



Engineering Services

Engineering the Goulburn Murray & Riverina

10th January 2023

Strathbogie Shire Council
PO Box 177,
EUROA, Vic. 3666

Attention: Libby Webster

**Re; Chinamans Bridge, at Nagambie
on Nagambie Heathcote Road over Goulburn River
- POST OCTOBER 2022 FLOOD STRUCTURAL ASSESSMENT**

Dear Libby,

Further to our earlier email correspondence on this subject and brief site discussions on site on Wednesday, we now write to provide the following brief report summarising our post October 2022 Flood event assessment for the above structure.

The contents of this report are briefly summarised below.

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Chinamans Bridge, at Nagambie on Nagambie Heathcote Road over Goulburn River - POST OCTOBER 2022 FLOOD STRUCTURAL ASSESSMENT

PURPOSE

The following is a preliminary engineering assessment and brief report considering the structural condition of the above bridge after the October 2022 flood event.

YOUR REQUIREMENTS

As described in our proposal, we note that you advise that the recent flood event resulted in floodwater rising to the deck level on the bridge. You also advised that there was debris trapped against the structure, some of which has since been removed.

You advise that the flood waters have now receded and most of the debris has been removed. You also advise that Council believes that the structure has deteriorated noticeably since our last assessment in 2018. Also, that some additional sections of bridge rail have either collapsed or have been removed.

You advise that there is some urgency because Council has closed the waterway and there is some public pressure for it be re-opened in time for the coming Christmas period. This is a very popular waterway being a thoroughfare between Lake Nagambie, the ski club and the nearby wineries.

We acknowledge that Council advises that this bridge was previously situated on the Heathcote Nagambie Road, a declared road (or main road). As such, this bridge was the responsibility of VicRoads and its predecessors up until the construction of the new concrete bridge about 100m upstream of this bridge. You advise that this bridge was not the responsibility of Council. Also, that Council's only interest in the structure is its potential impact upon waterway users and their safety.

LIMITATIONS OF THIS REPORT

From our previous work we know that the bridge deck is not readily accessible without significant risk. The bridge deck was noted to be particularly unstable and deemed to be not safely accessible. As with our previous report, we utilised a drone and a boat for the majority of our assessment observations.

SITE INSPECTIONS

This report is based upon our observations recorded during our site visit conducted on Wednesday 14/12/22. We acknowledge that Council arranged for the boat and boat operator to facilitate the on-water inspection work. Our on-water observations were supplemented by a series of other observations including a land based inspection and an aerial inspection using a drone. Please see attached for copies of our site photos and drone imagery.

As confirmed previously, many of the spans of the structure are not readily accessible to the drone for soffit inspections due to various obstructions hanging from the substructure. The drawings are intended to be descriptive sketches rather than detailed engineering drawings.

Our assessments methodology was limited to visual observation. As per our previous inspection we concluded that the bridge is too unstable for acoustic testing, (ie. sounding with hammer blow) from the boat. We had hard hats and a sledge hammer with us for that purpose however, however there was too much overhead debris to risk using that process. Again, this process did not include the collection of any samples nor any laboratory testing. This assessment takes into account the overall condition of the structure, noting any missing elements, visible decay, apparent deflections, failed connections etc.

