Nyrang Bridge
Concept Options Design Report

Cabonne Council

Document status

Revision	Date	Document status	Prepared by	Reviewed by
01	16/06/2023	Draft Issue	Yuhang Tang	Craig Riley
02	01/08/2023	Revised Issue	Yuhang Tang	Craig Riley

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1. Introduction

Nyrang Bridge, along Nangar Rd approximately 10km west of Canowindra, which crosses Nyrang Creek (-33.541274 148.551453), had its abutments washed away during the floods of November 2021. It was a single span concrete bridge approximately 7.8 m long by 8.8 m wide. As this is a major route between Canowindra and Eugowra which otherwise requires a 50km detour, a temporary solution was quickly adopted by the council involving repairing the abutment with the installation of sheet piles and concrete blocks.

Figure 1 Temporary Repair of Bridge in 2022

This temporary solution was in place for about a year, until in November 2022 another bigger flood swept through the region and washed out the temporary works to a far greater extent than the earlier event. The bridge approaches are currently washed away, and the bridge has been closed to traffic. An unsealed sidetrack with a pipe culvert causeway has been installed to carry traffic while the bridge failure and repair is investigated (refer Figure 2)

Bridge Knowledge has since been engaged by the council to present a concept design to either repair or replace the bridge. Bridge Knowledge inspected the site on 10 June 2023 and this report summarises these findings and suggests a way forward to reopen the road.

Figure 2 Existing Bridge Aerial View - approaches washed away.

Figure 3 View from Upstream of existing bridge with washed away approaches.

Figure 4 Temporary culvert-causeway sidetrack downstream from bridge

The existing Nyrang bridge is a two lane, single span bridge approximately 7.8 m long and 8.8 m wide. The exact detail of the design is unknown but appears to be simply supported insitu concrete. The foundation consists of four concrete piles at each abutment and there are notably no wingalls, curtainwalls or any typical abutment features.

Some photos of the recent site visit are presented below for context.

Figure 5 Concrete Block temporary abutment protection washed away.

Figure 6 Significant Scour Behind abutments

Figure 7 Looking upstream, significant debris evident.

2. Appreciation of Constraints

2.1. Geotechnical

Barnson conducted a geotechnical investigation on this bridge site (Report40887-GR01_A dated 03 Mar 2023) with 2 boreholes drilled. The subsurface profile consists of sandy clay of increasing stiffness down to about 10m where the borehole was terminated.

The engineering parameters of subsurface conditions were reported and are summarised in Table 1.

A geotechnical reduction factor of 0.52 is proposed for the design of the bridge foundations. A higher value may be applied if in situ testing is undertaken during installation.

Table 1 Geotechnical Design Values-Driven Pile Footings

Unit	Location and Depth (m)		Material Description	Spt(N)	Ultimate Bearing Capacity (kPa)	Ultimate Skin Friction (kPa)	Ultimate Skin Friction (Tension) (kPa)	Modulus of Elasticity Vertical (MPa)	Ultimate Shear Parameters
	BH1	BH2							
1A	-	0.7-4.5	Silty Clay Firm	5	225	25	12	8.5	Cu=25kPa
1B	-	4.5-9.5	Sandy Clay Stiff	10	900	50	25	25	Cu=100kPa
1C	1.5-8	9.5-10.5	Sandy Clay Hard	21	1800	75	37	35	Cu=200kPa

According to the aggressivity testing results, the exposure classification for piles installed in the ground is considered as B1 for concrete and non-aggressive for steel.

Table 2 Aggressive Testing Result

	Units	BH1	BH2
pH	-	7.6	7.9
Electrical Conductivity	µS/cm	270	90
Chloride	mg/kg	47	10
Sulphate	mg/kg	39	32

The report recommends that steel or concrete driven piles be considered due to the presence of stiff clays and penetrable layers. Concrete bored piles are also possible but would likely require temporary casing for excavation stability.

Steel piles driven to the full depth of borehole would provide approx. 120kN of tension resistance per pile. It is likely that the piles for the new bridge will need to extend deeper than the 8m of known clay and therefore there is a risk to the project as soil properties below this depth is unknown. However, the existing foundation appears to have bored piles which presumably extend down to rock below the clay layers and so it can be assumed that a driven pile will eventually refuse at this rock. The estimated length of pile will need to be confirmed in detailed design and it is likely that pile testing during installation will be required due to the unknown soil profile below 8 m depth.

The detailed Geotechnical report is attached as Appendix A.

2.2. Hydraulic Analysis

Bridge Knowledge conducted a hydraulic analysis to understand the estimated flood levels and velocities up to ARI2000 which is required for structural bridge design to AS5100. The results of the assessment are summarised in Table 3. The full hydraulic report is provided in Appendix B.

The results indicate that the velocity does become large (4.1m/s) when the bridge is nearly overtopped. As the ground consists of silty clay, and the bridge constricts the flow of water, it makes sense that the scouring of the abutments has occurred. The scour depth is calculated to be approximately 2 m using *Austroads Guide to Bridge Technology Part 8: Hydraulic Design of Waterway Structures*, Section 5.4.6.

With the road level at approximately RL 297.5m, it would appear that the road has an immunity of ARI20 (AEP5%) until it gets overtopped.

Under the existing 8 m bridge base case, the flood waters overtop the road under AEP5% a further 0.5m with an RL 298 m.

Table 3 Hydraulic assessment results

ARI	Flow (m3/s) (RFFE)	Velocity (m/s)	Water surface level (RL m)
2	32	1.8	295.3
5	75	3.3	295.6
10	117	4.1	296.2
20 (SLS)	171	3.0	297.2
50	264	1.4	297.9
100	354	1.5	298.0
200	444	1.6	298.0
500	563	1.7	298.1
1000	653	1.8	298.2
2000 (ULS)	743	1.9	298.2

2.3. Utilities

Bridge Knowledge conducted a brief BYDA investigation. Essential energy returned no services in the bridge area. Telstra reported various utilities near the site, also confirmed in the survey conducted by ARÊTE Survey Solutions issued on 24 Feb 2023. There is a direct buried cable along the Nangar road crossing Nyrang Creek downstream, some joints and jointing pits located west and south of the site. There are also overhead power lines going from Lawrences Road to downstream of Nyrang Creek. Other unidentified services may be present, and contractors must conduct their own due diligence in utility location. BYDA search results are included in appendix C

2.4. Barriers

Following the guidelines given in AS 5100.1:2017, low performance barriers are nominated due to the height of the bridge above the water level, estimated number of vehicles per day and for the fact that the existing bridge had thrie beam barriers installed.

3. Design Criteria

The criteria to be used in the design has been compiled from applicable standards and information provided by Council and is outlined in Table 4. Applicable Australian standards and design guides used during design include:

- AS1170.1:2002 – Structural Design Actions
- AS2159:2009 – Piling
- AS5100:2017 – Bridge Design Suite
- Austroads Guide to Road Design Part 3: Geometric Design (2016)
- Austroads Guide to Bridge Technology Part 8: Hydraulic Design of Waterway Structures (2018)

The design criteria have been provided to inform the subsequent detail design phase of the project.

Table 4 Nyrang Bridge design criteria

Category	Criteria	Reference
Design Life	100 Years	AS5100.1 Clause 8.2
AADT	1000, 25% HV	Assumed
Design Speed	100km/hr	
Crossfall	3% two-way	Minimum drainage requirement
Longitudinal grade	None	Concept Design
Minimum Length	16m	Concept Design
Alignment	Inline to existing road	Concept Design
Design Lanes	Two-lane bridge	Council
Bridge carriageway width	2x 3.5m lanes, 1.0m shoulders = 9m between barriers	Austroads Guide to Road Design Part 3
Design Vehicle	SM1600	AS1597.2 Clause 3.3.5
Traffic Barriers Performance Level	Low Performance thrie beam	Council
Materials	Superstructure to be concrete. Substructure to be concrete or steel	N/A
Wearing surface	Concrete with a broomed finish	N/A
Durability	Minimum exposure classifications: Concrete elements – B1 Steel elements - non-aggressive	AS5100.5 Table 4.3
Hydraulics	Serviceability (scour protection and immunity level) - 20 yr ARI (refer drawings) Ultimate (bridge design) - up to 2000 yr. ARI (refer drawings) 3m Debris Mat	AS5100.1 Clause 11.1
Earthquake	BEDC1	AS5100.2 Section 15

4. Concept Options

Various options were considered to restore the road to a serviceable condition. The options were 1) Do Nothing, 2) Repair/Rehabilitation, 3) Add additional spans or culverts and 4) Replace with a new bridge.

4.1. Option 1 Do Nothing

Nangar road is an important link between Eugowra and Canowindra and has a medium density of vehicles travelling on it per day with a large percentage of heavy vehicles and buses.

There is a temporary sidetrack that has been constructed currently carrying traffic – however this will certainly not survive the next flood and so will also be washed away in the short term. Long term use of the sidetrack is not feasible either, as traffic must slow down significantly to navigate the turns- it creates a hazard along the route from which there has already been several reported accidents and one fatality.

Eventually the road will be closed and if nothing is done, then a permanent detour route will need to be used to travel between Canowindra and Eugowra. Vehicles can travel northwest from Canowindra along Longs Corner Road to Eugowra via Murga, but this adds a further 14km and 10mins on the travel time. Longs Corner Road is a narrow local road between farm properties and is unsuitable for heavy vehicles; it will also become significantly damaged with more vehicles per day.

The alternative is to travel north along B81 to Cudal and south through Toogong along The Escort Way. This is an additional 30min (55min total) detour which would be significantly disruptive to the community as a long-term solution.

It is also understood that the local community have been very unhappy with the Nyrang bridge being closed and have voiced their collective concerns to the mayor and council on numerous occasions. It is very unlikely that the community would accept a permanent closure of the bridge.

This option is not recommended.

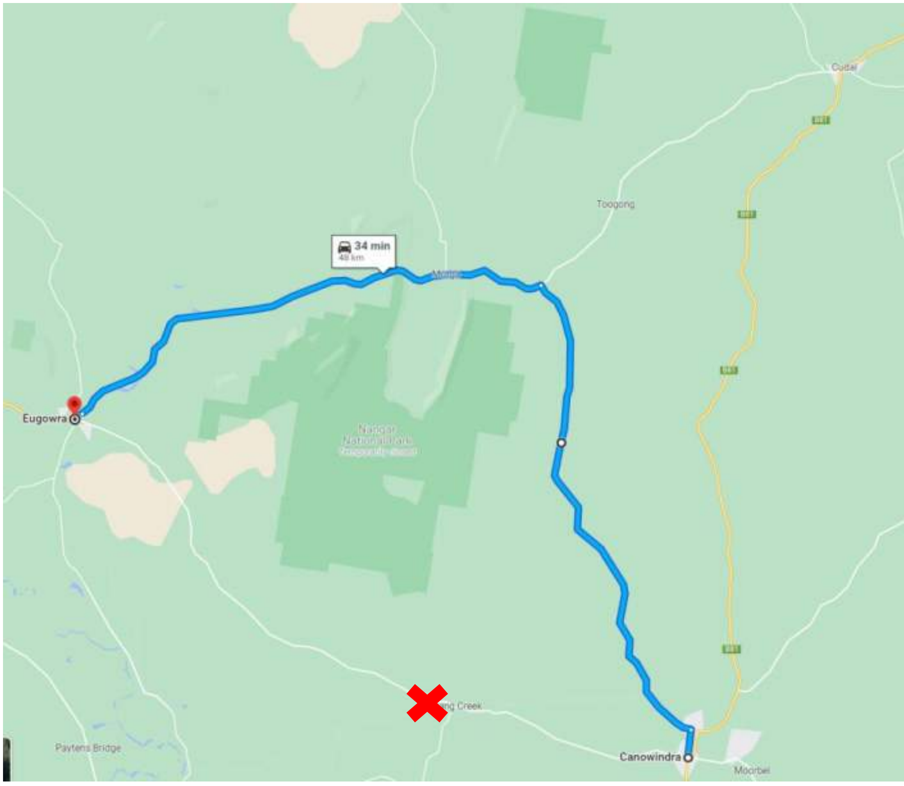

Figure 8 Alternative detour route

4.2. Option 2: Rehabilitation

This option involves returning the bridge to its original 8m single span format by backfilling the abutments and resealing the road. This would be feasibly achieved by installing a retaining wall, either with concrete or steel sheet piles and then back filling with appropriately drained select fill. Wingwalls approximately 3.5m high will be required to contain this embankment and combat future scour. The cost of this construction would be relatively cheap in the short term – but in the long term may prove expensive in requiring replacement in the future.

There are a few issues with this option.

- Firstly, the existing bridge is only 8m long, but the natural waterway is much larger. Notably the existing road sits on a reasonably sized embankment that extends out into the natural waterway. An 8m bridge is heavily constricting the natural flow of water which increases the velocity of water, and therefore increases the risk of scouring the embankment. It is likely that the bridge approaches would be scoured out again in a future flood. Nature has already demonstrated that an 8m span is not suitable at this location with the approaches being washed away twice in 2 years. This constriction is evident from the figure below.

