 11**.

Table 10 Heavy vehicle detour route assumptions for traffic originating from Flint Street & Bridge Street

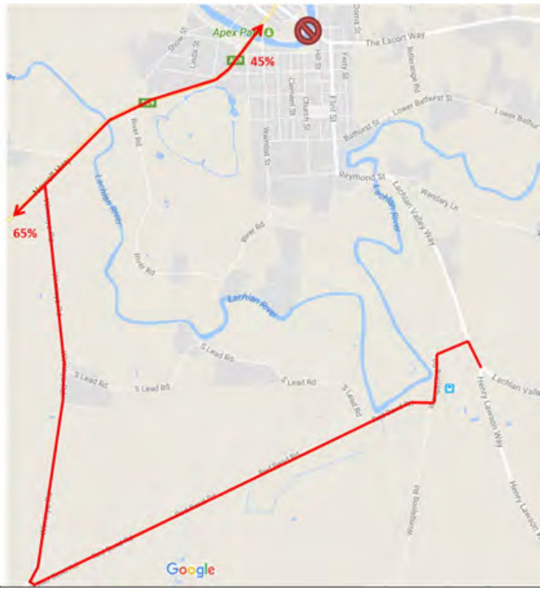
From Bridge Street East	From Flint Street South
	
Movement: Bridge Street East continuing straight:: • Traffic is distributed at the Wirrinya Road (E) approach at Newell Highway based on the heavy vehicle survey distribution at Camp Street (E) approach at Newell Highway	**Movement:** Flint Street South turning left into Bridge Street: • Traffic will turn left at Wongajong Road from Lachlan Valley Way instead of continuing straight • Traffic is distributed at the Wirrinya Road (E) approach at Newell Highway based on the surveyed distribution at Camp Street (E) approach at Newell Highway • No significant heavy vehicle generation between Wongajong Road and Bridge Street based on existing land use.

Table 11 Heavy vehicle detour route assumptions for traffic originating from Newell Highway & Camp Street

From Newell Highway North	From Newell Highway South
	
Movement: Newell Highway North turning left into Camp Street: • Traffic will continue straight on the highway and turn left at Wirrinya Road • Traffic is distributed at Wongajong Road (W) approach at Lachlan Valley Way based on the surveyed distribution at Bridge Street (W) approach at Flint Street.	**Movement**: Newell Highway South turning right into Camp Street: • Heavy vehicles will turn right at Wirrinya Road instead of continuing along the highway • Traffic is distributed at Wongajong Road (W) approach at Lachlan Valley Way based on the surveyed distribution at Bridge Street (W) approach at Flint Street • No significant heavy vehicle generation between Wirrinya Road and Sheriff Street based on existing land use.

3.1.3 Bus Services

The 558 route and two bus stops along Camp Street at South Circle Park (287148) and Bridge Street near Hill Street (287131) will be impacted by the closure of Camp Street Bridge. A new temporary route connecting South Forbes with Forbes Town Centre will need to be determined through consultation between Roads and Maritime and Forbes Bus Lines.

School services that are operating in the area will also be potentially impacted and new detour routes will need to be determined prior to the closure of the bridge.

3.1.4 Pedestrians and Cyclists

Pedestrians and cyclists will be diverted along Lake Forbes to Johnny Woods crossing at Sheriff Street, through the underpass at Newell Highway and along Newell Highway towards Camp Street as shown in **Figure 6**.

Depending on the final location of the construction compound on the eastern side of Camp Street Bridge, a temporary pedestrian access along Hill Street could be considered to connect the footpaths between Camp Street and Bandon Street.

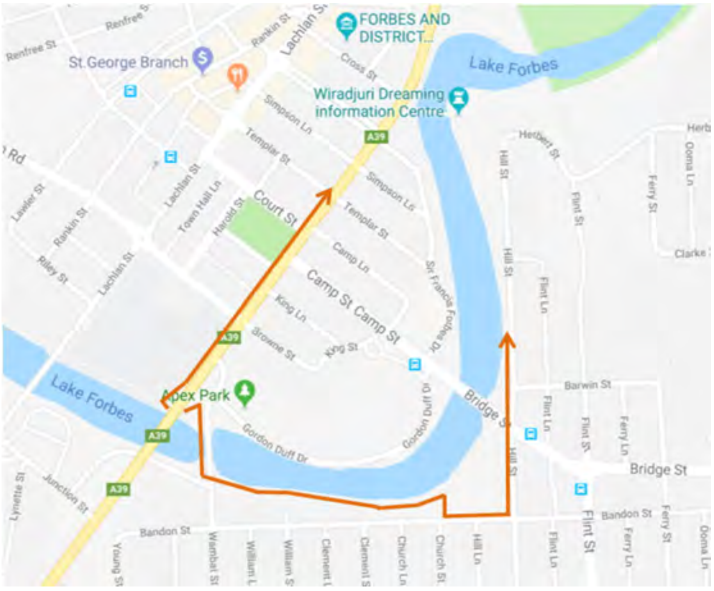


Figure 6 **Pedestrian and cyclists detour**

There are existing separated shared path facilities on the southern side of Lake Forbes with a dedicated path on the western side of Sheriff Street. As pedestrians and cyclists will need to cross Sheriff Street near James Street in order to access Johnny Woods crossing on the west, there is a potential for increased conflicts at Sheriff Street with diverted light vehicle traffic from Camp Street.

3.1.5 Emergency Vehicles

Emergency vehicles crossing Lake Forbes at Camp Street Bridge are assumed to be diverted using the proposed light vehicle detour from the intersection of Flint Street and either the intersection of Bandon Street or Oxford Street to the intersection the Newell Highway with either Oxford Street or Sheriff Street depending on the direction of traffic.

Based on site observations, there appears to be sufficient clearance at the key intersections along Newell Highway at Sheriff Street and Oxford Street, and along Flint Street at Bandon Street and Oxford Street to accommodate turning emergency vehicles.

3.1.6 Construction Traffic

Impacts on traffic during reconstruction of the Camp Street Bridge would be temporary in nature. Traffic impacts would occur as a result of the movement of construction and service vehicles along Newell Highway and access roads, for the haulage of construction materials and employee access to the site compound located west of Camp Street Bridge.

Truck movements during the construction phase are expected to increase by approximately 20 truck movements per day during earth work staging. Light vehicle movements from employees on site are expected to increase by 10 vehicle movements per day during the construction of deck slabs.

Newell Highway and Camp Street currently experience varied heavy vehicle movements. Based on traffic data collected, over 560 heavy vehicles per day use Camp Street Bridge and over 100 heavy vehicles per hour were recorded along Newell Highway at Camp Street during the AM peak. The additional truck movements are considered unlikely to have a significant effect along Newell Highway, but may have locally concentrated impacts at construction accesses through Camp Street and Sir Francis Forbes Drive.

3.1.7 Forecast Traffic Volumes

A spreadsheet model was used to forecast traffic volumes along the proposed detour routes based on the assumptions discussed in **Section 3.1.1** and **Section 3.1.2**.

As there are no scheduled bus services operating during the modelled AM and PM peak periods, for the purposes of assessing the operational performance of road network, no additional bus services were added to the model in SIDRA.

It is also assumed that no deliveries will be targeted during peak periods in order to minimise the impact of construction traffic on the road network. Additionally, employee site access will typically fall outside the standard RMS hours of operation between 7am to 6pm on a weekday. For the purposes of assessing the operational performance of road network during the construction period, no additional construction and employee traffic was modelled for the peak period.

A summary of all forecast turning movements during AM and PM peak are provided in **Appendix B**.

3.1.8 Intersection Performance

SIDRA modelling has been undertaken using the forecast turning movements to determine the operational impacts to key intersections along the proposed light and heavy vehicle detours.

The intersection of Newell Highway / Camp Street was not assessed as it is assumed that Camp Street will be closed to through traffic and local traffic access to the commercial and retail activity along Camp Street will be minimal.

Table 12 and **Table 13** summarise the performance of key intersections along the proposed detour route during the closure of Camp Street Bridge. The performance assessment in SIDRA demonstrates that all intersections are forecast to continue to operate at a satisfactory level of service (LoS A) during peak periods, with minimal intersection delays and queueing on all approaches. As expected, the intersection at Newell Highway and Sheriff Street would have the largest increase in traffic volumes due to the detour of light vehicle traffic from Camp Street Bridge. The average delay for the AM peak at Sheriff Street increased from 6.4 seconds to 7.4 seconds and queue lengths increased from 3.8m to 11.6m.

Table 12 Detour period intersection performance along proposed detour route (AM peak hour)

Intersection	Traffic volume (veh/hr)	Level of Service (LoS)	Degree of Saturation (DoS)	Average delay (s)	95% Back of Queue	
					Queue lengths (m)	Worst queueing approach
1: Newell Highway & Camp Street (priority)	NA					
2: Flint Street & Bridge Street (roundabout)	254	A	0.09	5.7	3.6	Bridge Street (E)
3: Flint Street & Bandon Street (priority)	323	A	0.09	6.6	3.2	Flint Street (N)
4: Newell Highway & Sheriff Street (priority)	1002	A	0.37	7.4	11.6	Sheriff Street (E)
5: Newell Highway & Oxford Street (priority)	495	A	0.13	9.1	3.7	Oxford Street (E)
6: Lachlan Valley Way & Wongajong Road (priority)	192	A	0.06	10.4	2.8	Wongajong Road (W)
7: Newell Highway & Wirrinya Road (priority)	317	A	0.10	9.8	3.9	Wirrinya Road (E)

Source: AECOM, 2017

Table 13 Detour period intersection performance along proposed detour route (PM peak hour)

Intersection	Traffic volume (veh/hr)	Level of Service (LoS)	Degree of Saturation (DoS)	Average delay (s)	95% Back of Queue	
					Queue lengths (m)	Worst queueing approach
1: Newell Highway & Camp Street (priority)	NA					
2: Flint Street & Bridge Street (roundabout)	269	A	0.09	8.2	3.3	Flint Street (S)
3: Flint Street & Bandon Street (priority)	352	A	0.07	6.6	2.6	Flint Street (N)
4: Newell Highway & Sheriff Street (priority)	1031	A	0.34	7.2	10.3	Sheriff Street (E)
5: Newell Highway & Oxford Street (priority)	498	A	0.12	8.7	3.2	Oxford Street (E)
6: Lachlan Valley Way & Wongajong Road (priority)	157	A	0.04	9.1	1.5	Wongajong Road (W)
7: Newell Highway & Wirrinya Road (priority)	273	A	0.06	9.5	1.7	Wirrinya Road (E)

Source: AECOM, 2017.

The intersection of Lachlan Valley Way and Wongajong Road is located approximately 290 metres from the railway level crossing to the west of Lachlan Valley Way. With the increase in heavy vehicle volumes on Wongajong Road due to the detour, the 95% back of queue length is predicted to increase to 2.8m during the AM peak and would provide sufficient clearance from the railway level crossing.

3.1.9 Iron Bridge Capacity

Iron Bridge is located on Reymond Street, west of Reisling Street. As seen in **Figure 7**, the bridge is narrow in nature and only one heavy vehicle is permitted on the bridge at any one time. Access to the holiday park is located approximately 90 metres east of Iron Bridge.

Figure 7 Iron Bridge

Table 14 and **Table 15** summarise the existing and projected traffic volumes on Iron Bridge, located on Reymond Street, west of Reisling Street. The projected traffic on Iron Bridge is based on the traffic volumes captured by the midblock traffic counts and the projected increase in heavy vehicles traffic during the operation of the detour.

During the operation of the heavy vehicle detour, it is estimated that Iron Bridge will have the largest increase in heavy vehicle traffic during the AM peak period with an increase of 16 heavy vehicles per hour eastbound and 5 heavy vehicles per hour westbound.

Table 14 Existing and projected traffic volumes on Iron Bridge (AM peak hour)

Scenario	Eastbound			Westbound		
	Light Vehicles	Heavy Vehicles	Total	Light Vehicles	Heavy Vehicles	Total
Existing	40	13	53	98	15	113
Detour operation	40	29	69	98	20	118

Source: AECOM, 2017.

Table 15 Existing and projected traffic volumes on Iron Bridge (PM peak hour)

Scenario	Eastbound			Westbound		
	Light Vehicles	Heavy Vehicles	Total	Light Vehicles	Heavy Vehicles	Total
Existing	77	8	85	64	7	71
Detour operation	77	14	91	64	13	77

Source: AECOM, 2017.

Iron Bridge is being reconfigured to single lane operation controlled by traffic signals at each approach prior to implementation of the heavy vehicle detour.

The queue length from the operation of the traffic signals on the bridge was assessed using the following assumptions:

- Green phase time of 60 seconds per direction;
- All red phase time of 30 seconds (where both directions are stopped) based on the total time for a vehicle to clear a distance of 150 metres between the two approaches with an average travel speed of 25 km/h and set up phase time; and
- Total cycle time of 180 seconds, consisting of 30 seconds of all red phase time and 60 seconds of green phase time from opposing direction.

The average queue length predicted at Iron Bridge is calculated using the following formula:

$$q = r * t_r$$

where q is the average queue length, r is the average arrival rate (veh/min) and t_r is the total red time per cycle (120 seconds or 2 minutes).

Table 16 summarises the results of the queueing assessment on Iron Bridge. The average queue length at Iron Bridge for the peak direction is estimated to be approximately four vehicles during each of the red phases with a maximum waiting time of two minutes. This will not have any significant impact on property access within the immediate vicinity of Iron Bridge, including access to the holiday park.

Table 16 Average queue length on Iron Bridge

Direction	AM peak		PM peak	
	Average arrival rate (veh/min)	Average queue length (veh)	Average arrival rate (veh/min)	Average queue length (veh)
Eastbound	1	2	2	4
Westbound	2	4	1	2

4.0 Summary and Recommendations

A traffic and transport assessment was prepared to determine the potential traffic and transport impacts during the construction of the Camp Street Bridge and forms part of the Review of Environmental Factors (REF). In particular, the following elements were assessed:

- A review of existing traffic and transport conditions, including existing operational performance of the key intersections along the detour routes;
- Operational performance of key intersections along the detour routes considering the cumulative impacts of existing traffic, detour traffic and additional traffic generated by construction activities;
- Operational impact of queueing on the Iron Bridge from the operation of a single lane controlled by traffic light during the construction period; and
- Operational impacts to public transport, pedestrian and cyclists.

4.1 Operational Intersection Performance

The existing performance of the key intersections within the study area indicated that they were operating at a satisfactory level of service (LoS A) during peak hours, with minimal intersection delays and queueing on all approaches.

Taking into account the cumulative impacts of existing traffic, detour traffic and additional traffic generated by construction activities, the road network would continue to operate at a satisfactory level of service (LoS A) during the closure of Camp Street Bridge. The intersection of Newell Highway and Sheriff Street would be most impacted by the detour traffic, with the average delay for the AM peak at Sheriff Street increasing from 6.4 seconds to 7.4 seconds and average queue lengths increasing from 3.8m to 11.6m.

With the increase in heavy vehicle traffic at the intersection of Lachlan Valley Way and Wongajong Road, the queue length on Wongajong Road is forecasted to be minimal and it would have sufficient clearance from the railway level crossing located approximately 290 metres west of the intersection

It is currently proposed that the light vehicle detour route would not be signposted. However, opportunities should be explored to provide signage for light vehicles alongside signage for heavy vehicles at the Flint Street and Bridge Street intersection to encourage the use of Bandon Street and Oxford Street as the preferred detour routes for light vehicles.

4.2 Operational Impact of Queueing on Iron Bridge

With the increase in heavy vehicles during the operation of the detour and due to the narrow nature of Iron Bridge, it is proposed that Iron Bridge would operate as a single lane bridge controlled by traffic signals at each approach for the duration of the heavy vehicle detour.

With an assumed total stopping time of 120 seconds per direction at the traffic signal, the average queue length at Iron Bridge for the peak direction is estimated to be approximately four vehicles. The forecasted queue length would not have any significant impact on property access within the immediate vicinity of Iron Bridge.

If required, the performance of the signal operation can be further improved with the use of actuated signals and loop detectors on each approach rather than fixed time signals. This would be beneficial during the AM peak period where there is a dominant westbound traffic flow on the bridge.

4.3 Operational Impacts to Public Transport, Pedestrians and Cyclists

Route 558 would be impacted by the closure of Camp Street Bridge and a new temporary route connecting South Forbes with Forbes Town Centre will need to be determined through consultation between Roads and Maritime and Forbes Bus Lines. School services that are operating in the area would also be potentially impacted and new detour routes will need to be determined prior to the closure of the bridge.

Depending on the final location of the construction compound on the eastern side of Camp Street Bridge, a temporary pedestrian footpath along Hill Street could be considered to connect the footpaths between Camp Street and Bandon Street.

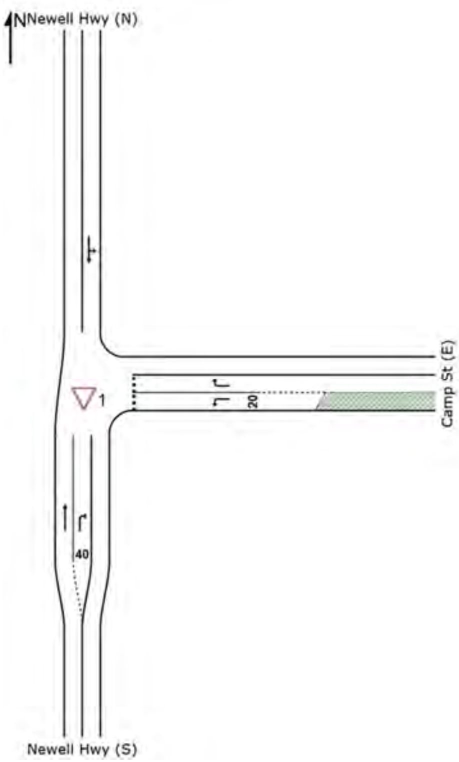
With pedestrians and cyclists diverted along Lake Forbes to Johnny Woods crossing at Sheriff Street, there is a potential for increased conflicts between pedestrians and cyclists with diverted light vehicles travelling on Sheriff Street. Whilst there were minimal pedestrian and cyclists activity observed during the site visit, opportunities should be explored to improve the safety of the pedestrian and cyclist crossing at Sheriff Street such as additional signage near James Street to reinforce Forbes as ‘A Pedestrian and Cycling Friendly Town’.

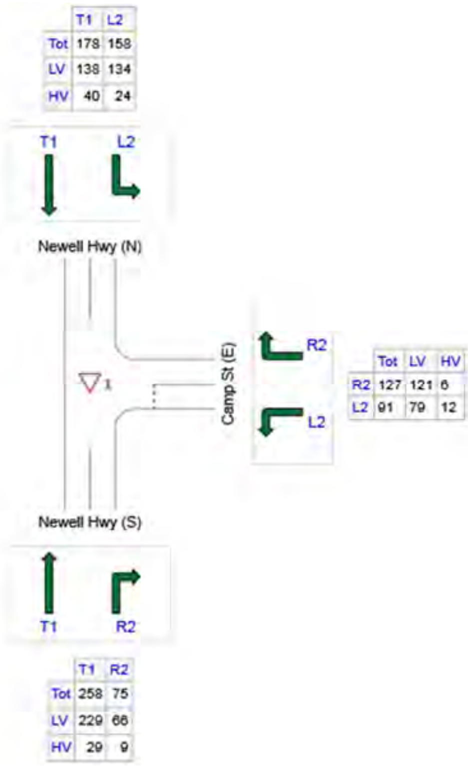
Appendix A

Existing Intersection Traffic

Appendix A Existing Intersection Traffic

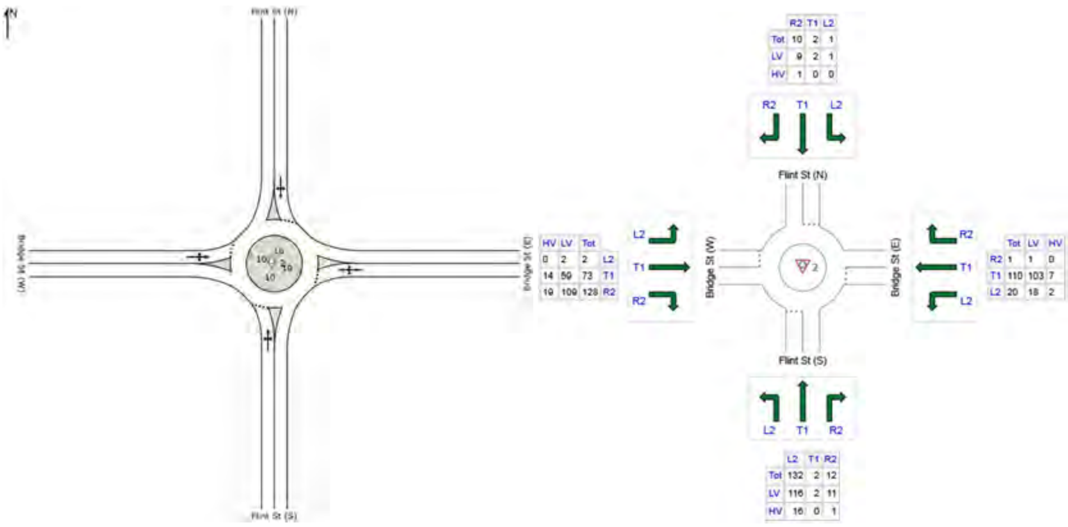
Newell Highway and Camp Street – AM Peak





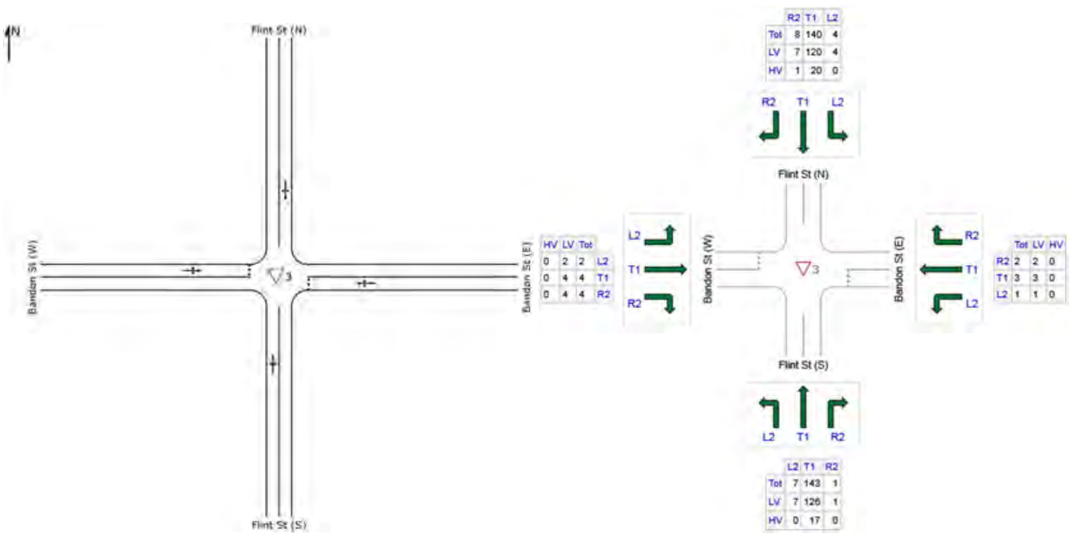
Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Newell Highway (S)											
2	T1	272	11.2	0.149	0.0	LOS A	0.0	0.0	0.00	0.00	50.0
3	R2	79	12.0	0.050	5.8	LOS A	0.3	2.0	0.46	0.58	45.2
Approach		351	11.4	0.149	1.3	NA	0.3	2.0	0.10	0.13	48.8
East: Camp Street (E)											
4	L2	96	13.2	0.058	5.2	LOS A	0.3	2.1	0.31	0.52	45.7
6	R2	134	4.7	0.167	7.3	LOS A	0.6	4.1	0.50	0.77	44.6
Approach		229	8.3	0.167	6.4	LOS A	0.6	4.1	0.42	0.66	45.0
North: Newell Highway (N)											
7	L2	166	15.2	0.209	4.7	LOS A	0.0	0.0	0.00	0.25	47.8
8	T1	187	22.5	0.209	0.0	LOS A	0.0	0.0	0.00	0.25	48.5
Approach		354	19.0	0.209	2.2	NA	0.0	0.0	0.00	0.25	48.1
All Vehicles		934	13.5	0.209	2.9	NA	0.6	4.1	0.14	0.31	47.6

Flint Street and Bridge Street – AM Peak



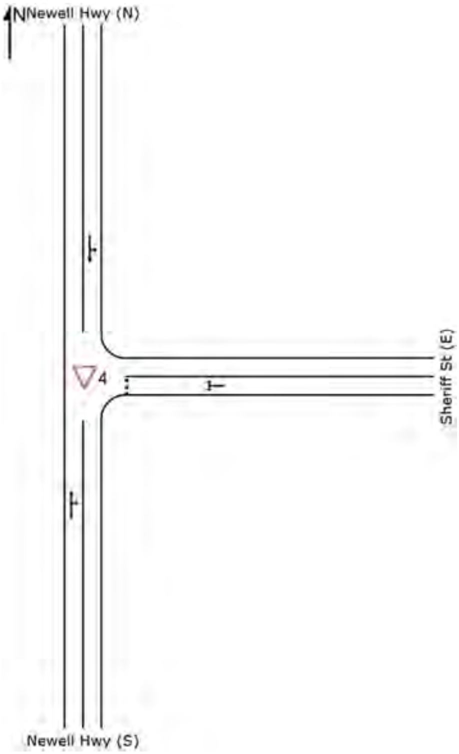
Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
Movement Performance - Vehicles											
South: Flint Street (S)											
1	L2	139	12.1	0.136	4.4	LOS A	0.7	5.6	0.32	0.50	46.2
2	T1	2	0.0	0.136	4.2	LOS A	0.7	5.6	0.32	0.50	47.2
3	R2	13	8.3	0.136	7.8	LOS A	0.7	5.6	0.32	0.50	47.0
Approach		154	11.6	0.136	4.7	LOS A	0.7	5.6	0.32	0.50	46.3
East: Bridge Street (E)											
4	L2	21	10.0	0.122	5.5	LOS A	0.6	4.5	0.33	0.51	52.8
5	T1	116	6.4	0.122	5.6	LOS A	0.6	4.5	0.33	0.51	54.0
6	R2	1	0.0	0.122	9.0	LOS A	0.6	4.5	0.33	0.51	53.9
Approach		138	6.9	0.122	5.6	LOS A	0.6	4.5	0.33	0.51	53.8
North: Flint Street (N)											
7	L2	1	0.0	0.013	5.6	LOS A	0.1	0.4	0.38	0.59	51.4
8	T1	2	0.0	0.013	5.8	LOS A	0.1	0.4	0.38	0.59	52.4
9	R2	11	10.0	0.013	9.5	LOS A	0.1	0.4	0.38	0.59	51.7
Approach		14	7.7	0.013	8.6	LOS A	0.1	0.4	0.38	0.59	51.8
West: Bridge Street (W)											
10	L2	2	0.0	0.151	4.6	LOS A	0.8	6.7	0.10	0.58	52.5
11	T1	77	19.2	0.151	5.0	LOS A	0.8	6.7	0.10	0.58	52.9
12	R2	135	14.8	0.151	8.4	LOS A	0.8	6.7	0.10	0.58	52.6
Approach		214	16.3	0.151	7.1	LOS A	0.8	6.7	0.10	0.58	52.7
All Vehicles		519	12.2	0.151	6.0	LOS A	0.8	6.7	0.23	0.54	50.9

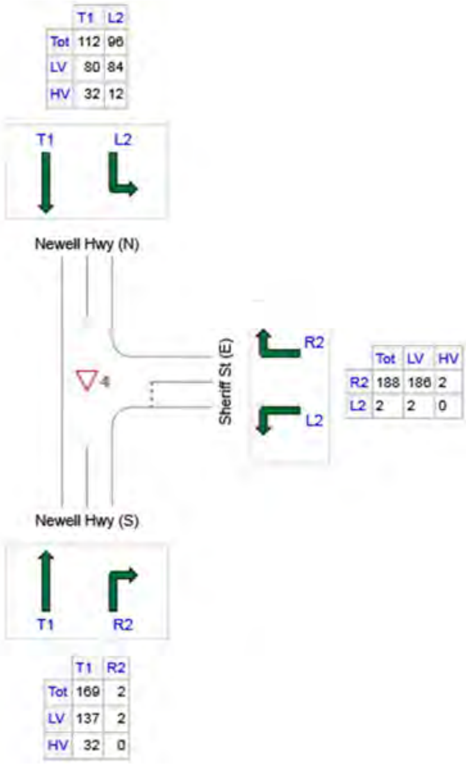
Flint Street and Bandon Street – AM Peak



Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Flint Street (S)											
1	L2	7	0.0	0.088	4.6	LOS A	0.0	0.1	0.01	0.03	49.3
2	T1	151	11.9	0.088	0.0	LOS A	0.0	0.1	0.01	0.03	49.8
3	R2	1	0.0	0.088	5.0	LOS A	0.0	0.1	0.01	0.03	48.8
Approach		159	11.3	0.088	0.2	NA	0.0	0.1	0.01	0.03	49.8
East: Bandon Street (E)											
4	L2	1	0.0	0.005	5.9	LOS A	0.0	0.1	0.24	0.55	53.5
5	T1	3	0.0	0.005	4.7	LOS A	0.0	0.1	0.24	0.55	53.6
6	R2	2	0.0	0.005	6.2	LOS A	0.0	0.1	0.24	0.55	52.9
Approach		6	0.0	0.005	5.4	LOS A	0.0	0.1	0.24	0.55	53.4
North: Flint Street (N)											
7	L2	4	0.0	0.091	6.0	LOS A	0.1	0.6	0.04	0.05	57.8
8	T1	147	14.3	0.091	0.0	LOS A	0.1	0.6	0.04	0.05	59.4
9	R2	8	12.5	0.091	6.2	LOS A	0.1	0.6	0.04	0.05	56.5
Approach		160	13.8	0.091	0.5	NA	0.1	0.6	0.04	0.05	59.2
West: Bandon Street (W)											
10	L2	2	0.0	0.011	6.0	LOS A	0.0	0.3	0.33	0.57	53.1
11	T1	4	0.0	0.011	5.4	LOS A	0.0	0.3	0.33	0.57	53.2
12	R2	4	0.0	0.011	7.1	LOS A	0.0	0.3	0.33	0.57	52.6
Approach		11	0.0	0.011	6.2	LOS A	0.0	0.3	0.33	0.57	52.9
All Vehicles		336	11.9	0.091	0.7	NA	0.1	0.6	0.04	0.06	54.0

Newell Highway and Sheriff Street – AM Peak

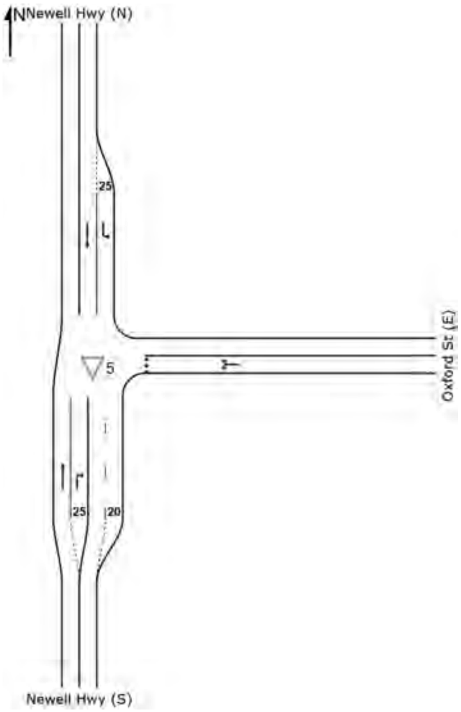


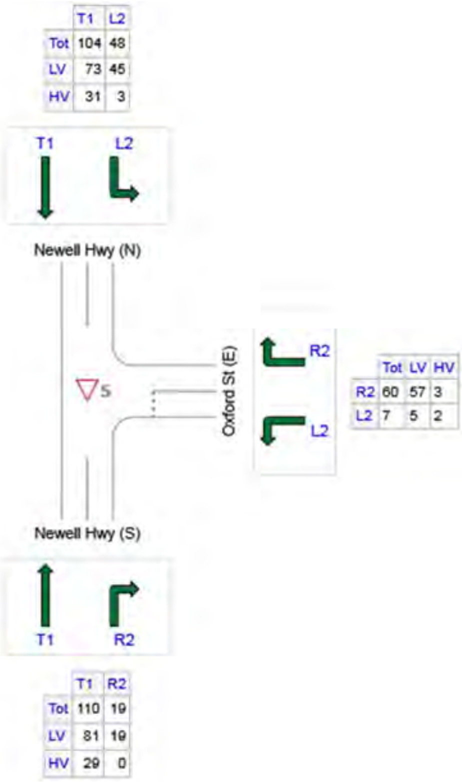


Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Newell Highway (S)											
2	T1	178	18.9	0.103	0.0	LOS A	0.0	0.1	0.01	0.01	59.9
3	R2	2	0.0	0.103	6.1	LOS A	0.0	0.1	0.01	0.01	57.6
Approach		180	18.7	0.103	0.1	NA	0.0	0.1	0.01	0.01	59.9
East: Sheriff Street (E)											
4	L2	2	0.0	0.165	6.0	LOS A	0.5	3.8	0.34	0.66	52.7
6	R2	198	1.1	0.165	6.4	LOS A	0.5	3.8	0.34	0.66	52.2
Approach		200	1.1	0.165	6.4	LOS A	0.5	3.8	0.34	0.66	52.2
North: Newell Highway (N)											
7	L2	101	12.5	0.131	5.7	LOS A	0.0	0.0	0.00	0.27	55.6
8	T1	118	28.6	0.131	0.0	LOS A	0.0	0.0	0.00	0.27	57.3
Approach		219	21.2	0.131	2.6	NA	0.0	0.0	0.00	0.27	56.5
All Vehicles		599	13.7	0.165	3.1	NA	0.5	3.8	0.11	0.32	55.9

Newell Highway and Oxford Street – AM Peak

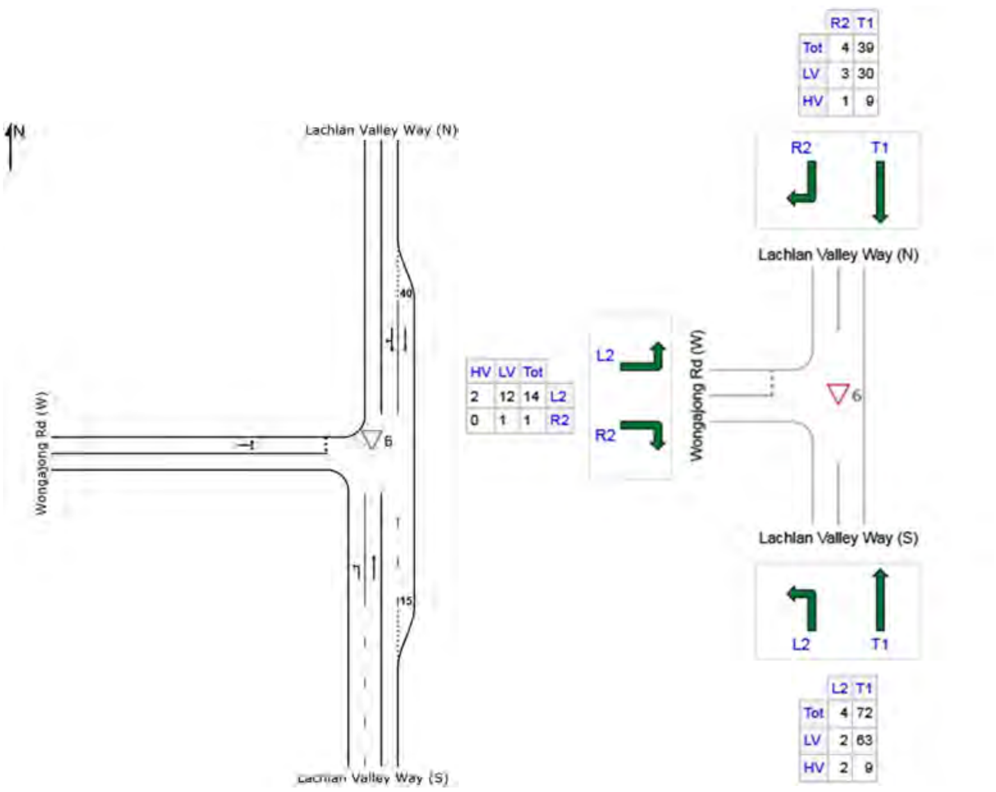




Movement Performance - Vehicles

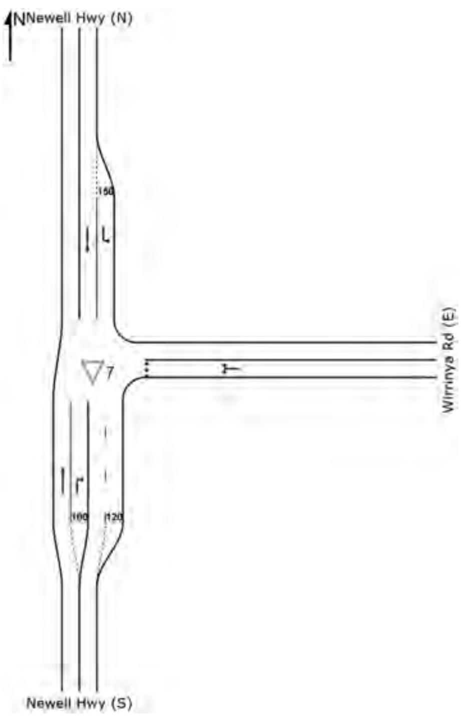
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Newell Highway (S)											
2	T1	116	26.4	0.070	0.0	LOS A	0.0	0.0	0.00	0.00	50.0
3	R2	20	0.0	0.016	5.2	LOS A	0.1	0.4	0.27	0.52	45.8
Approach		136	22.5	0.070	0.8	NA	0.1	0.4	0.04	0.08	49.3
East: Oxford Street (E)											
4	L2	7	28.6	0.093	6.4	LOS A	0.4	2.7	0.40	0.65	50.9
6	R2	63	5.0	0.093	7.9	LOS A	0.4	2.7	0.40	0.65	51.6
Approach		71	7.5	0.093	7.7	LOS A	0.4	2.7	0.40	0.65	51.5
North: Newell Highway (N)											
7	L2	51	6.3	0.028	5.6	LOS A	0.0	0.0	0.00	0.57	53.4
8	T1	109	29.8	0.067	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		160	22.4	0.067	1.8	NA	0.0	0.0	0.00	0.18	57.7
All Vehicles		366	19.5	0.093	2.6	NA	0.4	2.7	0.09	0.23	53.1

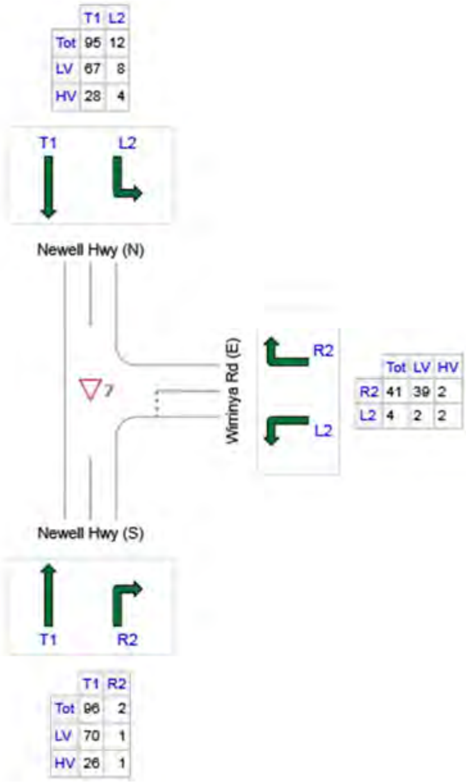
Lachlan Valley Way and Wongajong Road – AM Peak



Movement Performance - Vehicles												
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Lachlan Valley Way (S)											
1	L2	4	50.0	0.003	9.1	LOS A	0.0	0.0	0.00	0.66	59.4
2	T1	76	12.5	0.042	0.0	LOS A	0.0	0.0	0.00	0.00	100.0
Approach		80	14.5	0.042	0.5	NA	0.0	0.0	0.00	0.03	96.5
North: Lachlan Valley Way (N)											
8	T1	41	23.1	0.023	0.1	LOS A	0.0	0.3	0.04	0.06	97.7
9	R2	4	25.0	0.023	8.5	LOS A	0.0	0.3	0.05	0.08	74.2
Approach		45	23.3	0.023	0.8	NA	0.0	0.3	0.04	0.06	94.9
West: Wongajong Road (W)											
10	L2	15	14.3	0.011	6.0	LOS A	0.0	0.4	0.17	0.53	52.5
12	R2	1	0.0	0.011	6.3	LOS A	0.0	0.4	0.17	0.53	52.8
Approach		16	13.3	0.011	6.0	LOS A	0.0	0.4	0.17	0.53	52.5
All Vehicles		141	17.2	0.042	1.2	NA	0.0	0.4	0.03	0.10	87.7

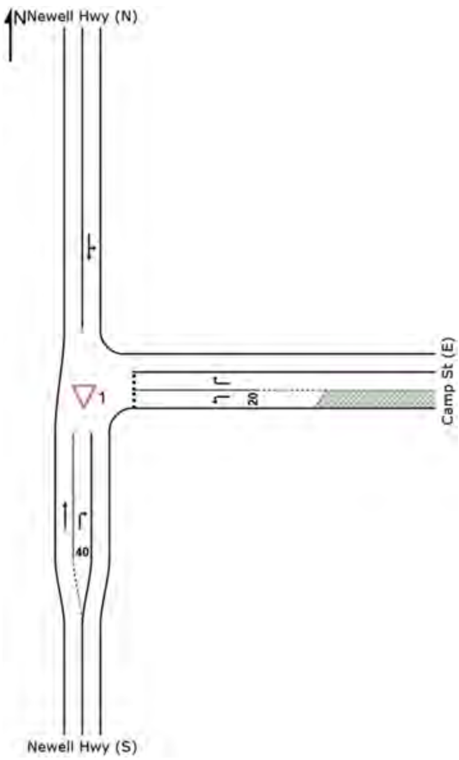
Newell Highway and Wirrinya Road – AM Peak

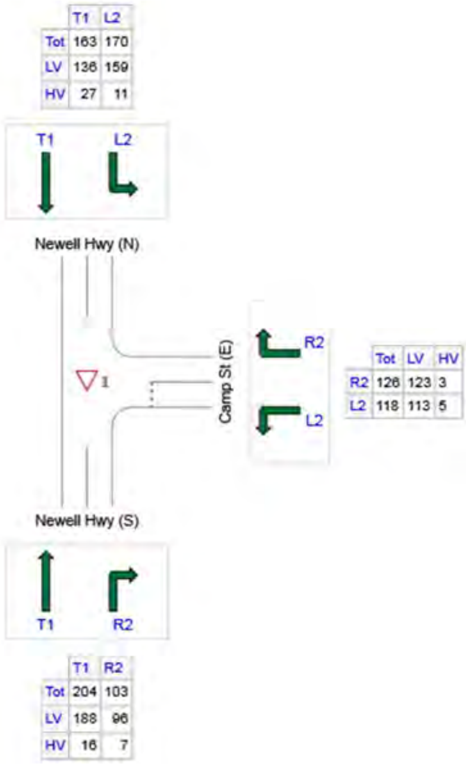




Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Newell Highway (S)											
2	T1	101	27.1	0.061	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
3	R2	2	50.0	0.002	8.4	LOS A	0.0	0.1	0.26	0.57	50.8
Approach		103	27.6	0.061	0.2	NA	0.0	0.1	0.01	0.01	79.0
East: Wirrinya Road (E)											
4	L2	4	50.0	0.058	6.6	LOS A	0.2	1.7	0.36	0.61	50.4
6	R2	43	4.9	0.058	7.3	LOS A	0.2	1.7	0.36	0.61	52.0
Approach		47	8.9	0.058	7.2	LOS A	0.2	1.7	0.36	0.61	51.8
North: Newell Highway (N)											
7	L2	13	33.3	0.008	7.6	LOS A	0.0	0.0	0.00	0.63	55.6
8	T1	100	29.5	0.061	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		113	29.9	0.061	0.9	NA	0.0	0.0	0.00	0.07	76.2
All Vehicles		263	25.2	0.061	1.7	NA	0.2	1.7	0.07	0.14	71.2

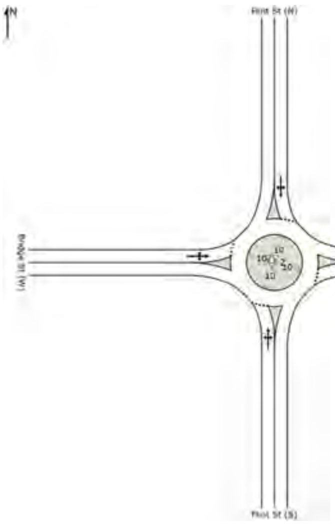
Newell Highway and Camp Street – PM Peak

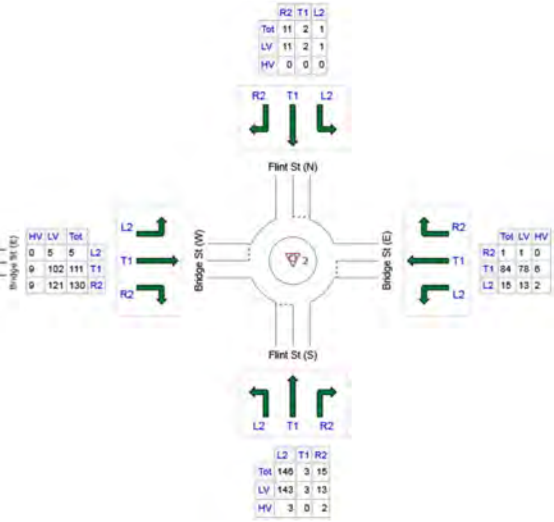




Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Newell Highway (S)											
2	T1	215	7.8	0.116	0.0	LOS A	0.0	0.0	0.00	0.00	50.0
3	R2	108	6.8	0.061	4.6	LOS A	0.0	0.0	0.00	0.54	46.3
Approach		323	7.5	0.116	1.6	NA	0.0	0.0	0.00	0.18	48.7
East: Camp Street (E)											
4	L2	124	4.2	0.070	5.1	LOS A	0.3	2.4	0.28	0.52	45.9
6	R2	133	2.4	0.154	6.9	LOS A	0.5	3.7	0.47	0.74	44.8
Approach		257	3.3	0.154	6.0	LOS A	0.5	3.7	0.38	0.63	45.3
North: Newell Highway (N)											
7	L2	179	6.5	0.198	4.6	LOS A	0.0	0.0	0.00	0.27	47.8
8	T1	172	16.6	0.198	0.0	LOS A	0.0	0.0	0.00	0.27	48.3
Approach		351	11.4	0.198	2.4	NA	0.0	0.0	0.00	0.27	48.1
All Vehicles		931	7.8	0.198	3.1	NA	0.5	3.7	0.11	0.34	47.5

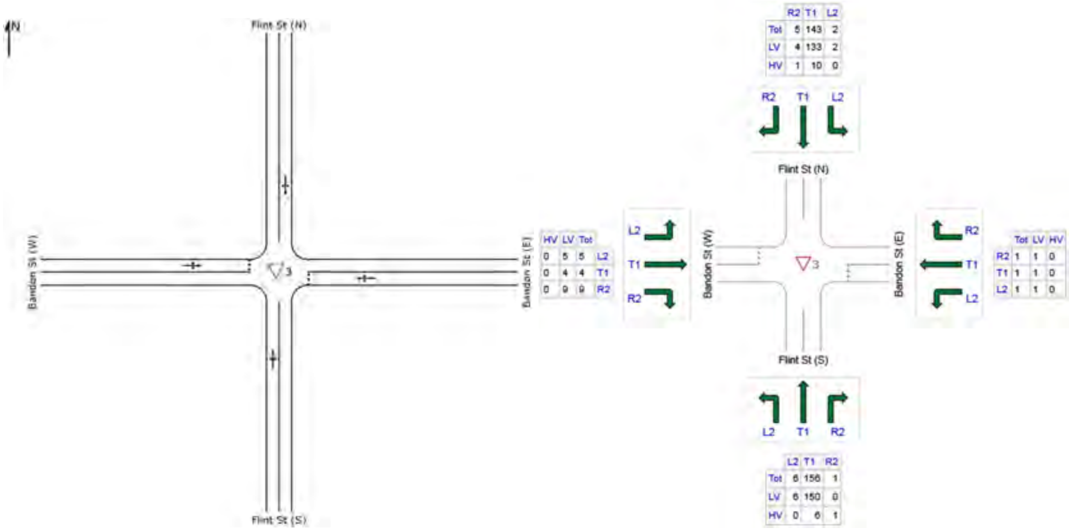
Flint Street and Bridge Street – PM Peak





Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Flint Street (S)											
1	L2	154	2.1	0.140	4.1	LOS A	0.8	5.4	0.28	0.49	46.4
2	T1	3	0.0	0.140	4.0	LOS A	0.8	5.4	0.28	0.49	47.3
3	R2	16	13.3	0.140	7.7	LOS A	0.8	5.4	0.28	0.49	47.0
Approach		173	3.0	0.140	4.4	LOS A	0.8	5.4	0.28	0.49	46.5
East: Bridge Street (E)											
4	L2	16	13.3	0.093	5.5	LOS A	0.5	3.4	0.32	0.50	52.7
5	T1	88	7.1	0.093	5.6	LOS A	0.5	3.4	0.32	0.50	54.0
6	R2	1	0.0	0.093	8.9	LOS A	0.5	3.4	0.32	0.50	53.9
Approach		105	8.0	0.093	5.6	LOS A	0.5	3.4	0.32	0.50	53.8
North: Flint Street (N)											
7	L2	1	0.0	0.014	5.8	LOS A	0.1	0.5	0.40	0.60	51.3
8	T1	2	0.0	0.014	5.9	LOS A	0.1	0.5	0.40	0.60	52.3
9	R2	12	0.0	0.014	9.4	LOS A	0.1	0.5	0.40	0.60	51.9
Approach		15	0.0	0.014	8.7	LOS A	0.1	0.5	0.40	0.60	51.9
West: Bridge Street (W)											
10	L2	5	0.0	0.177	4.6	LOS A	1.0	7.4	0.11	0.56	52.7
11	T1	117	8.1	0.177	4.9	LOS A	1.0	7.4	0.11	0.56	53.5
12	R2	137	6.9	0.177	8.4	LOS A	1.0	7.4	0.11	0.56	53.1
Approach		259	7.3	0.177	6.7	LOS A	1.0	7.4	0.11	0.56	53.3
All Vehicles		552	5.9	0.177	5.8	LOS A	1.0	7.4	0.21	0.53	51.0

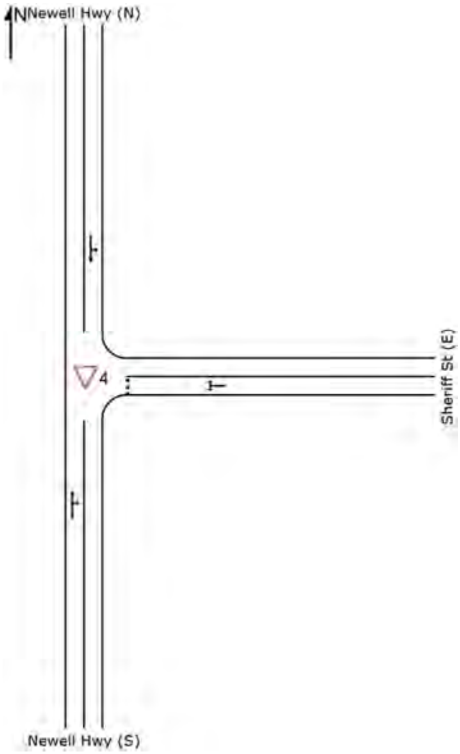
Flint Street and Bandon Street – PM Peak

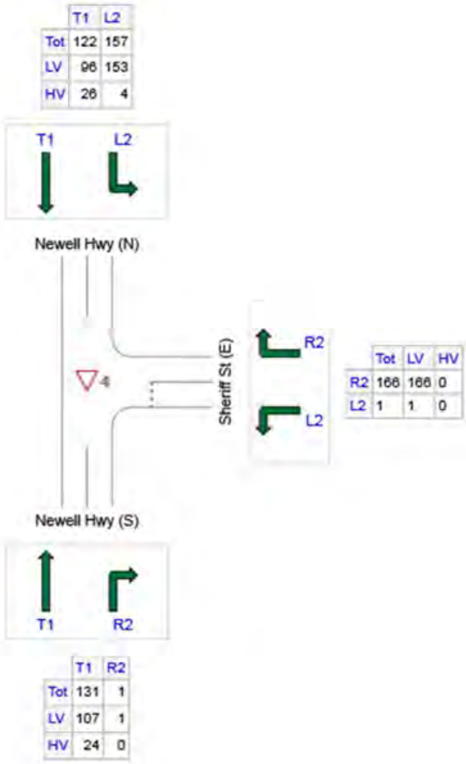


Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Flint Street (S)											
1	L2	6	0.0	0.091	4.6	LOS A	0.0	0.0	0.00	0.03	49.4
2	T1	164	3.8	0.091	0.0	LOS A	0.0	0.0	0.00	0.03	49.8
3	R2	1	100.0	0.091	5.0	LOS A	0.0	0.0	0.00	0.03	48.0
Approach		172	4.3	0.091	0.2	NA	0.0	0.0	0.00	0.03	49.8
East: Bandon Street (E)											
4	L2	1	0.0	0.002	5.9	LOS A	0.0	0.0	0.23	0.54	53.3
5	T1	1	0.0	0.002	4.7	LOS A	0.0	0.0	0.23	0.54	53.5
6	R2	1	0.0	0.002	6.2	LOS A	0.0	0.0	0.23	0.54	52.8
Approach		3	0.0	0.002	5.6	LOS A	0.0	0.0	0.23	0.54	53.2
North: Flint Street (N)											
7	L2	2	0.0	0.085	5.5	LOS A	0.0	0.0	0.00	0.03	58.1
8	T1	151	7.0	0.085	0.0	LOS A	0.0	0.0	0.00	0.03	59.8
9	R2	5	20.0	0.085	5.7	LOS A	0.0	0.0	0.00	0.03	56.5
Approach		158	7.3	0.085	0.3	NA	0.0	0.0	0.00	0.03	59.6
West: Bandon Street (W)											
10	L2	5	0.0	0.020	6.0	LOS A	0.1	0.5	0.32	0.59	52.9
11	T1	4	0.0	0.020	5.5	LOS A	0.1	0.5	0.32	0.59	53.0
12	R2	9	0.0	0.020	7.1	LOS A	0.1	0.5	0.32	0.59	52.4
Approach		19	0.0	0.020	6.4	LOS A	0.1	0.5	0.32	0.59	52.7
All Vehicles		352	5.4	0.091	0.6	NA	0.1	0.5	0.02	0.06	54.0

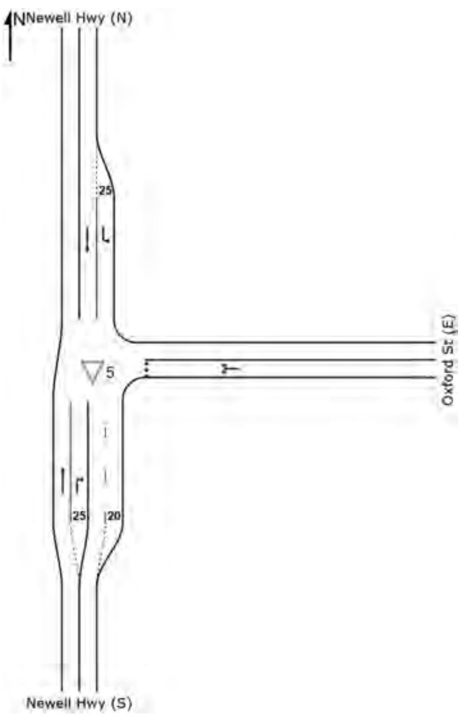
Newell Highway and Sheriff Street – PM Peak

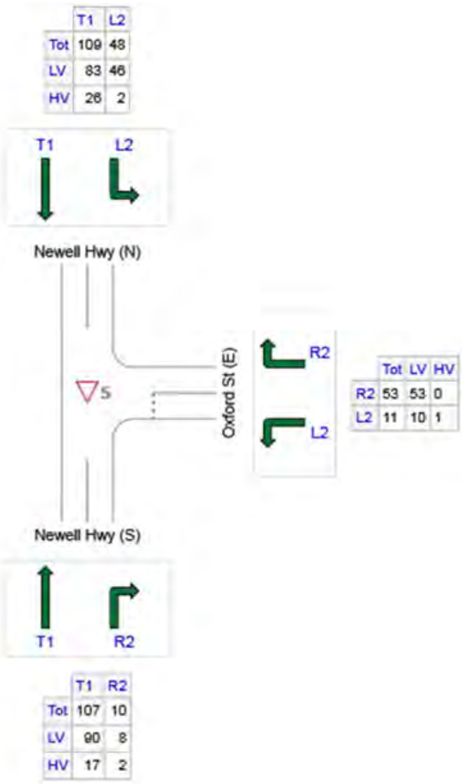




Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Newell Highway (S)											
2	T1	138	18.3	0.080	0.0	LOS A	0.0	0.0	0.00	0.00	59.9
3	R2	1	0.0	0.080	5.5	LOS A	0.0	0.0	0.00	0.00	57.7
Approach		139	18.2	0.080	0.0	NA	0.0	0.0	0.00	0.00	59.9
East: Sheriff Street (E)											
4	L2	1	0.0	0.144	6.0	LOS A	0.5	3.2	0.33	0.65	52.8
6	R2	175	0.0	0.144	6.4	LOS A	0.5	3.2	0.33	0.65	52.2
Approach		176	0.0	0.144	6.4	LOS A	0.5	3.2	0.33	0.65	52.2
North: Newell Highway (N)											
7	L2	165	2.5	0.166	5.6	LOS A	0.0	0.0	0.00	0.33	55.3
8	T1	128	21.3	0.166	0.0	LOS A	0.0	0.0	0.00	0.33	56.8
Approach		294	10.8	0.166	3.2	NA	0.0	0.0	0.00	0.33	55.9
All Vehicles		608	9.3	0.166	3.4	NA	0.5	3.2	0.09	0.35	55.6

