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New Zealand Transport Agency

Whirokino Trestle and Manawatu River Bridge Replacement
Post Construction Road Safety Audit

July 2021

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1. Background

1.1 Safety Audit Procedure

This report has been prepared for the newly constructed Whirokino Trestle and Manawatu Bridge on SH1 in the Horowhenua District between the towns of Foxton and Levin.

A road safety audit is a term used internationally to describe an independent review of a future or recently completed project which interact with the road environment to identify any safety concerns that may affect the safety performance. The audit team considers the safety of all road users and qualitatively reports on road safety issues or opportunities for safety improvement.

A road safety audit is therefore a formal examination of a road project, or any type of project which affects road users (including cyclists, pedestrians, mobility impaired etc.), undertaken by an independent competent team who identify and document road safety concerns.

A road safety audit is intended to help deliver a safe road system and is not a review of compliance with standards.

The primary objective of a road safety audit is to deliver a project that achieves an outcome consistent with Safer Journeys and the Safe System approach, that is, minimisation of death and serious injury. The road safety audit is a safety review used to identify all areas of a project that are inconsistent with a safe system and bring those concerns to the attention of the client in order that the client can make a value judgement as to appropriate action(s) based on the risk guidance provided by the safety audit team.

The key objective of a road safety audit is summarised as:

To deliver completed projects that contribute towards a safe road system that is increasingly free of death and serious injury by identifying and ranking potential safety concerns for all road users and others affected by a road project.

A road safety audit should desirably be undertaken at project milestones such as:

- Concept Stage (part of Business Case);
- Scheme or Preliminary Design Stage (part of Pre-Implementation);
- Detailed Design Stage (Pre-implementation / Implementation); and
- Pre-Opening / Post-Construction Stage (Implementation / Post-Implementation).

A road safety audit is not intended as a technical or financial audit and does not substitute for a design check on standards or guidelines. Any recommended treatment of an identified safety concern is intended to be indicative only, and to focus the designer on the type of improvements that might be appropriate. It is not intended to be prescriptive and other ways of improving the road safety or operational problems identified should also be considered.

In accordance with the procedures set down in the "NZTA Road Safety Audit Procedures for Projects Guideline, (Interim Release May 2013)", the audit report should be submitted to the client who will instruct the designer to respond. The designer should consider the report and comment to the client on each of any concerns identified, including their cost implications where appropriate, and make a recommendation to either accept or reject the audit report recommendation.

For each audit team recommendation that is accepted, the client shall make the final decision and brief the designer to make the necessary changes and/or additions. As a result of this

instruction the designer shall action the approved amendments. The client may involve a safety engineer to provide commentary to aid with the decision.

Decision tracking is an important part of the road safety audit process. A decision tracking table is embedded into the report format at the end of each set of recommendations to be completed by the designer, safety engineer and client for each issue documenting the designer response, client decision (and asset manager's comments in the case where the client and asset manager are not one and the same) and action taken.

A copy of the report including the designer's response to the client and the client's decision on each recommendation shall be given to the road safety audit team leader as part of the important feedback loop. The road safety audit team leader will disseminate this to team members.

1.2 The Safety Audit Team

The road safety audit was carried out in accordance with the "NZTA Road Safety Audit Procedures for Projects Guideline", (Interim Release May 2013) and also reference made to its earlier document (dated 2004).

The assessment team was as follows:

- s 9(2)(a) GHD Limited, Wellington - Auditor
- s 9(2)(a) GHD Limited, Wellington - Auditor
- s 9(2)(a) GHD Limited, Wellington - Barrier inspection
- s 9(2)(a) GHD Limited, Wellington - Observer

Members of the Safety Audit Team (SAT) undertook a daylight site inspection on 11th February 2020 and an evening and darkness site inspection on the 25th February 2020 prior to traffic being shifted onto the new road sections.

