HERITAGE AWARD NOMINATION

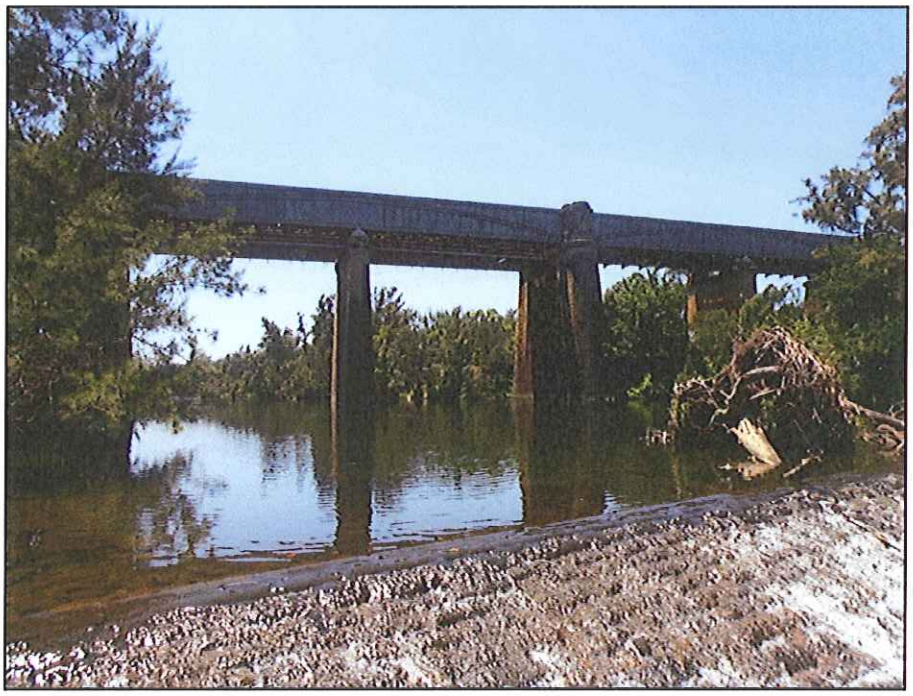
FOR THE

MENANGLE RAILWAY BRIDGE

MENANGLE, NSW

AS AN

Engineering Heritage National Landmark



Prepared by Ken Maxwell
for the
Engineering Heritage Committee
Engineers Australia, Sydney Division
February 2013

ENGINEERS
AUSTRALIA

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1. HERITAGE AWARD NOMINATION FORM

The Administrator
Engineering Heritage Australia
Engineers Australia
Engineering House
11 National Circuit
BARTON ACT 2600

Name of work: Menangle Railway Bridge over Nepean River

The above-mentioned work is nominated to be awarded an: Engineering Heritage National Landmark

Location, including address and map grid reference if a fixed work: Main South railway over the Nepean River at Menangle, NSW 2571. Latitude 34.11809°S Longitude 150.74364°E

Owner: Australian Rail Track Corporation Limited, 5/33 Newton Street, Broadmeadow NSW 2292

The owner has been advised of this nomination and a letter of agreement is contained in Section 2 of this Heritage Award Nomination Report.

Access to site: Public park (Menangle River Reserve), off Menangle Road, Menangle Park

Nominating Body: Sydney Engineering Heritage Committee

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Chair of Nominating Body

Date: 21/02/2013

.....

Chair of Divisional EHA Group

Date: .....

2. LETTER OF AGREEMENT FROM OWNER

AUSTRALIAN RAIL TRACK CORPORATION LTD

21 May 2012

Mr Simon Wiltshier
Chairman
Engineers Australia, Sydney Division
PO Box 1389
Chatswood
NSW 2065

Dear Mr Wiltshier

Re: Menangle Railway Bridge Engineers Australia Nomination for Heritage Recognition

Thank you for your letter regarding the nomination for recognition of the heritage value of the Menangle Railway Bridge.

The Australian Rail Track Corporation (ARTC) is happy to give in principal approval for the bridge to be nominated. Should the nomination succeed we would require more details on the exact location and fitting details of the plaque

Yours sincerely

Paul Samaras

Heritage Manager

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3. INTRODUCTION

Menangle Bridge is a wrought iron cellular through girder railway bridge, supported on a mixture of sandstone block and brick wall piers, across the Nepean River, 64 kilometres south west of Sydney on the Main South line to Melbourne.

This bridge is the oldest metal railway bridge in use in New South Wales and was the first large iron bridge constructed in the state railway network. It also has a dominant appearance in a rural landscape.

As such, this bridge is a heritage significant item of infrastructure and worthy of formal recognition as an Engineering Heritage National Landmark, based on the following:

- Design of Menangle Bridge was at the cutting edge of bridge technology, with design principles having been pioneered by Robert Stephenson in his Conwy Bridge (1849) over the River Conwy in Wales, UK.
- Only four bridges of its type were constructed in NSW and only two remain – the Menangle Bridge and Victoria Bridge at Penrith. The other two bridges were located on the Main South railway line over two separate crossings of the Wollondilly River north of Goulburn (superstructures removed following duplication of the railway on a new alignment onto brick arch viaducts in 1914).
- It was designed by John Whitton, the 'Father of the NSW Railways', and has direct design links back to Robert Stephenson, one of the great British civil engineers of the early to mid 19th century.
- The cellular (or tubular) girders in New South Wales had their origins in the famous tubular bridges of Robert Stephenson, being the Conwy Bridge (1849) and the Britannia Bridge (1850), both in Wales, UK, and the Victoria Bridge over the St Lawrence River in Canada (1860).
- It is rare, being one of the few surviving metal bridges constructed in NSW in the 1860s. It represents British heavy wrought iron bridge technology both within NSW and internationally (the 1850 Britannia Bridge [Wales, UK] was destroyed by fire in 1970 and replaced by a new bridge in 1972; the Conwy railway bridge is the only surviving example of this form of construction undertaken by Robert Stephenson).
- It was a vital element in the construction of the Main South railway line, known as the Great Southern Railway at the time of construction.