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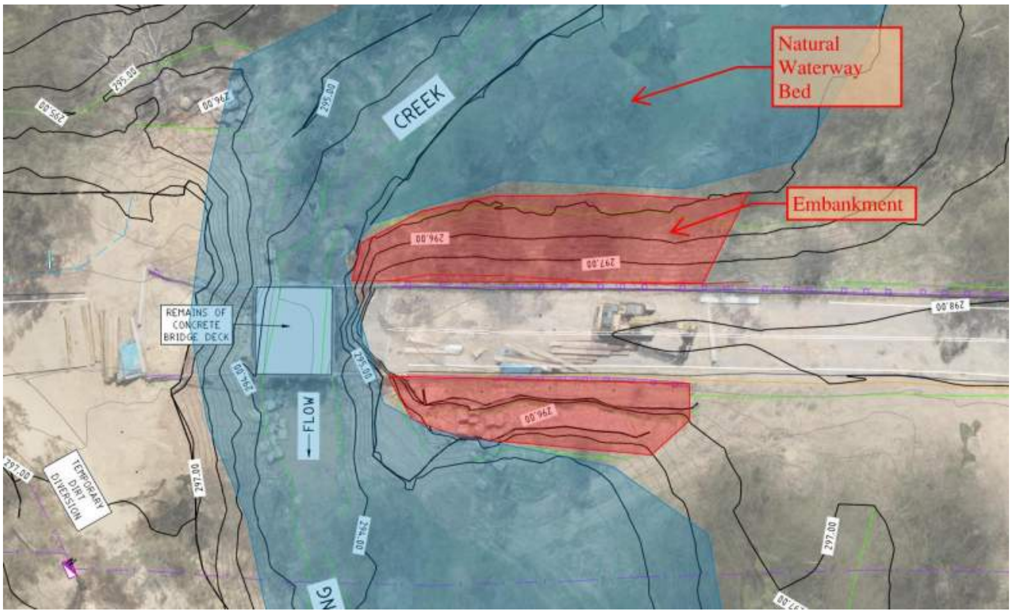

Figure 9 Depiction of embankment constricting river.

- Secondly, the bridge construction is not very comforting. The piles are all out of tolerance and their depth is unknown, the abutment was never designed with a curtain wall or wingwalls, and there is significant spalling of concrete evident and the bridge is rather old. The ability for this bridge to withstand future flood loads is questionable and its service life will soon be nearing an end. This means that under this option, the bridge will need to be carefully monitored and maintained constantly to ensure continued safe crossing.

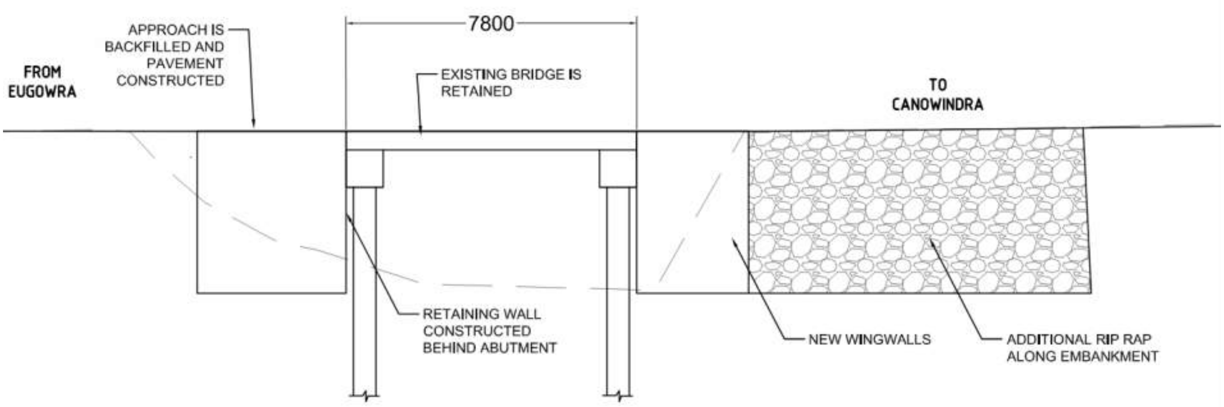

Figure 10 Nyrang Bridge Concept Design Option 1

4.3. Option 3: Additional Spans

Option 3 also involves keeping the original bridge but adding additional spans to increase the waterway area as shown in figure below. This will extend the whole bridge to a length of approximately 20m with 3 spans and reduce the need for large retaining walls and wingwalls as in Option 2. This will address the issues identified in Option 2 of reducing the constriction on the waterway.

However, this option also has several issues to consider:

- The problem identified in Option 2 of having an old bridge with poor construction evident will reduce the life of the proposed solution. It is questionable whether the old bridge can withstand stronger floods and the capacity of the foundations is unknown.
- This option introduces the need for 2 additional piers and 2 abutments. This is practically building 2 separate bridges against an old bridge to make a 3-span structure. It will quickly become very expensive to design, build and maintain. This is because the headstocks of the existing bridge cannot easily support a new span without significant modification works.
- The piles supporting a new headstock would likely be driven piles which will look inconsistent compared to the existing bored piles.

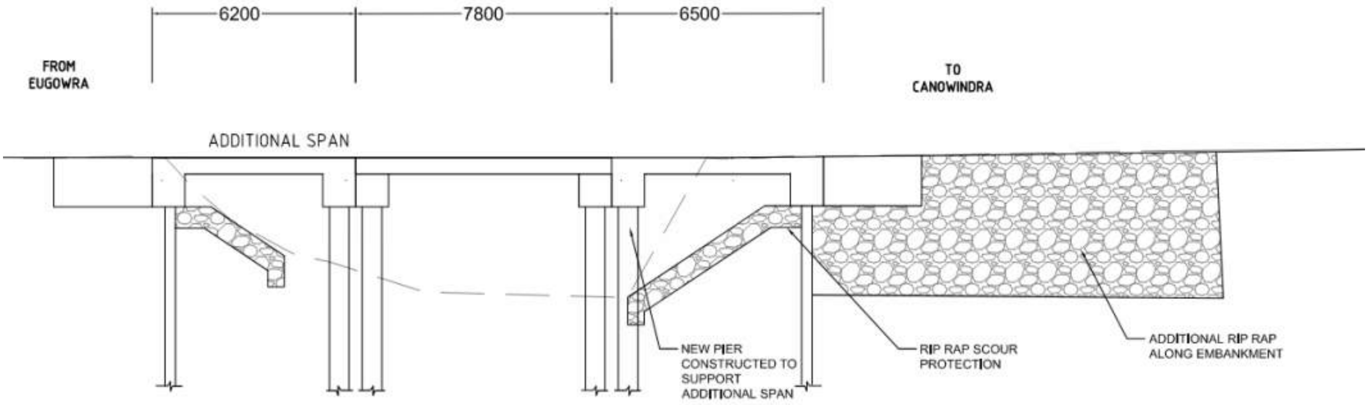

Figure 11 Option 3 – New Spans constructed.

A slight alternative to Option 3 would be Option 3b – installing box culverts on base slabs as opposed to new bridge spans on piers.

However, culverts have recently gone up in price significantly and are no longer considered to be the ultra-cheap option they once were. Furthermore, the ground conditions at this site are very poor – soft clay at the creek bed which would need significant strengthening works to accommodate the bearing pressures of a culvert base slab. This would mean a bridging layer of rock below the base slab further adding to the cost of construction.

Lastly, Nyrang creek would be considered by Fisheries as a class 2 waterway with a moderate fish habitat as it is a "*Named permanent stream, with clearly defined bed and banks with semi-permanent to permanent waters in pools or in connected wetland areas. Marine or freshwater aquatic vegetation is present*". This would immediately preclude the installation of box culverts without a significant justification in favour.

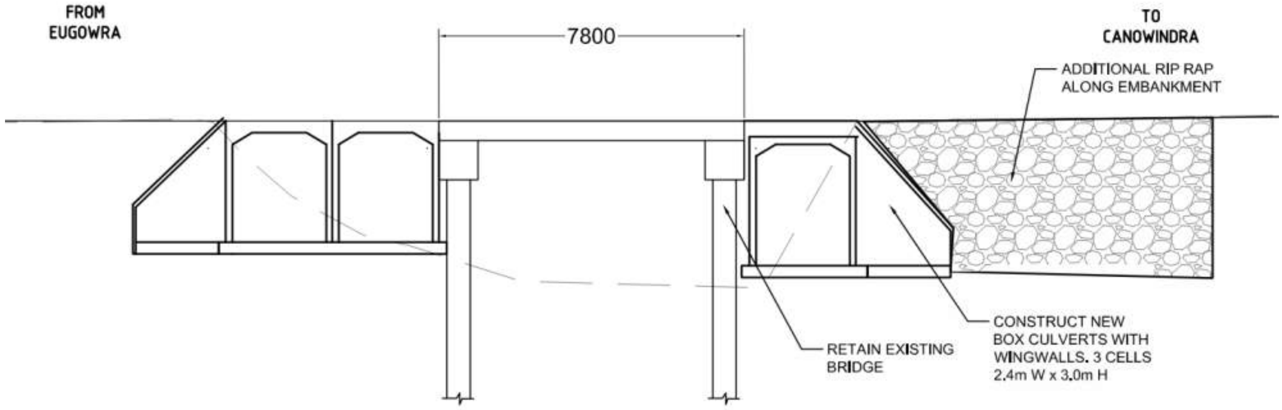

Figure 12 - Option 3b - Box Culverts Used to extend bridge span.

4.4. Option 4: New Bridge

Option 4 therefore proposes to demolish the existing bridge and replace with an entirely new, single span bridge compliant to current standards. This will address the design life concerns of the other options, while also providing a properly designed structure suitable for the excessive flooding conditions that prevail in the area. This means it will be a solution designed to last 100 years and provide safe passage for all traffic, including heavy vehicles.

It will comply with fisheries requirements as it will not provide any barrier to fish passage during construction or in the permanent state.

The hydraulic modelling has suggested that a bridge span approximately 13 m long will be suitable to accommodate flows under the ARI20 event without road inundation.

However, the natural erosion has opened up the distance between existing road to be around 16 m, which is shown in figure below. The new creek banks appear to fit well in this 16 m zone and with a 13 m bridge the scour rock protection would have constricted the waterway area. Therefore, it is recommended that a 16m bridge is adopted. This will convey more water during a flood and is a span that is still within the limits of standard precast planks, which are an affordable bridge option.

There are also some modular systems available that will span this distance, such as Inquik, which may be a viable option, depending on how Council intends on procuring the work.

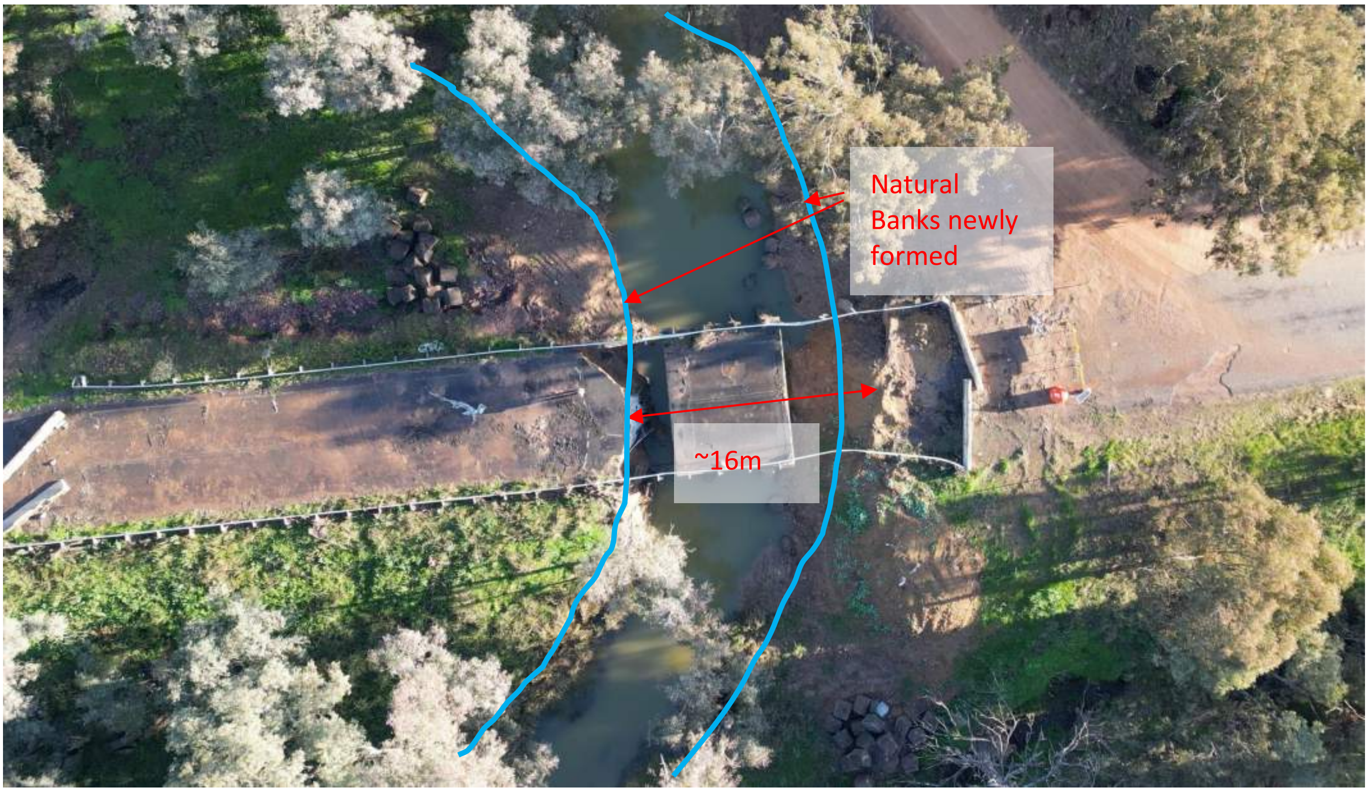

Figure 13 Natural Bank Lines and apparent 16m span

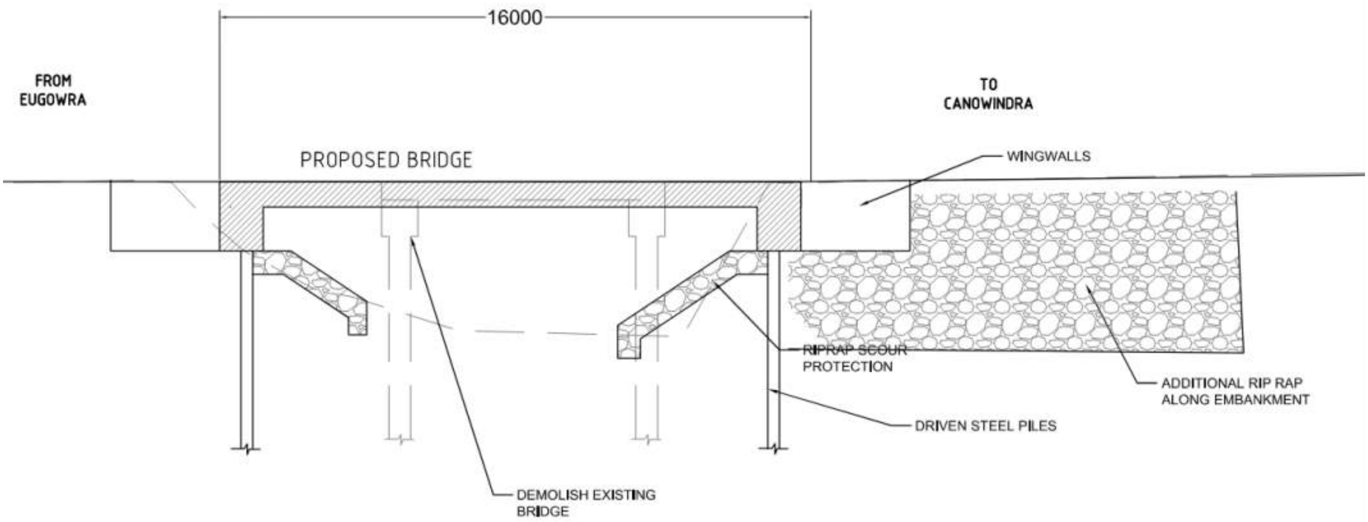

Figure 14 Nyrang Bridge Concept Design – Option 4

4.5.Pros and Cons

The pros and cons for each option are summarised below.