Newell Highway and Oxford Street – PM Peak

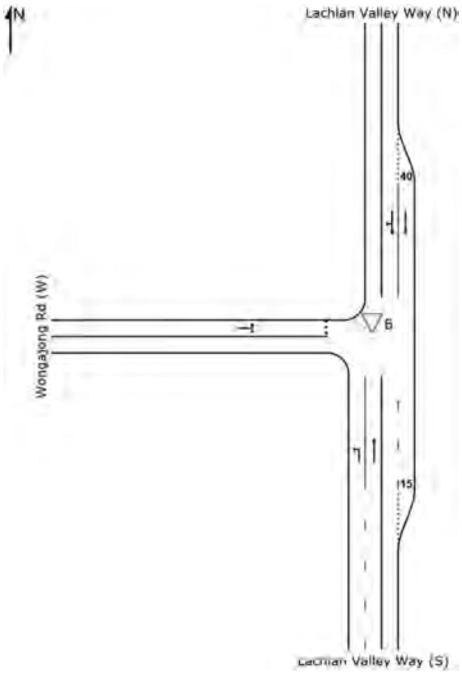


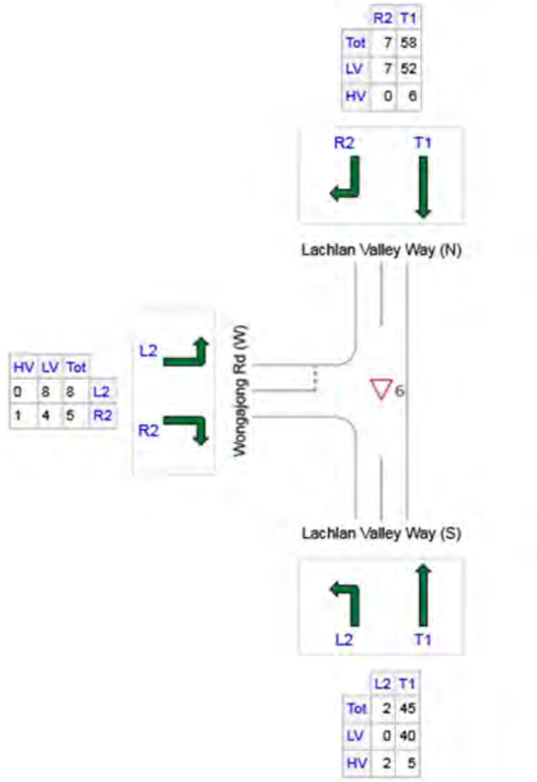


Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Newell Highway (S)											
2	T1	113	15.9	0.064	0.0	LOS A	0.0	0.0	0.00	0.00	50.0
3	R2	11	20.0	0.006	4.8	LOS A	0.0	0.0	0.00	0.54	46.1
Approach		123	16.2	0.064	0.4	NA	0.0	0.0	0.00	0.05	49.6
East: Oxford Street (E)											
4	L2	12	9.1	0.081	6.1	LOS A	0.3	2.2	0.37	0.62	51.9
6	R2	56	0.0	0.081	7.6	LOS A	0.3	2.2	0.37	0.62	52.0
Approach		67	1.6	0.081	7.3	LOS A	0.3	2.2	0.37	0.62	52.0
North: Newell Highway (N)											
7	L2	51	4.2	0.028	5.6	LOS A	0.0	0.0	0.00	0.58	53.4
8	T1	115	23.9	0.068	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		165	17.8	0.068	1.7	NA	0.0	0.0	0.00	0.18	57.8
All Vehicles		356	14.2	0.081	2.3	NA	0.3	2.2	0.07	0.22	53.6

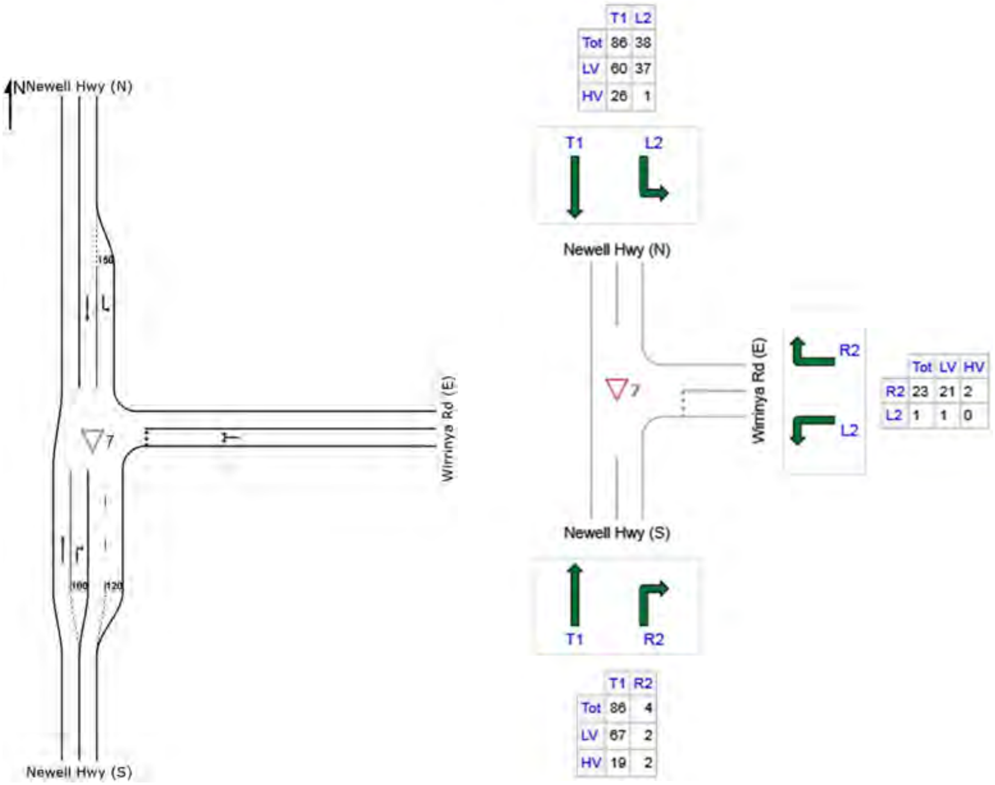
Lachlan Valley Way and Wongajong Road – PM Peak





Movement Performance - Vehicles												
Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Lachlan Valley Way (S)											
1	L2	2	100.0	0.002	9.1	LOS A	0.0	0.0	0.00	0.66	59.4
2	T1	47	11.1	0.026	0.0	LOS A	0.0	0.0	0.00	0.00	100.0
Approach		49	14.9	0.026	0.4	NA	0.0	0.0	0.00	0.03	97.1
North: Lachlan Valley Way (N)											
8	T1	61	10.3	0.031	0.0	LOS A	0.0	0.0	0.00	0.07	97.7
9	R2	7	0.0	0.031	7.4	LOS A	0.0	0.0	0.00	0.09	86.0
Approach		68	9.2	0.031	0.8	NA	0.0	0.0	0.00	0.07	96.3
West: Wongajong Road (W)											
10	L2	8	0.0	0.012	5.7	LOS A	0.0	0.3	0.15	0.54	53.2
12	R2	5	20.0	0.012	6.6	LOS A	0.0	0.3	0.15	0.54	52.1
Approach		14	7.7	0.012	6.0	LOS A	0.0	0.3	0.15	0.54	52.7
All Vehicles		132	11.2	0.031	1.2	NA	0.0	0.3	0.02	0.11	88.9

Newell Highway and Wirrinya Road – PM Peak



Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Newell Highway (S)											
2	T1	91	22.1	0.053	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
3	R2	4	50.0	0.003	7.7	LOS A	0.0	0.0	0.00	0.64	51.5
Approach		95	23.3	0.053	0.3	NA	0.0	0.0	0.00	0.03	78.1
East: Wirrinya Road (E)											
4	L2	1	0.0	0.032	5.8	LOS A	0.1	0.9	0.35	0.59	52.4
6	R2	24	8.7	0.032	7.2	LOS A	0.1	0.9	0.35	0.59	51.8
Approach		25	8.3	0.032	7.2	LOS A	0.1	0.9	0.35	0.59	51.9
North: Newell Highway (N)											
7	L2	40	2.6	0.022	7.0	LOS A	0.0	0.0	0.00	0.63	64.5
8	T1	91	30.2	0.056	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		131	21.8	0.056	2.1	NA	0.0	0.0	0.00	0.19	74.5
All Vehicles		251	21.0	0.056	2.0	NA	0.1	0.9	0.04	0.17	72.5

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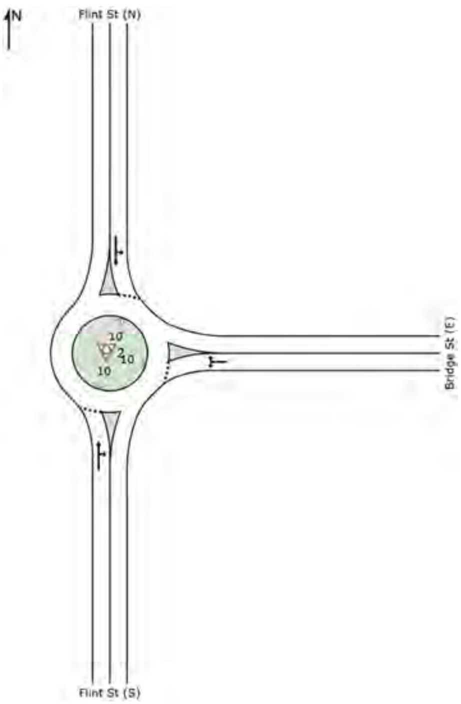
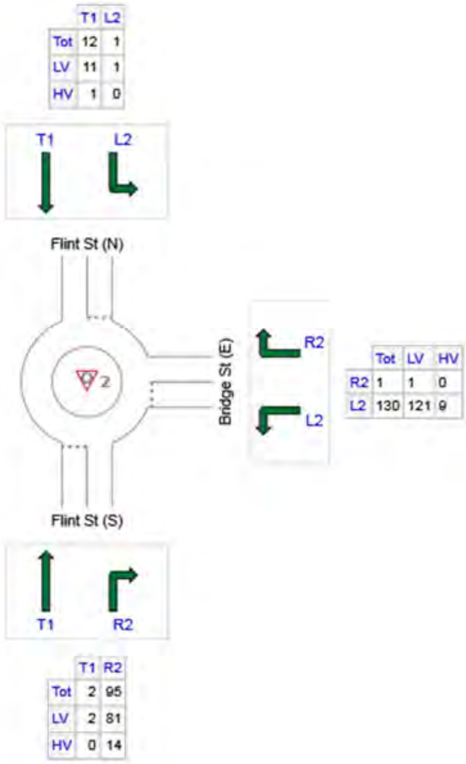
Appendix B

Forecast Intersection Volumes

Appendix B Forecast Intersection Volumes

Flint Street and Bridge Street – AM Peak

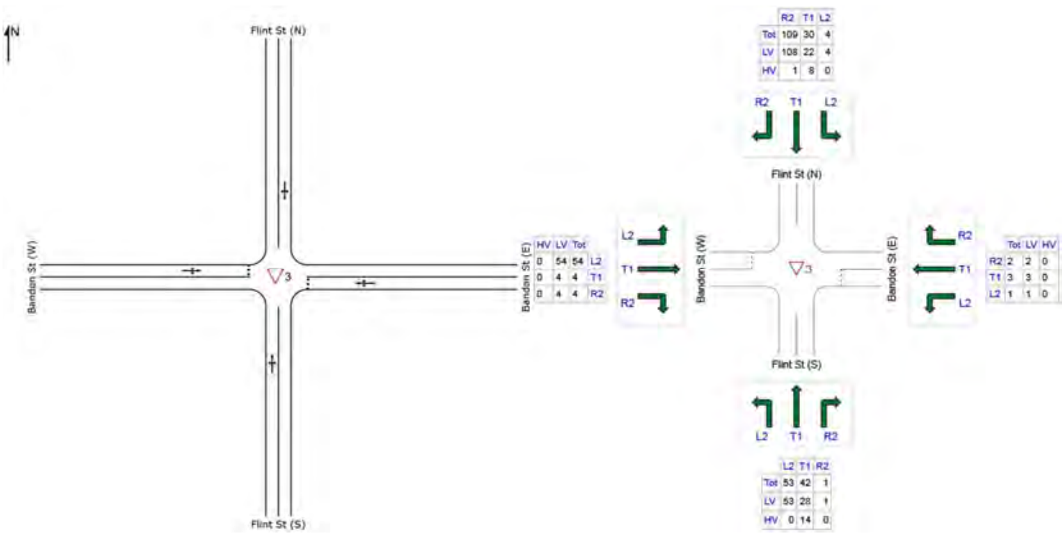




Movement Performance - Vehicles

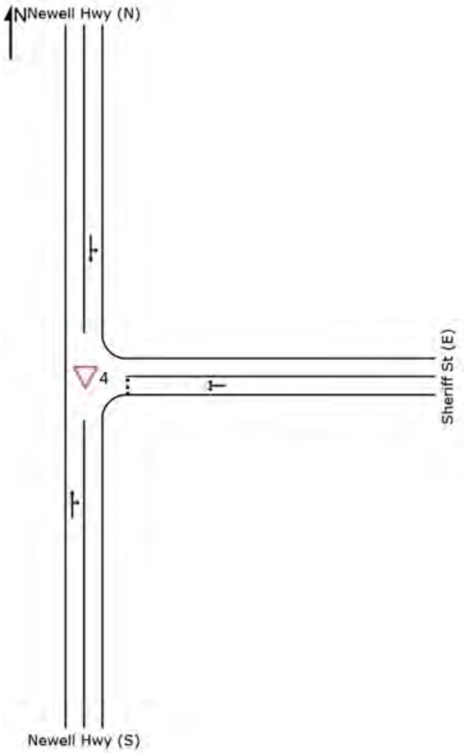
Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Flint Street (S)											
2	T1	2	0.0	0.065	3.5	LOS A	0.3	2.4	0.02	0.62	46.2
3	R2	100	14.7	0.065	7.1	LOS A	0.3	2.4	0.02	0.62	45.9
Approach		102	14.4	0.065	7.0	LOS A	0.3	2.4	0.02	0.62	45.9
East: Bridge Street (E)											
4	L2	137	6.9	0.094	4.6	LOS A	0.5	3.6	0.08	0.51	54.0
6	R2	1	0.0	0.094	8.2	LOS A	0.5	3.6	0.08	0.51	55.0
Approach		138	6.9	0.094	4.7	LOS A	0.5	3.6	0.08	0.51	54.0
North: Flint Street (N)											
7	L2	1	0.0	0.012	5.0	LOS A	0.1	0.4	0.24	0.45	53.5
8	T1	13	8.3	0.012	5.3	LOS A	0.1	0.4	0.24	0.45	54.3
Approach		14	7.7	0.012	5.2	LOS A	0.1	0.4	0.24	0.45	54.2
All Vehicles		254	10.0	0.094	5.7	LOS A	0.5	3.6	0.06	0.55	50.4

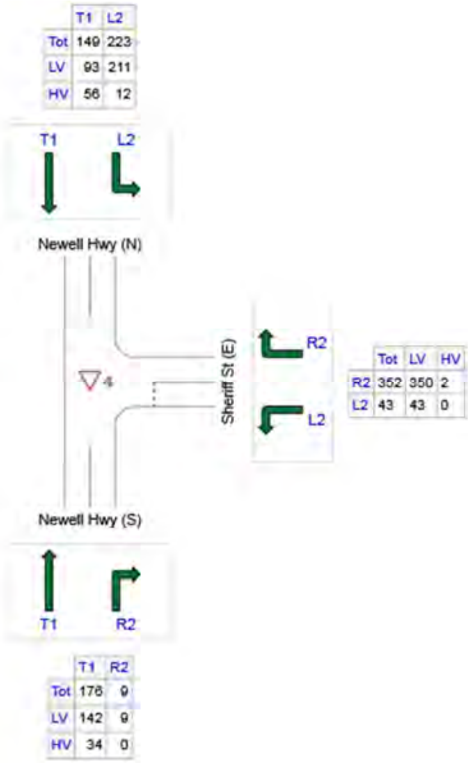
Flint Street and Bandon Street – AM Peak



Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Flint Street (S)											
1	L2	56	0.0	0.058	4.6	LOS A	0.0	0.1	0.00	0.30	47.6
2	T1	44	33.3	0.058	0.0	LOS A	0.0	0.1	0.00	0.30	48.0
3	R2	1	0.0	0.058	4.6	LOS A	0.0	0.1	0.00	0.30	47.1
Approach		101	14.6	0.058	2.6	NA	0.0	0.1	0.00	0.30	47.8
East: Bandon Street (E)											
4	L2	1	0.0	0.005	5.6	LOS A	0.0	0.1	0.13	0.55	53.8
5	T1	3	0.0	0.005	4.5	LOS A	0.0	0.1	0.13	0.55	54.0
6	R2	2	0.0	0.005	6.0	LOS A	0.0	0.1	0.13	0.55	53.3
Approach		6	0.0	0.005	5.2	LOS A	0.0	0.1	0.13	0.55	53.7
North: Flint Street (N)											
7	L2	4	0.0	0.090	5.9	LOS A	0.4	3.2	0.22	0.45	53.7
8	T1	32	26.7	0.090	0.3	LOS A	0.4	3.2	0.22	0.45	55.1
9	R2	115	0.9	0.090	5.8	LOS A	0.4	3.2	0.22	0.45	53.2
Approach		151	6.3	0.090	4.6	NA	0.4	3.2	0.22	0.45	53.6
West: Bandon Street (W)											
10	L2	57	0.0	0.045	5.7	LOS A	0.2	1.2	0.12	0.55	53.3
11	T1	4	0.0	0.045	5.1	LOS A	0.2	1.2	0.12	0.55	53.5
12	R2	4	0.0	0.045	6.6	LOS A	0.2	1.2	0.12	0.55	52.8
Approach		65	0.0	0.045	5.7	LOS A	0.2	1.2	0.12	0.55	53.3
All Vehicles		323	7.5	0.090	4.2	NA	0.4	3.2	0.13	0.42	51.6

Newell Highway and Sheriff Street – AM Peak

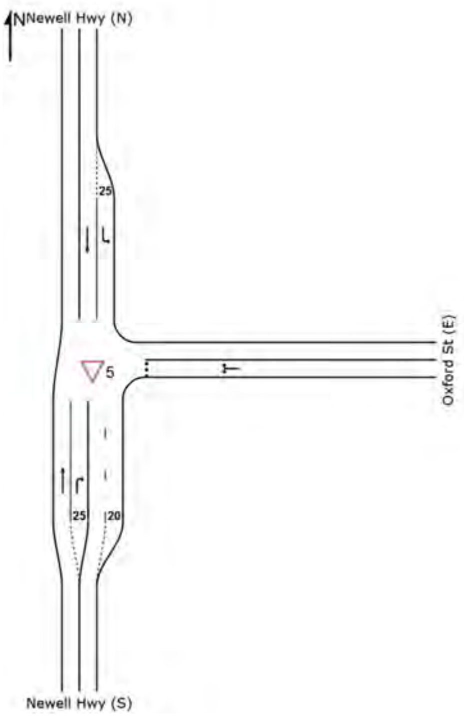


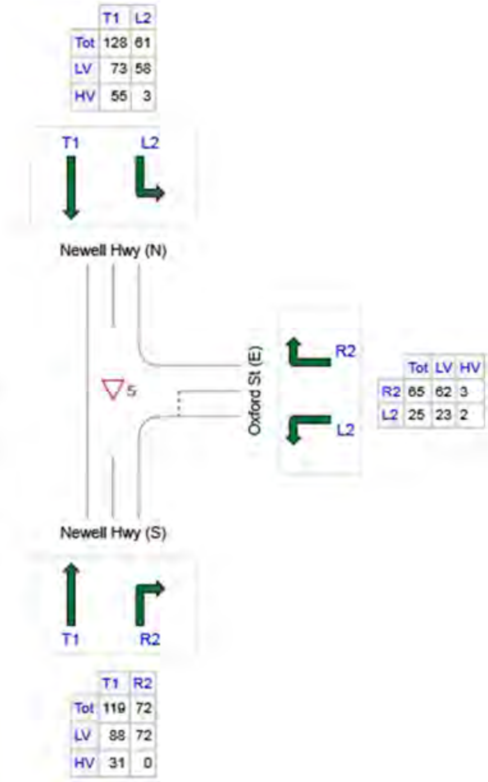


Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Newell Highway (S)											
2	T1	185	19.3	0.112	0.1	LOS A	0.1	0.6	0.06	0.03	59.4
3	R2	9	0.0	0.112	6.7	LOS A	0.1	0.6	0.06	0.03	57.2
Approach		195	18.4	0.112	0.4	NA	0.1	0.6	0.06	0.03	59.3
East: Sheriff Street (E)											
4	L2	45	0.0	0.366	6.5	LOS A	1.7	11.6	0.43	0.75	52.2
6	R2	371	0.6	0.366	7.4	LOS A	1.7	11.6	0.43	0.75	51.7
Approach		416	0.5	0.366	7.3	LOS A	1.7	11.6	0.43	0.75	51.8
North: Newell Highway (N)											
7	L2	235	5.4	0.231	5.6	LOS A	0.0	0.0	0.00	0.35	54.8
8	T1	157	37.6	0.231	0.0	LOS A	0.0	0.0	0.00	0.35	56.4
Approach		392	18.3	0.231	3.4	NA	0.0	0.0	0.00	0.35	55.5
All Vehicles		1002	10.9	0.366	4.4	NA	1.7	11.6	0.19	0.46	54.5

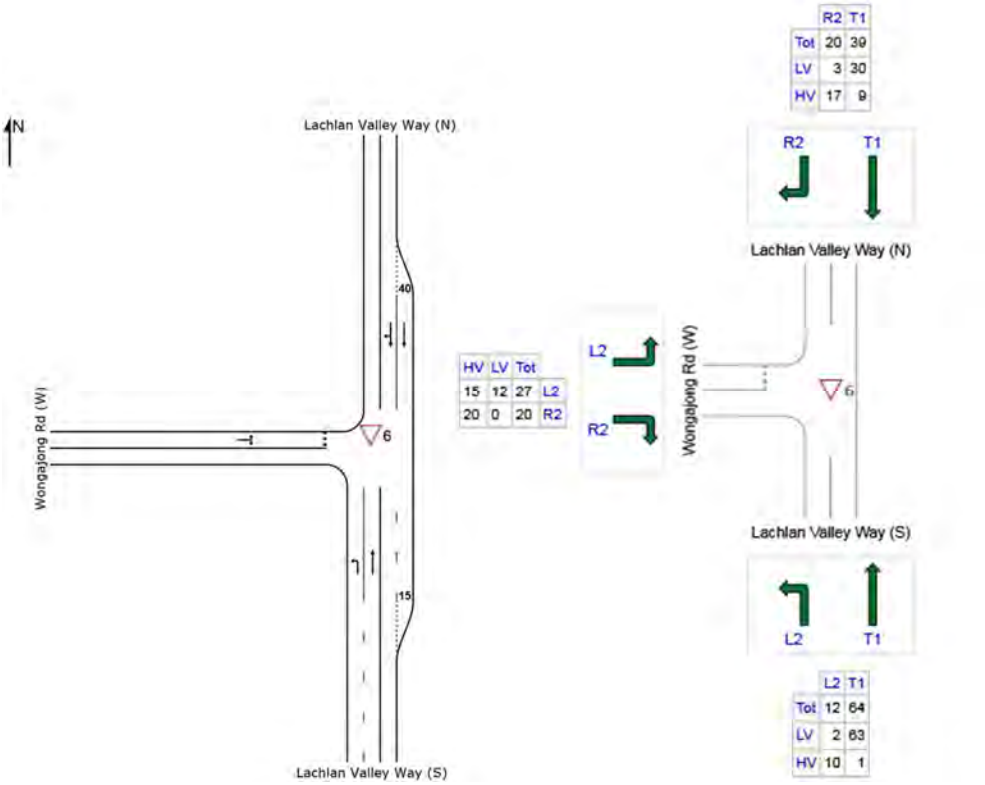
Newell Highway and Oxford Street – AM Peak





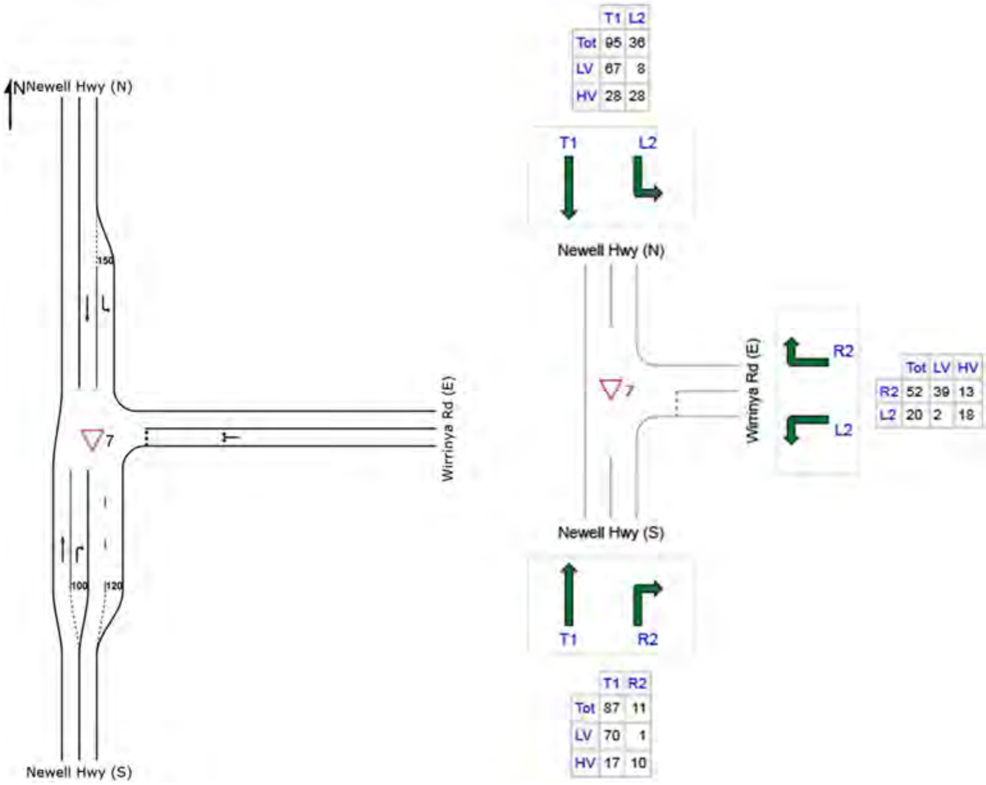
Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Newell Highway (S)											
2	T1	125	26.1	0.075	0.0	LOS A	0.0	0.0	0.00	0.00	50.0
3	R2	76	0.0	0.066	5.5	LOS A	0.3	1.8	0.33	0.56	45.7
Approach		201	16.2	0.075	2.1	NA	0.3	1.8	0.12	0.21	48.3
East: Oxford Street (E)											
4	L2	26	8.0	0.129	6.2	LOS A	0.5	3.7	0.42	0.67	51.3
6	R2	68	4.6	0.129	9.1	LOS A	0.5	3.7	0.42	0.67	51.2
Approach		95	5.6	0.129	8.3	LOS A	0.5	3.7	0.42	0.67	51.2
North: Newell Highway (N)											
7	L2	64	4.9	0.036	5.6	LOS A	0.0	0.0	0.00	0.58	53.4
8	T1	135	43.0	0.088	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		199	30.7	0.088	1.8	NA	0.0	0.0	0.00	0.19	57.7
All Vehicles		495	20.0	0.129	3.2	NA	0.5	3.7	0.13	0.29	52.3

Lachlan Valley Way and Wongajong Road – AM Peak



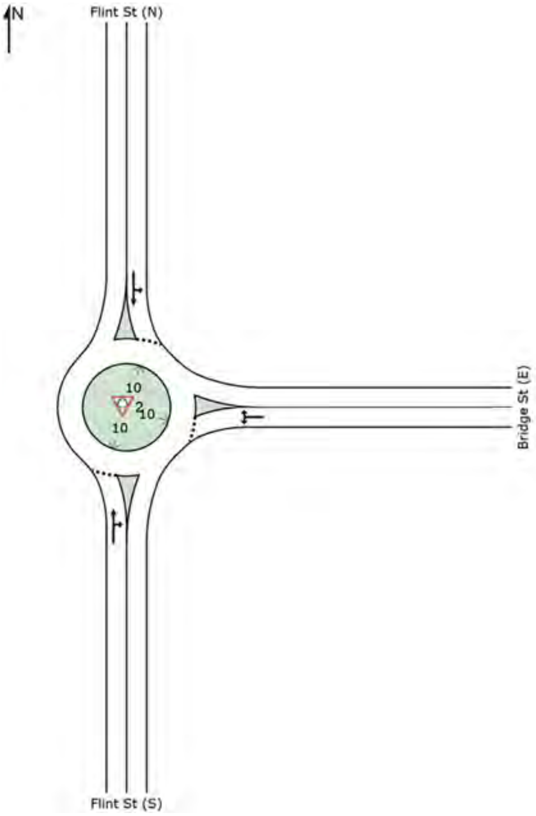
Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Lachlan Valley Way (S)											
1	L2	13	83.3	0.011	10.0	LOS A	0.0	0.0	0.00	0.67	52.3
2	T1	67	1.6	0.035	0.0	LOS A	0.0	0.0	0.00	0.00	100.0
Approach		80	14.5	0.035	1.6	NA	0.0	0.0	0.00	0.11	87.3
North: Lachlan Valley Way (N)											
8	T1	41	23.1	0.042	0.3	LOS A	0.2	1.8	0.12	0.17	96.6
9	R2	21	85.0	0.042	10.4	LOS A	0.2	1.8	0.19	0.26	55.2
Approach		62	44.1	0.042	3.7	NA	0.2	1.8	0.15	0.20	77.0
West: Wongajong Road (W)											
10	L2	28	55.6	0.062	6.5	LOS A	0.2	2.8	0.23	0.57	50.5
12	R2	21	100.0	0.062	8.4	LOS A	0.2	2.8	0.23	0.57	50.5
Approach		49	74.5	0.062	7.3	LOS A	0.2	2.8	0.23	0.57	50.5
All Vehicles		192	39.6	0.062	3.8	NA	0.2	2.8	0.11	0.26	70.9