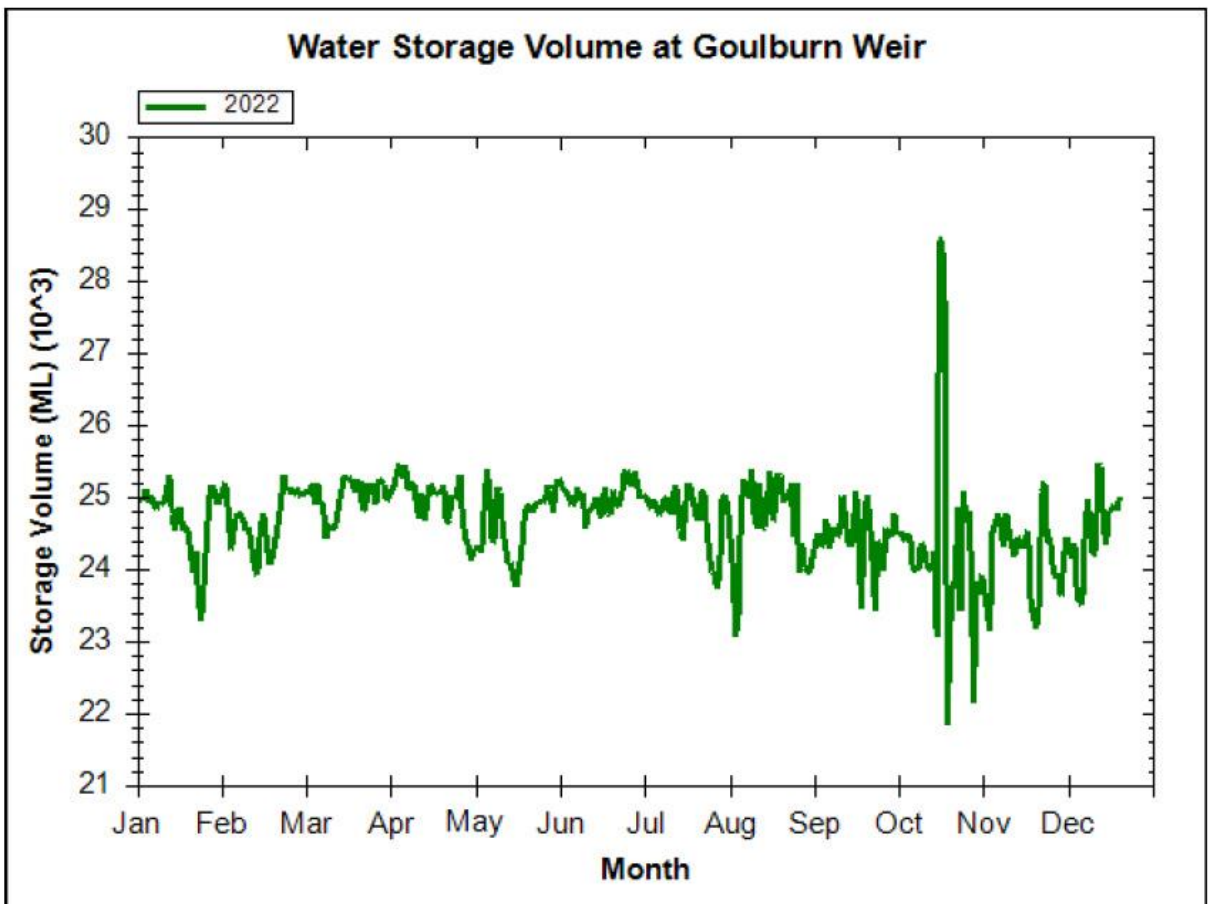
AVAILABLE INFORMATION

We also acknowledge the below flood image supplied by ¹Lee Roland. He advises that he recorded this image at 4.03pm on Friday 14/10/22. Also that this water level increased by about "12 to 18 inches" when the river peaked on Sunday 16/10/22.

¹ Lee Rowland is a local, Nagambie based tour boat operator.
He also operated the vessel arranged by Council and used for this inspection.



We also acknowledge the below image from Goulburn Murray Water depicting 2022 water volumes for at the Goulburn Weir, or within the Lake Nagambie storage.





PREVIOUS REPORT & SPECIFICATION

GMR has prepared 2 x previous for this structure as described below;

- Chinamans Bridge, at Nagambie on Nagambie Heathcote Road over Goulburn River - PRELIMINARY STRUCTURAL ASSESSMENT (DRAFT, dated 18/10/18).
- Chinamans Bridge Stability Works, at Nagambie on Nagambie-Heathcote Road over Goulburn River - TENDER SPECIFICATION, version, 23/12/18.

I provide the following brief summary the outcomes arising from the above work.

Preliminary Structural Assessment 18/10/18

This report included a visual inspection of the site and made the following recommendations.

RECOMMENDATIONS

In consideration of the above observation we recommend the following actions.