Table 5 Pros and Cons for Each Option

Option	Pros	Cons	Preference Ranking
Option 1 – Do Nothing	Lowest Cost Option	Long detour routes particularly for heavy vehicles Bridge has a lot of community attention and community will not accept this solution	4 - Reject
Option 2: Rehabilitation	Low cost Easiest to build	Construction of large retaining walls and wingwalls Confines waterway, and scouring of embankment likely to reoccur 100-year design life cannot be guaranteed	3 – Not Recommended
Option 3: Additional Spans	Opens up the waterway area and conveys ARI20 floods	Moderate Cost Difficult construction of additional piers or culverts in unsuitable ground Culverts likely rejected by fisheries	2 – Plausible
Option 4: New bridge	Suitable waterway area for flooding immunity Environmentally sensitive 100-year design life suitable for floods and meeting design criteria	Demolition and disposal of old bridge Moderate to High cost Need to go out to market for design and possibly construction. Timeline of completion is extended	1 – Recommended

5. Recommendations

Considering the discussion above and the provided information in this report, it would appear that the most viable solution is to demolish the existing Nyrang bridge and replace with a new, fully compliant concrete bridge at approximately 16 m span x 9 m width with low performance barriers supported on driven pile foundations. Refer to Appendix D for concept design drawing.

Appendix A
Geotechnical Investigation Report

Geotechnical Investigation Report

Nyrang Creek Bridge, Nyrang Creek NSW

(Our Reference: 40887-GR01_A)

Disclaimer

This report has been prepared solely for Cabonne Council in accordance with the scope provided by the client and for the purpose(s) as outlined throughout this report.

Barnson Pty Ltd accepts no liability or responsibility for or in respect of any use or reliance upon this report and its supporting material by anyone other than the client.

Project Name:	Nyrang Creek Bridge, Nyrnag Creek NSW
Client:	Cabonne Council
Project No.	40887
Report Reference	40887-GR01_A
Date:	3.03.2023
Revision:	A

Prepared by:	**Reviewed by:**
Gareth Williams Geotechnical Technician	Richard Noonan *BE(Hons) ME FIEAust CPEng NER* Director

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Appendix C – Borehole Logs
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1.0 INTRODUCTION

At the request of Cabonne Council, Barnson Pty Ltd has carried out a Geotechnical Investigation for the proposed bridge at Nyrang Creek NSW.

The purpose of the investigation is to provide a geotechnical investigation report and provision of geotechnical design parameters for the proposed bridge footings. The investigation was carried out with Guidance from the AS5100-2017 "Bridge Design Code" and AS2159-2009 Piling code.

Plate 1 – Area of Investigation

Cabonne Council is planning to construct a new bridge over "Nyrang Creek" at Nyrang Creek NSW. The proposed site features that are covered by this investigation are as follows.

- Proposed Bridge.

The investigation comprised of two (2) boreholes together with field mapping near the site. Details of the field work and laboratory testing are given in the report together with comments relevant to design and construction practice.

1.1 Terminology

The methods used in this report to describe the soil profiles, including visual classification of material types encountered, are in accordance with Australian standard AS1726-2017 "Geotechnical Site Investigations".

1.2 Limitations

The geotechnical section of Barnson Pty Ltd has conducted this investigation and prepared this report in response to specific instructions from the client to whom this report is addressed. This report is intended for the sole use of the client, and only for the purpose which it is prepared. Any third party who relies on the report or any representation contained in it does so at their own risk.

1.3 Geotechnical Testing

Representative samples from the site were subjected to the following range of tests in accordance with relevant method of Australian Standard AS1289:

- Soil Chemical Test
- Atterberg Limits
- Standard Penetration Testing (SPT's)

Test reports are attached in ***Appendix D***.

2.0 SITE DESCRIPTION

2.1 General Site Description

The site is situated in a rural area, approximately 11km west of Canowindra NSW over the Nyrang Creek.

The site is surrounded by rural farmland and the surrounding land is reserved for rural and agricultural purposes. The Nyrang Creek flows from northeast to southwest at the proposed bridge location.

The immediate site surrounding the bridge site is slightly undulating in all directions and sloping down to the creek bed itself.

The current bridge has suffered severe flood damge due to water flows. It appears the water has severley scoured the soil behind the spill through abutments. It is therefore now clear that the span of the existing bridge was insufficent for the waterway area, and a new bridge of larger span is required.

Plate 2 – General view of site.

Plate 3 – General view facing east.

Plate 4 – General view of site facing west.

3.0 METHOD OF INVESTIGATION

On the 13th of February 2023, a geotechnical investigation was carried out at the proposed bridge site over the Nyrang Creek at Nyrang Creek NSW. The fieldwork was undertaken in accordance with AS1726-2017, Geotechnical Site Investigation.

A drilling rig with a 90mm auger and tungsten tip was used to excavate two (2) boreholes for the proposed bridge to depths of 8.0m and 10.5m within the proposed areas. These are designated as boreholes 1 and 2.

Standard Penetrometer Tests (SPT) were undertaken at the boreholes at 1.5m intervals to assess the consistency of the subsoil materials. The detailed borehole logs with SPT results are attached in ***Appendix C***.

3.1 GPS Co-Ordinates

GPS Co-ordinates of the boreholes were recorded on site to enable plotting of the borehole locations. The following Table 1 shows this co-ordinates.

Table 1: GPS Co-Ordinates of Boreholes

Location	Longitude	Latitude	Proposed Structure
Borehole 1	148.551508	-33.541274	Western Bridge Abutment
Borehole 2	148.551648	-33.541409	Eastern Bridge Abutment

The boreholes were recorded on site with a Garmin Oregon 550 handheld GPS, using GDA94 Datum. The co-ordinates have an accuracy of +/- 5m. These locations are also shown on site plan in ***Appendix B***.

Disturbed sample (Ds<3kg) was sampled from the relevant borehole and returned to the Laboratory where chemical soil testing was undertaken to assess the corrosivity of the soil. The borehole logs are attached in ***Appendix C***.

4.0 GENERAL SUB-SURFACE CONDITIONS

4.1 Fill

A 0.02m thick layer of asphalt overlaying fill was encountered at both the boreholes. The fill consisted of sandy silt and silty gravel.

4.2 Sub-Soil

Alluvial soils were encountered throughout the boreholes. These generally comprised of slightly moist to wet silts and clays to depths as shown in the borelogs attached in ***Appendix C***.

4.3 Regional Geology

Reference to the Bathurst, New South Wales 1:250,000 Geological Series Sheet SI/55-8 indicates the surrounding area consists of "*Alluvium; gravel, sand, silt, clay*".

Rock was not encountered during our investigation.

4.4 Seismicity

Reference is made to AS1170.4-2007 as per clause 4.1.1 the sites sub-soil class is "C_e – Shallow Sub-soil".

5.0 LABORATORY TESTING

Disturbed samples were taken during the field investigation. Laboratory testing was carried out on selected samples of all different material types, with details of the sampling and testing shown below:

5.1 Soil Index Properties

Soil Index Properties testing were carried out on samples to aid in classification of the soils encountered and to assist in determining design parameters. This testing included:

Table 2: Summary of Laboratory Testing

Test	Test Method	Quantity	Notes	Sample Type
Atterberg Limits	AS1289 3.1.2 & 3.2.1 & 3.3.1 & AS 1289.3.4.1	12	General classification of soils for material assessment	Disturbed
Chemical Testing	APHA 4500-H+, APHA 2510 & APHA 4110-B	2	Bridge Footings	Disturbed

Disturbed samples were taken during the field investigation. Laboratory testing was carried out on selected samples of all different material types, with details of the sampling and testing shown below:

5.2 Atterberg Limits Testing (LS, LL, PI)

The Plasticity Limit results are summarised in the below table:

Table 3: Atterberg Limits Results (LS, LL, PI):

Borehole No.	Location	Depth (m)	Liquid Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)
1	Western Bridge Abutment	1.5	29	19	10.0
1	Western Bridge Abutment	3.0	40	30	9.5
1	Western Bridge Abutment	4.5	32	19	10.5
1	Western Bridge Abutment	6.0	31	18	11.0
1	Western Bridge Abutment	7.5	43	29	14.0
2	Eastern Bridge Abutment	1.5	23	6	3.0
2	Eastern Bridge Abutment	3.0	15	6	1.0
2	Eastern Bridge Abutment	4.5	25	18	7.5
2	Eastern Bridge Abutment	6.0	28	16	9.5
2	Eastern Bridge Abutment	7.5	22	11	8.0
2	Eastern Bridge Abutment	9.0	37	25	12.5
2	Eastern Bridge Abutment	10.5	41	19	14.0

Cohesive soils with a Plasticity Index range of 11-27% are likely to be moderately reactive to moisture change. Cohesive soils with a Plasticity Index range of 27-35% are likely to be highly reactive to moisture change.

5.3 Soil Aggressivity

Aggressivity testing was carried out by Envirolab (reference Certificate of analysis 316563) on samples. The results of this testing are contained in APPENDIX D. The aggressivity results taken from this report are as below:

Table 4: Aggressivity Testing (ref cert 316563 by Envirolab)

Misc Inorg - Soil			
Our Reference		316563-1	316563-2
Your Reference	UNITS	BH1	BH2
Depth		0.5	0.7
Date Sampled		13/02/2023	13/02/2023
Type of sample		Soil	Soil
Date prepared	-	20/02/2023	20/02/2023
Date analysed	-	20/02/2023	20/02/2023
pH 1:5 soil:water	pH Units	7.6	7.9
Electrical Conductivity 1:5 soil:water	µS/cm	270	90
Chloride, Cl 1:5 soil:water	mg/kg	47	10
Sulphate, SO4 1:5 soil:water	mg/kg	39	32

For the purpose of assessing minimum concrete cover requirements or steel corrosion rates, the pile designer can compare the results presented in Appendix D with the exposure classification criteria presented in AS2159-2009: Piling – Design and Installation, Table 6.4.2 (C) and Table 6.5.2 (C) and AS5100.5: Bridge Design - Concrete.

6.0 DESIGN PARAMETERS DISCUSSIONS

6.1 Geotechnical Design Parameters

Due to the presence of very stiff soils at depths of the proposed bridge site, the recommended bridge footings are to use either steel or concrete driven piles. Concrete cast in situ piles could also be used, however the bore hole may not stay intact during excavation due to the water table found at 6.4m depth in borehole no.2. Temporary or permanent casing would be needed to support the boreholes if bored cast in situ concrete piers are to be used.

The design parameters for use of driven piles into ground are presented below:

Table 5: Geotechnical Design Values –Driven Pile Footings

Unit	Location and Depth	Material Name	Design SPT (N)	Ultimate Bearing Capacity (kPa)	Ultimate skin Friction (kPa)	Ultimate skin friction (tension)	Modulus of Elasticity Vertical (MPa)	Ultimate Shear Strength Parameters
1A	BH2 (east abutment) 0.7m to 4.5m	Silty Clay Firm	5	225	25	12	8.5	Cu=25kPa
1B	BH 2(East abutment) 4.5m to 9.5m	Sandy Clay, Stiff	10	900	50	25	25	Cu = 100kPa
1C	BH1(west abutment) 1.5m to 8m BH2 (East abutment) 9.5m to 10.5m	Sandy clay Hard	21	1800	75	37	35	Cu=200kPa

The above values have been determined based on the 1992 Austroads Bridge Design Code, Section 3: Foundations, Commentary. Values must be factored by geotechnical reduction factor, refer below.

6.2 Design Parameter Notes:

- The ultimate skin friction values assume that any gap between a prefabricated pile and the pile hole is backfilled with concrete.

- A geotechnical strength reduction factor needs to be applied to the above values. Refer section 6.3 below.

- Pile ultimate base bearing capacities are based on pile length / diameter being greater than 4 and piles of a minimum of 4.5m depth. Shallower depth bearing capacities are provided for completeness only and are not to be used for shallow foundations.

6.3 Geotechnical Reduction factor

In accordance with AS2159 and AS5100.3, a geotechnical reduction factor must be applied to the ultimate values presented in table 4. The selection of the strength reduction factor (ϕg) will be dependent on the specified pile testing.

Based on the extent of the current investigation and uniformity of material encountered, a geotechnical strength reduction factor of ϕg=0.52 is recommended for the bridge footings as per the assessment requirement of AS 2159 and AS5100.3. A higher value may be applied if in place testing is undertaken.