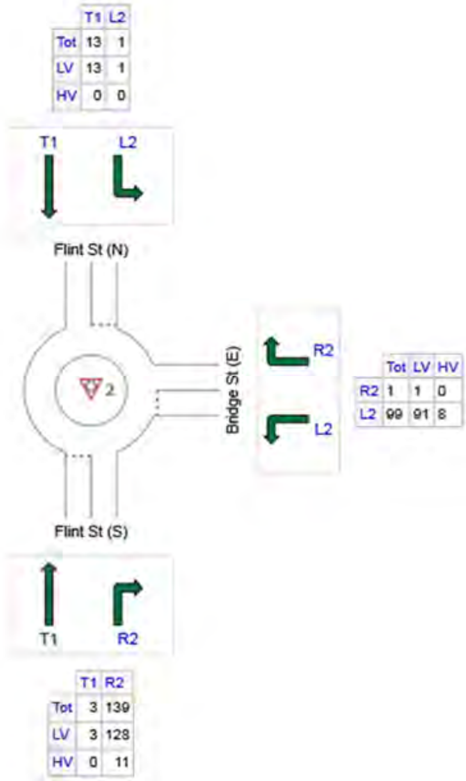
Newell Highway and Wirrinya Road – AM Peak



Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Newell Highway (S)											
2	T1	92	19.5	0.053	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
3	R2	12	90.9	0.015	9.8	LOS A	0.1	0.7	0.33	0.60	43.2
Approach		103	27.6	0.053	1.1	NA	0.1	0.7	0.04	0.07	73.0
East: Wirrinya Road (E)											
4	L2	21	90.0	0.102	7.3	LOS A	0.4	3.9	0.36	0.64	48.7
6	R2	55	25.0	0.102	8.2	LOS A	0.4	3.9	0.36	0.64	50.9
Approach		76	43.1	0.102	8.0	LOS A	0.4	3.9	0.36	0.64	50.3
North: Newell Highway (N)											
7	L2	38	77.8	0.032	8.4	LOS A	0.0	0.0	0.00	0.63	46.4
8	T1	100	29.5	0.061	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		138	42.7	0.061	2.3	NA	0.0	0.0	0.00	0.17	66.6
All Vehicles		317	37.9	0.102	3.3	NA	0.4	3.9	0.10	0.25	63.5

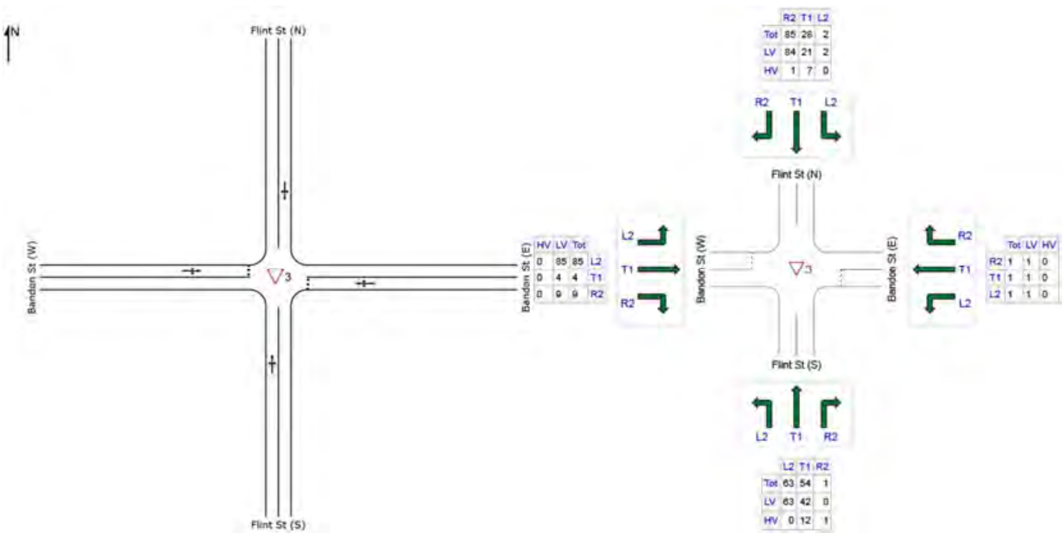
Flint Street and Bridge Street – PM Peak





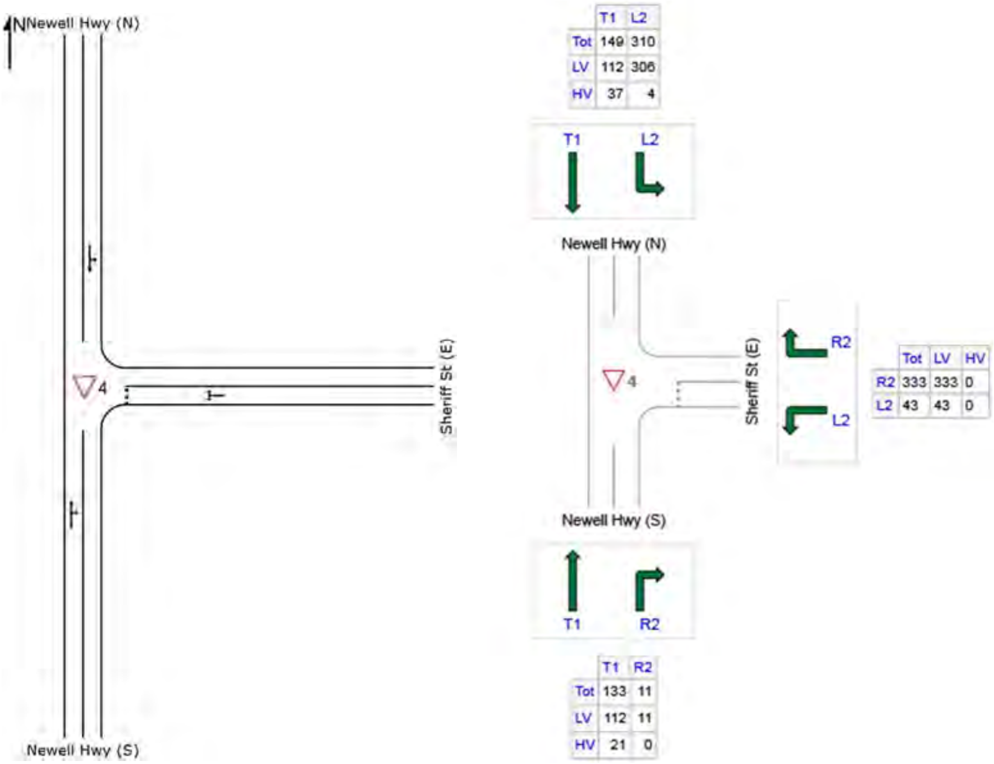
Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Flint Street (S)											
2	T1	3	0.0	0.091	3.5	LOS A	0.4	3.3	0.02	0.62	46.2
3	R2	146	7.9	0.091	7.1	LOS A	0.4	3.3	0.02	0.62	46.0
Approach		149	7.7	0.091	7.0	LOS A	0.4	3.3	0.02	0.62	46.0
East: Bridge Street (E)											
4	L2	104	8.1	0.073	4.7	LOS A	0.4	2.8	0.08	0.51	53.9
6	R2	1	0.0	0.073	8.2	LOS A	0.4	2.8	0.08	0.51	55.0
Approach		105	8.0	0.073	4.7	LOS A	0.4	2.8	0.08	0.51	53.9
North: Flint Street (N)											
7	L2	1	0.0	0.012	5.2	LOS A	0.1	0.4	0.29	0.46	53.3
8	T1	14	0.0	0.012	5.3	LOS A	0.1	0.4	0.29	0.46	54.4
Approach		15	0.0	0.012	5.3	LOS A	0.1	0.4	0.29	0.46	54.3
All Vehicles		269	7.4	0.091	6.0	LOS A	0.4	3.3	0.06	0.57	49.2

Flint Street and Bandon Street – PM Peak



Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Flint Street (S)											
1	L2	66	0.0	0.070	4.6	LOS A	0.0	0.1	0.00	0.29	47.7
2	T1	57	22.2	0.070	0.0	LOS A	0.0	0.1	0.00	0.29	48.2
3	R2	1	100.0	0.070	5.2	LOS A	0.0	0.1	0.00	0.29	46.4
Approach		124	11.0	0.070	2.5	NA	0.0	0.1	0.00	0.29	47.9
East: Bandon Street (E)											
4	L2	1	0.0	0.002	5.6	LOS A	0.0	0.0	0.09	0.55	53.7
5	T1	1	0.0	0.002	4.5	LOS A	0.0	0.0	0.09	0.55	53.9
6	R2	1	0.0	0.002	6.0	LOS A	0.0	0.0	0.09	0.55	53.2
Approach		3	0.0	0.002	5.4	LOS A	0.0	0.0	0.09	0.55	53.6
North: Flint Street (N)											
7	L2	2	0.0	0.074	5.9	LOS A	0.3	2.6	0.24	0.43	53.8
8	T1	29	25.0	0.074	0.4	LOS A	0.3	2.6	0.24	0.43	55.2
9	R2	89	1.2	0.074	5.9	LOS A	0.3	2.6	0.24	0.43	53.2
Approach		121	7.0	0.074	4.5	NA	0.3	2.6	0.24	0.43	53.7
West: Bandon Street (W)											
10	L2	89	0.0	0.072	5.7	LOS A	0.3	2.0	0.15	0.55	53.2
11	T1	4	0.0	0.072	5.0	LOS A	0.3	2.0	0.15	0.55	53.4
12	R2	9	0.0	0.072	6.6	LOS A	0.3	2.0	0.15	0.55	52.7
Approach		103	0.0	0.072	5.8	LOS A	0.3	2.0	0.15	0.55	53.2
All Vehicles		352	6.3	0.074	4.2	NA	0.3	2.6	0.13	0.42	51.4

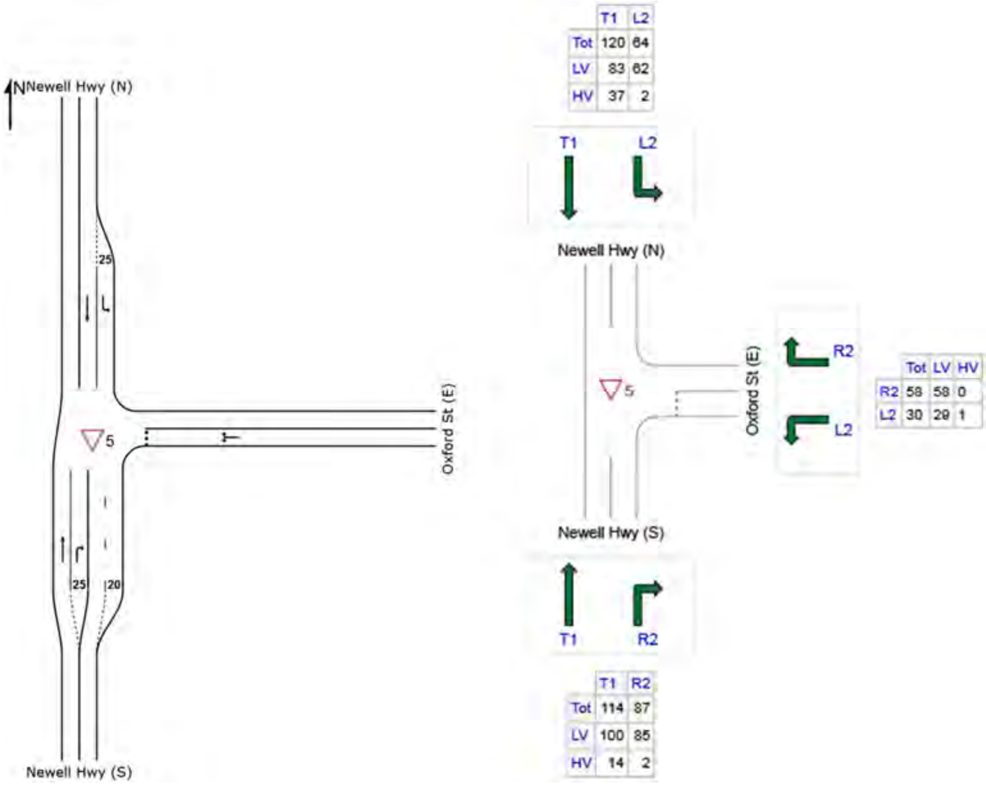
Newell Highway and Sheriff Street – PM Peak



Movement Performance - Vehicles

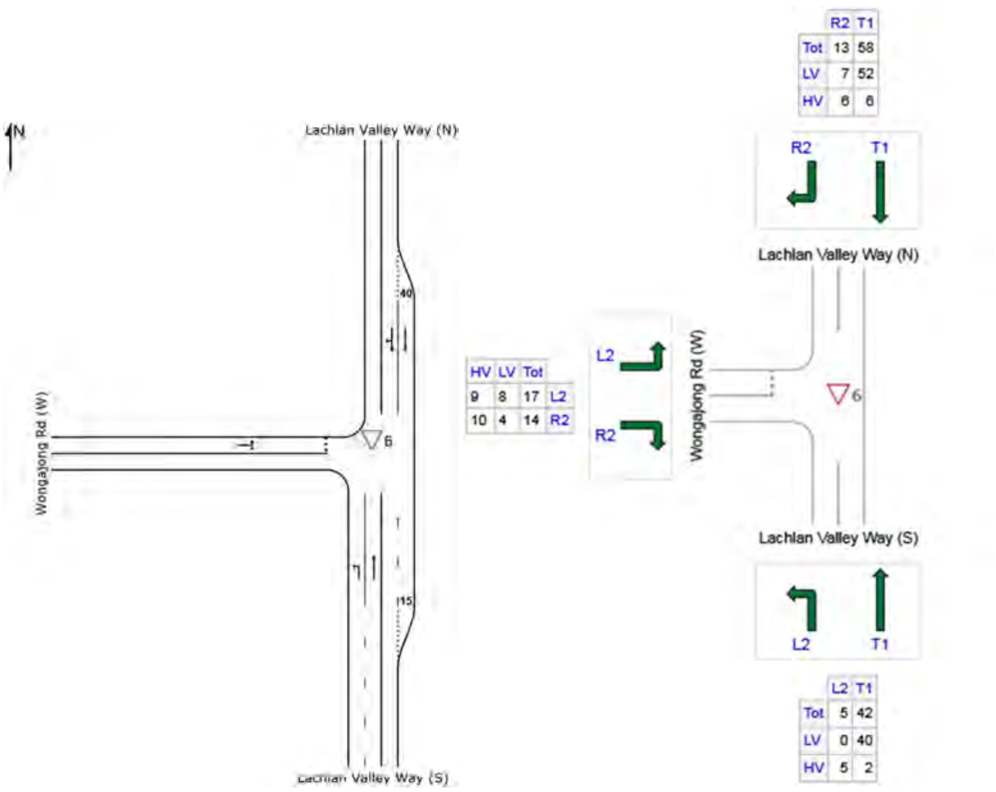
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Newell Highway (S)											
2	T1	140	15.8	0.087	0.2	LOS A	0.1	0.7	0.10	0.05	59.1
3	R2	12	0.0	0.087	7.0	LOS A	0.1	0.7	0.10	0.05	56.9
Approach		152	14.6	0.087	0.7	NA	0.1	0.7	0.10	0.05	58.9
East: Sheriff Street (E)											
4	L2	45	0.0	0.343	6.4	LOS A	1.5	10.3	0.41	0.73	52.4
6	R2	351	0.0	0.343	7.2	LOS A	1.5	10.3	0.41	0.73	51.9
Approach		396	0.0	0.343	7.1	LOS A	1.5	10.3	0.41	0.73	51.9
North: Newell Highway (N)											
7	L2	326	1.3	0.271	5.6	LOS A	0.0	0.0	0.00	0.40	54.7
8	T1	157	24.8	0.271	0.0	LOS A	0.0	0.0	0.00	0.40	56.2
Approach		483	8.9	0.271	3.8	NA	0.0	0.0	0.00	0.40	55.2
All Vehicles		1031	6.3	0.343	4.6	NA	1.5	10.3	0.17	0.47	54.4

Newell Highway and Oxford Street – PM Peak



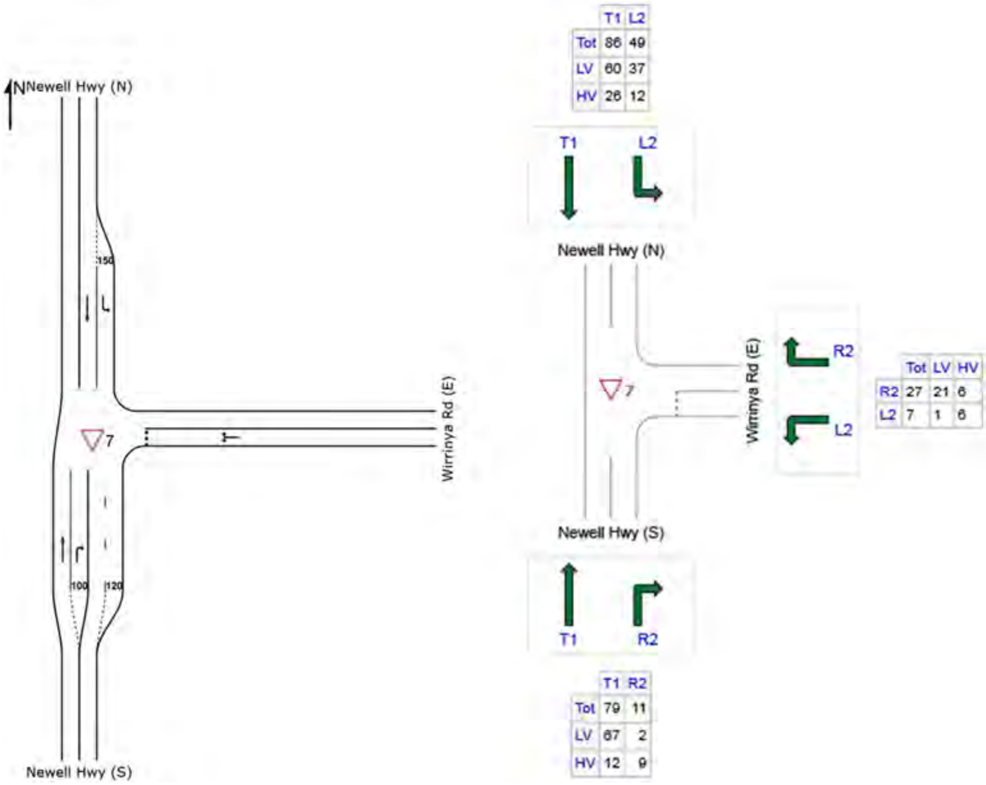
Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Newell Highway (S)											
2	T1	120	12.3	0.066	0.0	LOS A	0.0	0.0	0.00	0.00	50.0
3	R2	92	2.3	0.079	5.5	LOS A	0.3	2.3	0.32	0.56	45.7
Approach		212	8.0	0.079	2.4	NA	0.3	2.3	0.14	0.24	48.0
East: Oxford Street (E)											
4	L2	32	3.3	0.115	6.1	LOS A	0.5	3.2	0.38	0.64	51.8
6	R2	61	0.0	0.115	8.7	LOS A	0.5	3.2	0.38	0.64	51.7
Approach		93	1.1	0.115	7.8	LOS A	0.5	3.2	0.38	0.64	51.7
North: Newell Highway (N)											
7	L2	67	3.1	0.037	5.6	LOS A	0.0	0.0	0.00	0.58	53.5
8	T1	126	30.8	0.078	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		194	21.2	0.078	1.9	NA	0.0	0.0	0.00	0.20	57.5
All Vehicles		498	11.8	0.115	3.2	NA	0.5	3.2	0.13	0.30	52.1

Lachlan Valley Way and Wongajong Road – PM Peak



Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Lachlan Valley Way (S)											
1	L2	5	100.0	0.005	9.1	LOS A	0.0	0.0	0.00	0.66	59.4
2	T1	44	4.8	0.023	0.0	LOS A	0.0	0.0	0.00	0.00	100.0
Approach		49	14.9	0.023	1.0	NA	0.0	0.0	0.00	0.07	93.2
North: Lachlan Valley Way (N)											
8	T1	61	10.3	0.040	0.1	LOS A	0.1	0.9	0.06	0.11	96.9
9	R2	14	46.2	0.040	9.0	LOS A	0.1	0.9	0.08	0.15	66.0
Approach		75	16.9	0.040	1.7	NA	0.1	0.9	0.07	0.12	89.3
West: Wongajong Road (W)											
10	L2	18	52.9	0.037	6.3	LOS A	0.1	1.5	0.17	0.54	50.9
12	R2	15	71.4	0.037	7.8	LOS A	0.1	1.5	0.17	0.54	49.9
Approach		33	61.3	0.037	7.0	LOS A	0.1	1.5	0.17	0.54	50.4
All Vehicles		157	25.5	0.040	2.6	NA	0.1	1.5	0.07	0.19	77.8

Newell Highway and Wirrinya Road – PM Peak



Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Newell Highway (S)											
2	T1	83	15.2	0.047	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
3	R2	12	81.8	0.014	9.5	LOS A	0.1	0.6	0.31	0.60	44.7
Approach		95	23.3	0.047	1.2	NA	0.1	0.6	0.04	0.07	72.9
East: Wirrinya Road (E)											
4	L2	7	85.7	0.047	7.1	LOS A	0.2	1.7	0.34	0.61	49.0
6	R2	28	22.2	0.047	7.8	LOS A	0.2	1.7	0.34	0.61	51.2
Approach		36	35.3	0.047	7.6	LOS A	0.2	1.7	0.34	0.61	50.7
North: Newell Highway (N)											
7	L2	52	24.5	0.033	7.4	LOS A	0.0	0.0	0.00	0.63	57.9
8	T1	91	30.2	0.056	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		142	28.1	0.056	2.7	NA	0.0	0.0	0.00	0.23	70.2
All Vehicles		273	27.4	0.056	2.8	NA	0.2	1.7	0.06	0.22	67.7

Level 21, 420 George Street, Sydney, NSW 2000
PO Box Q410, QVB Post Office, NSW 1230
T +61 2 8934 0000 F +61 2 8934 0001
www.aecom.com

Appendix O

Noise and Vibration Impact Assessment

Camp Street Bridge Replacement, Forbes
Roads and Maritime Services
08-May-2018

Camp Street Bridge Replacement, Review of Environmental Factors

Noise and Vibration Impact Assessment

Camp Street Bridge Replacement, Forbes

Noise and Vibration Impact Assessment

Client: Roads and Maritime Services

ABN: 76 236 371 088

Prepared by

AECOM Australia Pty Ltd
Level 21, 420 George Street, Sydney NSW 2000, PO Box Q410, QVB Post Office NSW 1230, Australia
T +61 2 8934 0000 F +61 2 8934 0001 www.aecom.com
ABN 20 093 846 925

08-May-2018

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Quality Information

Document Camp Street Bridge Replacement, Forbes

Ref 60555121

Date 08-May-2018

Prepared by Jack Robinson

Reviewed by Gayle Greer

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
A	28-Nov-2017	Draft 1	Gayle Greer Technical Director	GG
B	20-Dec-2017	Draft 2	Gayle Greer Technical Director	GG
C	20-Dec-2017	Draft 3	Gayle Greer Technical Director	GG
D	16-Mar-2018	Draft 4	Gayle Greer Technical Director	GG
E	08-May-2018	Final incorporating Roads and Maritime comments	Gayle Greer Technical Director	Gayle Greer

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1.0 Introduction

1.1 Project Description

Roads and Maritime Services (Roads and Maritime) proposes to replace the existing bridge over Lake Forbes (B4286) with a new reinforced concrete bridge (B11707).

The project is located on Camp Street Bridge B4286. It is located over Lake Forbes on MR56 Lachlan Valley Way at Forbes. The project is in the local government area of Forbes Shire Council. It is in the state electorate of Dubbo.

The Camp Street Bridge was built in 1927 and is narrow, in poor condition and nearing the end of its life. A new bridge is needed to meet current design standards and improve safety for motorists and pedestrians into the future.

A new bridge across Lake Forbes will improve safety for motorists, pedestrians and reduce future maintenance requirements. The project involves building a new, wider bridge across Lake Forbes with wider travel lanes and pedestrian/cyclist paths. The design includes landscaping suitable to the surrounding lakeside environment. The lamp posts from the existing bridge will be incorporated in the design to complement the town's heritage aesthetics.

The benefits of the project are:

- Providing a value for money solution to replace the aging bridge and secure access for local and through traffic on the Escort and Lachlan Valley Way
- Provide for Heavy Mass Limit (HML) loads
- Improving road user safety through wider travel lanes, improved road approaches and pedestrian/cyclist paths across the new bridge;
- Improving connections for pedestrians and cyclists between both sides of Lake Forbes;
- Reduced ongoing maintenance costs;
- Improved environmental outcomes by managing stormwater runoff from the road into Lake Forbes;
- Retaining the lamp posts in the landscape design on the approach to bridge, to reference the past and link the bridge to the heritage aesthetic of the town; and
- Unique design to provide an iconic structure for the Forbes community for the future.

The features or the proposal include:

- Demolition of the existing Camp Street bridge and pedestrian bridge;
- Placement of a temporary in stream structure in Lake Forbes to facilitate demolition and construction of a new bridge;
- A new bridge on the same road alignment as the old bridge;
- A bridge with a minimum of 2 lane 2 way carriageway with 3.5m lanes and 1.5m clear shoulders with improved access for wide vehicles and provision of footpaths for cyclists and pedestrians;
- Design traffic speed to match existing (50 km/h horizontal and vertical design speed);
- Landscaping and drainage works;
- A temporary construction compound site, temporary stockpile and laydown area on the western side of Lake Forbes in open space either side of Camp Street;
- Ancillary works area including temporary stockpile and material laydown on the eastern side of Lake Forbes in open space either side of Bridge Street;
- Temporary heavy vehicle detour route for heavy vehicles to and from Orange on the Escort Way, and to and from Cowra on the Lachlan Valley Way. The detour from the intersection of Newell

Highway and Camp Street across the Fitzgerald Bridge then onto Wirrinya Road, Red Bend Road, onto Wongajong Road and then onto Lachlan Valley Way; and

- Temporary light vehicle detour for light vehicles travelling to and from the east and western sides of Lake Forbes. The detour will be from the intersection of Flint street and either the intersection of Bandon of Oxford street to the intersection the Newell Highway with either Oxford Street or Sheriff street depending on the direction of traffic.

Figure 1 Camp Street Bridge Replacement - Location map

1.2 Proposed scope of work

Roads and Maritime has engaged AECOM Australia Pty Ltd (AECOM) to conduct an assessment of noise and vibration impacts of the bridge replacement works. The scope of work for the noise and vibration impact assessment includes the following:

- Characterise the existing acoustic environment and identify nearby noise and vibration sensitive receivers;
- Establish construction noise management levels;
- Establish safe working vibration distances for the use of vibration intensive equipment associated with the works;
- Assess the likely noise emission from the site during the replacement works;
- Assess the vibration levels during construction;
- Assess potential impacts of construction traffic including detour routes; and
- Determine suitable and indicative construction noise management and mitigation measures, including limits on permissible hours of construction, silencing treatment of mechanical and mobile plant, management of mechanical and mobile plant, community consultation and/or other management measures.

The acoustic terminology used in this report is explained in Appendix A.

1.3 Relevant documents

The following documents are considered applicable to this project and have been utilised or referenced where appropriate.

- Construction Noise and Vibration Guideline, Roads and Maritime Services, 2016;
- Noise Policy for Industry, NSW Environment Protection Authority, 2017;
- NSW Road Noise Policy, Department of Climate Change, Environment and Water, 2011;
- Assessing Vibration: A Technical Guideline, NSW Department of Environment and Conservation, 2006;
- Interim Construction Noise Guideline, Department of Environment and Climate Change, 2009;
- Procedure: Preparing an Operational Traffic and Construction Noise and Vibration Assessment Report, Roads and Maritime Services, 2016;
- Australian Standard AS 2670.2 1990 Evaluation of human exposure to whole-body vibration. Part 2: Continuous and shock induced vibration in buildings (1 to 80 Hz);
- Australian Standard AS 2436-2010 Guide to noise and vibration control on construction, demolition and maintenance sites;
- German Standard DIN Standard 4150: Part 3 1999 Structural Vibration in Buildings - Effects on Structures, 1999;
- British Standard 7385: Part 2 1993 Evaluation and Measurement of Vibration in Buildings, 1993;
- British Standard 6472: Part 1 2008 Evaluation of Human Exposure to Vibration in Buildings, 2008; and
- Environmental Noise Management Manual, Roads and Traffic Authority of NSW, 2001.

2.0 Existing noise environment

In order to establish the existing noise environment within the vicinity of the bridge replacement works, ambient noise monitoring was conducted at three representative locations. The monitoring locations were determined from aerial photographs depicting land use surrounding the site and shown in the map in Appendix B.