The bridge, which is listed on the NSW State Heritage Register, is considered to be of National significance and deserving of award as an Engineering Heritage National Landmark.

4. DEFINITION OF ENGINEERING ITEM

4.1 Title of Engineering Heritage Work

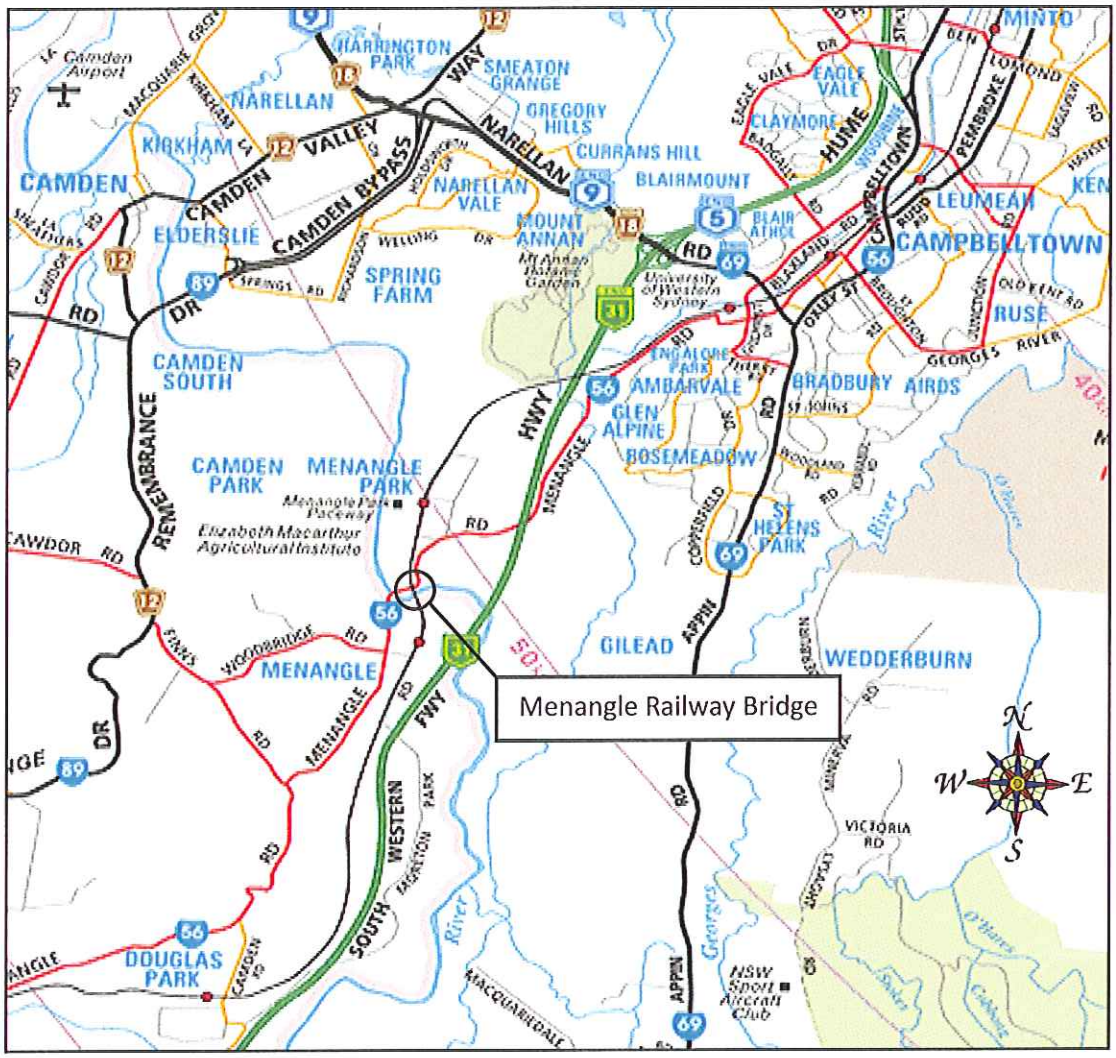
Menangle Railway Bridge over Nepean River at Menangle, New South Wales.

4.2 Scope of Engineering Heritage Work

The 1863 Menangle Bridge is the first large iron railway bridge erected in New South Wales.

Although part of the Main South railway line that connects Sydney with Melbourne, the bridge possesses high stand-alone heritage significance.

5. LOCATION MAP



6. HISTORICAL REVIEW

The 1863 Menangle Bridge is the first large iron railway bridge erected in New South Wales, whereas the first large railway bridge, an 8-span stone arch viaduct, was opened at Lewisham in 1855.

When John Whitton planned the railway extension from Campbelltown to Picton, he was under pressure from government to keep costs low by using as much local material as possible. A metal girder design had been proposed by contractors Peto, Brassey and Betts but Whitton substituted a timber bridge made from ironbark and other strong hardwoods, a relatively short 151 m (496 feet), low-level crossing.

However, the flood of 1860, some 18.3 m (60 feet) above the proposed rail level caused Whitton to design a high level, large span bridge to maximise the waterway, flanked by long timber approach viaducts, a total of 582 m (1,909 feet) in length. It was a massive structure for its time, comprising 5,909 cubic yards of masonry, 1,089 cubic yards of brickwork and 936 tons of wrought iron for a total cost of 94,562 pounds.