A. Continued Deterioration

*The continued degradation of the structure is inevitable.
That degradation will eventually result in the collapse of parts of the structure.
Given the high level of waterway usage, it is preferable that there be a planned and managed dismantling process rather than an uncontrolled collapse.
A demolition plan and schedule should be prepared for the controlled dismantling of this hazardous structure.*

B. Structural Stability

*Parts of this structure may collapse at any time.
The areas at risk are not readily repairable without large scale reconstruction works.
Public access to the areas at risk needs to be prevented until the structure is made safe (or demolished).*

C. Span 6 Stability

*Span 6 has been identified as that part of the structure which can be readily made safe.
The steel beams in that span are sound, however they need to be secured to prevent "roll over" in the event of an accidental vessel impact.
Consideration may also be given to a protective bumper to prevent accidental impact to piers 5 and 6.*

D. Waterway Cordon & Buoyage

*The unstable parts of the structure need to be cordoned off with buoys at water level to direct all upstream and downstream river traffic through span 6 only.
Boat operators are required to² comply with the Marine Safety Act, Marine Safety Regulations and Vessel Operating and Zoning Rules.
The cordon and buoyage should comply with these regulations and rules.*

E. Improved Signage

*Improved signage is required for boat operators warning of the bridge instability.
"Hazardous structure" warning signs should be placed on each side of the structure.
Additional "speed restriction" signs are required at the downstream and upstream approaches to the bridge.*

F. Access Fencing

*The deck access fencing needs to be repaired and a secure perimeter also established below the structure.
General public access to the structure from Heathcote-Nagambie Road should be closed off at each side.*

Stability Works Tender Specification 23/12/18

This specification was prepared for the implementation of Item C of the recommendations in the above report. This is a brief technical specification which includes engineering drawings.

² All recreational boaters and their vessels are required to comply with the relevant marine safety laws in the State. This includes (but is not limited to):

- Marine Safety Act 2010 (Vic) (MSA)
- Marine Safety Regulations 2012 (Vic) (MSR)
- Vessel Operating and Zoning Rules (VOZR) for Victorian Waters
- International Regulations for Preventing Collisions at Sea 1972 (COLREGS)
- relevant rules made by port managers or waterway managers.



Briefly the specifications require the steel beams to be secured in place, braced together to prevent rolling and the installation of a guardrail bumper at water level to protect the piers 5 and 6 from direct boat impact. The specification requires the contractor to secure a Works on a Waterway approval from the GBCMA and includes a series of Hold Points.

STRUCTURAL OVERVIEW

The following is an edited extract from our previous report. Where appropriate, I have updated that information to reflect any new and better information and highlighted the changes.

Please see attached general arrangement sketch and site photo logs. The existing structure is briefly described as follows;

Geometry

- *straight horizontal alignment, flat vertical geometry.*

Materials & Fixings.

- *with the exception of the beams in span no.6 the entire bridge has been constructed using hardwood timber and steel bolt fixings.*

Substructure.

- ***3a 15 x span structure, with 14 x piers.***
- *supported on a series of driven, hardwood, timber pile foundations.*
- *the original bridge was supported on about 126 x driven timber piles.*
- *most piers consist of 5 x load bearing (vertical) piles and an upstream and downstream raking pile which provides lateral stability and some debris protection.*

Abutments.

- *earth fill abutments each side, about 3m above ground level.*
- *earth fill retained with horizontal, sawn timber sheeting, behind 5 x driven hardwood, timber piles.*
- *simple wingwalls, with timber sheeting behind 3 x timber piles.*

Common Piers.

- *5 x load bearing (vertical piles) and a raking pile each side (ie. upstream and downstream).*
- *2 x sawn or squared hardwood, timber crossheads.*
- *a horizontal sawn timber rail each side, below the leaning squared timber props (or struts).*
- *a squared corbel with ornate end shapes, under each beam (stringer) over each pile.*
- *the piers in the deeper water are laterally braced with sawn timber braces to withstand debris impact.*

Lift Span Piers.