6.4 Construction Considerations – Footings

Contractors should make their own assessment of pile driving, drilling / excavation equipment required to penetrate the soil. Pre-boring for driven piles may be required to achieve sufficient embedment depths to provide lateral load capacity. Temporary or permanent casing will be required to support bored pile holes through sand layers. Contractors should make their own assessment as to the type of casing.

For bored piles, the base of the pile or footing should be cleaned using a suitable pile cleaning tool to remove the spoil remaining after augering and to limit pile settlement, if cast in situ concrete piers are used.

We recommend that a suitably qualified experienced Geotechnical Engineer assess the pile foundations during construction to check that the ground conditions are as advised by this report.

6.5 Temporary Piling Platforms

Temporary working platforms at the bridge abutments are expected to be required. The design of the working platforms should account for the following:

- The geometry and loadings of the proposed piling rig
- The contractor's construction methodology
- Temporary stability of the abutments

7.0 CONCLUSION

The testing methods adopted are indicative of the site's sub-surface conditions to the depths excavated and to specific sampling and/or testing locations in this investigation, and only at the time the work was carried out.

The accuracy of geotechnical engineering advice provided in this report may be limited by unobserved variations in ground conditions across the site in areas between and beyond test locations and by any restrictions in the sampling and testing which was able to be carried out, as well as by the amount of data that could be collected given the project and site constraints.

These factors may lead to the possibility that actual ground conditions and materials behaviour observed at the test locations may differ from those which may be encountered elsewhere on the site.

If the sub-surface conditions are found to differ from those described in this report, we should be informed immediately to evaluate whether recommendations should be reviewed and amended if necessary.

Appendix A - General Notes

GEOTECHNICAL INVESTIGATION GENERAL NOTES

This report contains the results of a geotechnical investigation conducted for a specific purpose and client. The results should not be used by other parties, or for other purposes, as they may contain neither adequate nor appropriate information. In particular, the investigation does not cover contamination issues unless specifically required to do so by the client.

TEST HOLE LOGGING

The information on the test hole logs (boreholes, test pits, exposures etc.) is based on a visual and tactile assessment, except at the discrete locations where the test information is available (field and/or laboratory results). The borehole logs include both factual data and inferred information. Reference should be made to the relevant sheets for the explanation of logging procedures (Soil and Rock Descriptions, Core Log Sheet Notes etc).

GROUNDWATER

Unless otherwise indicated, the water levels presented on the borehole logs are the levels of free water or seepage in the bore hole recorded at the given time of measuring. The actual groundwater level may differ from this recorded level depending on material permeability's (i.e. depending on response time of the measuring instrument). Further, variations of this level could occur with time due to such effects as seasonal, environmental and tidal fluctuations or construction activities. Confirmation of groundwater levels, phreatic surfaces or piezometric pressures can only be made by appropriate instrumentation techniques and monitoring programmes.

INTERPRETATION OF RESULTS

The discussion or recommendations contained within this report normally are based on a site evaluation from discrete borehole area. Generalised, idealised or inferred subsurface conditions (including any geotechnical cross-sections) have been assumed or prepared by interpolation and/or extrapolation of these data. As such these conditions are an interpretation and must be considered as a guide only.

CHANGE IN CONDITIONS

Local variations or anomalies in the generalised ground conditions do occur in the natural environment, particularly between discrete borehole locations. Additionally, certain design or construction procedures may have been assumed in assessing the soil-structure interaction behaviour of the site. Furthermore, conditions may change at the site from those encountered at the time of the geotechnical investigation through construction activities and constantly changing natural forces.

Any change in design, in construction methods, or in ground conditions as noted during construction, from those assumed or reported should be referred to this firm for appropriate assessment and comment.

GEOTECHNICAL VERIFICATION

Verification of the geotechnical assumptions and/or model is an integral part of the design process – investigation, construction verification and performance monitoring. Variability is a feature of the natural environment and, in many instances, verification of soil or rock quality, or foundation levels are required. There may be a requirement to extend foundation depths to modify a foundation system or to conduct monitoring as a result of this natural variability. Allowance for verification by geotechnical personnel accordingly should be recognised and programmed during construction.

FOUNDATIONS

Where referred to in the report, the soil or rock quality, or the recommendation depth of any foundation (piles, caissons footings etc.) is an engineering estimate. The estimate is influenced and perhaps limited, by the fieldwork method and testing carried out in connection with the site investigation, and other pertinent information as has been made available. The material quality and/or foundation depth remains, however, an estimate and therefore liable to variation. Foundation drawings, designs and specifications should provide for variations in the final depth, depending upon the ground conditions at each point of support, and allow for geotechnical verification.

REPRODUCTION OF REPORTS

Where it is desired to reproduce the information contained in our geotechnical report, or other technical information, for the inclusion in contract documents or engineering specification of the subject development, such reproductions should include at least all of the relevant test hole and test data, together with the appropriate standard description sheets and remarks made in the written report of a factual or descriptive nature.

Reports are the subject of copyright and shall not be reproduced either totally or in part without the express permission of this firm.

ROCK

Rock Strength

Rock strength is a scale of strength, based on point load index testing, or field testing.

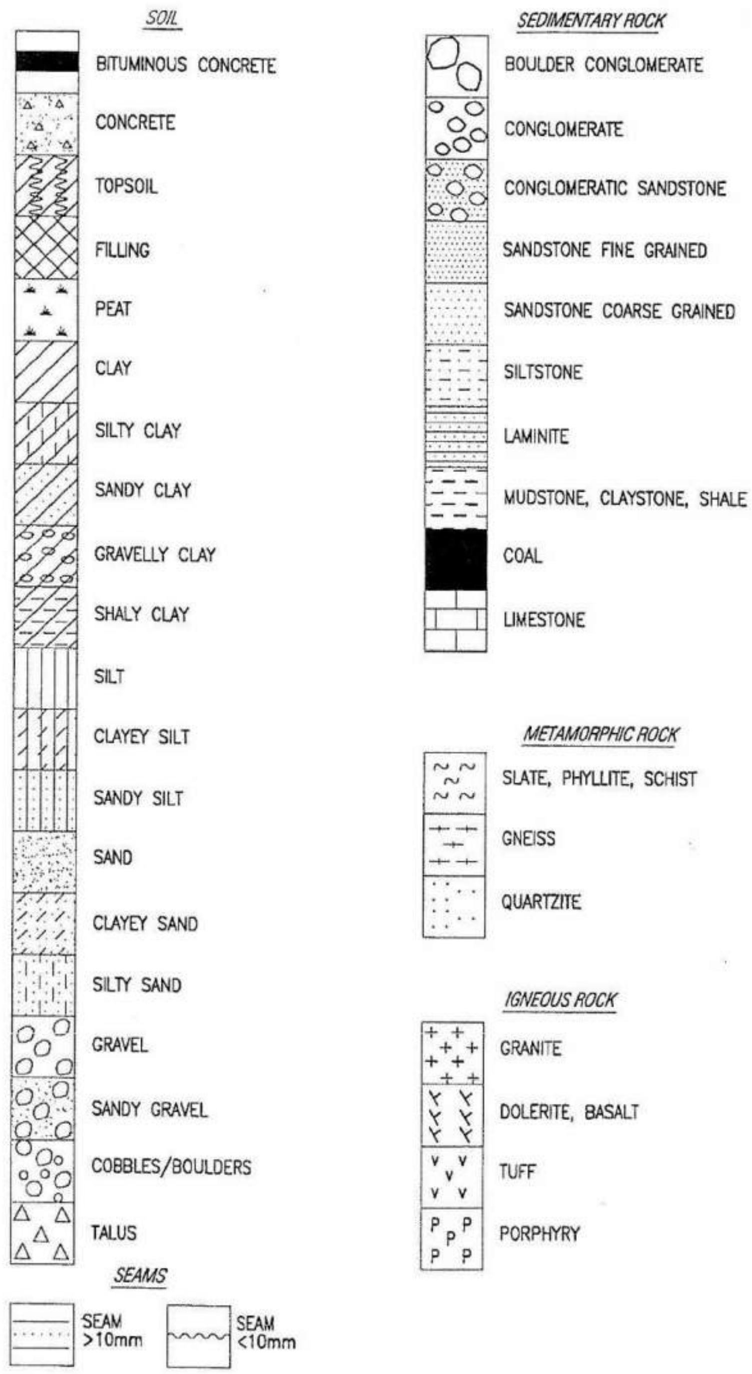
Term	Letter Symbol	Point load index (MPa) Is (50)	Field guide to strength
Extremely low	EL	< 0.03	Easily remoulded by hand to a material with soil properties.
Very low	VL	0.03 – 0.1	Material crumbles under firm blows with sharp end of pick.
Low	L	0.1 – 0.3	Easily scored by knife, has dull sound under hammer.
Medium	M	0.3 – 1.0	Readily scored with knife, core pieces broken by hand with difficulty
High	H	1 – 3	Rock rings under hammer, core piece broken by pick only.
Very high	VH	3 – 10	Hand specimen breaks with pick after more than one blow.
Extremely high	EH	> 10	Hand specimen breaks with pick after several than one blow.

Rock Weathering

Rock weathering is the degree of rock weathering, determined in the field.

Term	Letter Symbol	Definition
Residual soil	RS	Soil developed on extremely weathered rock.
Extremely weathered rock	XW	Soil is weathered to such an extent that it has soil properties, i.e. it disintegrates or can be remoulded in water.
Distinctly weathered rock	DW	Rock strength usually changed by weathering. The rock may be discoloured, usually by iron staining, porosity is increased.
Slightly weathered rock	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh rock	FR	Rock shows no sign of decomposition or staining.

GRAPHIC SYMBOLS FOR SOIL & ROCK



Appendix B - Site Plan with Borehole Locations


BH1
BH2

Appendix C - Borehole Logs

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Barnson
1/36 Darling Street
Dubbo NSW 2830
Telephone: 1300 BARNSON

BOREHOLE NUMBER 1

CLIENT Cabonne Council
PROJECT NAME Geotechnical Investigation
PROJECT NUMBER 40887
PROJECT LOCATION Nyrang Creek Bridge, Nyrang Creek NSW

DATE STARTED 13/2/23 **COMPLETED** 13/2/23
R.L. SURFACE
LONGITUDE ---
DRILLING CONTRACTOR Barnson
SLOPE 90°
LATITUDE ---
EQUIPMENT Drill Rig CEDR00917
HOLE LOCATION Borehole 1
HOLE SIZE 90mm
LOGGED BY GW
CHECKED BY NR
NOTES

Method	Samples	Depth (m)	Graphic Log	Classification Symbol	Material Description	SPT Results	Additional Observations
Open-drive samplers - thin-walled		0			ASPHALT		ASPHALT
					Sandy SILT: with gravel: pink: slightly moist: stiff: low plasticity		FILL
				CL	Sandy Silty CLAY: brown: slightly moist: very stiff: medium plasticity		ALLUVIAL
	Disturbed Sample LS = 10.0% PI = 19%	1–2				SPT = 4, 9, 12 N=21	
	Disturbed Sample LS = 9.5% PI = 30%	3				SPT = 5, 9, 12 N=21	
				CL	Silty CLAY: trace gravel: brown: slightly moist: very stiff to hard: medium plasticity		ALLUVIAL
	Disturbed Sample LS = 10.5% PI = 19%	4–5				SPT = 7, 12, 14 N=26	
	Disturbed Sample LS = 11.0% PI = 18%	6				SPT = 8, 12, 16 N=28	
	Disturbed Sample LS = 14% PI = 29%	7–8				SPT = 9, 15, 21 N=36	
		8			Borehole 1 terminated at 8m		

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11

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1/36 Darling Street
Dubbo NSW 2830
Telephone: 1300 BARNSON

BOREHOLE NUMBER 2

CLIENT Cabonne Council
PROJECT NAME Geotechnical Investigation
PROJECT NUMBER 40887
PROJECT LOCATION Nyrang Creek Bridge, Nyrang Creek NSW

DATE STARTED 13/2/23 **COMPLETED** 13/2/23
R.L. SURFACE
LONGITUDE ---
DRILLING CONTRACTOR Barnson
SLOPE 90°
LATITUDE ---
EQUIPMENT Drill Rig CEDR00917
HOLE LOCATION Borehole 2
HOLE SIZE 90mm
LOGGED BY GW
CHECKED BY NR
NOTES

Method	Samples	Depth (m)	Graphic Log	Classification Symbol	Material Description	SPT Results	Additional Observations
Open-drive samplers - thin-walled					ASPHALT		ASPHALT
					Silty GRAVEL: grey: slightly moist: dense: low plasticity		FILL
	Disturbed Sample LS = 3.0% PI = 6%; Disturbed Sample LS = 1.0% PI = 6%	0.7		CL	Sandy Silty CLAY: trace gravel: brown: slightly moist: stiff: low to medium plasticity	SPT = 5, 4, 7 N=11; SPT = 1, 1, 1 N=2	ALLUVIAL
	Disturbed Sample LS = 7.5% PI = 18%	3.1		ML	Clayey SILT: brown: wet: soft: medium plasticity	SPT = 3, 3, 3 N=6	ALLUVIAL
	Disturbed Sample LS = 9.5% PI = 16%; Disturbed Sample LS = 8.0% PI = 11%; Disturbed Sample LS = 12.5% PI = 25%			CL	Sandy CLAY: trace gravel: grey mottled orange: wet: firm to very stiff: medium to high plasticity	SPT = 3, 3, 5 N=8; SPT = 4, 4, 6 N=10; SPT = 6, 7, 10 N=17	ALLUVIAL; STANDING WATER LEVEL AT 6.4m
	Disturbed Sample LS = 14.0% PI = 19%			CL	Sandy CLAY: trace gravel: grey mottled orange: slightly moist: hard: medium to high plasticity	SPT = 12, 19 25 at 130mm	ALLUVIAL
					Borehole 2 terminated at 10.5m		