The iron superstructure was manufactured in the UK at the Canada Works, Birkenhead (opposite Liverpool) and shipped out in December 1861. One ship arrived in Sydney in April 1862 but the other was wrecked at the entrance to the Mersey River, UK. However, the replacement ironwork was delivered to Sydney in December 1862.

Construction of the stone (quarried locally) abutments and piers was completed in October 1862 and the iron bridge was assembled ready for service by June 1863. Load testing, by three locomotives in full steam, followed and the line to Picton was opened on 1 July 1863.

The use of a continuous superstructure was technically significant because the analysis of such structures was a relatively new, sophisticated procedure. Also, it showed that Whitton and Sir John Fowler (eminent British civil engineer and John Whitton's brother-in-law) appreciated the structural benefits that a continuous girder over three spans offered compared to three simply-supported spans.

The sister bridge to the Menangle Bridge was the Victoria Bridge over the Nepean River at Penrith. Their sizes and design were such that they were featured in an international text book titled *Modern Examples of Road and Railway Bridges* by William H Maw and James Dredge, London, 1872.

A timeline of events relating to this bridge is as follows:

- Design of wrought iron box girders, continuous over three (3) spans in 1859, however, tender price considered too high.
- Lower-level timber truss bridge proposed around 1860.
- Wrought iron box girder bridge at higher level adopted after a massive flood occurred in 1860.
- Continuous box girder superstructure over three spans of 49.4 metres (162 feet) and supported on sandstone block wall piers constructed 1862-1863 (opened to traffic on 1st July 1863).
- Intermediate brick wall piers (thereby halving the spans) and an additional cross girder system added 1905-07.

- Original timber approach viaducts were reduced in length and also replaced by steel girder spans and brick wall piers in 1923.
- Steel plates welded to the original cross girder webs in 1929.
- Derailment on the bridge in 1975 contained by the box girders with some damage.
- Temporary closure for four weeks in March 2003, when large cracks were found in original cross girder connection cleats and cracks were found in the welds, and fatigue failure of U-bolts suspending cross girders was feared.
- Bridge re-opened to rail traffic in April 2003 with a 20 km/h speed restriction.
- Quasi-static tests on instrumented bridge on 27th June 2003.
- Speed restriction lifted to 40 km/h in August 2003.
- Intense inspection for new cracks and monitoring of existing cracks through 2003-4.
- Line speed tests on instrumented bridge on 14th May 2004.
- Bridge structural integrity and safety was confirmed and speed reinstated to 80 km/h in October 2005.

7. HERITAGE ASSESSMENT

7.1 BASIC DATA

Item Name: Menangle Railway Bridge over Nepean River

Other/Former Names: Menangle Railway Viaduct

Location: Latitude 34.11809°S Longitude 150.74364°E

Address: Main South line over Nepean River

Suburb/Nearest Town: Menangle

State: New South Wales

Local Government Area: Wollondilly Shire

Owner: Australian Rail Track Corporation Limited (ARTC)

Current Use: Active railway bridge

Former Use (if any)**:** N/A

Designer: John Whitton, Engineer-in-Chief, Railways Branch, NSW Department of Public Works and Sir John Fowler, British civil engineer (design checker)

Maker/Builder: Peto, Brassey and Betts (Birkenhead, England UK)

Year Started: 1862 **Year Completed:** 1863

Physical Description: Since 1907, when intermediate piers were built in the middle of the three (3) original 49.4 m (162 feet) spans, the bridge has comprised 6 x 24.2 m (79.3 feet) spans. Between the original stone abutments, these additional brick piers alternate with the original stone piers.

The superstructure consists of two massive, continuous wrought iron, cellular (box) girders. These 3.8 m (12.5 feet) deep girders are at 7.8 m (25.5 feet) centres which allows for double track between them, supported on a series of closely spaced cross girders.

On the outer surfaces of the girders there are pairs of curved angle iron suggesting the inclusion of an arch. These are purely decorative; there is no arch action, the superstructure being a girder.

At the Sydney end, one of the ornamental tops to a pier was demolished by a derailment in 1975. The iron bridge received only localised superficial damage but the stonework was not replaced, thereby leaving the cellular cross section of the girder exposed.

Physical Condition: Good

Modifications and Dates: The principal modification was the building of the intermediate piers in 1907 which, by halving the original spans, greatly increased the load capacity of the bridge such that it is still in service carrying modern heavy, fast rail traffic.

The original iron bridge was flanked by timber trestle viaducts, which were replaced by steel girder spans supported on brick wall piers in 1923.

Heritage Listings

Name: State Heritage Register

Title: Menangle Rail Bridge over Nepean River

Number: 01047

Date: 2nd April 1999

Name: ARTC Section 170 Heritage and Conservation Register

Title: Bridge over the Nepean River at Menangle, 64.410km

Number: 4280315

Date: Approved by the Heritage Council July 2011

Name: Menangle Rail Bridge over Nepean River

Title: Wollondilly Local Environmental Plan 2011

Number: Item No.I80

Date:

7.2 ASSESSMENT OF SIGNIFICANCE

Historical significance: The 1863 Menangle Railway Bridge over the Nepean River is one of the most historic bridges in Australia. It was the first large iron bridge in New South Wales and the largest bridge until the 1889 Hawkesbury River Bridge.

Historic Individuals or Association: The design of the bridge was carried out jointly by John Whitton, Engineer-in-Chief, Railways Branch, NSW Department of Public Works and Sir John Fowler, an eminent British civil engineer specialising in the design and construction of railways and railway infrastructure during the early to late 1800s.