- *span 6 was originally constructed as a "lift span" to allow the deck to be raised for the passage of paddle steamers.*
- *span 6 is wider than the others, is supported by 4 x steel beams (tapered flange beams).*
- *there are modified or non-standard piers each side of this span to support the deck lift mechanism.*
- *pier 4 & 7 were supports for the counterweights each side of the "lift span".*

Superstructure

- *there are 5 x bridge beams (stringers), all round, unsawn logs supported by the corbels.*
- *under each beam there is a squared short "under-beam" supported by the leaning props (or struts) off the piers.*
- *there are a series of sawn hardwood, crossbeams at about 1.5m spacing's which are supported by the stringers and span across the width of the bridge.*
- *the steel beams across span 6 have no web cleats or stiffeners and no cross bracing.*
- *the steel beams are no longer directly attached to the supporting timber blocks or crossbeams.*

Decking & Railing.

- *the deck has a longitudinal alignment.*
- *the deck is a series of sawn hardwood planks, staggered alternately jointed and clamped to the crossbeams below.*
- *the deck has a bituminous surface, ie. a spray seal and aggregate wearing surface.*
- *there is an apparent deck scupper between the outer deck planks and the kerbs.*

Bridge Railing.

- *the bridge railing consists of a simple vertical squared, timber kerb, with painted timber posts, a vertical mid-rail and a rotated top rail.*
- *the rail support posts are bolted to the cross beams and kerb.*

³ We acknowledge that our previous report described the bridge as having 14 x spans and 13 x piers. We now advise that there are 15 x spans and 14 x piers. The overall bridge length and other dimensions are unchanged.



STRUCTURAL CONDITION SUMMARY

I briefly summarise our structural assessment observations as follows;

2018 ASSESSMENT	2022 ASSESSMENT
<p>1. <u>Structural Stability</u> In its present condition I anticipate a significant collapse may occur at any time. That collapse may result in the collapse of an entire span. The likelihood of that collapse is significantly escalated in the event of any debris/vessel impact or foot traffic. It is likely that within 10 years the majority of the current structure will have collapsed into the river with only some piles and the abutments remaining.</p>	<p>This structure has deteriorated significantly since 2018. Segments of this structure may collapse at any time.</p>
<p>2. <u>Access to Structure</u> Whilst about 75% of the deck timber appears to be intact, the deck is presently, generally unsafe to access. Despite appearances, much of the remaining deck has decayed and is unsafe to walk on. The sound sections of deck are also susceptible to failure. This is mainly due to the failure of the supporting superstructure elements and the substructure. The deck is severely compromised, the surface being uneven with variable deck levels of up to 1 one metre subsidence (ie. below normal deck level).</p>	<p>The deck has deteriorated further with less than 50% of the deck now being self-supporting. The deck at west abutment is no longer self-supporting. The entire deck over spans 2 and 3 have buckled and collapsed.</p>
<p>3. <u>Vulnerable to Impact</u> The slightest impact of the supporting substructure may cause a partial collapse. Objects may fall from the structure at any time.</p>	<p>This situation has worsened. The structure may collapse with or without impact.</p>
<p>4. <u>Supporting Substructure (Piers & Piles)</u> Most of the piles have significant loss of section, varying from 50-80%. Many (about 20%) of the piles have either failed or are missing. Pier 12 has only functioning pile remaining (out of 5) and may collapse at any time. Pier 2 only has 3 load bearing piles remaining. Many of the piles have subsided, some up to 1.5m. There are numerous signs of previous boat impact with bent bolts etc.</p>	<p>There were about 126 x piles in the original structure. There are presently about 51 x piles either missing, broken or otherwise compromised.</p>
<p>5. <u>Superstructure (Stringers & Cross Beams)</u> About half of the props (or struts) and under-beams have collapsed or dropped and no-longer support the bridge beams. A similar proportion of the props and beams have failed or are missing also. The steel beams in Span 6 appear to be sound, however they are poorly secured and may roll over and fall from the piers.</p>	<p>Currently, about 30% of the bridge beams (stringers), corbels, props or crossheads are missing, broken or otherwise compromised.</p>
<p>6. <u>Bridge Railing</u> Much of the bridge railing is missing or draping off the deck in the remaining areas. There are numerous elements hanging from the bridge, some with bolts protruding.</p>	<p>Council has removed some of the draping bridge rail, however about 25% of the railing remains and is at risk of collapse.</p>
<p>7. <u>Security & Warning Signage</u> The fencing erected at each of the abutments has been compromised by vandals, as a result deck is readily accessible. The approach signage remains readable, however the signage attached has faded and is no longer illegible.</p>	<p>The security fencing is unchanged. The bridge deck remains accessible.</p>
<p>8. <u>Access for Repairs</u> The structure is unsafe for maintenance access and should not be relied upon to support worker access for repairs or demolition. Workers should be supported on independent work platforms, ie. on either an independent, stabilised scaffold or a barge.</p>	<p>This situation is unchanged. The structure should not be relied upon to support workers.</p>
<p>9. <u>Span 6 Steel Beams</u> The steel beams in span 6 are vulnerable to "roll over" and need to be secured. The existing fixings require attention to ensure that they are engaged with the beams. The stability of the beams can be enhanced with an addition strut added to the underside of the bottom flange linking all 4 beams and props attached each side to prevent a roll over.</p>	<p>This situation has worsened. The beams have not been braced, remain unsecured and may roll over at any time. The end supports for beam 2 and 3 have failed, causing the beams to drop about 100-150mm.</p>