Appendix D - NATA Laboratory Reports

Material Test Report

Report Number:	**40887-1**
Issue Number:	1
Date Issued:	03/03/2023
Client:	Cabonne Council
	P.O. Box 17, Molong NSW 2866
Contact:	Azeem Afzal
Project Number:	40887
Project Name:	Bridge Investigation
Project Location:	Nyrang Creek Bridge, Nyrang Creek NSW
Work Request:	7666
Sample Number:	D23-7666A
Date Sampled:	14/02/2023
Dates Tested:	14/02/2023 - 23/02/2023
Sampling Method:	AS 1289.1.3.1 3.1.3.2 - Open-drive samplers - thin-walled sampler
Sample Location:	**Borehole 1, Depth: 1.5m**
Material:	Brown Sandy Silty CLAY

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Barnson Pty Ltd
Dubbo Laboratory
16 L Yarrandale Road Dubbo NSW 2830
Phone: 1300 BARNSON
Email: jeremy@barnson.com.au

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NATA WORLD RECOGNISED ACCREDITATION

Approved Signatory: Jeremy Wiatkowski
Geotechnical Technician
NATA Accredited Laboratory Number: 9605

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	29		
Plastic Limit (%)	10		
Plasticity Index (%)	**19**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	**10.0**		
Cracking Crumbling Curling	Curling		

Material Test Report

Report Number:	**40887-1**
Issue Number:	1
Date Issued:	03/03/2023
Client:	Cabonne Council P.O. Box 17, Molong NSW 2866
Contact:	Azeem Afzal
Project Number:	40887
Project Name:	Bridge Investigation
Project Location:	Nyrang Creek Bridge, Nyrang Creek NSW
Work Request:	7666
Sample Number:	D23-7666B
Date Sampled:	14/02/2023
Dates Tested:	14/02/2023 - 20/02/2023
Sampling Method:	AS 1289.1.3.1 3.1.3.2 - Open-drive samplers - thin-walled sampler
Sample Location:	**Borehole 1, Depth: 3.0m**
Material:	Brown Sandy Silty CLAY

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Barnson Pty Ltd
Dubbo Laboratory
16 L Yarrandale Road Dubbo NSW 2830
Phone: 1300 BARNSON
Email: jeremy@barnson.com.au

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Approved Signatory: Jeremy Wiatkowski
Geotechnical Technician
NATA Accredited Laboratory Number: 9605

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	40		
Plastic Limit (%)	10		
Plasticity Index (%)	**30**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	**9.5**		
Cracking Crumbling Curling	Curling		

Material Test Report

Report Number:	**40887-1**
Issue Number:	1
Date Issued:	03/03/2023
Client:	Cabonne Council
	P.O. Box 17, Molong NSW 2866
Contact:	Azeem Afzal
Project Number:	40887
Project Name:	Bridge Investigation
Project Location:	Nyrang Creek Bridge, Nyrang Creek NSW
Work Request:	7666
Sample Number:	D23-7666C
Date Sampled:	14/02/2023
Dates Tested:	14/02/2023 - 20/02/2023
Sampling Method:	AS 1289.1.3.1 3.1.3.2 - Open-drive samplers - thin-walled sampler
Sample Location:	**Borehole 1, Depth: 4.5m**
Material:	Brown Silty CLAY Trace Gravel

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Barnson Pty Ltd
Dubbo Laboratory
16 L Yarrandale Road Dubbo NSW 2830
Phone: 1300 BARNSON
Email: jeremy@barnson.com.au

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Approved Signatory: Jeremy Wiatkowski
Geotechnical Technician

NATA Accredited Laboratory Number: 9605

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	32		
Plastic Limit (%)	13		
Plasticity Index (%)	**19**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	**10.5**		
Cracking Crumbling Curling	Cracking & Curling		

Material Test Report

Report Number:	**40887-1**
Issue Number:	1
Date Issued:	03/03/2023
Client:	Cabonne Council P.O. Box 17, Molong NSW 2866
Contact:	Azeem Afzal
Project Number:	40887
Project Name:	Bridge Investigation
Project Location:	Nyrang Creek Bridge, Nyrang Creek NSW
Work Request:	7666
Sample Number:	D23-7666D
Date Sampled:	14/02/2023
Dates Tested:	14/02/2023 - 20/02/2023
Sampling Method:	AS 1289.1.3.1 3.1.3.2 - Open-drive samplers - thin-walled sampler
Sample Location:	**Borehole 1, Depth: 6.0m**
Material:	Brown Silty CLAY Trace Gravel

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Barnson Pty Ltd
Dubbo Laboratory
16 L Yarrandale Road Dubbo NSW 2830
Phone: 1300 BARNSON
Email: jeremy@barnson.com.au

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Approved Signatory: Jeremy Wiatkowski
Geotechnical Technician

NATA Accredited Laboratory Number: 9605

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	31		
Plastic Limit (%)	13		
Plasticity Index (%)	**18**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	**11.0**		
Cracking Crumbling Curling	Cracking & Curling		

Material Test Report

Report Number:	**40887-1**
Issue Number:	1
Date Issued:	03/03/2023
Client:	Cabonne Council P.O. Box 17, Molong NSW 2866
Contact:	Azeem Afzal
Project Number:	40887
Project Name:	Bridge Investigation
Project Location:	Nyrang Creek Bridge, Nyrang Creek NSW
Work Request:	7666
Sample Number:	D23-7666E
Date Sampled:	14/02/2023
Dates Tested:	14/02/2023 - 23/02/2023
Sampling Method:	AS 1289.1.3.1 3.1.3.2 - Open-drive samplers - thin-walled sampler
Sample Location:	**Borehole 1, Depth: 7.5m**
Material:	Brown Silty CLAY Trace Gravel

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Barnson Pty Ltd
Dubbo Laboratory
16 L Yarrandale Road Dubbo NSW 2830
Phone: 1300 BARNSON
Email: jeremy@barnson.com.au

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Geotechnical Technician
NATA Accredited Laboratory Number: 9605

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	43		
Plastic Limit (%)	14		
Plasticity Index (%)	**29**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	**14.0**		
Cracking Crumbling Curling	Curling		

Material Test Report

Report Number:	**40887-1**
Issue Number:	1
Date Issued:	03/03/2023
Client:	Cabonne Council
	P.O. Box 17, Molong NSW 2866
Contact:	Azeem Afzal
Project Number:	40887
Project Name:	Bridge Investigation
Project Location:	Nyrang Creek Bridge, Nyrang Creek NSW
Work Request:	7666
Sample Number:	D23-7666F
Date Sampled:	14/02/2023
Dates Tested:	14/02/2023 - 27/02/2023
Sampling Method:	AS 1289.1.3.1 3.1.3.2 - Open-drive samplers - thin-walled sampler
Sample Location:	**Borehole 2, Depth: 1.5m**
Material:	Brown Sandy Silty CLAY Trace Gravel

Barnson Pty Ltd
Dubbo Laboratory
16 L Yarrandale Road Dubbo NSW 2830
Phone: 1300 BARNSON
Email: jeremy@barnson.com.au

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Approved Signatory: Jeremy Wiatkowski
Geotechnical Technician

NATA Accredited Laboratory Number: 9605

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	23		
Plastic Limit (%)	17		
Plasticity Index (%)	**6**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	**3.0**		
Cracking Crumbling Curling	Cracking		

Material Test Report

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Dubbo Laboratory
16 L Yarrandale Road Dubbo NSW 2830
Phone: 1300 BARNSON
Email: jeremy@barnson.com.au

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Approved Signatory: Jeremy Wiatkowski
Geotechnical Technician
NATA Accredited Laboratory Number: 9605

Report Number:	**40887-1**
Issue Number:	1
Date Issued:	03/03/2023
Client:	Cabonne Council P.O. Box 17, Molong NSW 2866
Contact:	Azeem Afzal
Project Number:	40887
Project Name:	Bridge Investigation
Project Location:	Nyrang Creek Bridge, Nyrang Creek NSW
Work Request:	7666
Sample Number:	D23-7666G
Date Sampled:	14/02/2023
Dates Tested:	14/02/2023 - 24/02/2023
Sampling Method:	AS 1289.1.3.1 3.1.3.2 - Open-drive samplers - thin-walled sampler
Sample Location:	**Borehole 2, Depth: 3.0m**
Material:	Brown Sandy Silty CLAY Trace Gravel

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	15		
Plastic Limit (%)	9		
Plasticity Index (%)	**6**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	**1.0**		
Cracking Crumbling Curling	Cracking		

Material Test Report

Report Number:	**40887-1**
Issue Number:	1
Date Issued:	03/03/2023
Client:	Cabonne Council
	P.O. Box 17, Molong NSW 2866
Contact:	Azeem Afzal
Project Number:	40887
Project Name:	Bridge Investigation
Project Location:	Nyrang Creek Bridge, Nyrang Creek NSW
Work Request:	7666
Sample Number:	D23-7666H
Date Sampled:	14/02/2023
Dates Tested:	14/02/2023 - 24/02/2023
Sampling Method:	AS 1289.1.3.1 3.1.3.2 - Open-drive samplers - thin-walled sampler
Sample Location:	**Borehole 2, Depth: 4.5m**
Material:	Brown Clayey SILT

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Barnson Pty Ltd
Dubbo Laboratory
16 L Yarrandale Road Dubbo NSW 2830
Phone: 1300 BARNSON
Email: jeremy@barnson.com.au

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Approved Signatory: Jeremy Wiatkowski
Geotechnical Technician

NATA Accredited Laboratory Number: 9605

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	25		
Plastic Limit (%)	7		
Plasticity Index (%)	**18**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	**7.5**		
Cracking Crumbling Curling	Cracking & Curling		

Material Test Report

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Barnson Pty Ltd
Dubbo Laboratory
16 L Yarrandale Road Dubbo NSW 2830
Phone: 1300 BARNSON
Email: jeremy@barnson.com.au

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Approved Signatory: Jeremy Wiatkowski
Geotechnical Technician

NATA Accredited Laboratory Number: 9605

Report Number:	**40887-1**
Issue Number:	1
Date Issued:	03/03/2023
Client:	Cabonne Council P.O. Box 17, Molong NSW 2866
Contact:	Azeem Afzal
Project Number:	40887
Project Name:	Bridge Investigation
Project Location:	Nyrang Creek Bridge, Nyrang Creek NSW
Work Request:	7666
Sample Number:	D23-7666I
Date Sampled:	14/02/2023
Dates Tested:	14/02/2023 - 27/02/2023
Sampling Method:	AS 1289.1.3.1 3.1.3.2 - Open-drive samplers - thin-walled sampler
Sample Location:	**Borehole 2, Depth: 6.0m**
Material:	Grey Mottled Orange Sandy CLAY Trace Gravel

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	28		
Plastic Limit (%)	12		
Plasticity Index (%)	**16**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	**9.5**		
Cracking Crumbling Curling	Cracking & Curling		

Material Test Report

Report Number:	**40887-1**
Issue Number:	1
Date Issued:	03/03/2023
Client:	Cabonne Council P.O. Box 17, Molong NSW 2866
Contact:	Azeem Afzal
Project Number:	40887
Project Name:	Bridge Investigation
Project Location:	Nyrang Creek Bridge, Nyrang Creek NSW
Work Request:	7666
Sample Number:	D23-7666J
Date Sampled:	14/02/2023
Dates Tested:	14/02/2023 - 23/02/2023
Sampling Method:	AS 1289.1.3.1 3.1.3.2 - Open-drive samplers - thin-walled sampler
Sample Location:	**Borehole 2, Depth: 7.5m**
Material:	Grey Mottled Orange Sandy CLAY Trace Gravel

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Barnson Pty Ltd
Dubbo Laboratory
16 L Yarrandale Road Dubbo NSW 2830
Phone: 1300 BARNSON
Email: jeremy@barnson.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Jeremy Wiatkowski
Geotechnical Technician

NATA Accredited Laboratory Number: 9605

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	22		
Plastic Limit (%)	11		
Plasticity Index (%)	**11**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	**8.0**		
Cracking Crumbling Curling	Cracking & Curling		

Material Test Report

Report Number:	**40887-1**
Issue Number:	1
Date Issued:	03/03/2023
Client:	Cabonne Council
	P.O. Box 17, Molong NSW 2866
Contact:	Azeem Afzal
Project Number:	40887
Project Name:	Bridge Investigation
Project Location:	Nyrang Creek Bridge, Nyrang Creek NSW
Work Request:	7666
Sample Number:	D23-7666K
Date Sampled:	14/02/2023
Dates Tested:	14/02/2023 - 24/02/2023
Sampling Method:	AS 1289.1.3.1 3.1.3.2 - Open-drive samplers - thin-walled sampler
Sample Location:	**Borehole 2, Depth: 9.0m**
Material:	Grey Mottled Orange Sandy CLAY Trace Gravel

barnson.

Barnson Pty Ltd
Dubbo Laboratory
16 L Yarrandale Road Dubbo NSW 2830
Phone: 1300 BARNSON
Email: jeremy@barnson.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

NATA WORLD RECOGNISED ACCREDITATION

Approved Signatory: Jeremy Wiatkowski
Geotechnical Technician
NATA Accredited Laboratory Number: 9605

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	37		
Plastic Limit (%)	12		
Plasticity Index (%)	**25**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	**12.5**		
Cracking Crumbling Curling	Curling		

Material Test Report

Report Number:	**40887-1**
Issue Number:	1
Date Issued:	03/03/2023
Client:	Cabonne Council P.O. Box 17, Molong NSW 2866
Contact:	Azeem Afzal
Project Number:	40887
Project Name:	Bridge Investigation
Project Location:	Nyrang Creek Bridge, Nyrang Creek NSW
Work Request:	7666
Sample Number:	D23-7666L
Date Sampled:	14/02/2023
Dates Tested:	14/02/2023 - 27/02/2023
Sampling Method:	AS 1289.1.3.1 3.1.3.2 - Open-drive samplers - thin-walled sampler
Sample Location:	**Borehole 2, Depth: 10.5m**
Material:	Grey Mottled Orange Sandy CLAY Trace Gravel

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Dubbo Laboratory
16 L Yarrandale Road Dubbo NSW 2830
Phone: 1300 BARNSON
Email: jeremy@barnson.com.au

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NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Jeremy Wiatkowski
Geotechnical Technician

NATA Accredited Laboratory Number: 9605

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	41		
Plastic Limit (%)	22		
Plasticity Index (%)	**19**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	**14.0**		
Cracking Crumbling Curling	Cracking & Curling		

Appendix E – Environmental Testing Results

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 316563

Client Details	
Client	Barnson Pty Ltd
Attention	Gareth Williams
Address	Unit 1, Riverview Business Park, 36 Darling St, Dubbo, NSW, 2830

Sample Details	
Your Reference	**Cabonne Council-Nyrang Creek Bridge, Nyrang Creek**
Number of Samples	2 Soil
Date samples received	15/02/2023
Date completed instructions received	15/02/2023

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.