Creative or Technical Achievement: The three-span continuous girder design was, for the 1860s, a technically sophisticated design and on a grand scale. The cellular construction, whereby the top and bottom parts of the girders are made in the form of two boxes or cells, was a recent development for resisting lateral buckling, based on the experimental research in the UK by Fairbairn and Hodgkinson for the famous Conwy Bridge (1849) and Britannia Bridge (1850), both in Wales, UK.

The sister bridge to the Menangle Bridge was the Victoria Bridge over the Nepean River at Penrith. Their sizes and design were such that they were featured in an international textbook titled *Modern Examples of Road and Railway Bridges* by William H Maw and James Dredge,

London, 1872. As previously mentioned, these wrought iron cellular railway bridges have direct design links to the famous British civil engineer, Robert Stephenson.

Research Potential: The 3-span continuous girder design was, for the 1860s, a technically sophisticated design that was noted in an international 1872 text book. The cellular construction, whereby the top and bottom parts of the girders are made in the form of two boxes or cells, was a recent development for resisting lateral buckling arising from the famous experiments by Fairbairn and Hodgkinson for the 1849 Britannia Bridge in Wales, UK.

Social: The Main South railway has been an enormous benefit to the social and commercial development of the southern quarter of New South Wales for 140 years, and this bridge, part of the original railway construction, has shared in the significance of that contribution.

Rarity: The Menangle and Victoria (Penrith) Bridges are the only two bridges of their type remaining in New South Wales.

Representativeness: The Menangle and Victoria Bridges are excellent examples of heavy duty, wrought iron girder bridges continuous over three spans.

Integrity/Intactness: Apart from the inclusion of the intermediate piers in 1907, the 1863 Menangle Railway Bridge retains most of its original fabric.

References: State Heritage Register listing: http://www.environment.nsw.gov.au/heritageapp/ViewHeritageItemDetails.aspx?ID=5012102

Statement of Significance: Refer Section 8 of this Heritage Award Nomination Report.

Area of Significance: National

8. STATEMENT OF SIGNIFICANCE

The Menangle Railway Bridge, constructed in 1863 over the Nepean River, is one of the most historic bridges in Australia because:

a. It was the first large iron bridge in New South Wales and the largest bridge until the 1889 Hawkesbury River Bridge;
b. It has a dominant appearance in a rural landscape;
c. It shares in the enormous benefits, social and commercial, that the Main South railway has made to New South Wales in 150 years;
d. It was a technically advanced design for its time and received international recognition in 1872; and
e. It incorporates design principles linked to the famous British bridge engineer, Robert Stephenson and two leading contemporary British civil engineers, William Fairbairn and Eaton Hodgkinson, who conducted a series of tests on the effectiveness of cellular construction and associated analytical investigations, respectively.

The Menangle and Victoria Bridges are the only bridges of their type in New South Wales. They are excellent examples of heavy duty, wrought iron girder bridges continuous over three spans. Apart from the inclusion of the intermediate piers in 1907, the 1863 Menangle Bridge retains most of its original fabric.

The Menangle Railway Bridge is the oldest surviving bridge on the railway system in New South Wales and is of highest significance in the development of railway technology in the state. It is an excellent example of early bridge construction. The bridge is one of two identical bridges constructed for the NSW Railways, the other being over the Nepean River at Penrith. The Penrith Bridge was opened in 1867 but has been used for road traffic since 1907. The Menangle Railway Bridge is typical of British bridge engineering of the 1860s, the iron spans having been fully imported. Additional supporting piers were later constructed under the spans so that heavier engines could be used on the Main South line.

The bridge is of national, if not international, significance as there are few such bridges still in use even in the United Kingdom.

9. INTERPRETATION PLAN

9.1 Interpretation Strategy

Interpretation will be by:

- Identifying the works as an Engineering Heritage National Landmark.
- Public ceremony to unveil that marker.
- Interpretation panel which summarises the heritage and significant features of the works for the public.

This Interpretation Plan provides a summary of the proposals for design, content, location, manufacture and funding of the proposed interpretation panel.

9.2 Structure of the Interpretation

In accordance with the latest international designs, the panel will be a self-standing sign mounted at waist height, inclined at a 30 to 40 degree angle from the horizontal to facilitate viewing by a person standing facing the panel.

The size of the panel itself will be approximately 1200mm wide x 500mm deep.

The panel material could appropriately be one of a number of suitable materials that meets high standards of corrosion and vandal resistance.

The panel surface coating containing the image could also be provided by a number of modern interpretive products now marketed for this purpose; including vitreous enamel (on steel surface), or plasticised surface-coatings. It must meet high standards of image definition, colour-fastness and scratch resistance.

The panel will be mounted on a solid and strong stand that deters/resists attack from vandals, but on the other hand provides a pleasing and clean appearance.

A photograph of the latest, 2008 'standard' interpretation panel currently used by the Parks Service of the USA is shown as Figure 1 below, and this design is highly recommended by Engineers Australia.

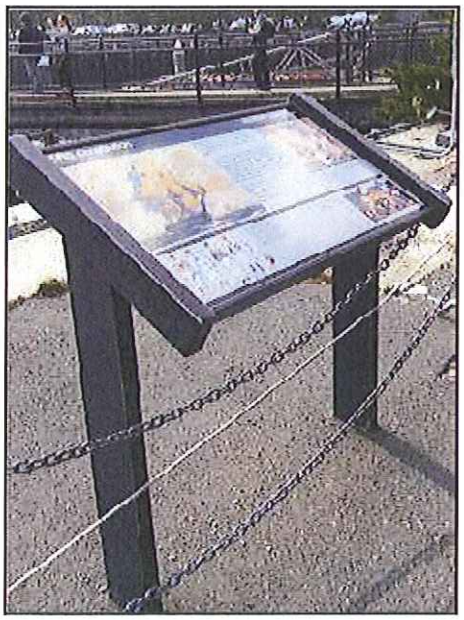


Figure 1 – USS Constitution interpretation panel

An example of an interpretation panel for the bridges of Cowra, NSW is shown in Figure 2 below.