DISCUSSION

Existing Situation - New Damages

As earlier, Council advises that the waterway is currently closed to waterway users. All waterway traffic is directed via span 6, ie. being the widest span and also where the steel beams are situated. There are a series of buoys each side of the bridge directing traffic to span 6. There are also speed limit signs in place and some illegible (faded) warning signs attached to the structure.

In addition to the recent flood impact, this structure has continued to degrade as a result of progressive weathering, decay and deterioration due to continuing exposure of the substructure and a lack of maintenance. I briefly summarise the new damages as follows;

- i. Several upstream raking piles have been impacted by debris and have broken.
- ii. Two spans of bridge deck have collapsed over spans 2 and 3.
- iii. Pier No.2 has partially collapsed and continues to degrade. The momentum of this collapse is likely to escalate and may result in a spontaneous total failure at any time.
- iv. In span 6, the supports for steel beams 2 and 3 have failed and the beam ends have dropped. This span is no longer considered to be a safe passage for boats.
- v. The upstream counterweight tower on the west side of span 6 has collapsed as a result of debris impact. Several timber elements are no longer secure, suspended precariously over the water and may detach at any time.
- vi. A significant amount of visible flood debris remains insitu within the waterway, on the upstream side of Piers No. 3, 4 and 5. There may also be other debris present beneath water surface and not readily visible.
- vii. The continued degradation of the supporting structural elements (piles, beams, corbels and props) has resulted in an increasing number being compromised. Two piers (Pier No.3 and 11) now no longer include any remaining, sound load bearing piles. Several others (Piers No. 1, 2, 3, 10, 12 and 13) have only one sound load bearing pile remaining.
- viii. The deck above river bank at the west abutment has deteriorated significantly. This area is not safe and needs to be securely fenced off to prevent people congregating or accessing this area.

Recent Flood Event

The recent flood event has resulted in a number of flood event related damages to the substructure which has resulted in the failure of a further 20 x timber piles. Some of these piles have failed as a result of direct debris impact and others have failed as a result of lateral movement in response to the effects of high velocity water movement, higher flow rates and accumulated debris pressure.

From our review of the available river level information, we understand that the Goulburn River at this location experienced high flows and flooding from about 13/10/22 through to early November 2022. Another flood event may occur at any time.

There is a significant debris load remaining on the upstream side of the bridge near Piers No.3, 4 and 5. Some of that debris remains buoyant and includes several large logs which continue to flex in response to water movement. That flex action acts as a working (live) load upon the structure. The continuing effects of this flood event are yet to materialise.

Some of the piles which had been previously identified as having failed or been compromised have now dislodged or deflected as a result of the flood impact. Some of the upper and lower pile segments each side of the failure are no longer axially aligned. As a result these mis-aligned piles no longer offer any vertical support to the structure.