Report Details	
Date results requested by	22/02/2023
Date of Issue	21/02/2023

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Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By

Nancy Zhang, Laboratory Manager

Misc Inorg - Soil			
Our Reference		316563-1	316563-2
Your Reference	UNITS	BH1	BH2
Depth		0.5	0.7
Date Sampled		13/02/2023	13/02/2023
Type of sample		Soil	Soil
Date prepared	-	20/02/2023	20/02/2023
Date analysed	-	20/02/2023	20/02/2023
pH 1:5 soil:water	pH Units	7.6	7.9
Electrical Conductivity 1:5 soil:water	µS/cm	270	90
Chloride, Cl 1:5 soil:water	mg/kg	47	10
Sulphate, SO4 1:5 soil:water	mg/kg	39	32

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.

QUALITY CONTROL: Misc Inorg - Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			20/02/2023	[NT]	[NT]	[NT]	[NT]	20/02/2023	[NT]
Date analysed	-			20/02/2023	[NT]	[NT]	[NT]	[NT]	20/02/2023	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	100	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	107	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	100	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	104	[NT]

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.

The recommended maximums for analytes in urine are taken from "2018 TLVs and BEIs", as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

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: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-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.

Where matrix spike recoveries fall below the lower limit of the acceptance criteria (e.g. for non-labile or standard Organics <60%), positive result(s) in the parent sample will subsequently have a higher than typical estimated uncertainty (MU estimates supplied on request) and in these circumstances the sample result is likely biased significantly low.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Appendix B

Hydraulic Assessment Report

Our Ref: BKP406-CC-RPT-FL-02-01

15 June 2023
Y. Tang

Nyrang Bridge- Hydraulic Assessment

1. Introduction

The existing Nyrang bridge is a two-lane, single span bridge with an 8m span, and a deck level at RL 297.5m. The approaches behind abutments were washed out during a flood event in 2022, while the bridge structure remains.

As part of the concept consideration of replacement options, this memorandum report summarises flooding the analysis conducted to date.

2. Previous Analysis

Premise Pty Ltd had previously conducted a basic flood assessment considering various options for replacement with the results of this analysis summarised below.

Assumptions

- RORB model was used for the hydrological analysis.
- Critical Rainfall duration: 24 hr.
- Design rainfall by considering the climate change effect for RCP6 scenario and horizon year 2070 (i.e. increasing rate of 8.9%)= 79.9 128.5, and 142.7 mm for the events 20%, 2%, and 1% AEP, respectively.
- Loss Parameters : Storm Initial Losses 35 (mm) by considering the Median Pre-burst Depths for the critical rainfall duration (=24hr) of 0.2, 1.5, and 2.2 mm for the events 20%, 2%, and 1% AEP, respectively.
- Storm Continuing Losses= 2.4 x 0.4 = 0.96 (mm/h)
- Overland flow routing parameters: Kc=29.6, and m=0.8 which were confirmed with Runoff Coefficient obtained from the reference table (Ven Te Chow, 1988) and for AEP 20% the model result was in consistent with Regional Flood Frequency Estimation (RFFE) results.
- The average slope of the Nyrang Creek is obtained 0.26% from the DEM 5m throughout a reach of 1300 m downstream from the bridge and 1500 m upstream from the bridge (totally 2800 m).
- The roughness Manning's number was assumed to be 0.04.

Results

For the existing bridge situation(base case)

AEP	20%	10%	5%	2%	1%
ARI	4.5	9.5	20	50	100
Q	70.3	107.5	138.3	181.3	212.9
V	3.34	0.73	0.81	0.9	0.96
RL	297.48	297.98	298.03	298.1	298.14

The flood modelling was also carried out considering various structural options including:

- B1: New Bridge at 9m
- B2: New Bridge at 11m
- B3: New Bridge at 13m
- BC1: Keep Existing bridge and add 1 Cell Culvert 2.4x2.4
- BC2: Keep Existing bridge and add 2 Cell culvert 2.4x2.4
- BC3: Keep Existing bridge and add 3 Cell culvert 2.4x2.4
- BC4: Keep Existing bridge and add 4 Cell culvert 2.4x2.4
- C1: Completely Replace with 3 Cell Culvert 2.4x2.4
- C2: Completely Replace with 4 Cell Culvert 2.4x2.4
- C3: Completely Replace with 5 Cell Culvert 2.4x2.4
- C4:Completely Replace with 6 Cell Culvert 2.4x2.4
- C5:Completely Replace with 7 Cell Culvert 2.4x2.4
- C6:Completely Replace with 8 Cell Culvert 2.4x2.4

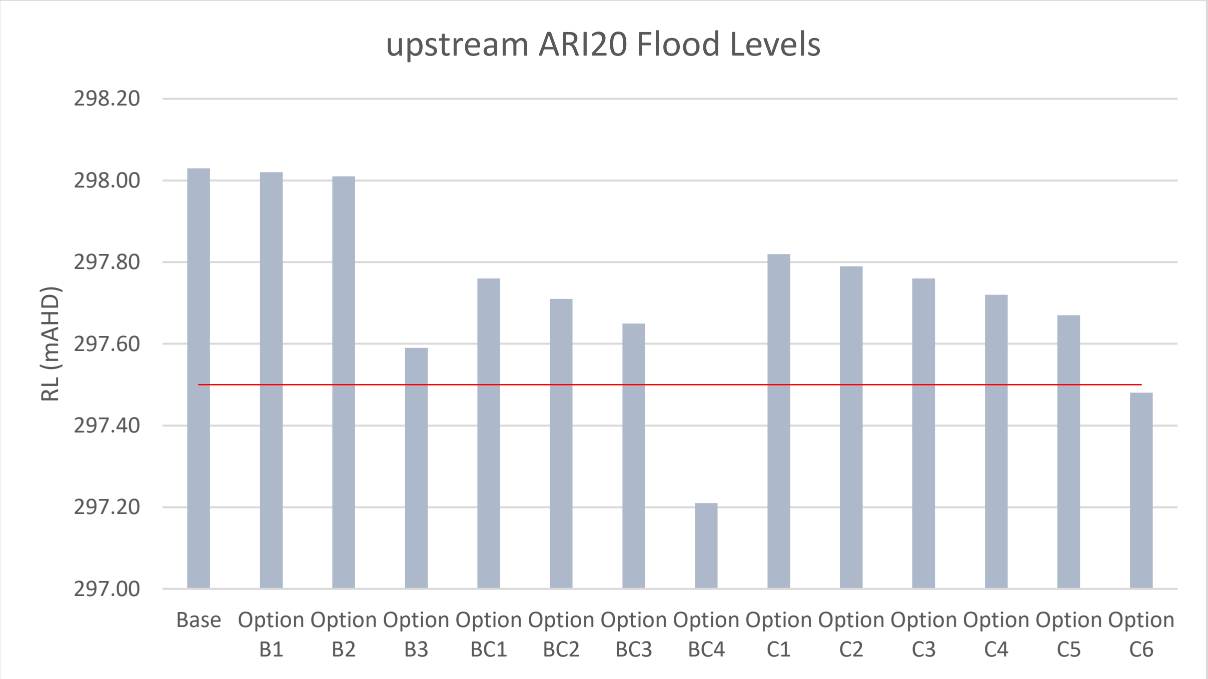


Figure 1 Flood Level Comparison of Options Considered

This red line indicates the level of the road and the figure indicates that during an ARI20 event the existing case is overtopped. A 13m bridge span greatly reduces the amount of water overtopping the bridge. Culverts restrict the flow unless a very large 4 cell culvert is build next to the existing bridge.

3. Further Analysis

Bridge Knowledge also carried out a high level one dimensional analysis to understand the velocities and levels up to ARI2000 which is needed for structural design of the bridge to AS5100.

Assumptions

A 1D HEC-RAS model was used with hydrology data sourced from ARR's Regional Flood Frequency Estimation (RFFE) Model 2015.

Flows for a range of events up to the 100-year ARI event were obtained from the RFFE Model 2015. The 50 and 100-year ARI events were then used to linearly extrapolate the flows up to the 2000-year ARI event. The flows are summarised in **Error! Reference source not found.** and are also illustrated in Figure 2.

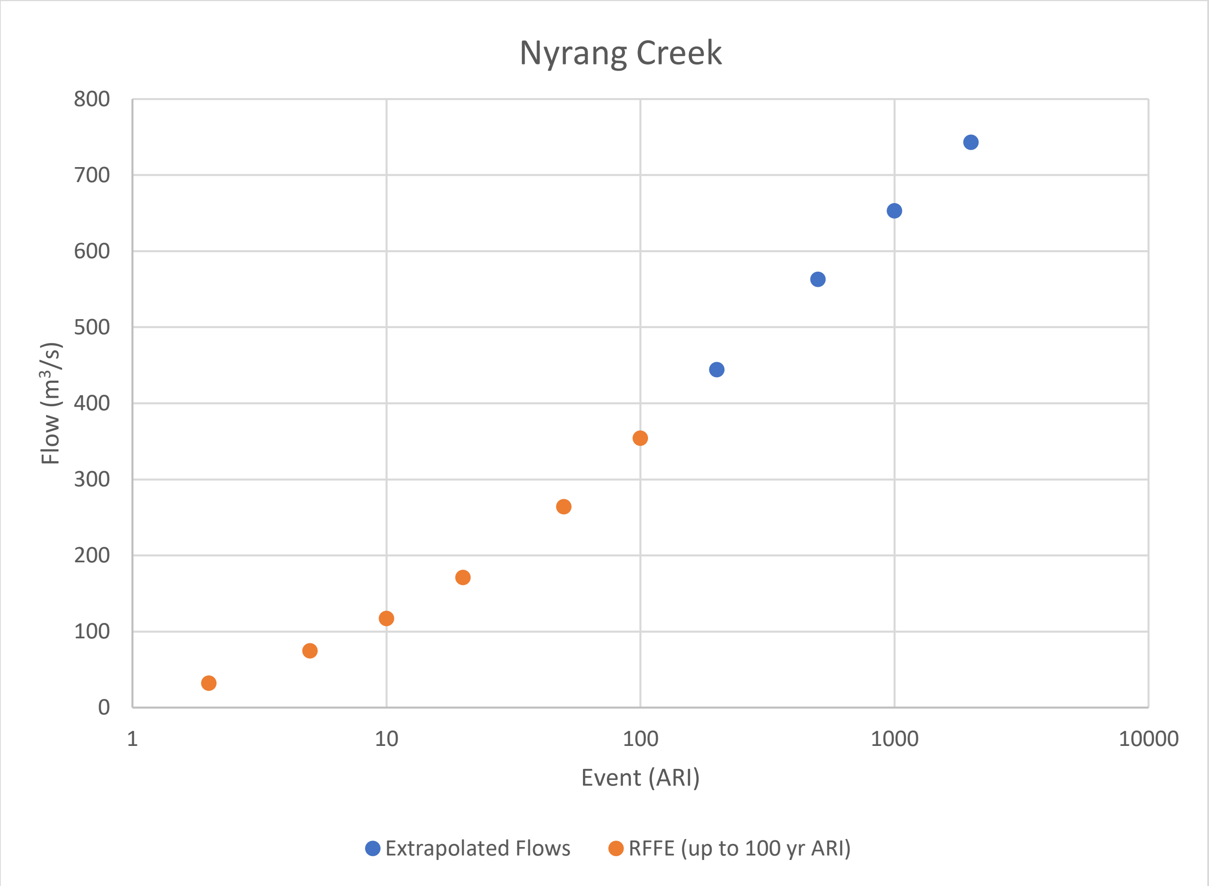


Figure 2: Flows up to 100-year ARI and extrapolated flows up to 2000-year ARI

The terrain data used in this analysis was sourced from a combination of survey data (Council provided) and Lidar data (5m).

The bridge was modelled by assuming the following dimensions:

- 9m width
- 12m single span
- Structural depth of 0.5m

The bridge deck level was modelled at 297.5m (survey datum), which matches the existing deck level.

Manning's n value is utilised in HEC-RAS to define the stream roughness. Manning's n values for the stream have been adopted from the Austroads Guide to Bridge Technology Part 8: Hydraulic Design of Waterway Structures – 2019 (AGBT Part 8), Table A2 as summarised in Table 1.

Table 1: Manning's n values

Location	Description	Value
Main channel	Irregular section, slight channel meander, some weed, heavy brush on banks.	0.07
Overbanks	Short grass.	0.03

Results

The cross-section at the bridge location is shown in Figure 3 which shows the flood levels for the modelled events and the long section of the bridge location is shown in Figure 4.