Figure 2 – Interpretation Panel for Cowra Bridges, October 2002

9.3 Design Process for the Panel Content

The basic panel content will be proposed and an initial layout developed by Sydney Engineering Heritage Committee (SEHC). SEHC's partner and sponsor of the heritage recognition award, the ARTC, will be consulted in preparing the content.

When satisfactory design content has been achieved, it will be submitted for the approval of the EHA Heritage Recognition Committee and ARTC. Following approval of the draft design and content, it will be submitted to Engineers Australia's Marketing Manager in the Canberra office, who will finalise the graphical content and prepare an .eps (vector graphics) file required by the surface-coating manufacturer.

9.4 Content of the Interpretation

A summary of the proposed content is provided below:

Title: The title of the interpretation is proposed to be "The Menangle Railway Bridge".

Layout: In accordance with good interpretation practice, the content of the panel will be divided into two themes for ease of understanding by the public.

Primary theme (engineering): Topics to be briefly addressed will be the role of the bridge within the railway network, significant engineering features of the bridge (derived from Statement of Significance) and the bridge as an icon for the community.

Secondary theme (social/personal): It is proposed to introduce the joint bridge designers, John Whitton and Sir John Fowler and their achievements. Also, acknowledgement of the strong design links to Robert Stephenson and the testing and subsequent analysis by Fairbairn and Hodgkinson on the cellular/tubular form of bridge construction.

9.5 Graphics

Images: Early photographs of Menangle Bridge (prior to construction of intermediate brick piers), drawing of the bridge, including cross-section of superstructure (highlighting cellular form of construction) and map of railway network.

Portraits: Suitable photographs of the bridge designers to add a personal touch to the secondary theme.

9.6 Location of the Interpretation Panel and Heritage Marker

The interpretation panel will be located in close proximity to the Menangle Railway Bridge. Good interpretation policy suggests that the sign be placed at a view point for the heritage works; preferably allowing readers of the interpretation to be able to see the item, or the detail being described by looking up.

The heritage marker is, preferably, to be placed on the works, out of reach of damage. It should also be visible and as close as possible to the interpretation panel. If this is not possible, then an image of the heritage marker can be added to the interpretation content.

An initial study of the possibilities for placement of the heritage marker and the interpretation panel, as well as the site for the ceremony, has already been carried out, and suggested locations are shown in the photographs below.

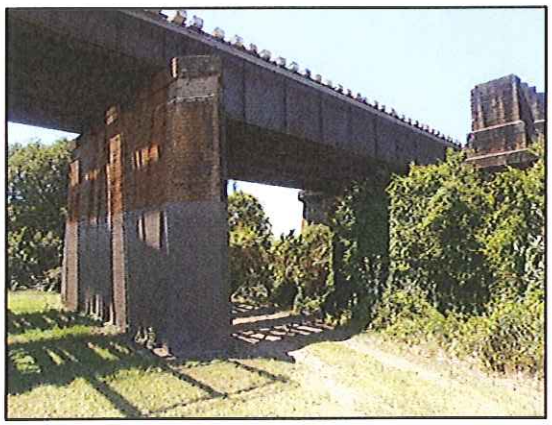


Figure 3 - Proposed Site for Ceremony and Interpretation Panel

Figure 4 – Suggested Marker Location

9.7 Manufacture

Quotations for the panel will be called from three (3) manufacturers whom are known to have produced signs of the appropriate quality. A preferred tenderer will be selected from the responses on the basis of price, quality, service and estimate of the cost for replacement of damaged panel surface.

9.8 Funding

An estimate for the cost of the interpretation panel at Menangle is $2,000 to $3,000. Engineering Heritage Australia will provide volunteer and in-house design resources for the above processes and actions in order to reduce this cost to a minimum (of mainly manufacturing costs).

10. REFERENCES

Guide to Engineering Heritage Recognition Program, Engineers Australia (2010)

Bridges Down Under, Fraser D, Australian Railway Historical Society (1995)

Making the Railways, Burke D, State Library of New South Wales Press in Association with the State Rail Authority of NSW, Sydney Australia (1995)

Colonial Engineer: John Whitton 1819-1898 and the Building of Australia's Railways, Lee R (2000)

Australian Railway Historical Society Bulletin No.32, June 1940

Structural Reassessment of Wrought Iron Bridges, Grundy P, Department of Civil Engineering, Monash University, Melbourne, Victoria, Australia

The First Sixty Years of Metal Bridges in New South Wales, Fraser D J, Multi-disciplinary Engineering Transactions, Vol GE 10, No.1, June 1986, The Institution of Engineers, Australia

State Heritage Register listing:
http://www.environment.nsw.gov.au/heritageapp/ViewHeritageItemDetails.aspx?ID=5012102