The noise monitoring was conducted and processed in accordance with the *Noise Policy for Industry* (NPfI).

2.1 Instrumentation

The long-term unattended noise logging was conducted using class 1 sound analysers, as listed in Table 1 below. The sound level meter used to conduct attended surveys was a Bruel & Kjaer 2250 (Serial Number 3009330). The long-term noise logger and the sound level meter were calibrated before and after the measurements with a drift in calibration not exceeding ±0.5 dB.

Loggers were set to measure in 15 minute periods continuously. The overall statistical noise levels were recorded (i.e. L_{A90}, L_{A10}, L_{A1}), as well as the equivalent energy level (L_{Aeq}).

All the acoustic instrumentation employed during the noise measurements comply with the requirements of "*AS IEC 61672.1-2004 Electroacoustics – Sound level meters – Specifications*" and have current calibration certificates (i.e. calibrated in the last two years).

2.2 Meteorological data

Weather data for the area were sourced from the Bureau of Meteorology Forbes Airport Automatic Weather Station (AWS) and were used to identify periods of adverse weather occurring during the noise monitoring period. As required by the NPfI guidelines, extraneous noise events and noise data adversely affected by weather e.g. rain and wind were excluded.

2.3 Unattended monitoring

Noise logging was conducted by AECOM from 12 October to 26 October 2017 to measure the background noise level. Details of the loggers are presented in Table 1.

Table 1 Noise logging locations and equipment

Logger	Address	Start date	End date	Logger type	Serial number
L1	14 Bandon Street, Forbes	12/10/17	12/10/17	Rion NL-52	164395
L2	Corner of Oxford Street & Newell Highway, Forbes	12/10/17	26/10/17	Rion NL-52	553966
L3	88 Reymond Street, Forbes	12/10/17	26/10/17	Rion NL-52	1043455

The results of the noise monitoring were processed in accordance with the procedures contained in the NPfI.

The background noise level is defined by the NSW Environmental Protection Authority (EPA) as 'the underlying level of noise present in ambient noise when all unusual extraneous noise is removed'. It can include sounds that are normal features of a location and may include birds, traffic, insects etc. The background noise level is considered to be represented by the L_{A90} descriptor. The noise levels measured at the proposed development site were analysed to determine a single assessment background level (ABL) for each day, evening and night period in accordance with the EPA's NSW Noise Policy for Industry (NPfI), for each monitoring location.

The ABL is established by determining the lowest ten-percentile level of the L_{A90} noise data acquired over each period of interest. The background noise level or rating background level (RBL) representing the day, evening and night-time assessment periods is based on the median of individual ABLs determined over the entire monitoring period. An overall representative L_{Aeq} noise level is determined by logarithmically averaging each assessment period for the entire monitoring period.

The ABLs and existing L_{Aeq} ambient noise levels for each noise monitoring location for each assessment period (day, evening and night) are presented in Appendix B, along with complete noise logger graphs – the L_{A1}, L_{A10}, L_{A90} and L_{Aeq} noise levels are shown on the graphs. Periods where extraneous wind and rain occur are also shown on the graphs.

A summary of the calculated RBLs and existing L_{Aeq} ambient noise levels are presented in Table 2. Full details of the logged noise levels are presented in Appendix B.

Table 2 Existing background (L_{A90}) and ambient (L_{Aeq}) noise levels

Measurement location	Background L_{A90} and ambient noise levels L_{Aeq}, dB(A)		
	Day[1]	Evening[1]	Night[1]
L1 – 14 Bandon Street, Forbes			
Rating background level L_{A90}	40[2]	35[2]	30[2]
Log Average L_{Aeq}			
L2 – Corner of Oxford Street & Newell Highway, Forbes			
Rating background level L_{A90}	39	42	30
Log Average L_{Aeq}	58	58	55
L3 – 88 Reymond Street, Forbes			
Rating background level L_{A90}	38	38	33
Log Average L_{Aeq}	62	58	54

Notes:

1. *Day is defined as 7:00 am to 6:00 pm, Monday to Saturday and 8:00 am to 6:00 pm Sundays & Public Holiday; Evening is defined as 6:00 pm to 10:00 pm, Monday to Sunday & Public Holidays; Night is defined as 10:00 pm to 7:00 am, Monday to Saturday and 10:00 pm to 8:00 am Sundays & Public Holidays.*
2. *Logger 1 failed during the first day of monitoring. However from the limited data it was noted that noise levels at this location were similar to the levels measured at L2 and L3 (L_{A90} 44 dB(A)) during the late afternoon period. To provide a conservative approach background noise levels were estimated using the Roads and Maritime Construction Noise Estimator Tool. It is noted that the daytime noise levels are very similar to those measured at L2 and L3.*

2.4 Attended noise monitoring

Attended monitoring was conducted at four locations on 26 and 27 October 2017. The attended noise monitoring locations are each logging location shown in Appendix C and an additional location along the heavy vehicle detour route.

The purpose of these measurements was to characterise the noise environment in the vicinity of the residential receivers. Table 3 presents a summary of these measurements. Weather conditions were fine with moderate winds and scattered clouds on the day of monitoring.

Table 3 Attended noise monitoring results

Monitoring location	Date and time	Description	Attended measurement results, dB(A)			
			$L_{A1, 15min}$	$L_{A10, 15 min}$	$L_{Aeq, 15min}$	$L_{A90, 15min}$
L1 – 14 Bandon Avenue, Forbes	16:06 26 October 2017	• Predominantly road traffic noise from Newell Highway. • Light wind noise in trees, some insect noise. • Water fountain approximately 100 m away can be heard in addition to truck noise over nearby bridge.	56	52	49	45
L2 – Newell Highway & Oxford Street, Forbes	16:34 26 October 2017	• Ambient noise levels controlled by road traffic from Newell Highway, light intermittent traffic noise from Oxford Street. • Light wind noise in nearby bushes. • Cicadas barely audible.	70	63	59	45
L3 – 88 Reymond Street, Forbes	17:11 26 October 2017	• Ambient noise levels controlled by road traffic along College Road and Reymond Street. • Moderate wind noise in surrounding trees.	70	66	60	42
423 Red Bend Road, Forbes	09:36 27 October 2017	• Ambient noise levels controlled by nearby birds and livestock. • Occasional road traffic pass-by event on Wirrinya Road and Red Bend Road (about once every 5 minutes).	60	48	49	31

3.0 Noise criteria

3.1 Construction noise criteria

3.1.1 NSW - Interim Construction Noise Guideline (ICNG)

The NSW Environment Protection Authority's (EPA) *Interim Construction Noise Guideline* (ICNG) is the principal guidance for the assessment and management of construction noise in NSW.

The ICNG recommends that a quantitative assessment is carried out for all 'major construction projects that are typically subject to the EIA processes. Noise levels due to construction activities are predicted at nearby receivers using environmental noise modelling software and compared to the levels provided in Section 4 of the ICNG.

Where an exceedance of the management levels is predicted the ICNG advises that receivers can be considered 'noise affected' and the proponent should apply all feasible and reasonable work practises to minimise the noise impact. The proponent should also inform all potentially impacted residents of the nature of the works to be carried out, the expected noise level and duration, as well as contact details.

Where construction noise levels reach 75 dB(A) residential receivers can be considered as 'highly noise affected' and the proponent should, in consultation with the community, consider restricting hours to provide respite periods.

The ICNG defines what is considered to be feasible and reasonable as follows:

> *Feasible*
>
> > *A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements.*
>
> *Reasonable*
>
> > *Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure.*

Construction noise management levels (NMLs) for residential receivers are derived using the information in Table 4.

Table 4 Noise at residences using quantitative assessment, extract from the Interim Construction Noise Guideline

Time of day	NML, $L_{Aeq,15min}$, dB(A)[1]	How to apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences 2. If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see section 7.2.2 (ICNG).

Notes:

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

3.1.2 Construction noise management levels – Residential receivers

It is understood that construction activities would take place during recommended standard working hours (07.00 am – 6.00 pm Monday to Friday and 8.00 am – 1.00 pm Saturday). Roads and Maritime approval would be sought prior to undertaking any work outside these hours. Occasional deliveries will be undertaken on Saturday afternoons (1pm – 4 pm) or Sunday (8am to 1pm) where required to manage other potential impacts such as traffic disruption. Night works will be undertaken occasionally where required for important safety or constructability reasons.

Construction noise management levels for the most affected residential receivers are shown in Table 5.

Table 5 Construction noise management levels - Residential receivers

Noise catchment area	Rating background level, L_{A90} dB(A)	Noise management levels, L_{Aeq} dB(A)
NCA 1	40	50

3.1.2.1 Construction noise management levels - Non-residential receivers

Noise management levels recommended by the ICNG for non-residential receivers are shown in Table 6.

Table 6 Construction noise management levels – Non-residential receivers

Land use	Management level, $L_{Aeq\ (15\ min)}$ (applies when properties are in use)
Place of worship	55 dB(A)[1]
Commercial - Offices, retail outlets	70 dB(A)

Notes:

1. *These external management levels are based upon a 45 dB(A) internal noise management level and a 10 dB reduction from outside to inside through an open window.*

3.2 Construction road traffic noise criteria

Noise from construction traffic on public roads is not covered by the ICNG. However the ICNG does refer to the Environmental Criteria for Road Traffic Noise (ECRTN), now superseded by the Road Noise Policy (RNP), for the assessment of noise arising from construction traffic on public roads.

To assess noise impacts from construction and detour traffic, an initial screening test should be undertaken by evaluating whether existing road traffic noise levels will increase by more than 2 dB (A). Where the predicted noise increase is 2 dB (A) or less, then no further assessment is required. However, where the predicted noise level increase is greater than 2 dB (A), and the predicted road traffic noise level exceeds the road category specific criterion then noise mitigation should be considered for those receivers affected. The RNP does not require assessment of noise impact to commercial or industrial receivers.

3.3 Construction vibration criteria

The relevant standards/guidelines for the assessment of construction vibration are summarised in Table 7.

Table 7 Standards/guidelines used for assessing construction vibration

Item	Standard/guideline
Structural damage	German Standard DIN 4150 – Part 3 – Structural Vibration in Buildings – Effects on Structures (DIN 4150)
Human comfort (tactile vibration) [1]	Assessing Vibration: A Technical Guideline (AVATG)

Notes:

1. *This document is based upon the guidelines contained in British Standard 6472:1992, "Evaluation of human exposure to vibration in buildings (1-80 Hz)". This British Standard was superseded in 2008 with BS 6472-1:2008 "Guide to evaluation of human exposure to vibration in buildings – Part 1: Vibration sources other than blasting" and the 1992 version of the Standard was withdrawn. Although a new version of BS 6472 has been published, the Environment*

Protection Authority still requires vibration to be assessed in accordance with the 1992 version of the Standard at this point in time.

Vibration, at levels high enough, has the potential to cause damage to structures and disrupt human comfort. Vibration and its associated effects are usually classified as continuous, impulsive or intermittent as follows:

- Continuous vibration continues uninterrupted for a defined period and includes sources such as machinery and continuous construction activities for example, a tunnel boring machine;
- Impulsive vibration is a rapid build up to a peak followed by a damped decay. It may consist of several cycles at around the same amplitude, with duration typically less than two seconds and no more than three occurrences in an assessment period. This may include occasional dropping of heavy equipment or loading activities; and
- Intermittent vibration occurs where there are interrupted periods of continuous vibration, repeated periods of impulsive vibration or continuous vibration that varies significantly in magnitude. This may include intermittent construction activity, impact pile driving, jack hammers.

3.3.1 Structural damage

At present, no Australian Standards exist for the assessment of building damage caused by vibration.

DIN 4150 provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are presented in Table 8. DIN 4150 states that buildings exposed to higher levels of vibration than recommended limits would not necessarily result in damage.

A conservative limit provided by Roads and Maritime as part of its environmental procedures, is 2 mm/s at the property boundary.

Table 8 DIN 4150: Structural damage safe limits for building vibration

Group	Type of structure	Vibration velocity in mm/s			
		At foundation at a frequency of			Vibration at the horizontal plane of the highest floor
		Less than 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (eg buildings that are under a preservation order)	3	3 to 8	8 to 10	8

3.3.2 Human comfort – Tactile vibration

3.3.2.1 Intermittent vibration

The assessment of intermittent vibration outlined in the EPA guideline Assessing Vibration: A Technical Guideline is based on Vibration Dose Values (VDVs). The VDV accumulates the vibration energy received over the daytime and night-time periods.

Maximum and preferred VDVs for intermittent vibration arising from construction activities are listed in Table 9. The VDV criteria are based on the likelihood that a person would be annoyed by the level of vibration over the entire assessment period.

Table 9 Preferred and maximum vibration dose values for intermittent vibration ($m/s^{1.75}$)

Location	Daytime (7 am – 10 pm)		Night-time (10 pm – 7 am)	
	Preferred	Max	Preferred	Max
Critical areas	0.1	0.2	0.1	0.2
Residences	0.2	0.4	0.13	0.26
Offices, schools, educational institutions and places of worship	0.4	0.8	0.4	0.8

4.0 Construction noise assessment

4.1 Construction noise model

In order to assess noise impact from the site during the bridge replacement works, a noise model was created to represent 'reasonable' worst periods of construction activities.

The construction of the proposed development has been modelled in SoundPLAN Version 7.3. The following features were included in the noise model:

- Ground topography;
- Ground absorption and reflection;
- Buildings (residential and non-residential); and
- Construction noise sources (listed in Table 10 and Table 11).

Noise emissions from the construction sites have been modelled using an implementation of the ISO 9613-2:1996 propagation algorithm with neutral meteorological conditions.

4.1.1 Construction scenarios and noise sources

This assessment takes into account the likely worst case scenarios within each construction stage in terms of noise and vibration impacts from the construction methodology.

The construction stages consist of:

1. Advance works. This stage consists of activities such as utility relocations
2. Preliminary earthworks. This stage consists of initial earthworks to widen the approaches on the bridge to accommodate the new, wider bridge
3. Demolition. This stage includes the dismantling and removal of the existing bridge and pylons. It includes the installation of temporary instream works, such as rock platforms, required to demolish the bridge. Two demolition scenarios have been considered for noise impact assessment 3 a and 3b. The 3a scenario assumes that sheet piling will be undertaken as part of the bridge demolition. It has been modelled as a separate activity. Scenario 3b assumes that the bridge will be demolished without the use of sheet piling
4. Bridge construction. This stage involves piling for the new piers and installation of the new bridge deck
5. Final roadworks and landscaping. This stage includes activities such as the construction of the new road surface, drainage and landscaping
6. Construction compound decommission. This stage involves the removal of the site compounds and temporary pads.

Likely construction equipment to be used during each scenario is presented in Table 10. Table 11 presents the sound power levels of the proposed construction equipment for the works. These sound power levels are typical values taken from data provided in the Australian Standard AS2436-2010, Guide to noise control on construction, demolition and maintenance sites and the UK Department for Environment, Food and Rural Affairs (DEFRA) noise database and assume equipment is modern and in good working order.

Table 10 Construction stages and associated equipment

Construction equipment to be used	Construction scenario						
	1 – Advance works	2 – Preliminary earthworks	3a – Demolition - Sheet Piling	3b – Demolition of existing bridge	4 – Bridge Construction	5 – Final roadworks and landscaping	6 – Construction compound decommission
Backhoe	•						
Trench roller	•						
Rigid truck	•	•					
Light vehicle	•	•					•
Underbore rig	•						
Excavator		•	•	•	•	•	•
Padfoot roller		•					
Smooth roller		•					
Rubber tyre roller		•					
Grader		•					
Water cart		•					
Loader		•					
Crane			•	•	•		
Welding equipment			•		•		•
Electric power tools				•	•		
Dump truck				•		•	
Truck			•	•	•		•
Hydraulic breaker				•	•		
Concrete saw				•			
Water pump				•	•		
Oxy-cutter				•			
Pneumatic hammer				•	•		
Compressor				•	•		•
Soil stabiliser						•	
Spreader truck						•	
Franna crane				•	•	•	
Concrete truck						•	
Sealing truck						•	
Front end loader						•	•

Construction equipment to be used	Construction scenario						
	1 – Advance works	2 – Preliminary earthworks	3a – Demolition - Sheet Piling	3b – Demolition of existing bridge	4 – Bridge Construction	5 – Final roadworks and landscaping	6 – Construction compound decommission
Generator				•	•	•	•
Sheet Piling			•				
Impact Piling Rig					•		
Hydraulic Vibrating Hammer			•		•		
Concrete Pump					•		
Concrete Agitator					•		
Concrete Vibrator					•		

Table 11 Construction equipment and associated sound power levels

Construction equipment	Sound power level, dB(A)
Backhoe	102
Trench roller	109
Truck (rigid and sealing)	98[1]
Light vehicle	90
Underbore rig	103
Excavator	105
Padfoot	109
Smooth roller	105
Rubber tyre roller	107
Grader	109
Water cart	100
Loader	103
Crane	106
Welding equipment	101
Electric power tools	108
Dump truck	104
Road truck	108
Hydraulic breaker	112
Concrete saw	110
Water pump	96
Oxy-cutter	93
Pneumatic hammer	112
Compressor	109
Soil stabiliser	109
Spreader truck	103
Franna crane	93
Concrete truck	106
Front end loader	108
Generator	101
Sheet Piling	116
Drop hammer (9t)	119
Hydraulic Vibrating Hammer	112
Concrete Pump	106
Concrete Agitator	105
Concrete Vibrator	97

Notes: 1 - Sound power levels are time-weighted

4.1.2 Predicted construction noise impacts

Construction activities are expected to commence in in the second quarter 2019 subject to approvals and funding availability. The proposal has an expected duration of 54 weeks subject to weather. The predicted impact from the assumed 'reasonable' worst case 15 minute period of each stage of construction works has been assessed. No construction is expected to take place outside of standard construction hours, however, occasionally works may be required outside these hours for important safety or constructability reasons.

The assessment assumes no noise mitigation at the construction site and that equipment, as listed in Table 10, is in use for the entire 15 minute period. A summary of the number of receivers where construction noise levels are predicted to exceed NMLs during the loudest construction stages are presented in Table 12 during standard construction hours.

It can be expected that there may be differences between predicted and measured noise levels due to variations in instantaneous operating conditions, plant in operation during the measurement and also the location of the plant equipment. The acoustic shielding calculated in the model due to fixed building structures would also vary as the construction equipment moves around the site. Neutral weather conditions were assumed for all construction scenarios.

Appendix D presents the construction noise contours and also indicates the level of exceedance over the noise management levels for each nearby noise sensitive receiver.

Table 12 Predicted construction noise impacts

Construction scenario	Overall sound power level of construction stage, dB(A)	Exceedance of NML		
		0-5 dB	6-10 dB	11-20 dB
		Number of receivers exceeding NML		
1 – Advance works	111	19	13	3
2 – Preliminary earthworks	115	72	22	7
3a – Demolition - Sheet piling[1]	116	68	32	15
3b – Demolition of existing bridge	119	104	68	19
4 – Bridge construction[1]	119	104	68	19
5 – Final roadworks and landscaping	118	73	64	18
6 – Construction compound	114	22	19	1

Notes: 1 When the impact or sheet piling rigs are in use, it is unlikely that any other noisy equipment will be in use concurrently.

Results show noise levels at up to 191 receivers are predicted to exceed NMLs during the loudest construction stages, demolition of the existing bridge and construction of the new bridge. Of these exceedances, 104 are predicted to exceed by up to 5 dB, 68 are predicted to exceed by up to 10 dB and 19 to exceed by up to 20 dB. The most affected receivers are located along Hill Street, Barwin Street and Bridge Street.

The predicted noise levels at the worst affected receivers are 69 dB(A). No receivers are predicted to be 'highly affected' where noise levels over 75 dB(A) are predicted during the loudest construction stage.

As noted above it is understood that construction works will generally be undertaken during standard construction hours only. Occasional out of hours works may be required for deliveries where required to minimise other impacts such as traffic disruption. Occasional night works may also be undertaken where required for important safety and constructability reasons.

Mitigation strategies that should be considered during all work stages and instigated where appropriate are presented in Section 6.0 below.

4.2 Construction traffic assessment

Table 13 below presents the existing traffic flows at two locations in Forbes during the am and pm peak periods. During the bridge replacement works two detour routes will be in operation. Heavy vehicles will detour from the intersection of Newell Highway and Camp Street across the Fitzgerald Bridge then onto Wirrinya Road, Red Bend Road, onto Wongajong Road and then onto Lachlan Valley Way. Light vehicles will detour from the intersection of Flint Street and either the intersection of Bandon or Oxford Street to the intersection the Newell Highway with either Oxford Street or Sheriff Street depending on the direction of traffic.

Table 13 also presents the additional detour traffic. The increase in road traffic noise levels due to construction and diversion traffic was calculated using Roads and Maritime's Construction Road Traffic Noise Estimator. It can be seen that the noise increases are less than 2 dB(A) therefore no further assessment is required, in accordance with the RNP.

Table 13 Existing traffic flows and additional traffic flows due to detour routes

Period	Route	Existing am peak hour flow		Additional am peak hour flow		Relative noise increase, dB(A)
		Light	Heavy	Light	Heavy	
AM peak	Newell Highway Near Oxford Street	256	66	25	26	1.1
PM Peak		272	45	30	8	0.6
AM peak	Reymond Street	138	28	0	21	1.6
PM Peak		141	15	0	12	1.3

5.0 Construction vibration assessment

Vibration intensive works may take place as part of the bridge replacement. The works may include the use vibratory rollers, hydraulic hammers and pile boring.

Typical safe working distances for vibratory rollers are provided below in Table 14. With the exception of the impact pile driver, these safe working distances are based upon the safe working distances presented in the Road and Maritime's Construction Noise and Vibration Guideline and AECOM's library of vibration data. The safe working distances for the impact pile driver are based upon the *BS 5228-2:2009 "Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration*". Should these safe working distances be maintained, no adverse vibrational impacts are predicted.

Table 14 Recommended safe working distances for vibration intensive plant

Plant	Rating/Description	Minimum Safe Working Distance (m)	
		Cosmetic Damage	Human Response
		Residential	
Vibratory roller	< 50 kN (Typically 1-2t)	5	15-20
	< 100 kN (Typically 2-4t)	6	20
	< 200 kN (Typically 4-6t)	12	40
	< 300 kN (Typically 7-13t)	15	100
	> 300 kN (Typically 13-18t)	20	100
	> 300 kN (> 18 t)	25	100
Small Hydraulic Hammer	(300 kg – 5 to 12t excavator)	2	7
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7	23
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22	73
Vibratory Pile Driver	Sheet piles	2 – 20	20
Impact Pile Driver (9t)[1]	10 kJ per blow	35	104
	25 kJ per blow	49	147
	50 kJ per blow	64	192
	85 kJ per blow	79	236
	133 kJ per blow	93	280
Pile Boring	≤ 800 mm	2 (nominal)	4

Notes: 1 The safe working distances are based on the use of a 9t hammer, however the energy produced would vary depending on the drop height. The safe working distance are based on the piles being driven at refusal.

6.0 Recommended mitigation measures

6.1 Noise mitigation measures

This section of the report presents construction noise and vibration mitigation measures to be considered for implementation to minimise and manage construction noise impacts.

The construction noise and vibration assessment presented in Chapter 4.0 of this report detailed a number of exceedances of the noise management levels within this project. These were predicted as a result of various different construction activities. Exceedances of up to 19 dB(A) were predicted. The most affected receivers are located along Hill Street, Barwin Street and Bridge Street.

Standard mitigation measures should be implemented on all construction projects. These standard mitigation measures are presented in Appendix E.

In addition specific noise mitigation has also been recommended in accordance with the RMS Construction Noise and Vibration Guideline. This includes notifications and verification as detailed in Table 15 below.

Table 15 Specific noise mitigation measures

Measure	Description
Notification (letterbox drop or equivalent)	Advanced warning of works and potential disruptions can assist in reducing the impact on the community. The notification may consist of a letterbox drop (or equivalent) detailing work activities, time periods over which these will occur, impacts and mitigation measures. Notification should be a minimum of 5 working days prior to the start of works. The approval conditions for projects may also specify requirements for notification to the community about works that may impact on them. Letterbox drops are to be undertaken of the noise affected residences as identified in Figure 4 of Appendix D at least 5 days prior to the start of works.
Verification	Verification should include measurement of the background noise level and construction noise. Verification should assess the most affected receivers on Hill Street, Barwin Street and Bridge Street.

These specific noise mitigation measures apply to the noise sensitive receivers where construction noise levels are predicted to be more than 10 dB(A) over the NML. From Table 12 it can be seen that up to 19 receivers are affected by such noise levels during demolition of the existing bridge and construction of the new bridge. The properties where the specific noise mitigation measures are to be implemented are indicated in Appendix D.

6.2 Vibration mitigation measures

In some circumstances, construction activity within or close to the safe working distances cannot be avoided due to the work required and the prevalent geological site conditions. These conditions may not be fully understood until work has commenced. For vibration intensive activities that occur within the safe working distances, management methods to mitigate should include:

6.2.1 Vibration monitoring

If it is expected that the safe working distances are to be encroached at any point in the works, vibration monitoring is recommended to determine site specific safe working distances. Works should begin farthest from sensitive receivers and then site specific safe working distances calculated based on the vibration measurements.

If ongoing works are required within the site specific safe working distances then a temporary relocatable vibration monitoring system would be installed, to warn operators (via flashing light, audible alarm, short message service (SMS) etc) when vibration levels are approaching the cosmetic damage objective.

6.2.2 Building condition surveys

Prior to the commencement of vibration intensive work, existing condition surveys would be undertaken on all properties and structures within 100 metres from the nearest impact piling location.

6.2.3 Equipment selection and maintenance

Impact hammer size and maximum drop height would be selected taking into account the safe working distances and the distance between the area of construction and the most affected sensitive receiver.

The use of less vibration intensive methods of construction or equipment would be considered where feasible and reasonable when working in proximity to existing structures.

Equipment would be maintained and operated in an efficient manner, in accordance with manufacturer's specifications, to reduce the potential for adverse vibration impacts.

6.2.4 Works scheduling

Wherever feasible and reasonable, vibration intensive works at locations where high vibration levels are generated at sensitive receivers should be scheduled during less sensitive times of the day eg 9:00 am to 5:00 pm or as determined through community consultation.

7.0 Conclusion

AECOM has conducted an assessment of noise and vibration impacts of works associated with the replacement of the Camp Street Bridge on Camp Street, Forbes, NSW.

The scope of the assessment included noise measurement surveys of existing background noise levels, establishment of noise and vibration criteria, noise and vibration model predictions for construction scenarios and a noise and vibration impact assessment relative to appropriate criteria.

This impact assessment considered the impact of noise and vibration on nearby noise sensitive receivers during the worst case construction scenarios. The noise and vibration assessment was carried out in accordance with NSW regulatory requirements which results in addressing the assessment as follows:

Construction noise and vibration

The construction noise assessment was conducted in accordance with EPA's Interim Construction Noise Guideline and the Road and Maritime Services' Construction Noise and Vibration Guideline. The typical worst case construction scenarios have been considered. The noise assessment associated with the works indicates a number of exceedances of the ICNG noise management levels at nearby residential receivers. The level and number of exceedances are provided in section 4.1.2 and in Appendix D. The most affected receivers are located along Hill Street, Barwin Street and Bridge Street.

Noise mitigation measures have been recommended to mitigate the construction noise impact at adjacent sensitive (residential) receivers. The measures include:

- Standard mitigation measures;
- Notification for the potentially affected residents; and
- Verification of construction noise levels.

Safe working distances for vibration intensive construction works have been presented. Impact piling may encroach safe working distances. It is recommended that site specific safe working distances be determined after attended measurements are completed during initial works. Building condition surveys may also be required. All other vibration intensive works are unlikely to encroach the safe working distances.

Construction road traffic noise

The road traffic noise associated with construction activities and the two detour routes was assessed in accordance with EPA's Road Noise Policy.

The road traffic noise assessment indicates compliance with the RNP as the noise increase on detour routes is predicted to be less than 2 dB.

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Appendix A

Acoustic Terminology

Appendix A Acoustic Terminology

The following is a brief description of acoustic terminology used in this report.

Sound power level	The total sound emitted by a source.
Sound pressure level	The amount of sound at a specified point.
Decibel, dB	The measurement unit of sound.
A Weighted decibels, dB(A)	The A weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4 kHz) which the human ear is most sensitive to, and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A).
Decibel scale	The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume. Examples of decibel levels of common sounds are as follows:

0dB(A)	Threshold of human hearing
30dB(A)	A quiet country park
40dB(A)	Whisper in a library
50dB(A)	Open office space
70dB(A)	Inside a car on a freeway
80dB(A)	Outboard motor
90dB(A)	Heavy truck pass-by
100dB(A)	Jackhammer/Subway train
110 dB(A)	Rock Concert
115dB(A)	Limit of sound permitted in industry
120dB(A)	747 take off at 250 metres

Frequency, Hz	The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high pitched sound and a low frequency to a low pitched sound.
Equivalent continuous sound level, L_{eq}	The constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy.
L_{max}	The maximum sound pressure level measured over the measurement period.
L_{min}	The minimum sound pressure level measured over the measurement period.
L_{10}	The sound pressure level exceeded for 10% of the measurement period. For 10% of the measurement period it was louder than the L_{10}.