1.3 Report Format

The potential road safety problems identified have been ranked as follows:-

The expected crash frequency is qualitatively assessed on the basis of expected exposure (how many road users will be exposed to a safety issue) and the likelihood of a crash resulting from the presence of the issue. The severity of a crash outcome is qualitatively assessed on the basis of factors such as expected speeds, type of collision, and type of vehicle involved.

Reference to historic crash rates or other research for similar elements of projects, or projects as a whole; have been drawn on where appropriate to assist in understanding the likely crash types, frequency and likely severity that may result from a particular concern.

The frequency and severity ratings are used together to develop a combined qualitative ranking for each safety issue using the Concern Assessment Rating Matrix in Table 1 below. The qualitative assessment requires professional judgement and a wide range of experience in projects of all sizes and locations.

Table 1: Concern Assessment Rating Matrix

Severity (likelihood of death or serious injury)	Frequency (probability of a crash)			
	Frequent	Common	Occasional	Infrequent
Very likely	Serious	Serious	Significant	Moderate
Likely	Serious	Significant	Moderate	Moderate
Unlikely	Significant	Moderate	Minor	Minor
Very unlikely	Moderate	Minor	Minor	Minor

While all safety concerns should be considered for action, the client or nominated project manager will make the decision as to what course of action will be adopted based on the guidance given in this ranking process with consideration to factors other than safety alone. As a guide a suggested action for each concern category is given in Table 2 below.

Table 2: Risk Categories

Concern	Suggest Action
Serious	A major safety concern that must be addressed and requires changes to avoid serious safety consequence
Significant	Significant concern that should be addressed and requires changes to avoid serious safety consequences
Moderate	Moderate concern that should be addressed to improve safety
Minor	Minor concern that should be addressed where practical to improve safety

In addition to the ranked safety issues it is appropriate for the safety audit team to provide additional comments with respect to items that may have a safety implication but lie outside the scope of the safety audit. A comment may include items where the safety implications are not yet clear due to insufficient detail for the stage of project, items outside the scope of the audit such as existing issues not impacted by the project or an opportunity for improved safety but not necessarily linked to the project itself. While typically comments do not require a specific recommendation, in some instances suggestions may be given by the auditors.

1.4 Scope of Audit

This audit is a Post Construction (Pre-Opening) Stage Safety Audit of Whirokino Trestle and Manawatu River Bridge Replacement. This audit includes all works completed prior to the shifting of traffic onto the new alignment. Elements not audited include:

- Cycle-path
- Link Road
- Whirokino Road intersection

The SAT has a copy of the preliminary design safety audit completed in December 2014, a specimen design safety audit completed in May 2016, and February 2018.

1.5 Documents Provided

The SAT has been provided with the following documents for this audit:

- Whirokino Trestle and Manawatu River Bridge, 142220/07, Bloxam Burnett & Oliver, 28 July 2016, drawings 5001, 5201-5204, 5221, 5223 and 5224, 5351-5356, and 5361.
- Whirokino Trestle and Manawatu River Bridge Preliminary Design Safety Audit Report, GHD Limited, December 2014.
- Whirokino Trestle and Manawatu River Bridge Specimen Design Safety Audit Report, GHD Limited, May 2016.
- Whirokino Trestle and Manawatu River Bridge Median Barrier Safety Audit Report, GHD Limited, February 2018.

1.6 Disclaimer

The findings and recommendations in this report are based on an examination of available relevant plans, the specified road and its environs, and the opinions of the SAT. However, it must be recognised that eliminating safety concerns cannot be guaranteed since no road can be regarded as absolutely safe and no warranty is implied that all safety issues have been identified in this report. Safety audits do not constitute a design review or an assessment of standards with respect to engineering or planning documents.

Readers are urged to seek specific technical advice on matters raised and not rely solely on the report.

While every effort has been made to ensure the accuracy of the report, it is made available on the basis that anyone relying on it does so at their own risk without any liability to the safety audit team or their organisations.