APPENDIX A – PHOTOGRAPHS

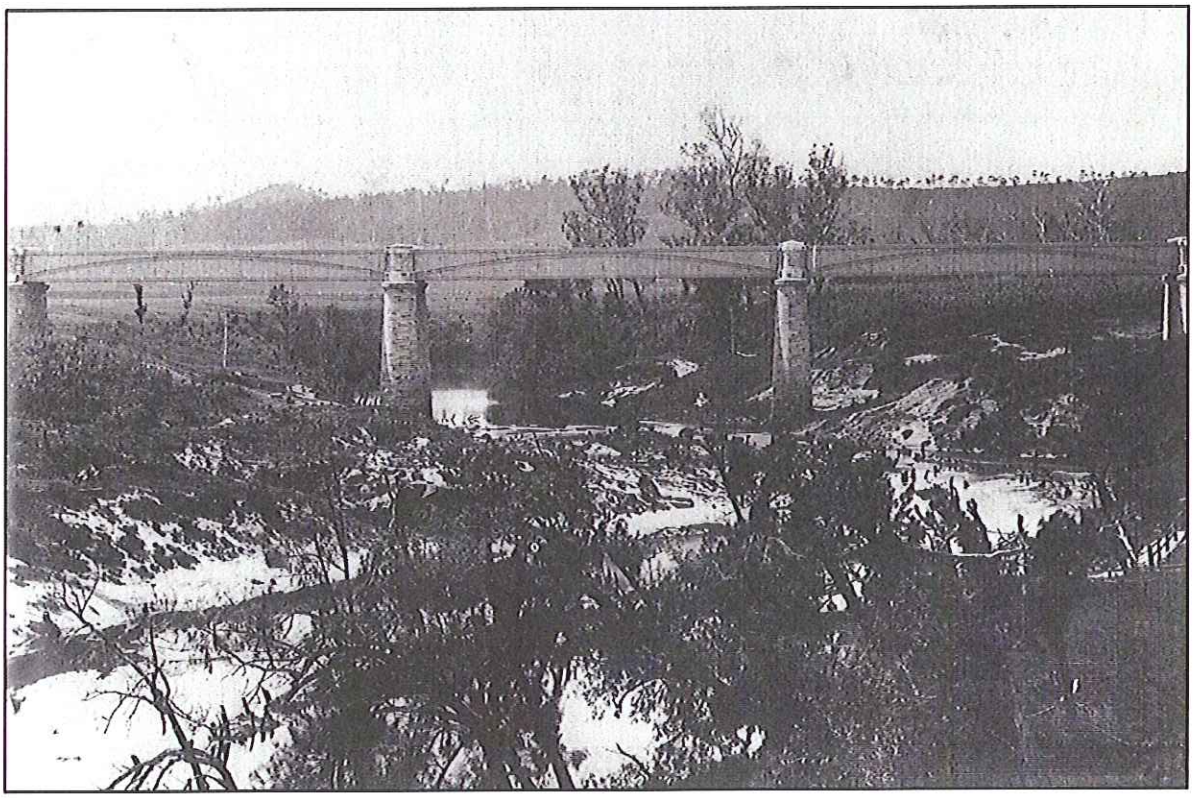


Figure 5 – Early View of Menangle Railway Bridge

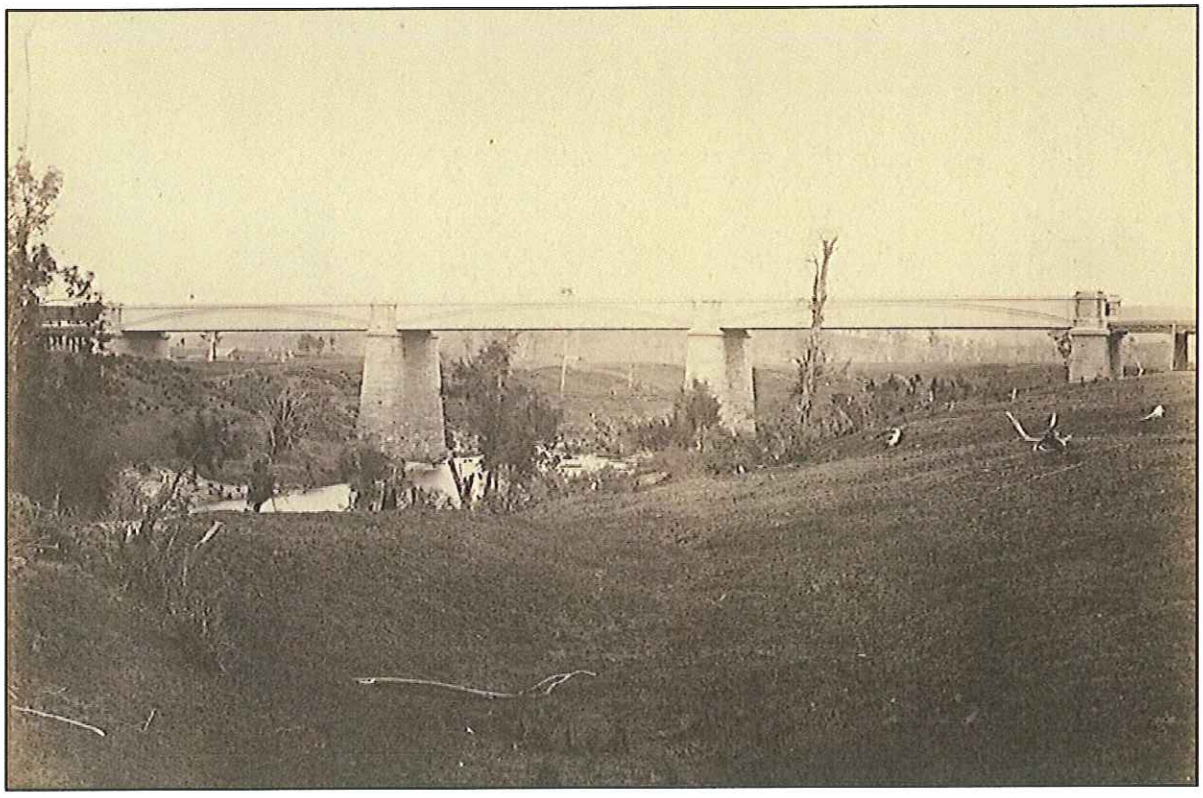


Figure 6 – 1866 View of Menangle Railway Bridge

Figure 7 – Menangle Railway Bridge, March 1999