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}.
Ambient noise	The all-encompassing noise at a point composed of sound from all sources near and far.
Background noise	The underlying level of noise present in the ambient noise when extraneous noise (such as transient traffic and dogs barking) is removed. The L_{90} sound pressure level is used to quantify background noise.
Traffic noise	The total noise resulting from road traffic. The L_{eq} sound pressure level is used to quantify traffic noise.
Day	The period from 0700 to 1800 h Monday to Saturday and 0800 to 1800 h Sundays and Public Holidays.
Evening	The period from 1800 to 2200 h Monday to Sunday and Public Holidays.
Night	The period from 2200 to 0700 h Monday to Saturday and 2200 to 0800 h Sundays and Public Holidays.
Assessment background level, ABL	The overall background level for each day, evening and night period for **each day** of the noise monitoring.
Rating background level, RBL	The overall background level for each day, evening and night period for the **entire length** of noise monitoring.
Weighted sound reduction index [R_w]	A single figure representation of the air-borne sound insulation of a partition based upon the R values for each frequency measured in a laboratory environment.

*Definitions of a number of terms have been adapted from Australian Standard AS1633:1985 *"Acoustics – Glossary of terms and related symbols"*, the EPA's NSW Noise Policy for Industry and Road Noise Policy.

Appendix B

Logging Locations

Camp Street Bridge Replacement - Logger and Alternative Route Map

Camp Street Bridge
Logging locations
Alternate Route

N
0 250 500 1,000 m

Appendix C

Logging Results

McFeeters Motor Museum - Newell Hwy Oxford Street Forbes - 12/10/17 - 26/10/17

Logger Setup

Logger Type: Rion NL52

Serial No : 553966

Address: 7 Oxford Street , Forbes

Location: Underneath Museum Sign

Facade / Free Field: Free Field

Environment: Noise environment dominated by road traffic from Newell Highway. Some light traffic noise from Oxford Street. Slight wind noise in nearby bushes. Cicadas barely audible.

Logger Setup Photo

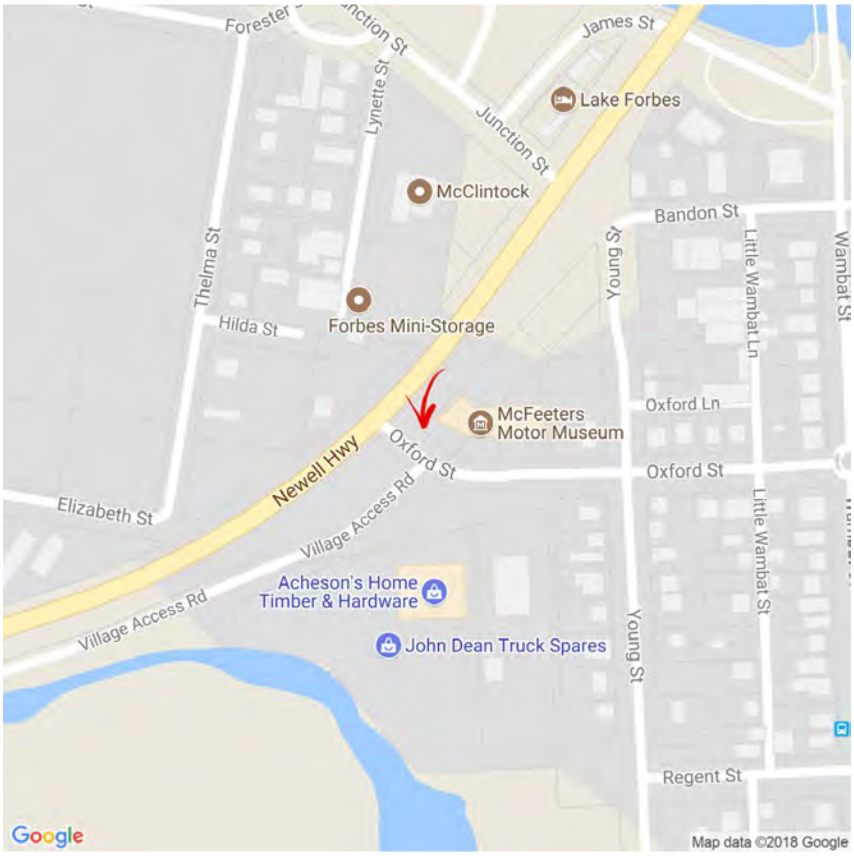
INP Noise Level, dB(A)

	Log Average	RBL
Day	58	39
Evening	58	42
Night	54	30

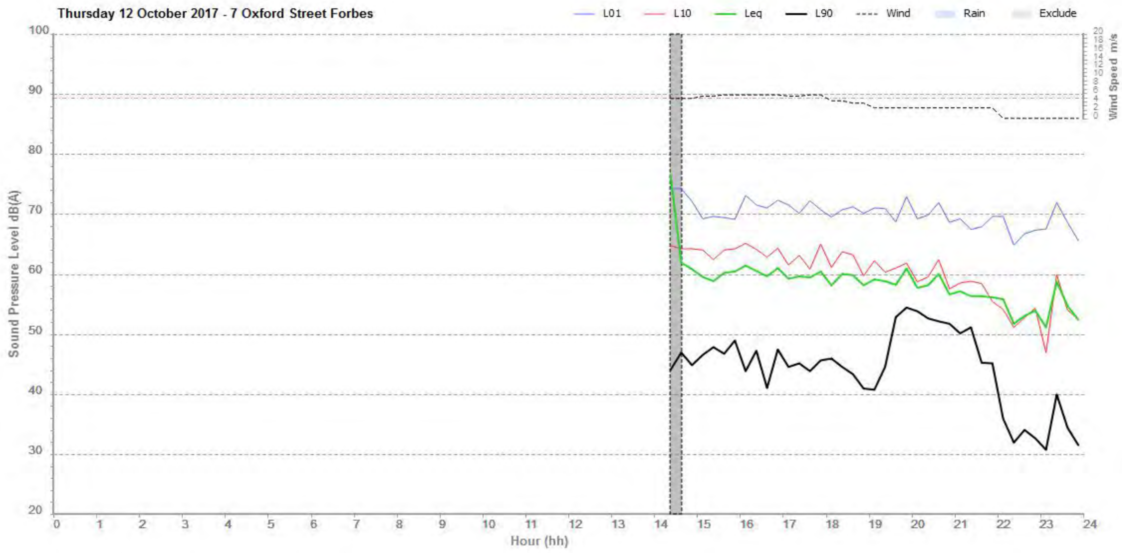
RNP Noise Level, dB(A)

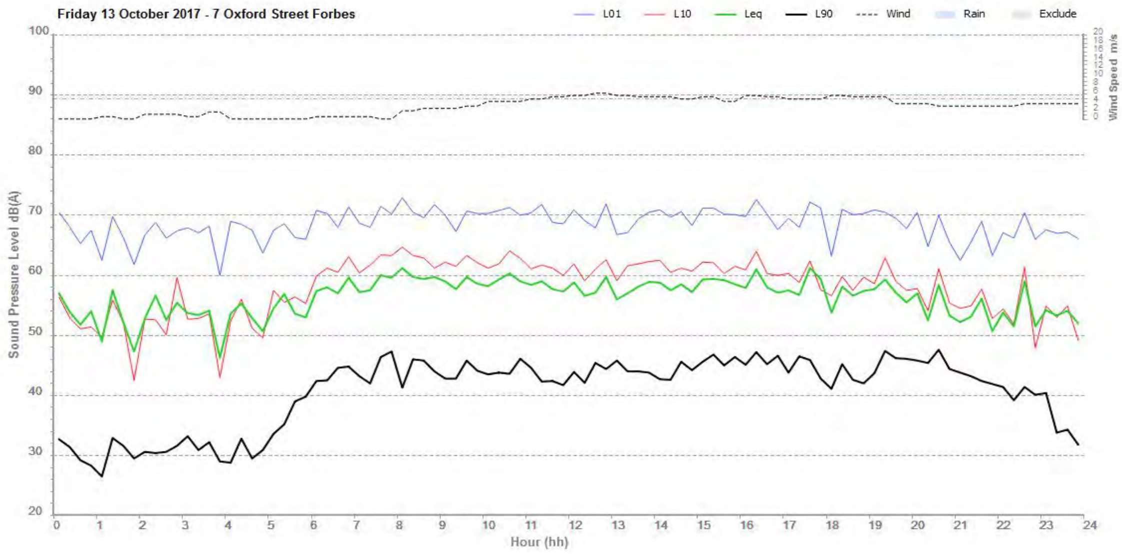
	$L_{Aeq(1hr)}$	$L_{Aeq(period)}$
Day (7am - 10 pm)	-	-
Night (10pm - 7am)	-	-

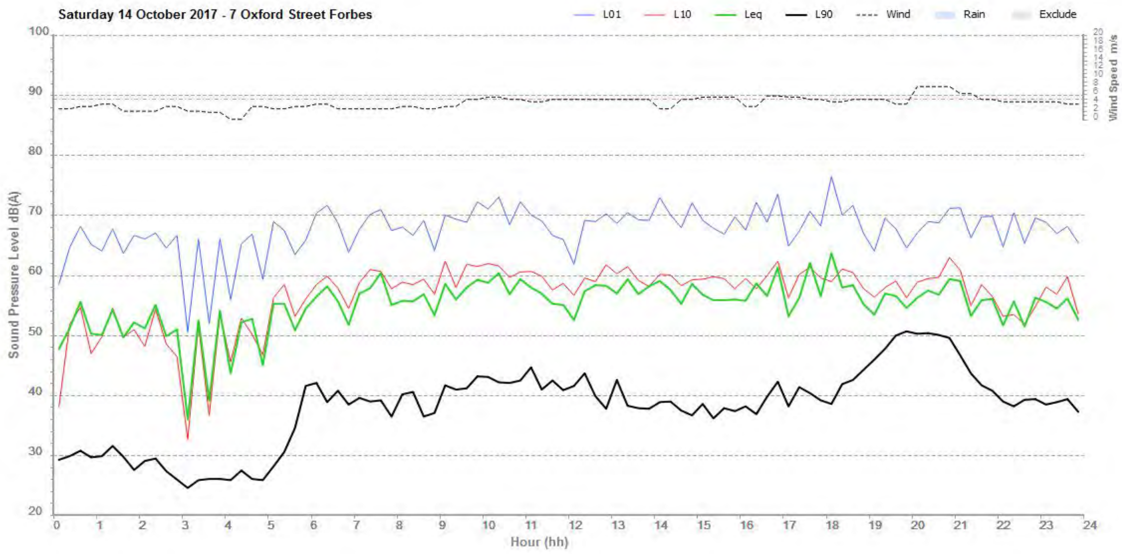
Logger Location Map



Logger Graphs







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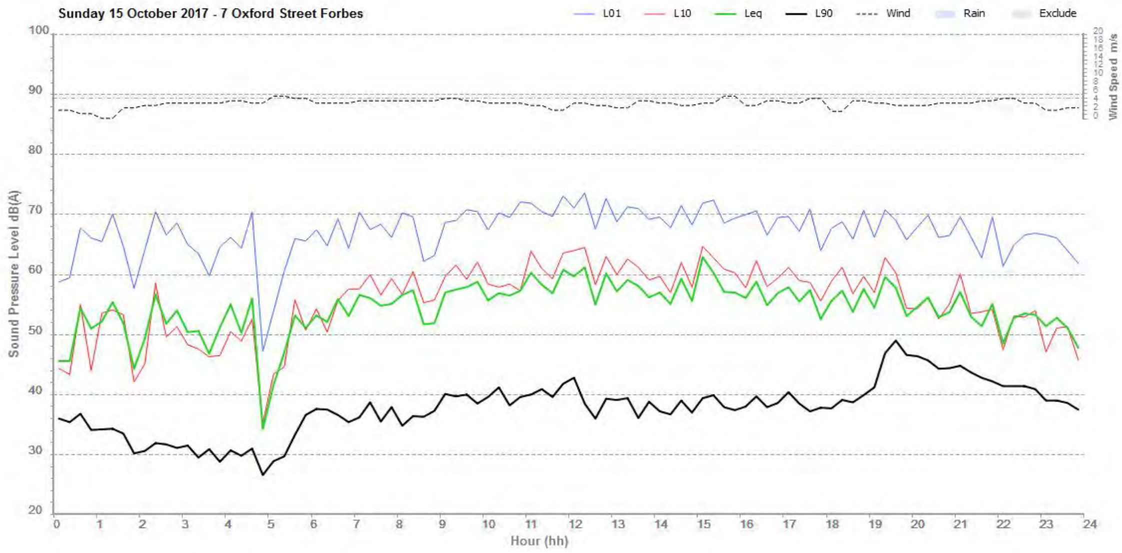

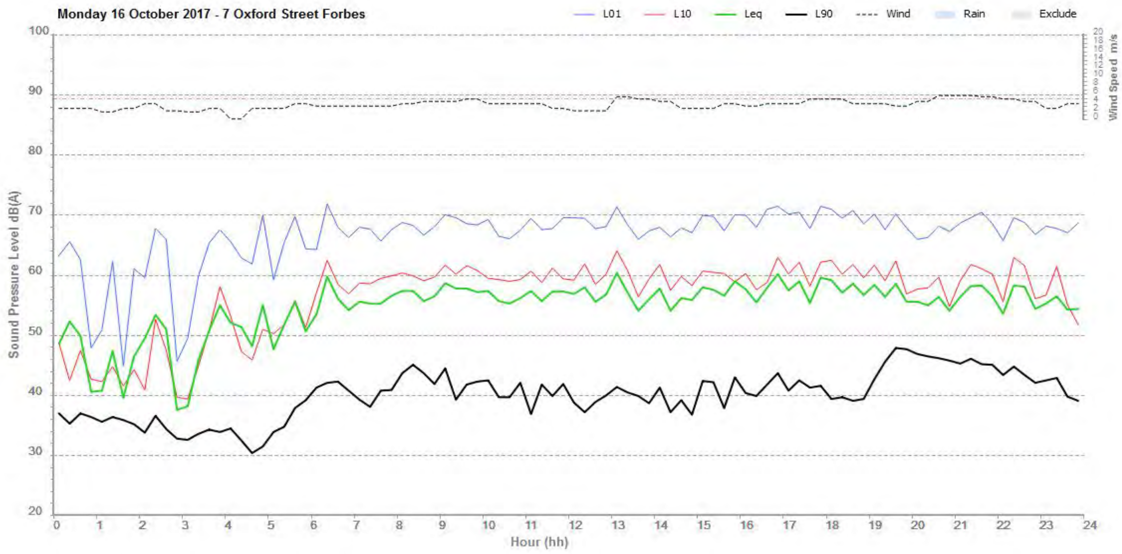

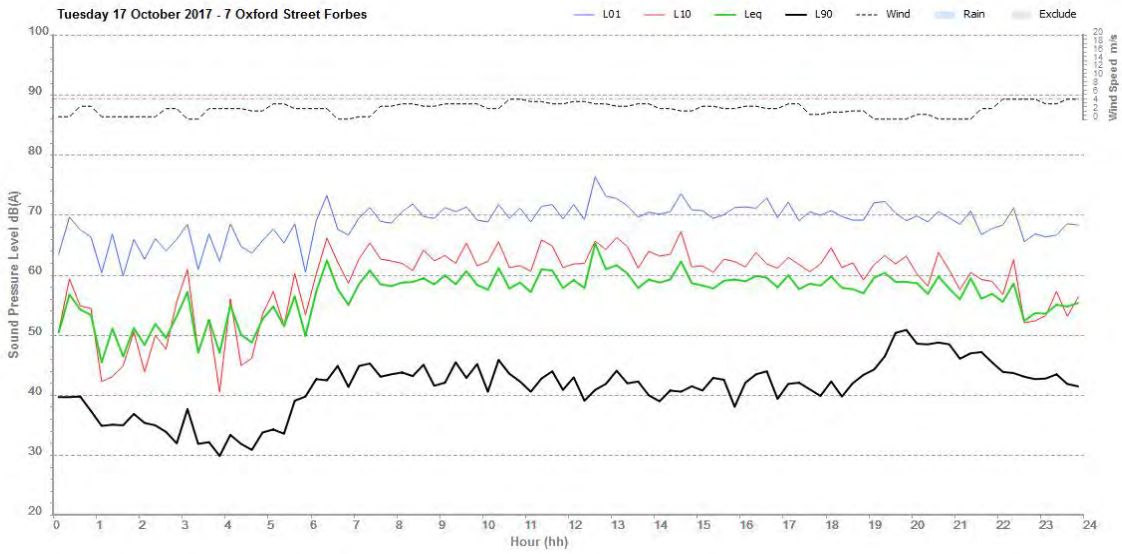

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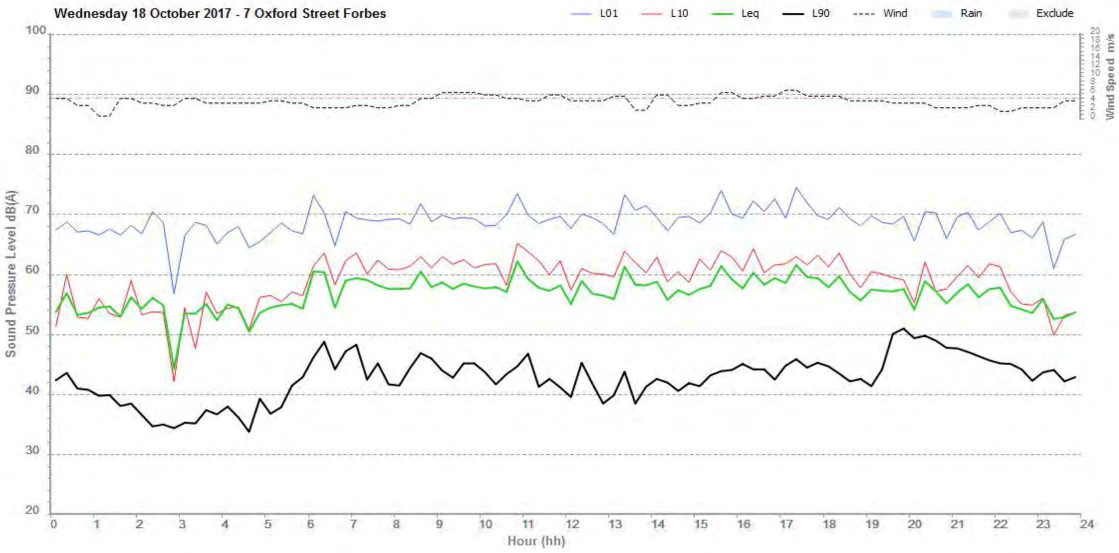

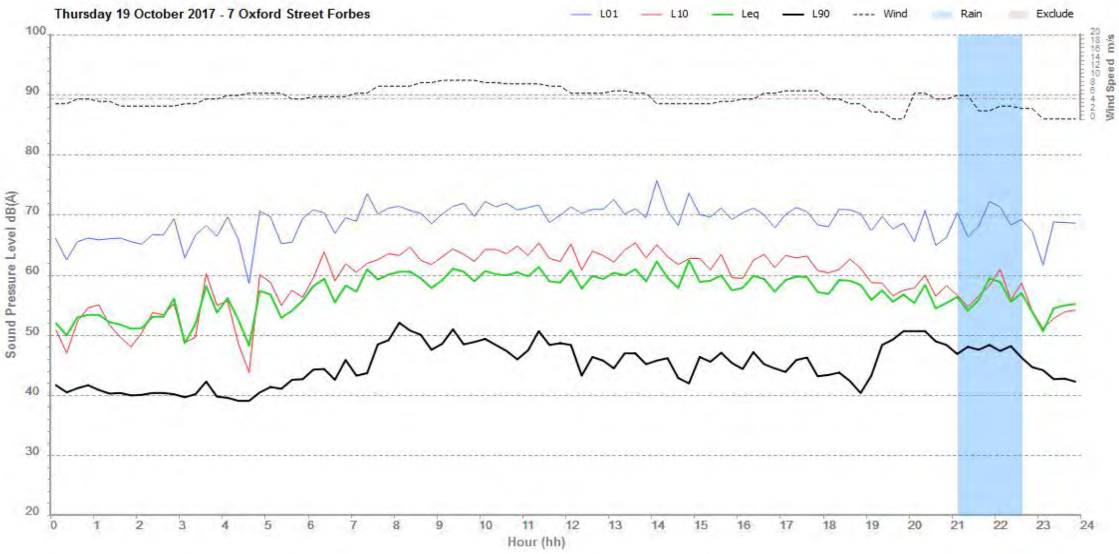

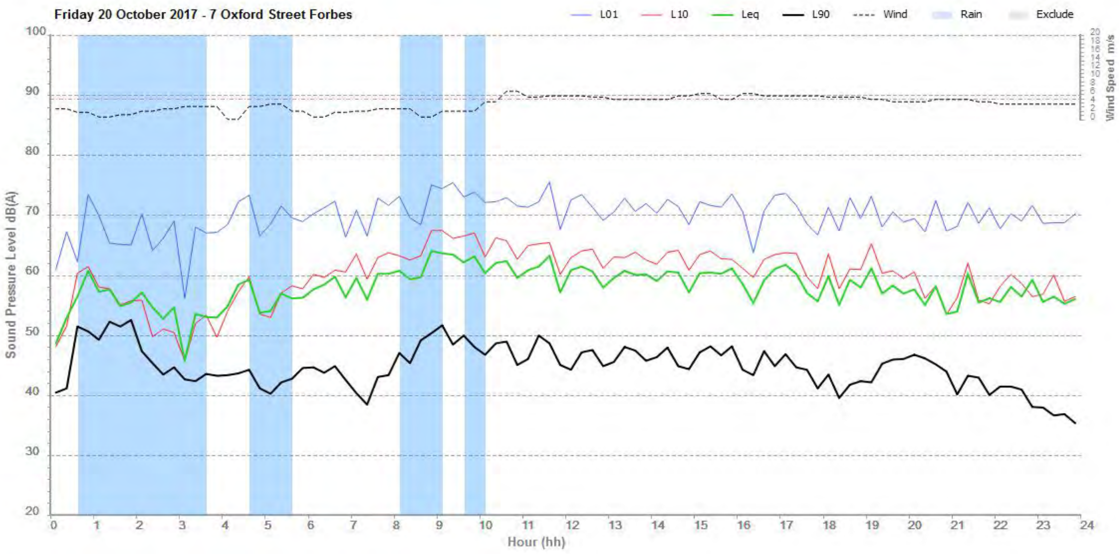

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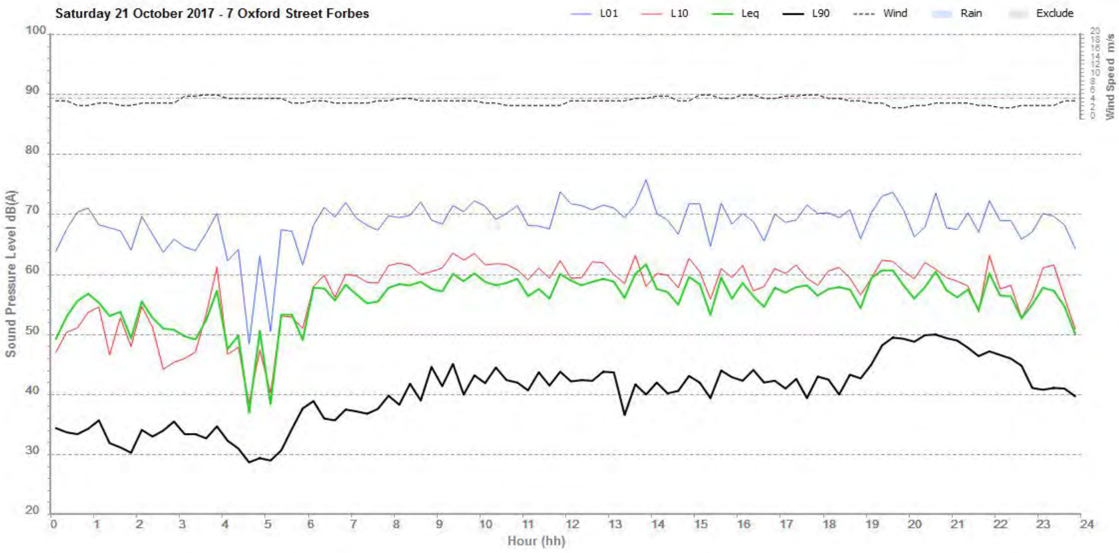