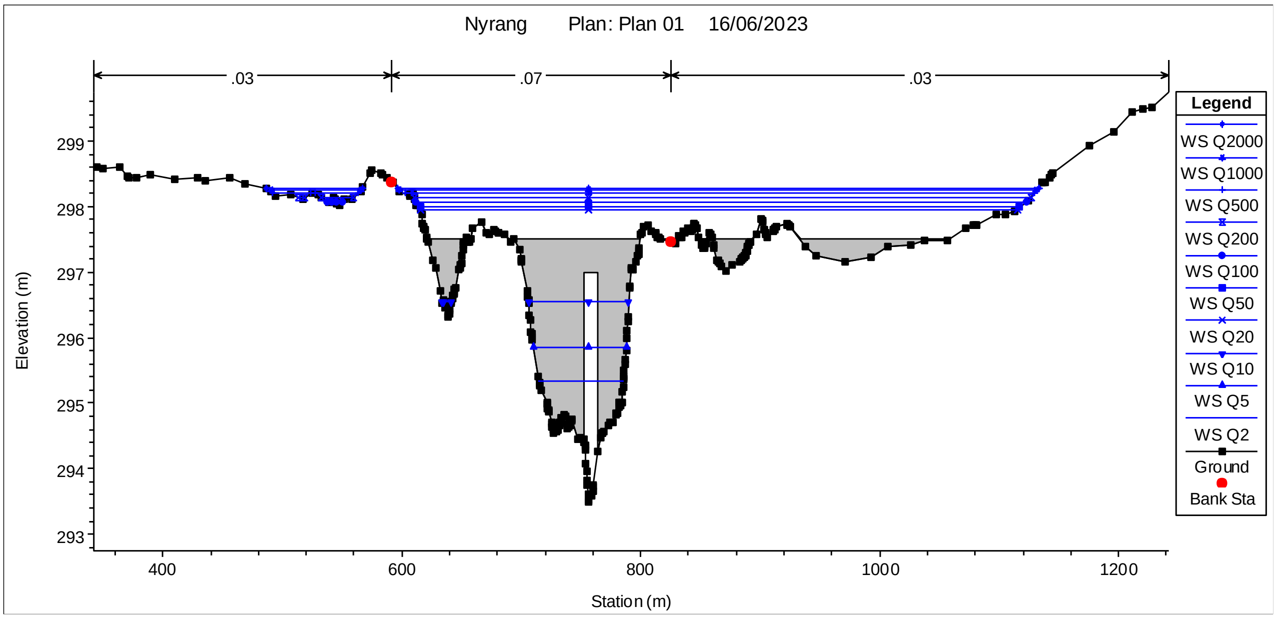


Figure 3: Cross-section showing flood levels

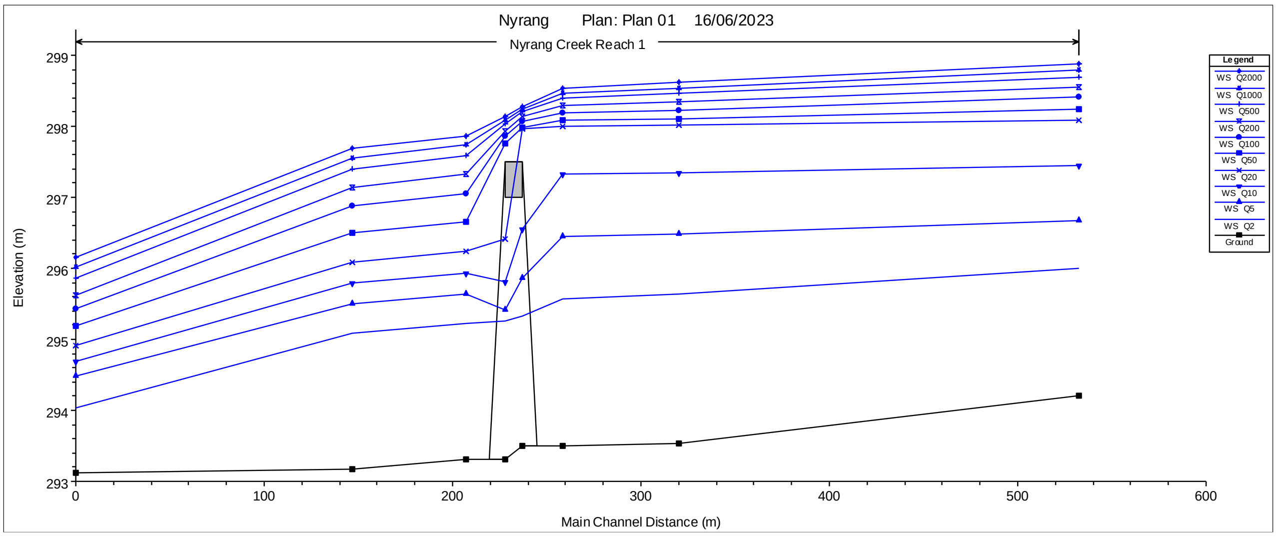


Figure 4: Long section showing flood levels

The velocities and flood levels are summarised in Table 2.

Table 2: Summary of flood assessment results

ARI	Flow (m3/s)	Velocity (m/s)	Flood Level (m AHD)
2	32	1.8	295.3
5	75	3.3	295.6
10	117	4.1	296.2
20	171	3.0	297.2
50	264	1.4	297.9
100	354	1.5	298.0
200	444	1.6	298.0
500	563	1.7	298.1
1000	653	1.8	298.2
2000	743	1.9	298.2

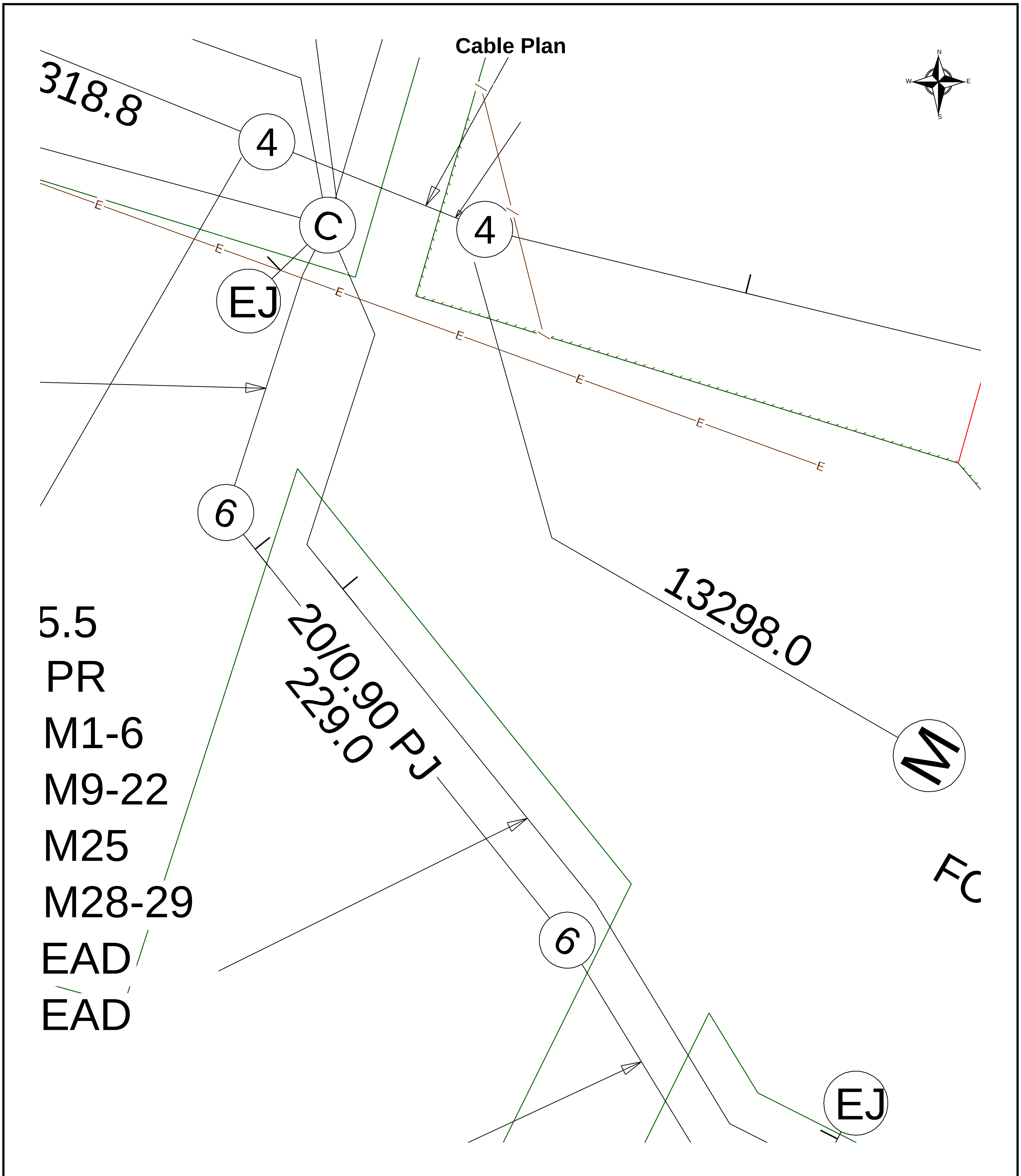
These results closely align with the previous analysis completed for option B3 which was a 13m span bridge, where under ARI20 the velocity was 3.8m/s and the level was 297.59m (compared to 3.0m/s and 297.2m).

Both analyses indicate that a longer bridge provides a significant reduction in flood immunity, and at 12m span ARI20 conveyance is satisfied.

Note that this hydraulic assessment has used a basic 1D HEC-RAS model and non-time-dependent RFFE flows to output velocities and flood levels that are appropriate for calculating flood loads on a bridge for the various ARI flood events. This assessment does not determine the extent of inundation, afflux changes or flood duration. If this information is required a two-dimensional model with time-dependent

Appendix C

BYDA Search



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CAUTION: Fibre optic and/ or major network present in plot area. Please read the Duty of Care and contact Telstra Plan Services should you require any assistance.

WARNING
Telstra plans and location information conform to Quality Level "D" of the Australian Standard AS 5488-Classification of Subsurface Utility Information.
As such,Telstra supplied location information is indicative only.Spatial accuracy is not applicable to Quality Level D.
Refer to AS 5488 for further details. The exact position of Telstra assets can only be validated by physically exposing it.
Telstra does not warrant or hold out that its plans are accurate and accepts no responsibility for any inaccuracy.
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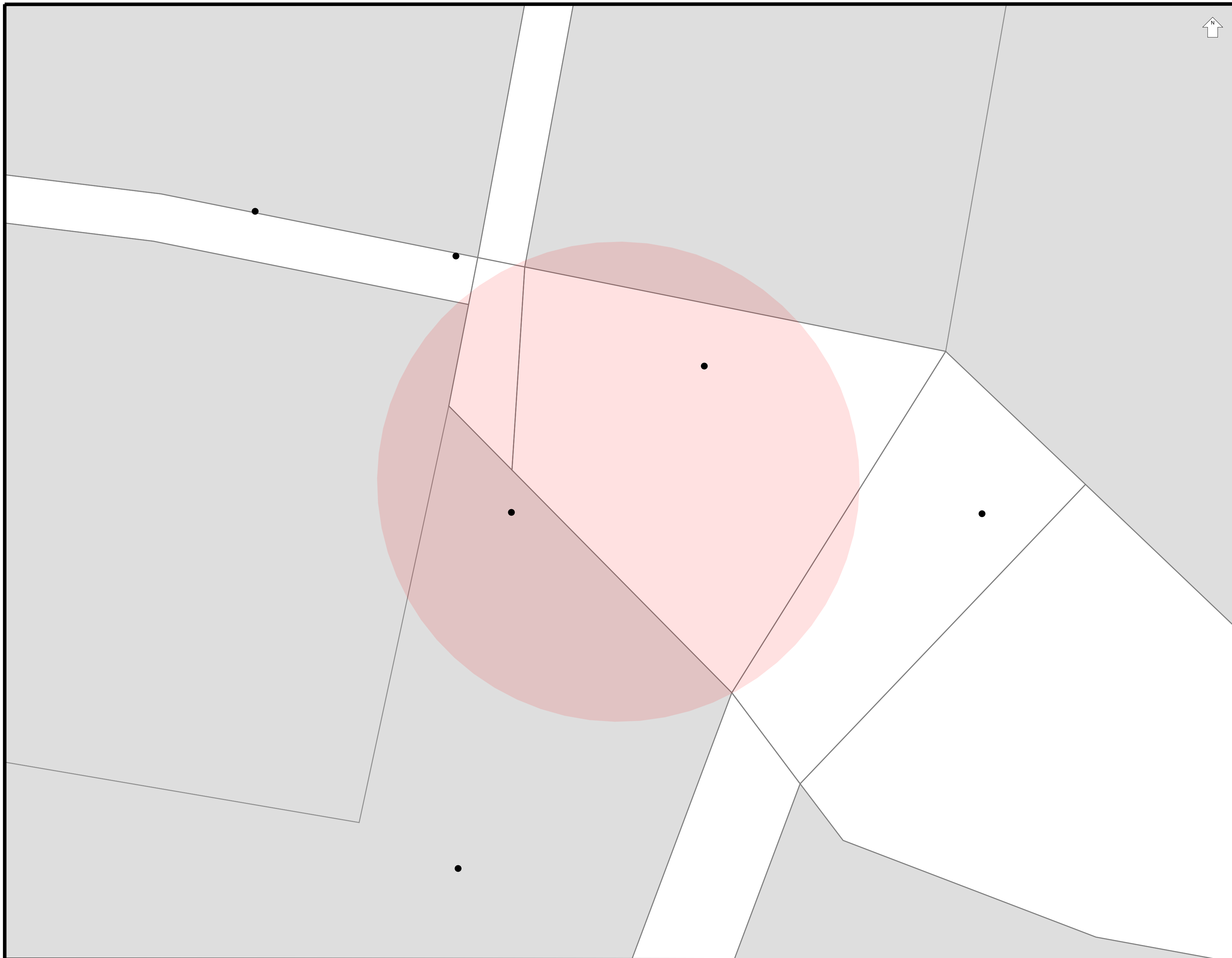
A Certified Locating Organisation is an essential part of the process to validate the exact location of Telstra assets and to ensure the asset is protected during construction works.

See the Steps- Telstra Duty of Care that was provided in the email response.



Overhead wires not shown
LOOK UP & LIVE!