Figure 8 – Menangle Railway Bridge, February 2003

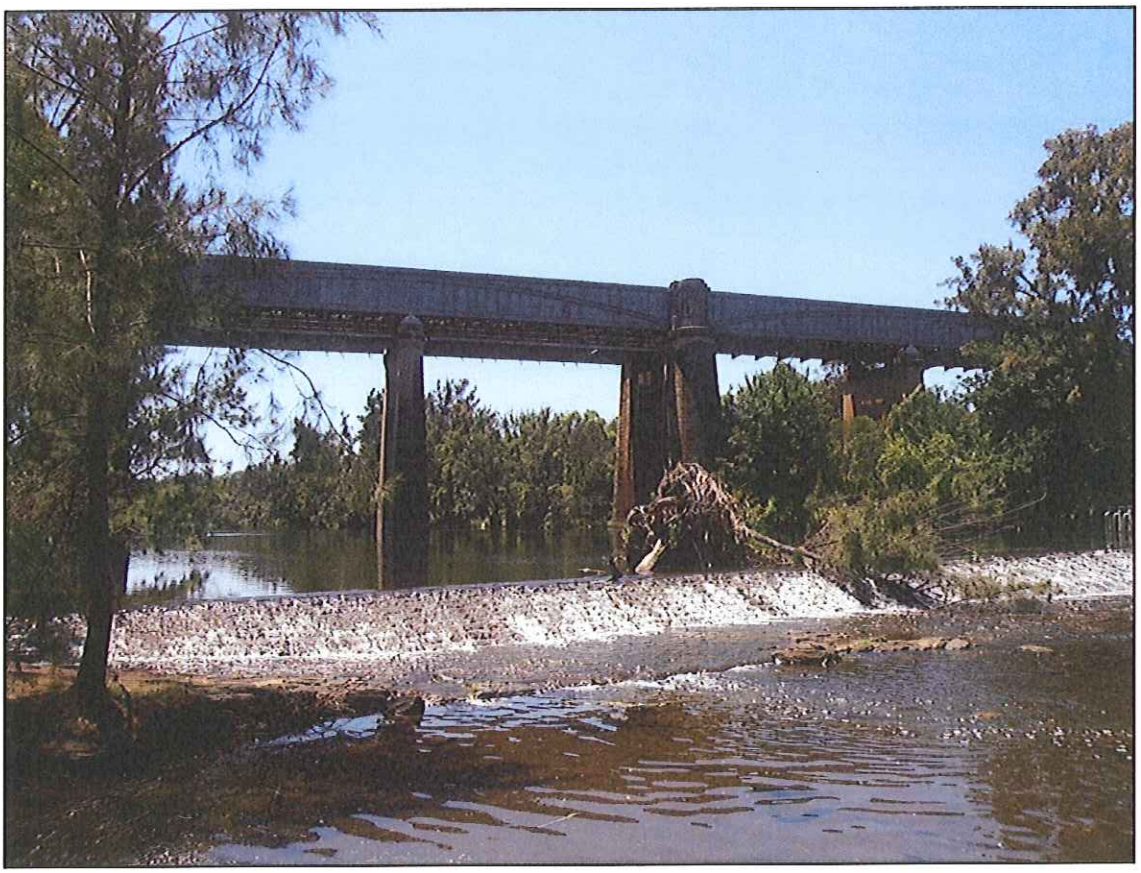


Figure 9 – Western Elevation of Menangle Railway Bridge, December 2012

Figure 10 – Northernmost Sandstone Pier of Menangle Railway Bridge, December 2012