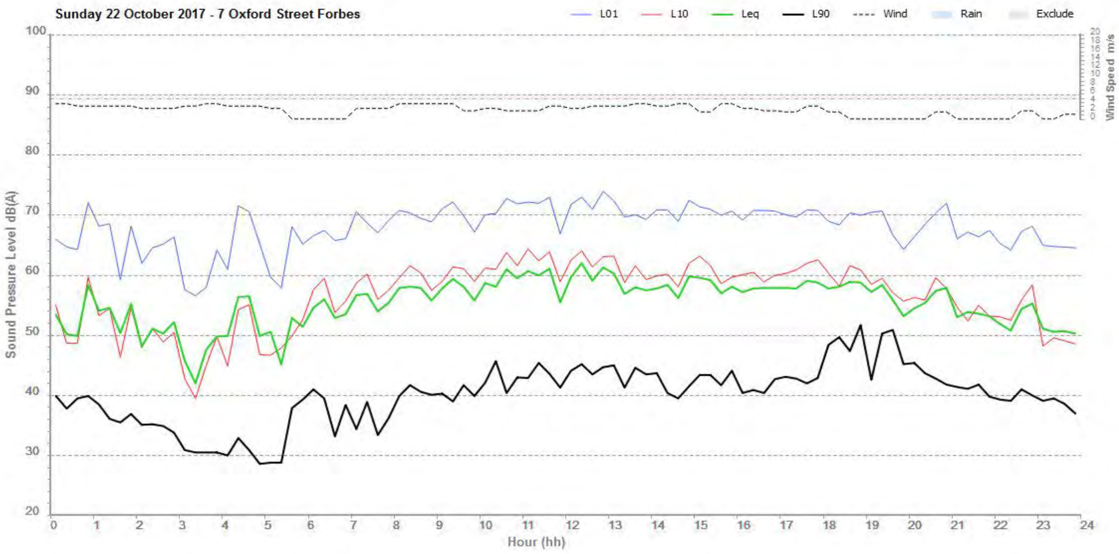

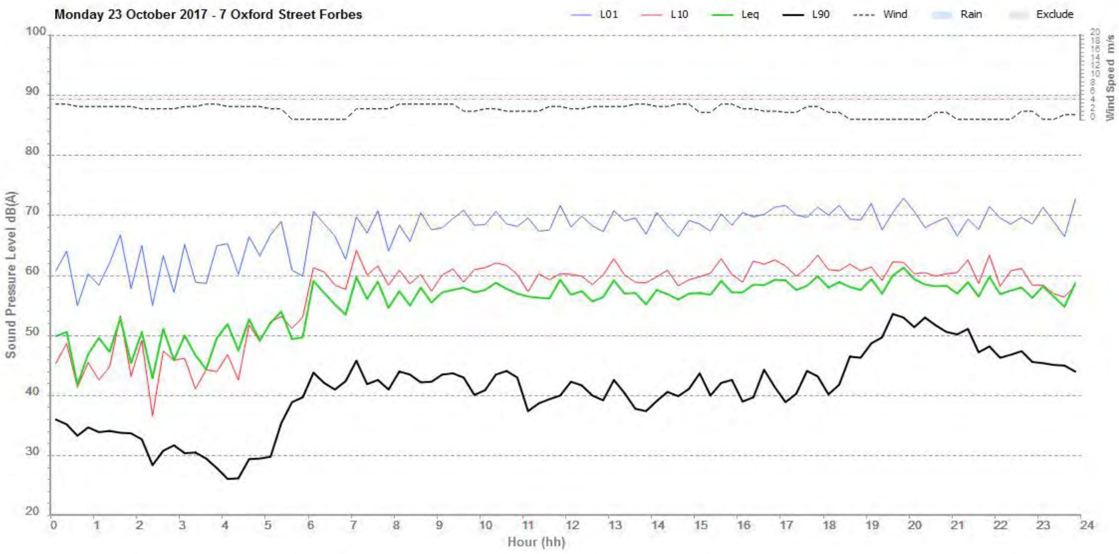

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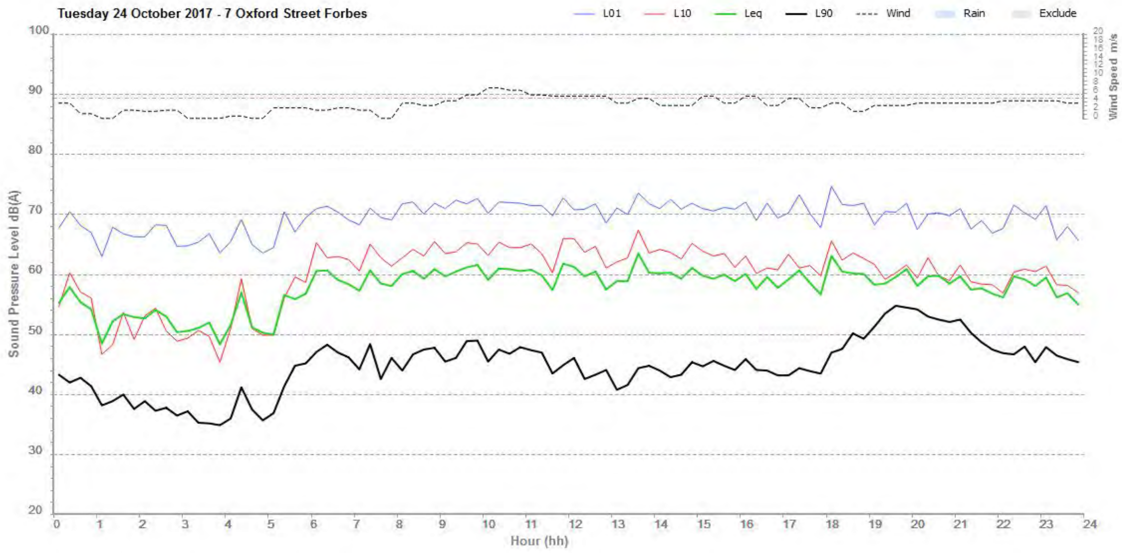
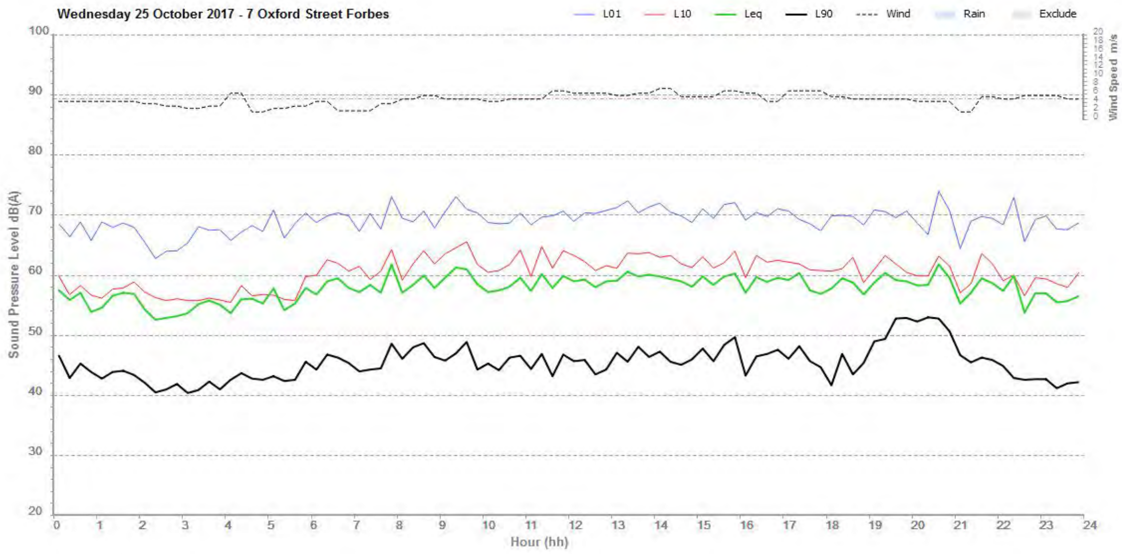
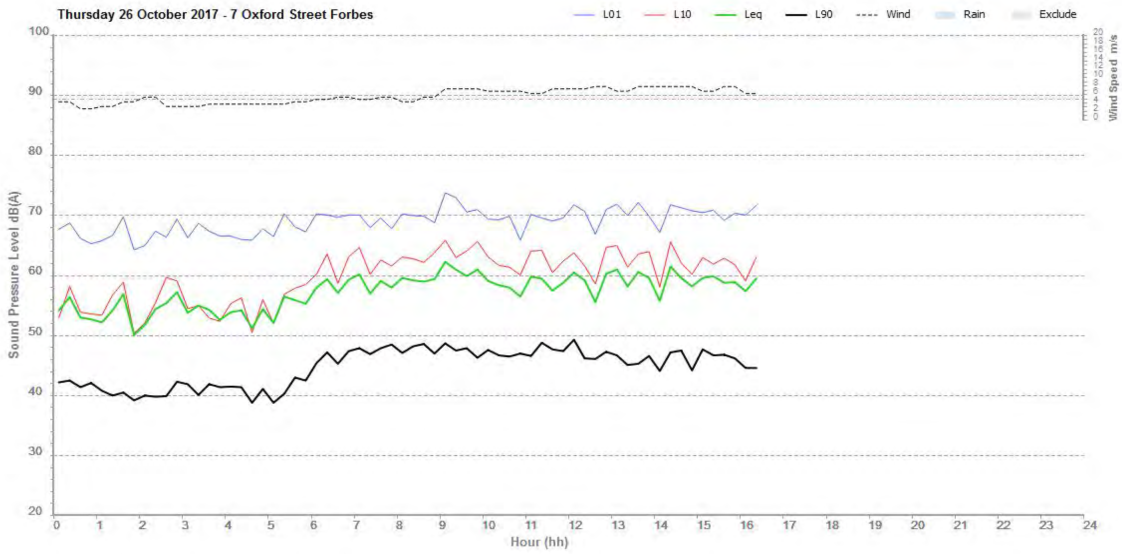






Apex Riverside Tourist Park - 88 Reymond Street Forbes - 12/10/17 - 26/10/17

Logger Setup

Logger Type: Rion NL52

Serial No : 1043455

Address: 88 Reymond St , Forbes

Location: On Fence

Facade / Free Field: Free Field

Environment: Moderate wind noise. Light road traffic noise from Reymond Street.

Logger Setup Photo

INP Noise Level, dB(A)

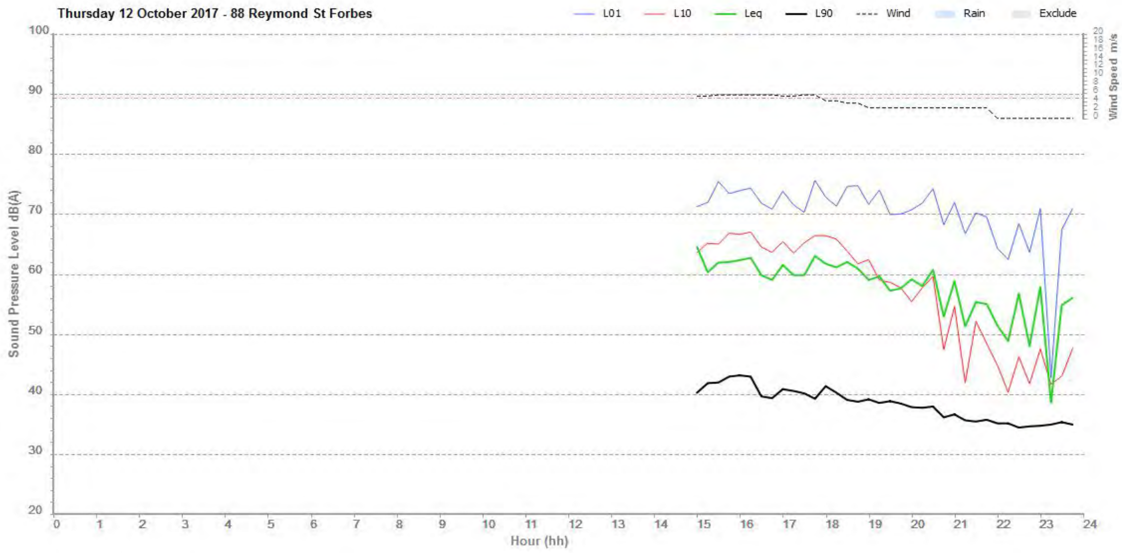
	Log Average	RBL
Day	62	38
Evening	58	38
Night	54	33

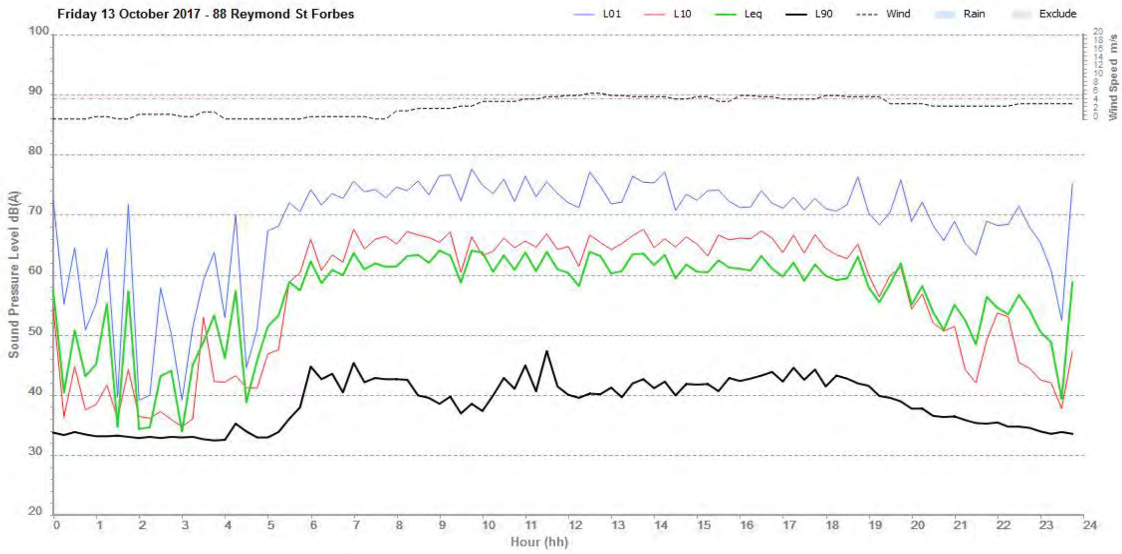
RNP Noise Level, dB(A)

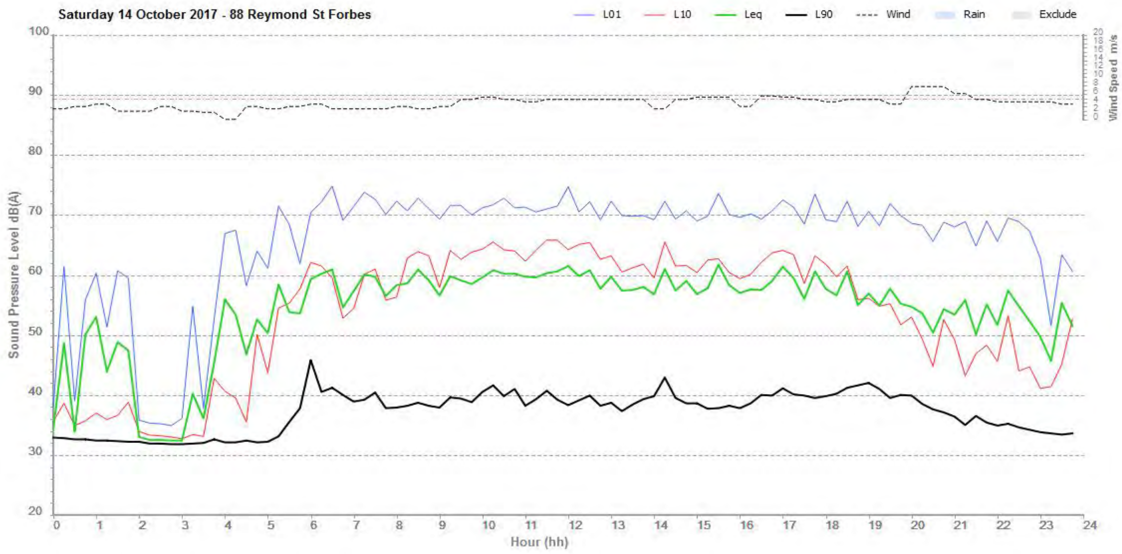
	$L_{Aeq(1hr)}$	$L_{Aeq(period)}$
Day (7am - 10 pm)	-	-
Night (10pm - 7am)	-	-

Logger Location Map

Logger Graphs







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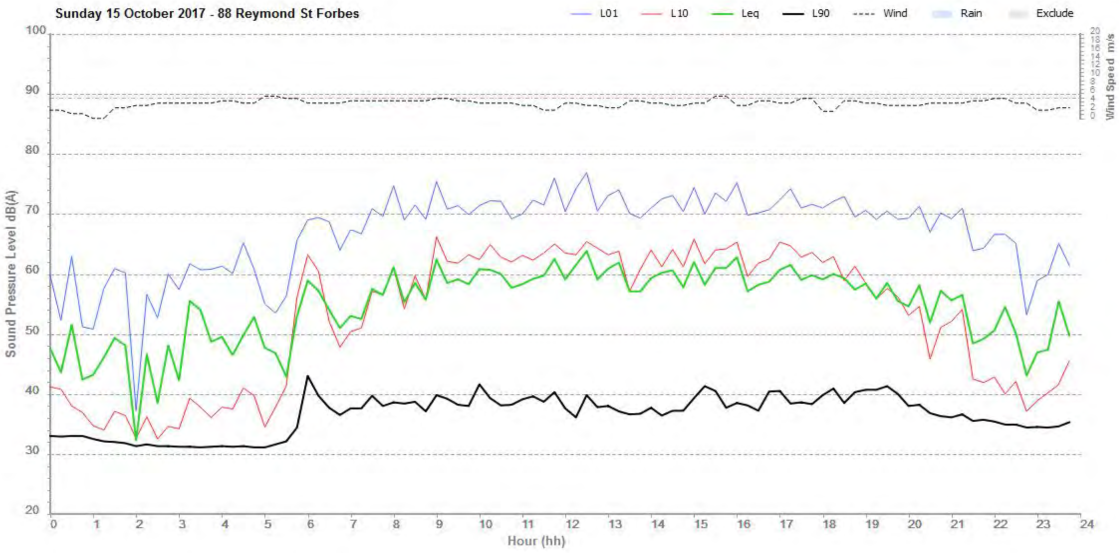

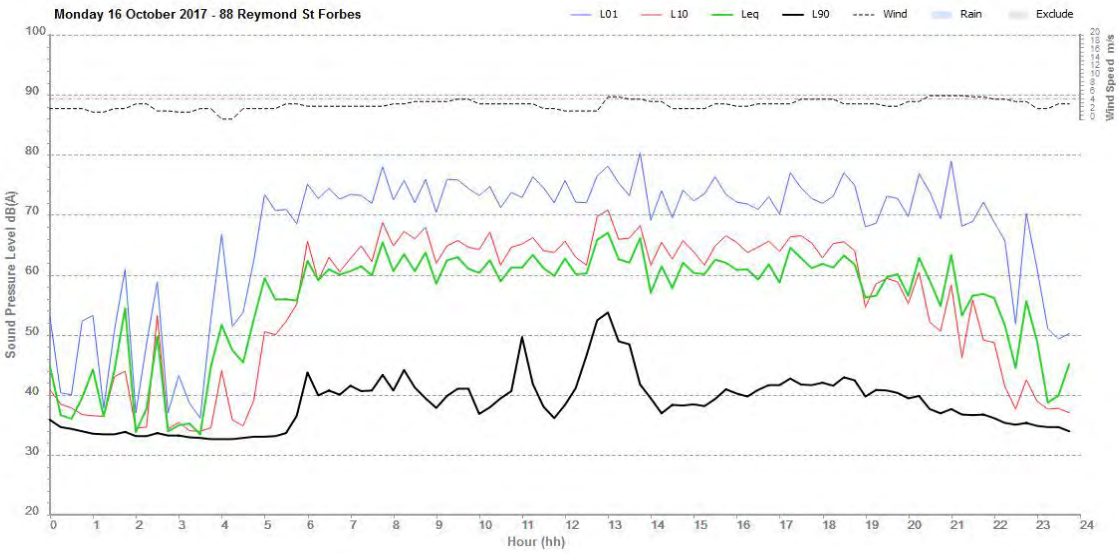

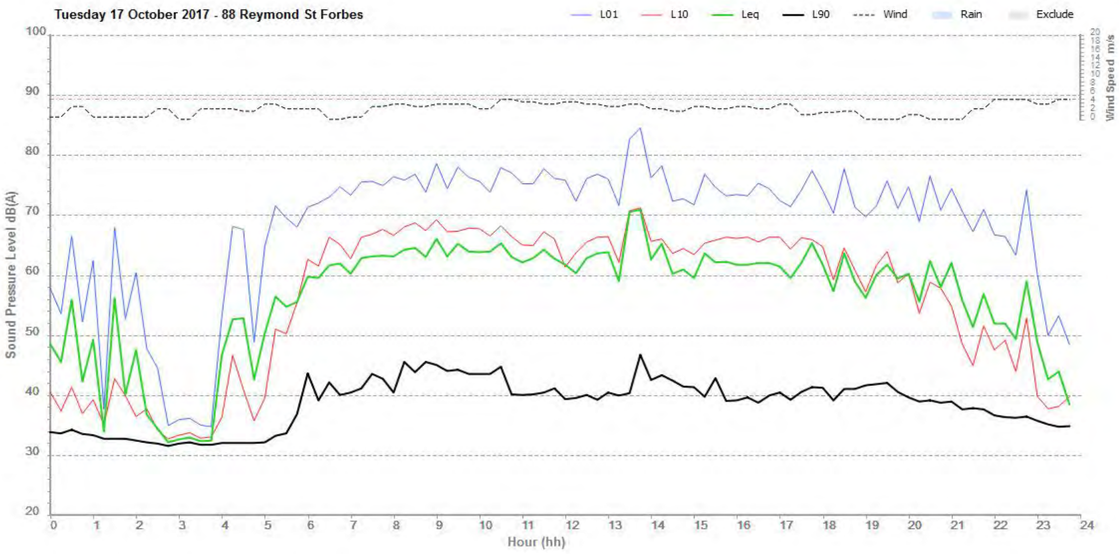

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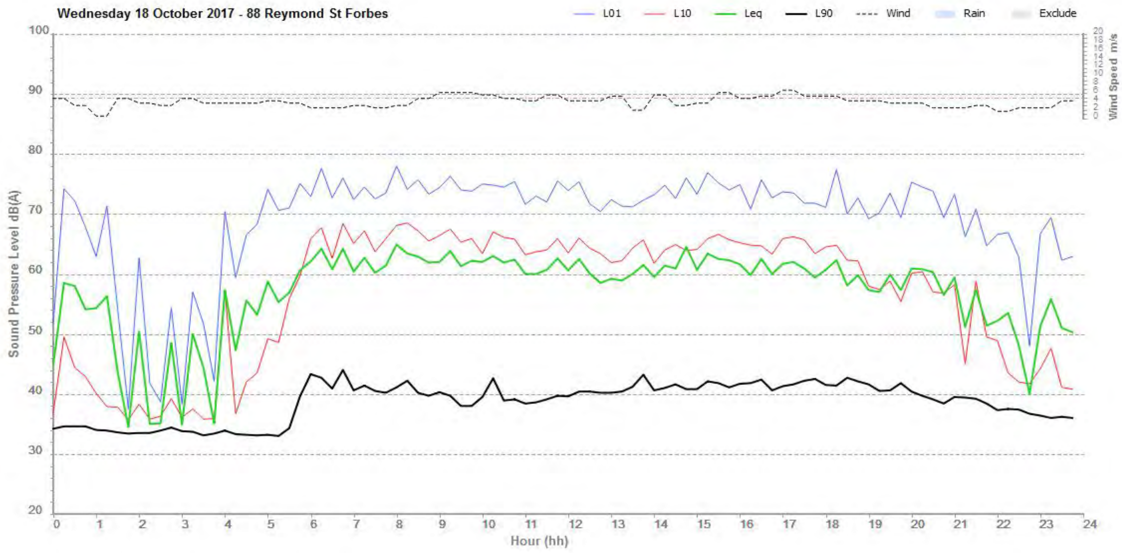

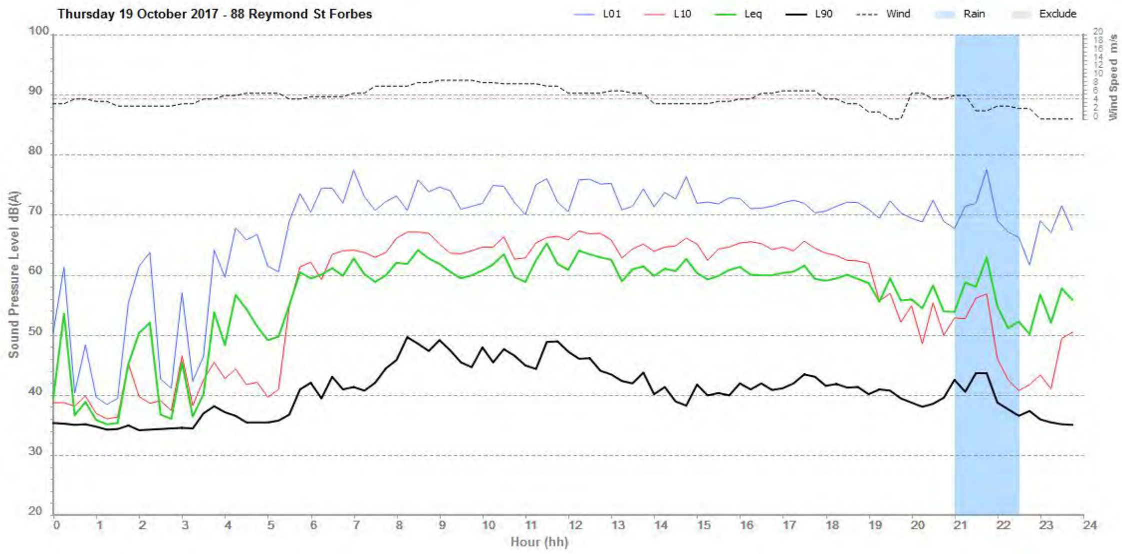

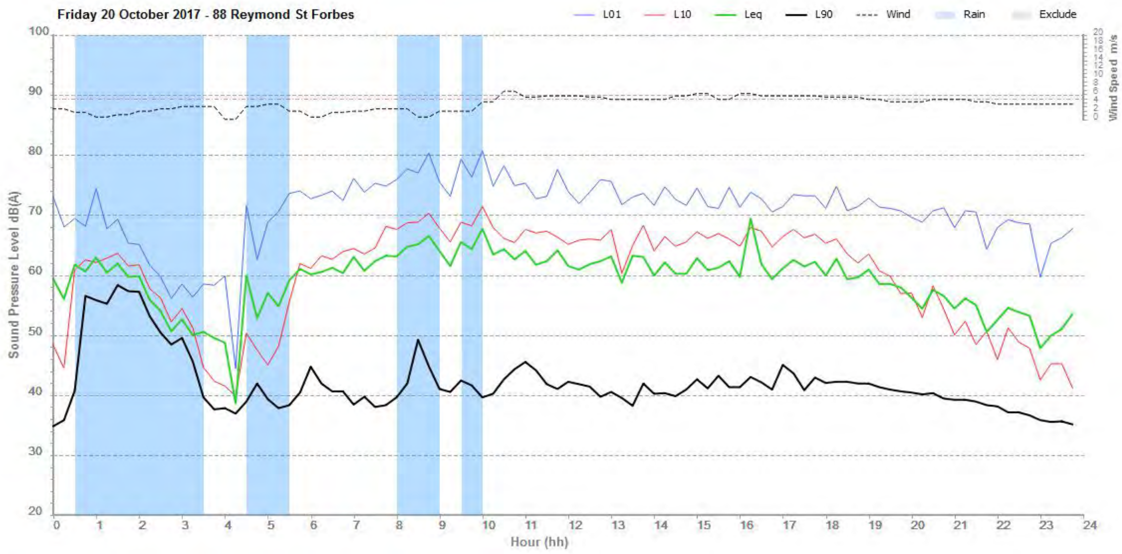

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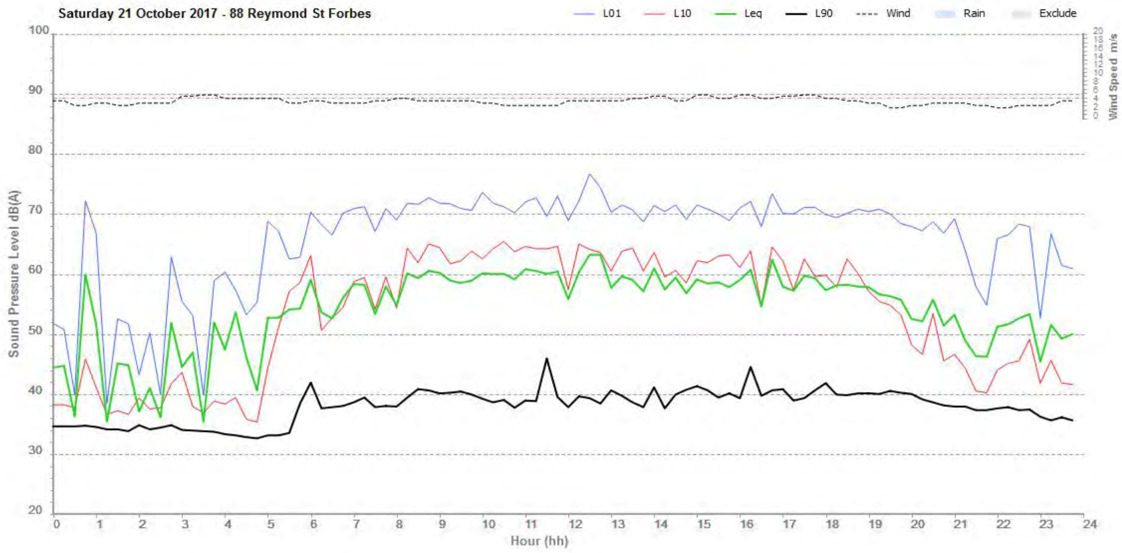