Current Structural Stability

The supporting structural elements have now deteriorated to such an extent, that sections of the bridge may collapse at any time. That collapse may be triggered by any relative minor disturbance including an earth tremor, a boat or debris impact, strong winds, fallen limbs, debris impact or further flooding.



The most likely cause of failure being accidental boat impact. A collapse may also be triggered by the continued degradation and failure of the structural elements. This structure is particularly a hazard to the following persons;

- Persons who access the deck.
The structure can no longer be relied upon to support any access to the deck.
- Persons near to or under the structure (particularly anglers).
Sections of this structure may collapse at any time.
- Persons utilising the waterway near to or downstream of the structure.
Fallen debris from this structure contains protruding bolts and other fixings.
That debris will be conveyed by the water flow and may be floating and readily visible or alternatively may also be submerged below the surface.

Previous Report Recommendations

In consideration of the recommendations from our previous report, we note the following progress;

RECOMMENDATION	STATUS
<p>A. <u>Continued Deterioration</u> The continued degradation of the structure is inevitable. That degradation will eventually result in the collapse of parts of the structure. Given the high level of waterway usage, it is preferable that there be a planned and managed dismantling process rather than an uncontrolled collapse. A demolition plan and schedule should be prepared for the controlled dismantling of this hazardous structure.</p>	NOT DONE
<p>B. <u>Structural Stability</u> Parts of this structure may collapse at any time. The areas at risk are not readily repairable without large scale reconstruction works. Public access to the areas at risk needs to be prevented until the structure is made safe (or demolished).</p>	NOT DONE
<p>C. <u>Span 6 Stability</u> Span 6 has been identified as that part of the structure which can be readily made safe. The steel beams in that span are sound, however they need to be secured to prevent "roll over" in the event of an accidental vessel impact. Consideration may also be given to a protective bumper to prevent accidental impact to piers 5 and 6.</p>	NOT DONE
<p>D. <u>Waterway Cordon & Buoyage</u> The unstable parts of the structure need to be cordoned off with buoys at water level to direct all upstream and downstream river traffic through span 6 only. Boat operators are required to ⁴comply with the Marine Safety Act, Marine Safety Regulations and Vessel Operating and Zoning Rules. The cordon and buoyage should comply with these regulations and rules.</p>	PART DONE
<p>E. <u>Improved Signage</u> Improved signage is required for boat operators warning of the bridge instability. "Hazardous structure" warning signs should be placed on each side of the structure. Additional "speed restriction" signs are required at the downstream and upstream approaches to the bridge.</p>	PART DONE
<p>F. <u>Access Fencing</u> The deck access fencing needs to be repaired and a secure perimeter also established below the structure. General public access to the structure from Heathcote-Nagambie Road should be closed off at each side</p>	NOT DONE

⁴ All recreational boaters and their vessels are required to comply with the relevant marine safety laws in the State. This includes (but is not limited to):

- Marine Safety Act 2010 (Vic) (MSA)
- Marine Safety Regulations 2012 (Vic) (MSR)
- Vessel Operating and Zoning Rules (VOZR) for Victorian Waters
- International Regulations for Preventing Collisions at Sea 1972 (COLREGS)
- relevant rules made by port managers or waterway managers.



Likely Mechanism of Failure

The continued stability of this structure is dependent upon the integrity of the supporting, principal structural elements. The majority of these elements are timber. That timber is degraded as a result of decay and continues to deteriorate. The progressive deterioration of the deck has exposed much of the supporting timber to the elements and accelerated that decay process, particularly at the structural joints. The recent flood event, the associated upstream debris impacts and increased lateral hydraulic pressure has further accelerated that deterioration process.

As noted above, many of the supporting piles are missing or have failed. Many of the crossheads, beams, corbels and props are missing or have failed also. We anticipate that the collapse of a pier or span will precipitate the failure of adjacent spans. That initial collapse may be slow and incremental as per the current span 2 and 3 collapse, or may alternatively occur suddenly and without warning.

The collapse of each span will result in about 5 to 6 tonne of timber, suddenly falling 7 or 8 metres to the water below. The consequences of that impact are clearly significant for any persons or vessels below and also the abutting spans. Further collapses of adjacent spans are imminent. Left unmanaged, that collapse process will continue for many years if not decades, generating debris and causing hazards in the waterway.