APPENDIX B – DRAWINGS

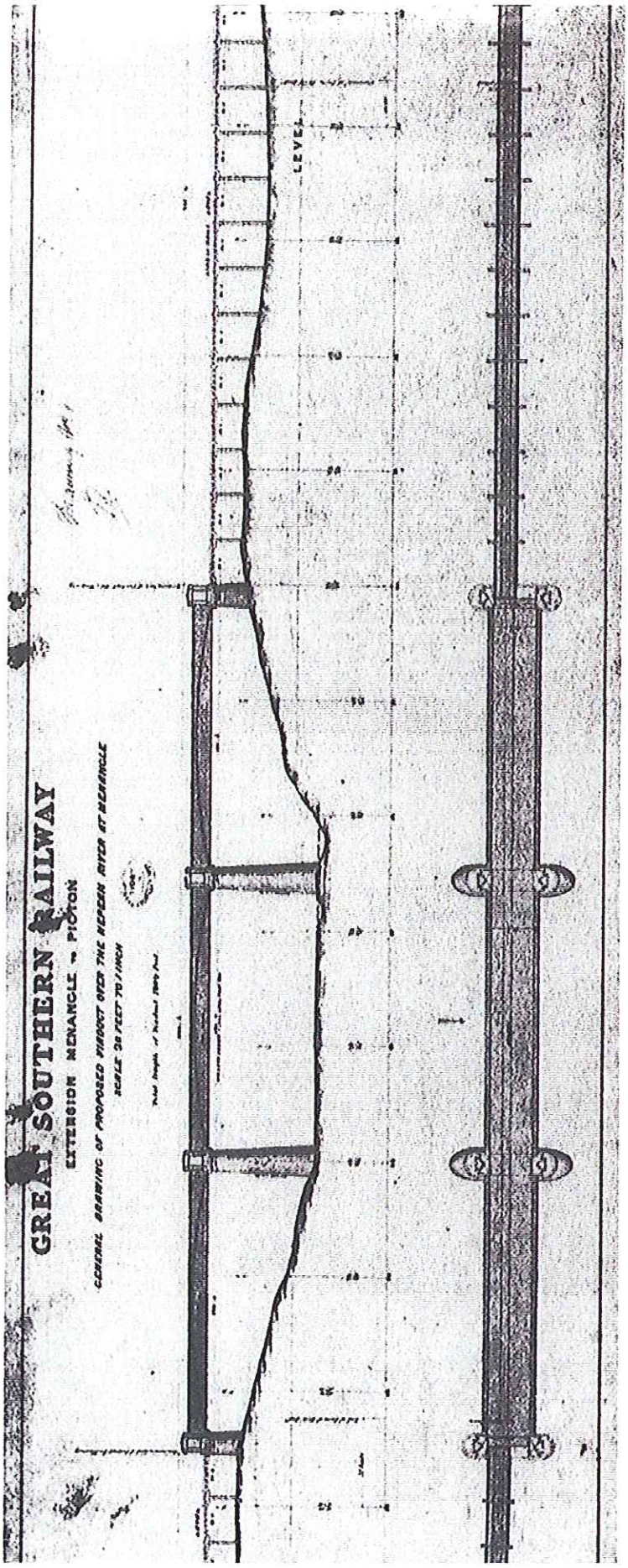


Figure 11 – Original Bridge Drawing

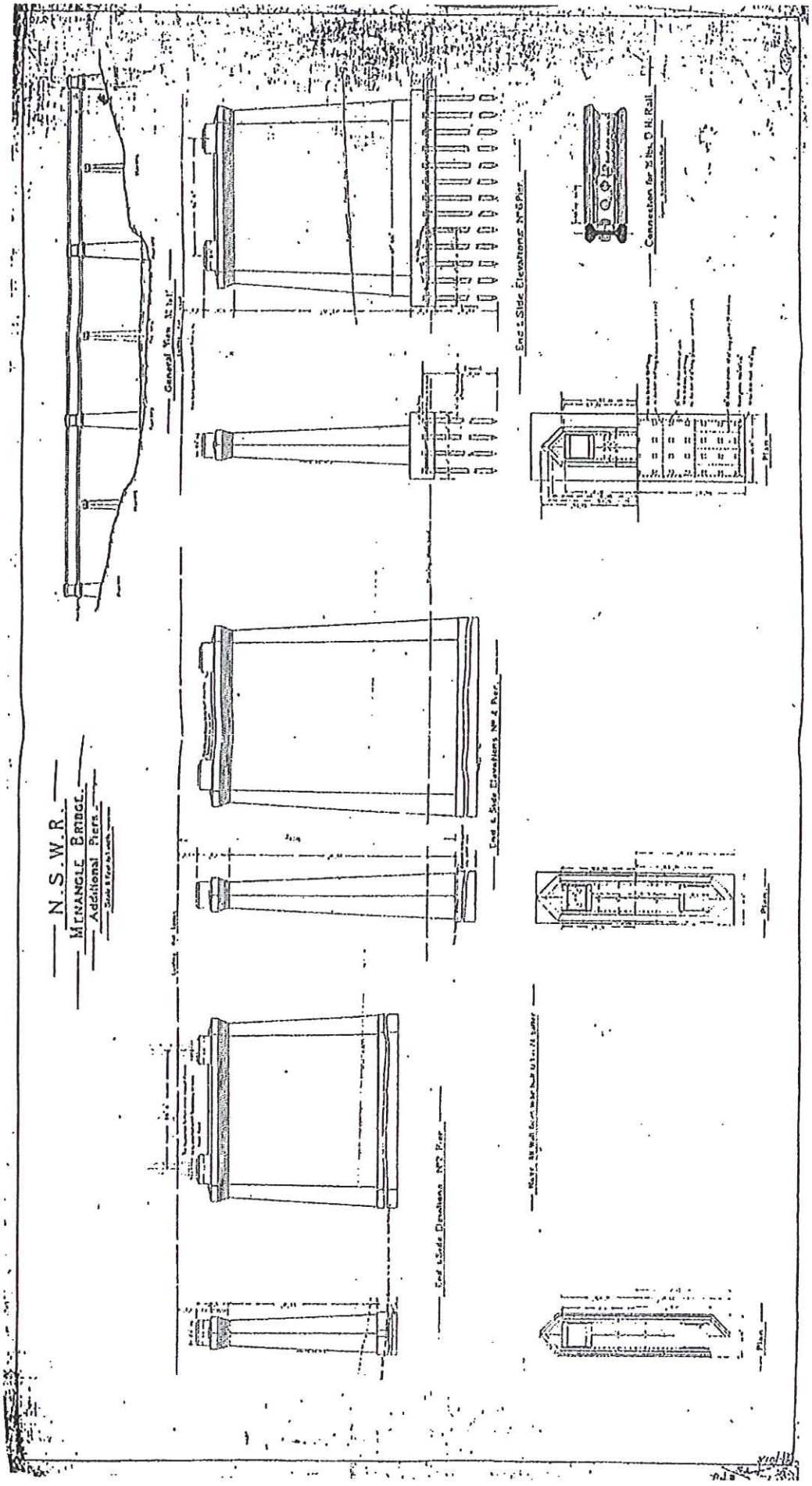


Figure 12 – Drawing of Intermediate Piers