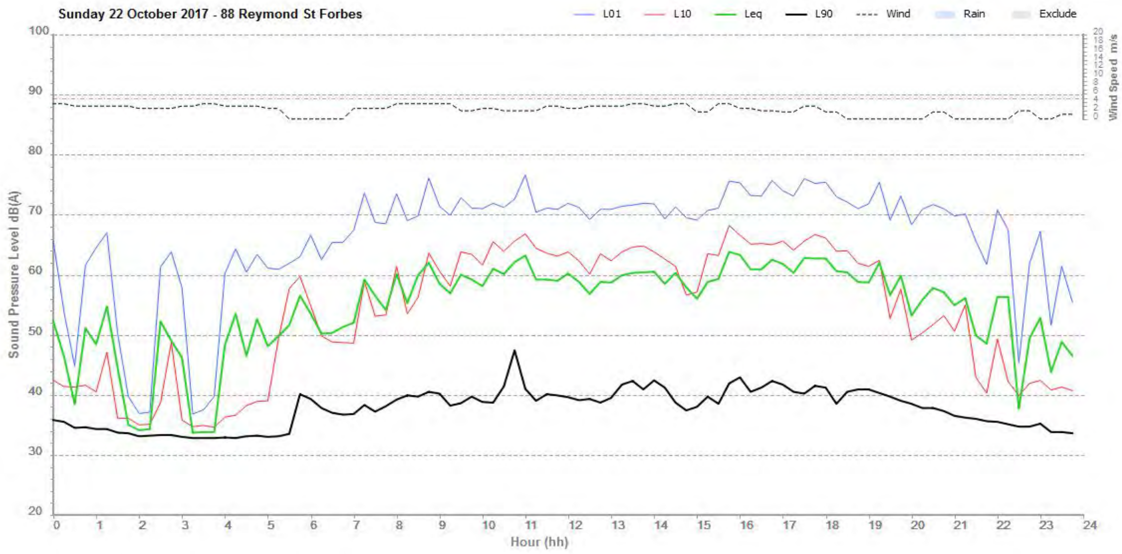

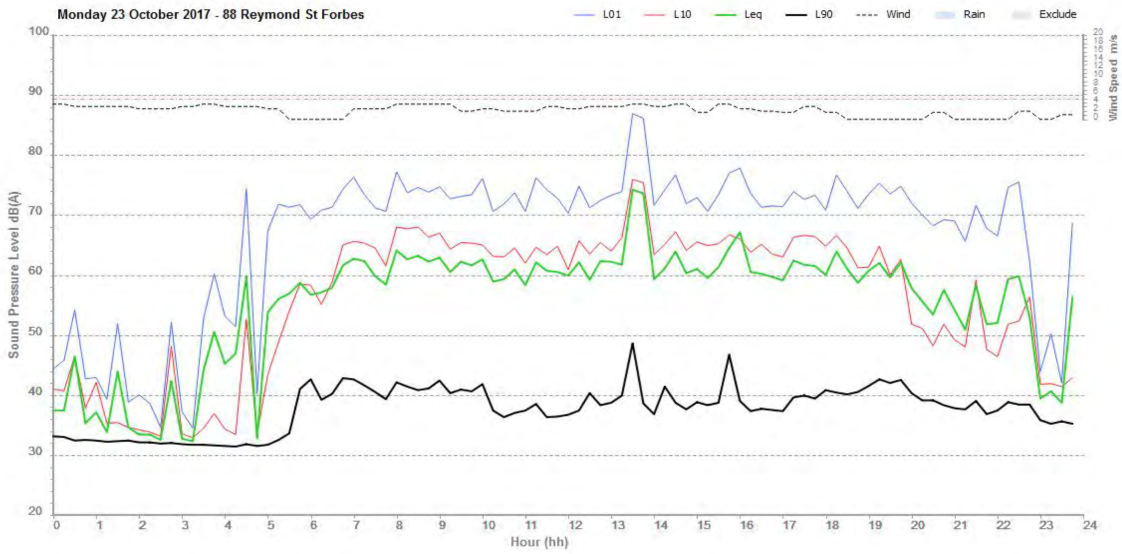

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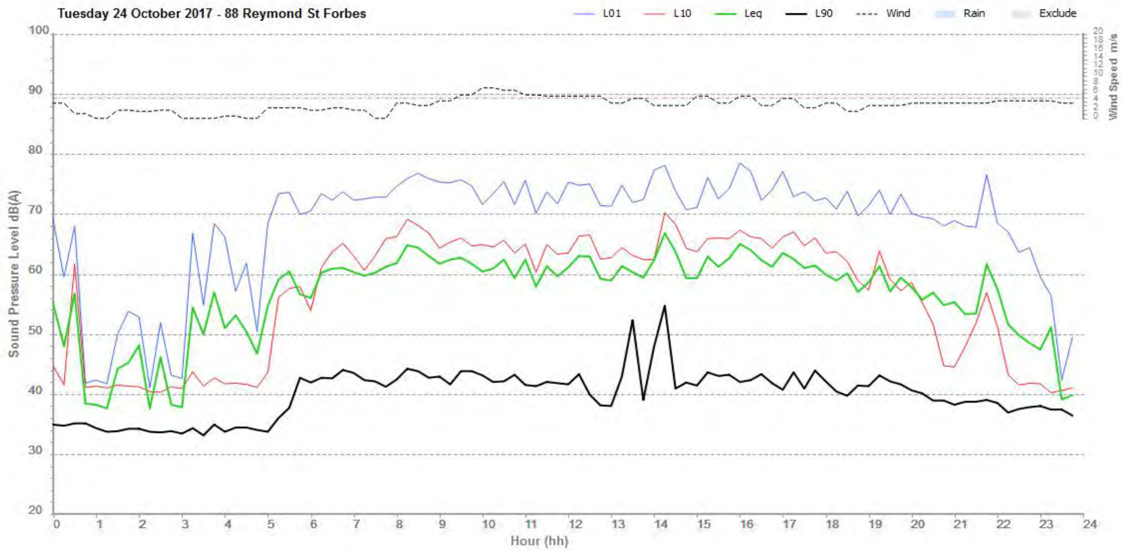
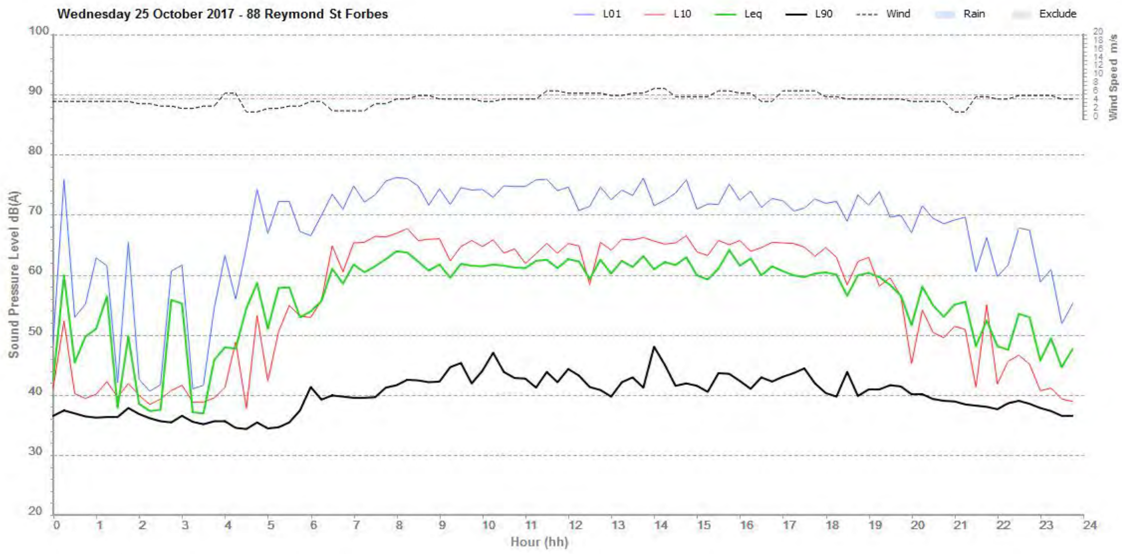
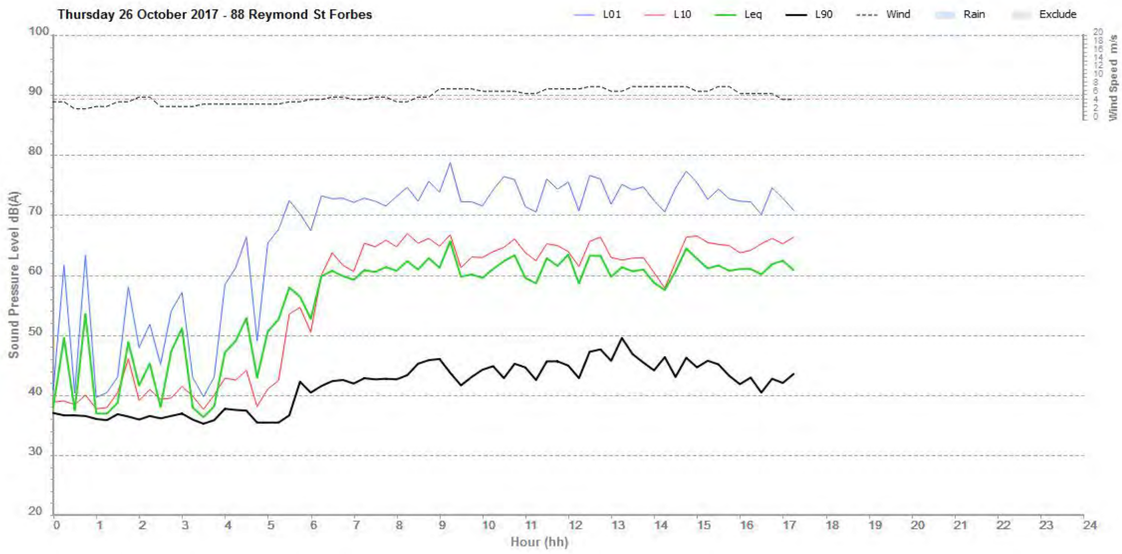
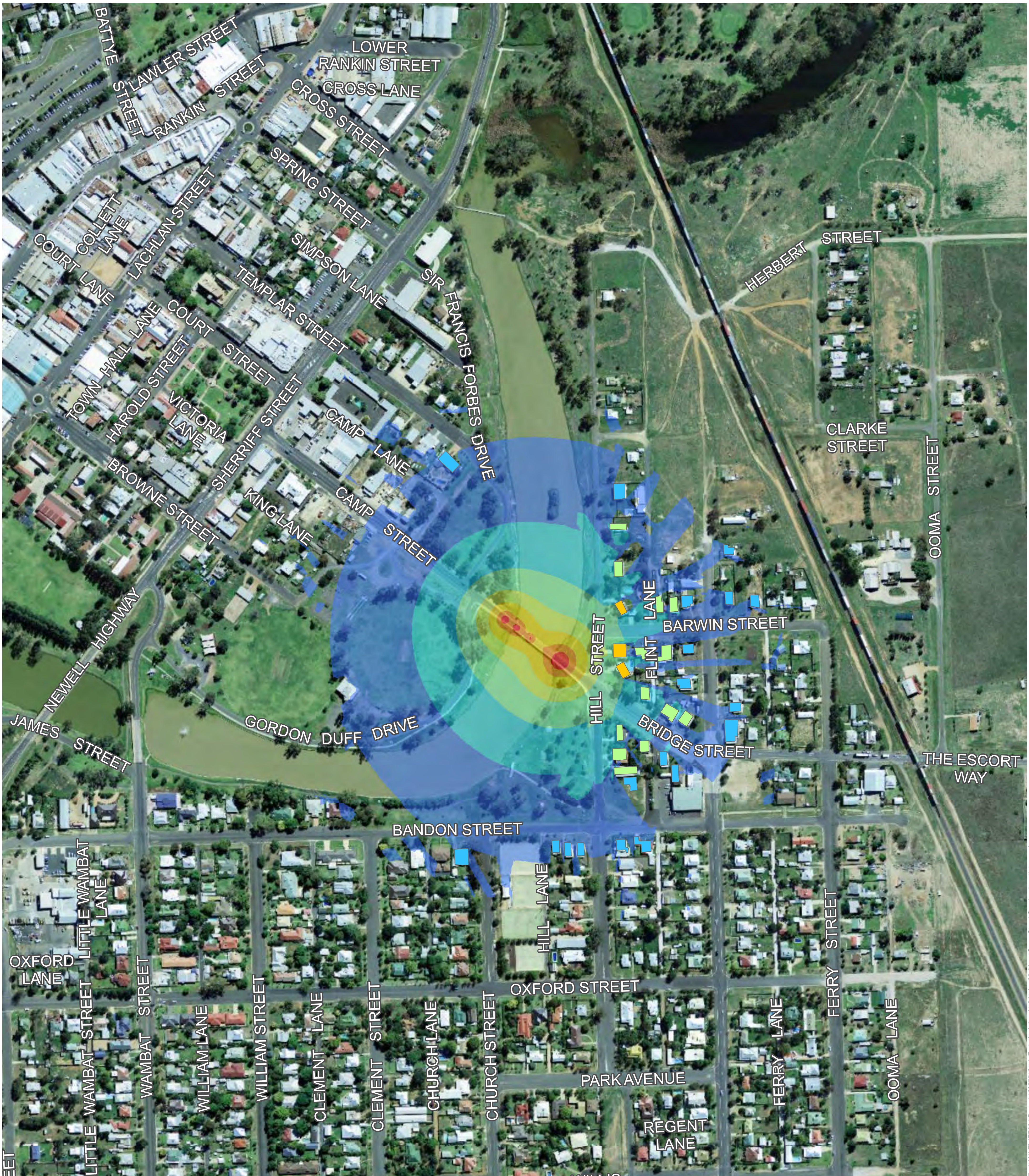






Appendix D

Construction Noise Contours



Camp Street Bridge Replacement - Stage 1

AECOM

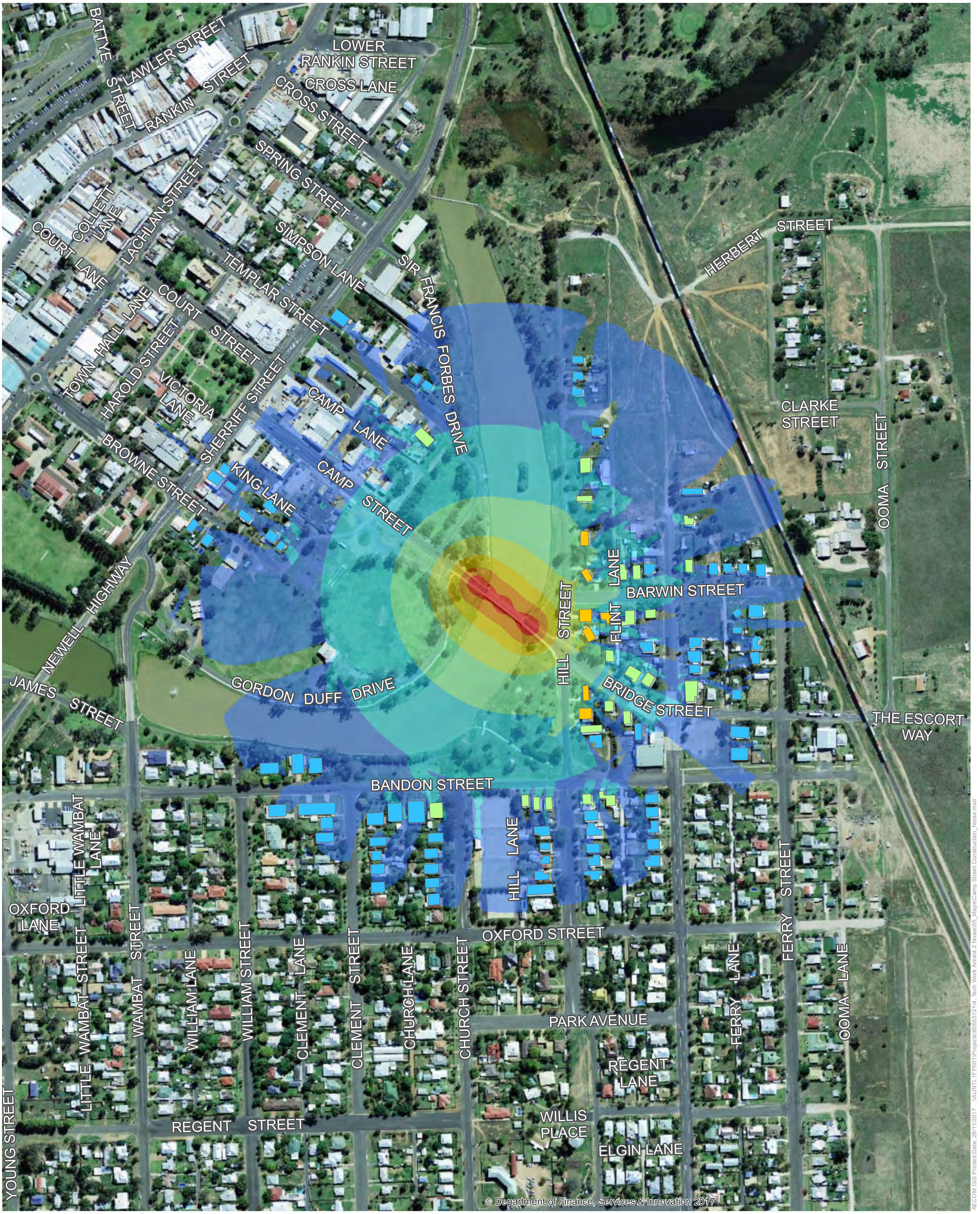
N 0 25 50 100 m

Sound Pressure Level, L_{Aeq} dB(A)

50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
> 80

Exceedance of NML

1 - 5
6 - 10
11 - 20



Camp Street Bridge Replacement - Stage 2

AECOM

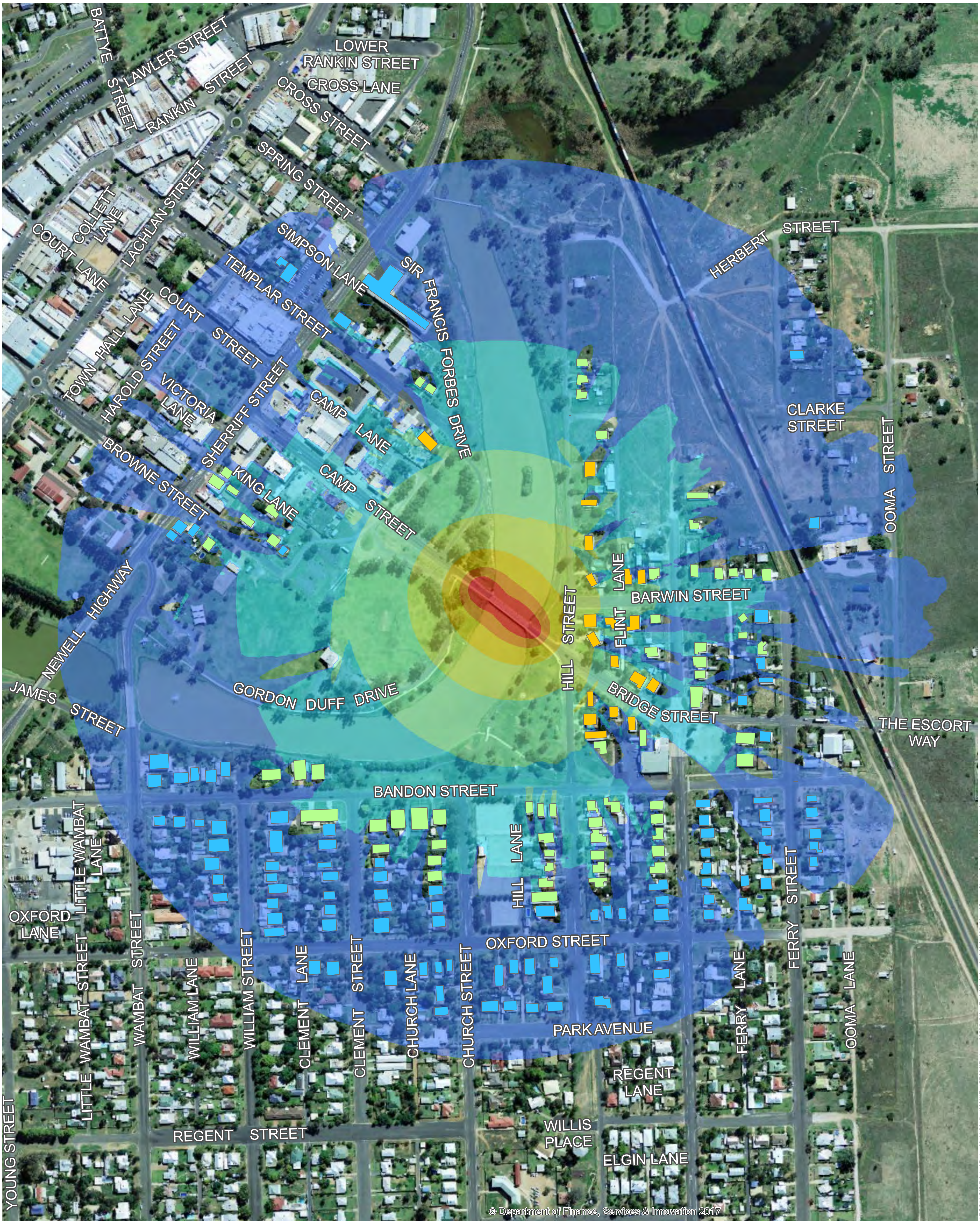
0 25 50 100 m

Sound Pressure Level, L_{Aeq} dB(A)

50 - 55, 55 - 60, 60 - 65, 65 - 70, 70 - 75, 75 - 80, > 80

Exceedance of NML

1 - 5
6 - 10
11 - 20



Camp Street Bridge Replacement - Stage 3

AECOM

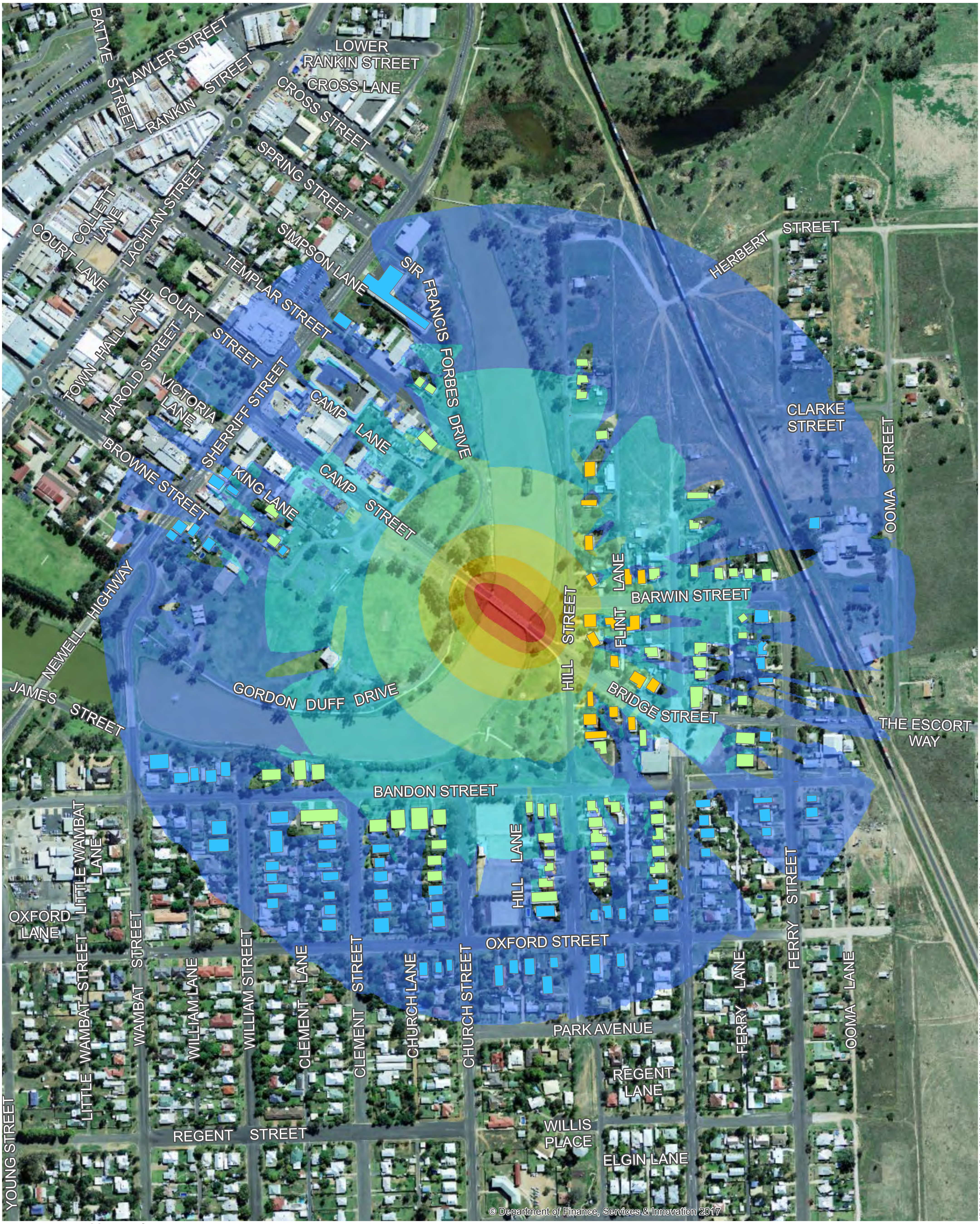
0 25 50 100 m

Sound Pressure Level, L_{Aeq} dB(A)

50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
> 80

Exceedance of NML

1 - 5
6 - 10
11 - 20



Camp Street Bridge Replacement - Stage 4

AECOM

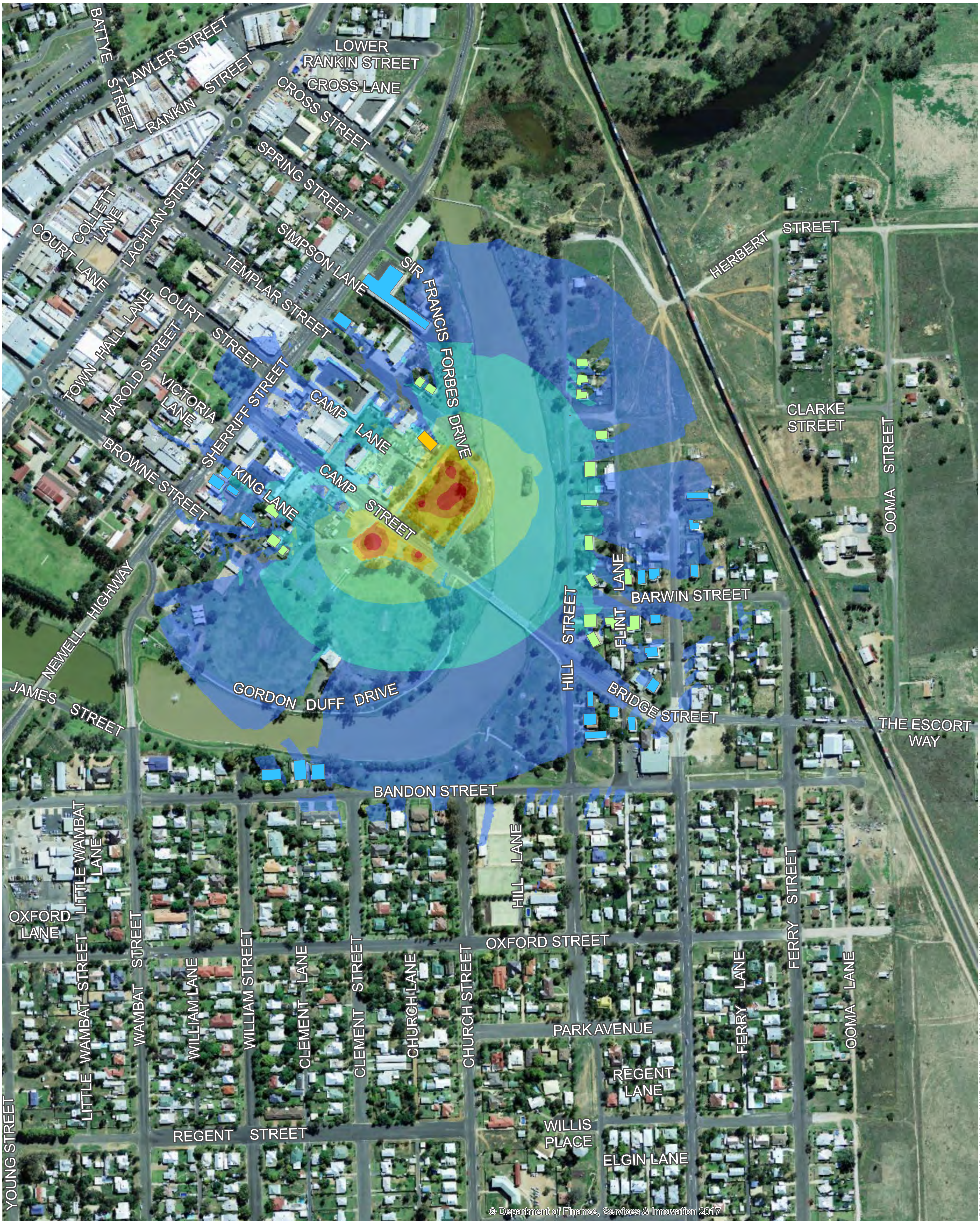
N 0 25 50 100 m

Sound Pressure Level, L_{Aeq} dB(A)

50 - 55, 55 - 60, 60 - 65, 65 - 70, 70 - 75, 75 - 80, > 80

Exceedance of NML

1 - 5
6 - 10
11 - 20



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Camp Street Bridge Replacement - Compound

AECOM

N 0 25 50 100 m

Sound Pressure Level, L_{Aeq} dB(A)

50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
> 80

Exceedance of NML

< 0
1 - 5
6 - 10
11 - 20

Appendix E

Standard Mitigation Measures

Appendix E Standard Mitigation Measures

Action required	Applies to	Details
Management Measures		
Implement community consultation or notification measures	Airborne noise	Notification detailing work activities, dates and hours, impacts and mitigation measures, indication of work schedule over the night time period, any operational noise benefits from the works (where applicable) and contact telephone number. Notification should be a minimum of 7 calendar days prior to the start of works. For projects other than maintenance works more advanced consultation or notification may be required. Please contact Roads and Maritime Communication and Stakeholder Engagement for guidance. Website (If required) Contact telephone number for community Email distribution list (if required) Community drop in session (if required by approval conditions).
Site inductions	Airborne noise	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: • all relevant project specific and standard noise and vibration mitigation measures • relevant licence and approval conditions • permissible hours of work • any limitations on high noise generating activities • location of nearest sensitive receivers • construction employee parking areas • designated loading/unloading areas and procedures • site opening/closing times (including deliveries) • environmental incident procedures.
Behavioural practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors.
Verification	Airborne noise	Where specified a noise verification program is to be carried out for the duration of the works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.

Action required	Applies to	Details
Source Controls		
Construction hours and scheduling.	Airborne noise	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods.[1] This should be confirmed through community consultation as restricted hours may lead to an overall longer construction program.
Construction respite period during normal hours and out-of-hours work	Airborne noise	As a guide high noise and vibration generating activities[1] near receivers should be carried out in continuous blocks that do not exceed 3 hours each, with a minimum respite period of one hour between each block. The duration of each block of work and respite should be flexible to accommodate the usage and amenity at nearby receivers. As noted above this should be confirmed through community consultation.
Equipment selection	Airborne noise	Use quieter and less vibration emitting construction methods where feasible and reasonable. Ensure plant including the silencer is well maintained.
Plant noise levels	Airborne-noise	The noise levels of plant and equipment must have operating Sound Power or Sound Pressure Levels compliant with the criteria in Appendix F1 of the Construction Noise and Vibration Guideline. Implement a noise monitoring audit program to ensure equipment remains within the more stringent of the manufacturers specifications or Appendix F1.
Rental plant and equipment	Airborne-noise	The noise levels of plant and equipment items are to be considered in rental decisions and in any case cannot be used on site unless compliant with the criteria in Appendix F1 of the Construction Noise and Vibration Guideline.
Use and siting of plant	Airborne-noise	Simultaneous operation of noisy plant within discernible range of a sensitive receiver is to be avoided. The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Noise-emitting plant to be directed away from sensitive receivers. Only have necessary equipment on site.

[1] High noise and vibration generating activities include sheet and pile driving and rock hammering and breaking

Action required	Applies to	Details
Plan worksites and activities to minimise noise and vibration.	Airborne noise	Locate compounds away from sensitive receivers and discourage access from local roads. Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site. Where additional activities or plant may only result in a marginal noise increase and speed up works, consider limiting duration of impact by concentrating noisy activities at one location and move to another as quickly as possible.
Reduced equipment power	Airborne noise	Use only the necessary size and power.
Non-tonal and ambient sensitive reversing alarms	Airborne noise	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work. Consider the use of ambient sensitive alarms that adjust output relative to the ambient noise level.
Minimise disturbance arising from delivery of goods to construction sites	Airborne noise	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers. Select site access points and roads as far as possible away from sensitive receivers. Dedicated loading/unloading areas to be shielded if close to sensitive receivers. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible. Avoid or minimise these out of hours movements where possible.
Path Controls		
Shield stationary noise sources such as pumps, compressors, fans etc	Airborne noise	Stationary noise sources should be enclosed or shielded whilst ensuring that the occupational health and safety of workers is maintained. Appendix F of AS 2436: 1981 lists materials suitable for shielding.
Shield sensitive receivers from noisy activities	Airborne noise	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.

rms.nsw.gov.au

contactus@rms.nsw.gov.au

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