The debris released from any collapse will render the waterway immediately downstream of the structure hazardous. That debris will include fallen timber and segments of asphalt or bituminous surfacing from the bridge surface.

SUMMARY

In consideration of the above information, I briefly summarise the present situation as follows;

- a) Structural Stability
I estimate that together with the continued deterioration of the structure since 2018 and the adverse effect of the recent flood event, this structure is now about 25 to 30% more vulnerable than when assessed in 2018.
As a consequence of this deterioration, this structure is vulnerable to collapse at any time.
- b) Accidental Impact
The existing structure is most vulnerable to accidental boat impact.
- c) Recent Flood Event
The recent flood event has accelerated the deterioration of the bridge.
- d) Waterway Safety
There is presently no safe thoroughfare available under the bridge for pedestrians or boats.
The waterway signage has been impacted by the recent flood event and needs to be restored.
- e) Controlled Demolition
If allowed to continue to degrade, this structure will progressively deteriorate and collapse into the waterway.
This structure needs to be demolished in a controlled manner to protect the waterway and waterway users.
- f) Bridge Access
The deck and the riverbanks under the bridge remain accessible.
Access to these areas need to be closed off.
The riverbank under the bridge on west side continues to be a popular location for informal gatherings of people.
- g) Make Safe Recommendations
Please see below recommendations for Council's attention.
There are a series of short-term measures which need to be addressed immediately to address the potential imminent collapse of this structure and protect the public.
There are also longer term measures which include the planned, controlled demolition and removal of the structure.



RECOMMENDATIONS

I make the following recommendations.

A. Short Term make Safe Measures

The following actions need to be implemented immediately in preparation for the anticipated imminent collapse (at any time) of sections of the bridge;

i. Waterway Closure

The waterway in the vicinity of the bridge and downstream to the boat ramp should remain closed to waterway users.

ii. Bridge Access

Access to the bridge deck and the riverbank along the underside of the bridge needs to be closed off immediately and remain closed until the structure is removed.

iii. Warning Signage

The on-water signage needs to be restored and enhanced to clearly advise boat operators of the hazards and discourage or prevent passage beneath the structure.

Warning signs need to be also erected at the boat ramps advising boat operators of the hazardous nature of the bridge and the waterway closure.

B. Long Term Make Safe Measures

The following actions require appropriate planning and preparations.

Item iv. needs to be addressed within the next 2 to 4 x weeks.

Item v. may take 6 to 12 x months to implement.

iv. Imminent Collapse

That Council prepare an appropriate plan and arrange for appropriate resources to be available for its response to the anticipated imminent and continuing, progressive collapse of parts of this structure.

v. Managed Demolition

That Council plan for the managed and controlled demolition of this structure.

That the existing structure be demolished within the next 12 x months.

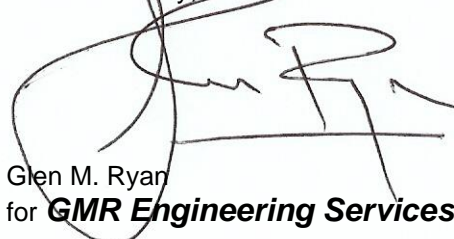
SUPPORTING INFORMATION

To aid our assessment of this structure and facilitate the preparation of this report we prepared the following further information, copies of which are attached.

- General Arrangement Sketch
 - 1 x A4 page, substructure sketch, aerial image of deck and downstream profile, not to scale, dated 16/12/22.
- Site Photo Log, dated 14/12/22
 - 119 x photos on 17 x A3 size pages, in colour.
- Drone Image Log, dated 14/12/22
 - 21 x images on 4 x A3 pages, in colour.
- Comparison of 2018 & 2022 Images, dated 14/12/22
 - 30 x selected images with markups on 4 x A3 size pages, in colour.

I trust that the above information is clear. Should you require any further information on this subject please contact the undersigned.

Yours Faithfully,



Glen M. Ryan
for **GMR Engineering Services**