LEGEND

- LV Underground Cable
- HV Underground Cable
- Underground Pipe
- Underground Earth or Wires
- Ground Substation
- Pole
- Cubicle
- Pit
- Area of Interest

Critical Assets

Contact Essential Energy on 13 23 91

- Zone Substation
- Underground Cable
- Underground Fibre

Proposed Works

- Area of proposed works

Proposed assets are shown as orange symbols

THE INFORMATION ON THIS MAP MAY NOT BE ACCURATE.
If details are incorrect, please notify Essential Energy on 13 23 91 (or fax 1800 354 636)

ISSUE DATE: 21/06/2023

You must resubmit your request if you have not started work within 4 weeks of the 'Issue Date' above

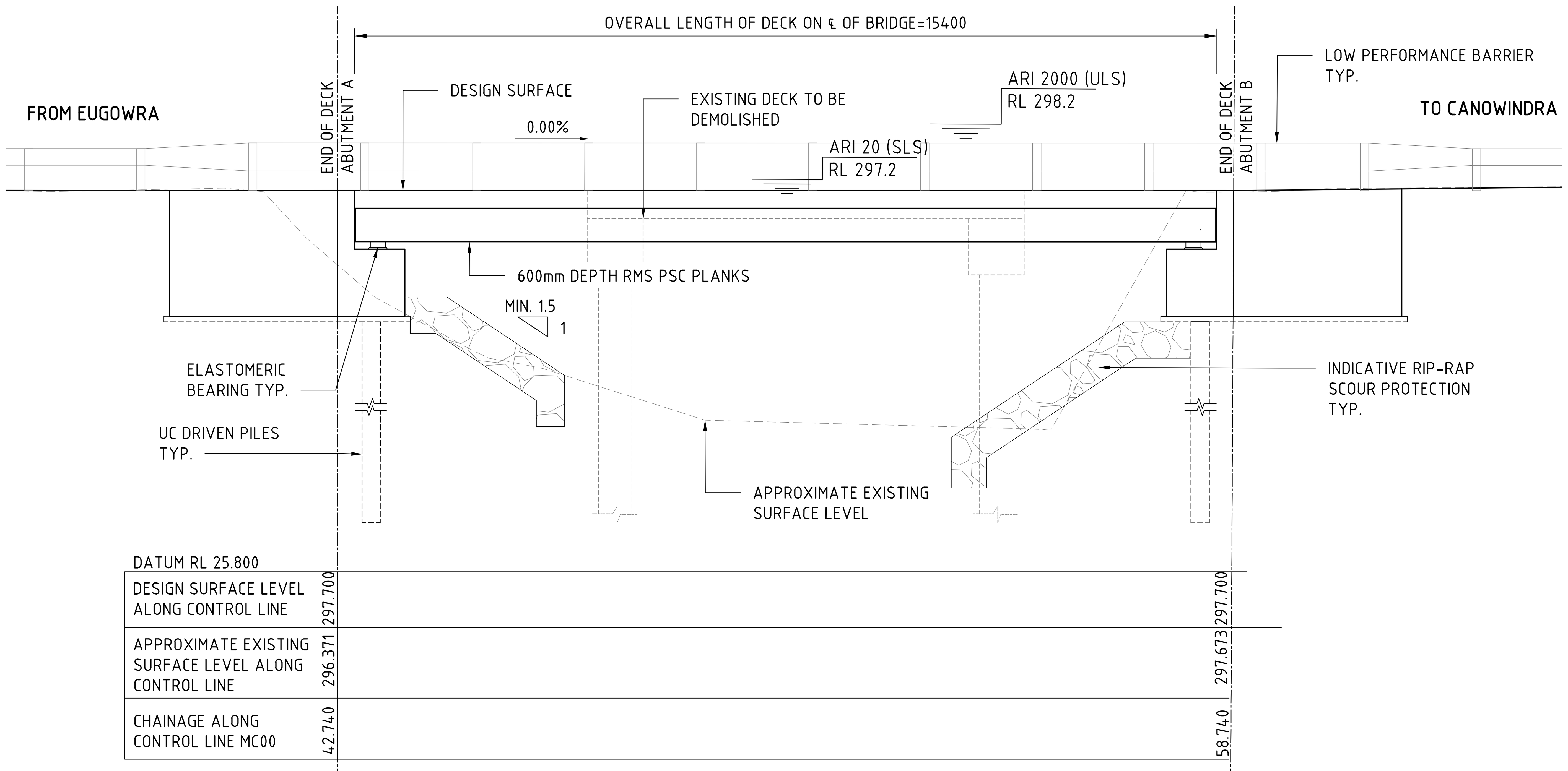
A4 SCALE: 1:2116

essential energy

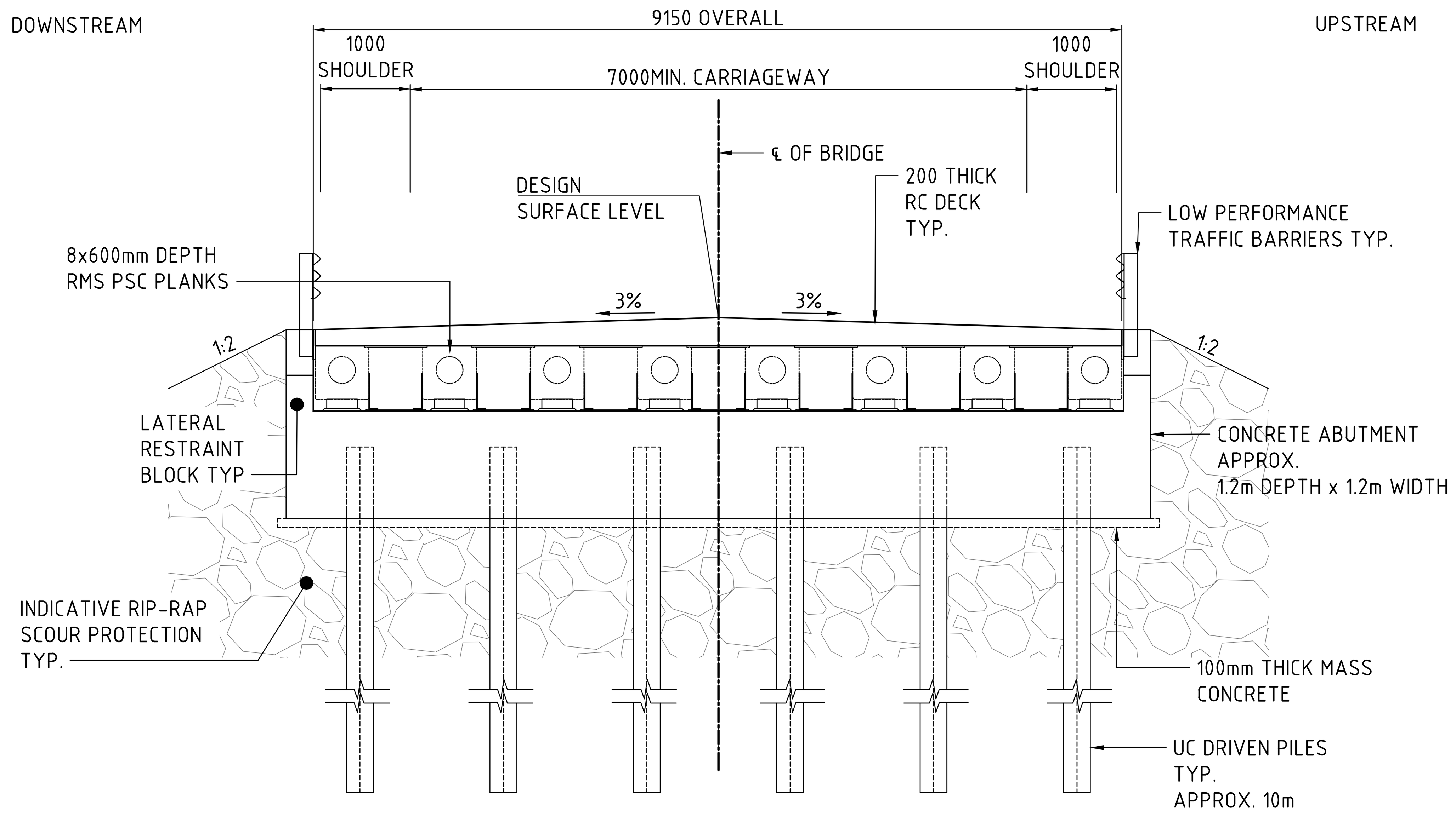
Job Number: 34454795 Sequence number: 226095441 Job location: 5913 Warraderry Way, Nyrang Creek Map Centre: 148° 33' 5.8", -33° 32' 28.9"

Appendix D

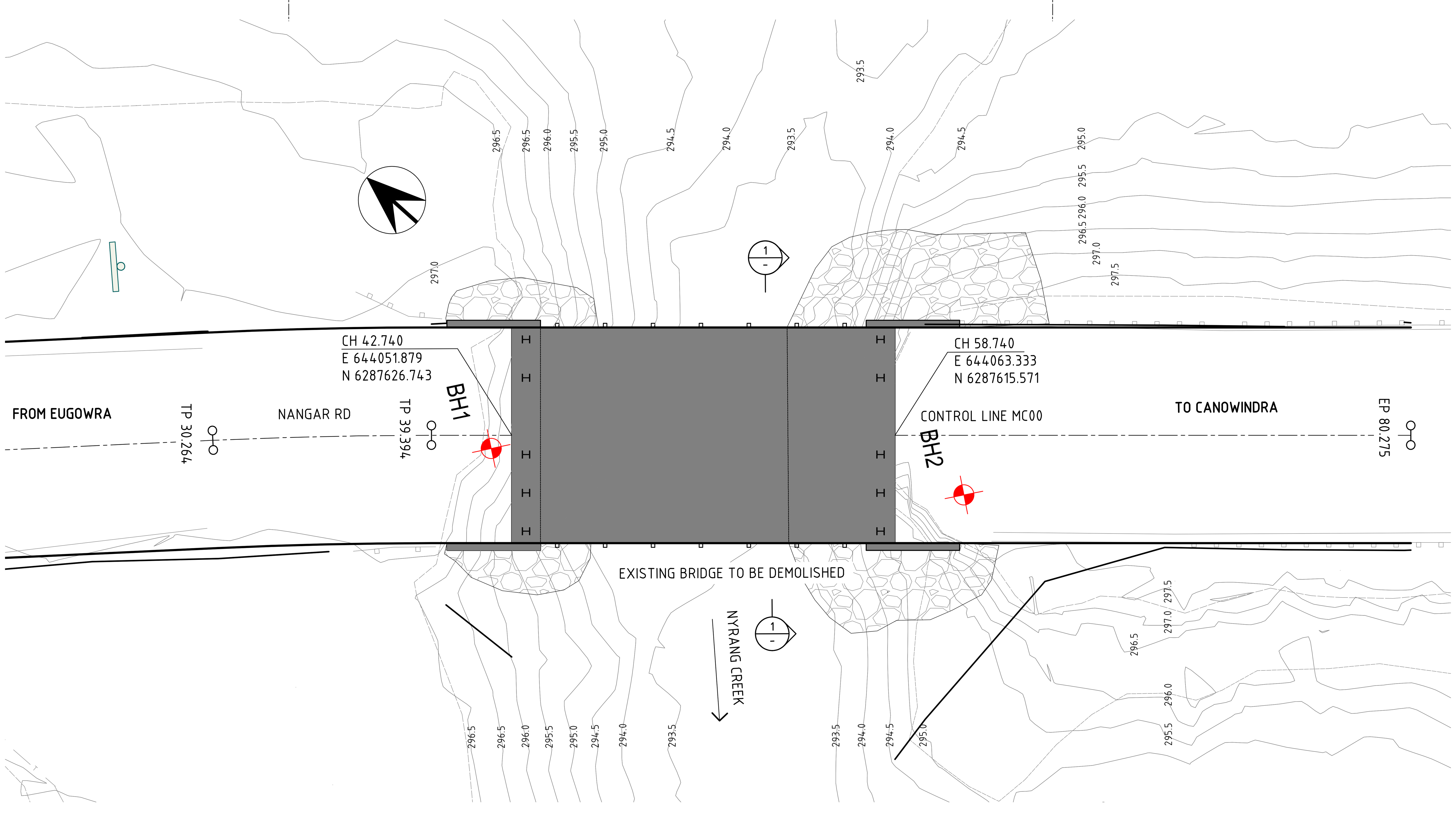
Concept Drawing



ELEVATION - ALONG MC00



SECTION 1 / -



PLAN

GENERAL NOTES

SCALE 0 1000 2000 3000 4000 5000mm OR AS SHOWN.

DIMENSION IN MILLIMETRES.
CHAINAGES AND REDUCED LEVELS ARE IN METRES.
REDUCED LEVELS ARE TO THE AUSTRALIAN HEIGHT DATUM.
CO-ORDINATES ARE TO MGA ZONE 55.

CONCEPT DESIGN

NOT FOR CONSTRUCTION

ISSUE	DATE	AMENDMENT DESCRIPTION	PREP	CHECK	AUTH
1	06/07/2023	CONCEPT DESIGN	YT	CR	DM

THIS DRAWING IS CONFIDENTIAL AND SHALL ONLY BE USED FOR THE PURPOSE OF THE NOMINATED PROJECT

	PREPARED	CHECKED
DESIGN	YH. TANG	C. RILEY
DRAWING	YH.TANG	C.RILEY

PREPARED BY: bk. bridge knowledge — YH. TANG, BRIDGE ENGINEER

CABONNE COUNCIL

NANGAR RD — CABONNE COUNCIL

NYRANG BRIDGE REPLACEMENT
CONCEPT DESIGN

GENERAL ARRANGEMENT

DRAWING SET No	BKP406-CC-BR002
DRAWING No	BR002-DRG-01
ISSUE STATUS	CONCEPT DESIGN
ISSUE	1
No SHEETS	1
SHEET No	1