1.7 Project Description

The existing Whirokino Trestle and Manawatu Bridge on SH1 between Foxton and Levin requires replacement. Previous audits have been completed on the design without a median barrier on the bridge and associated widening of the embankment shoulders. This audit will exclusively focus on changes to the design as a result of the inclusion of a median barrier and associated widening.

Figure 1 from the specimen design shows the existing and proposed replacement alignments and surrounding environment.

Throughout this report references to locations have been provided based on the SH1 southbound running distance from Culvert 9651 (at approximately Reference Station 954, Route Position 11.0), as per the drawings. For Whirokino Road and Link Road the running distance is from the intersection with SH1, and for Matarapa Road the running distance is from Link Road.

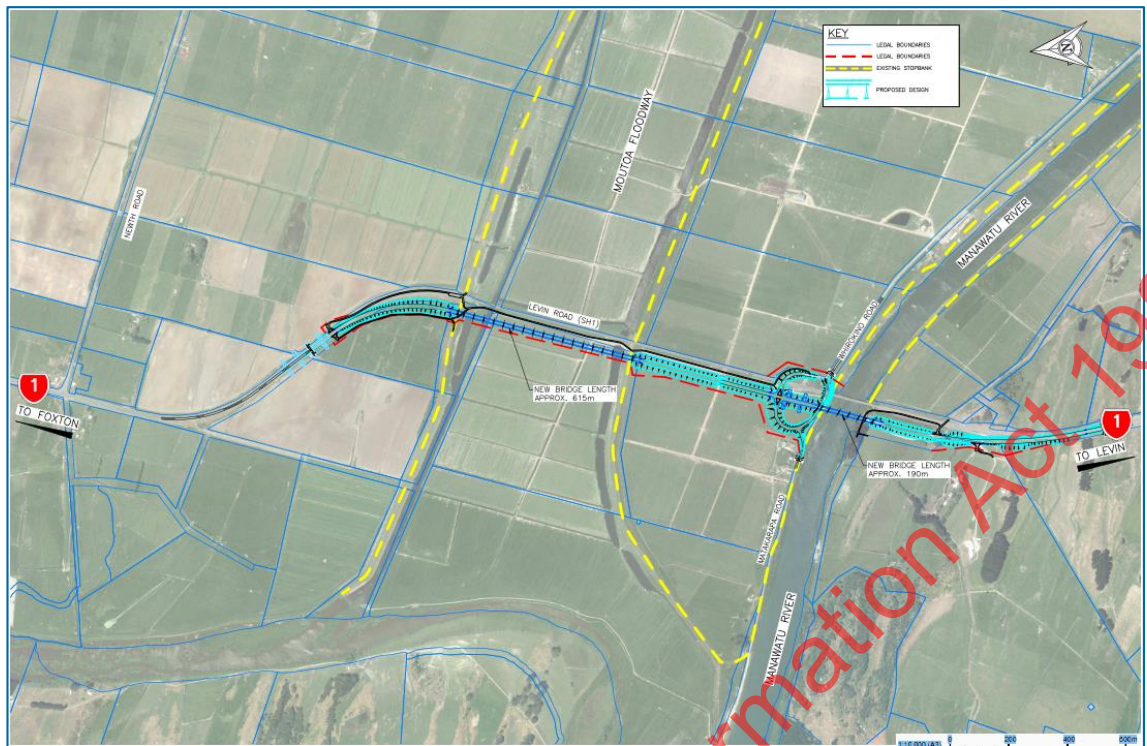


Figure 1: Project Elements and Road Layout (Drawing 5002)

1.8 Previous Audit Findings

Below is a list of findings from the previous median barrier design safety audit.

Issue	Concern Level	Outcome
2.1.1 Rest area right turning	Significant	Only signpost rest area access for southbound traffic.
2.1.2 Shoulder width at Whirokino Road	Moderate	Retain shoulder width.
2.2.1 Directional signs at SH1 intersection	Minor	To be rationalised if an issue in construction.
2.2.2 No right turn sign	Minor	Remove no right turn signs from highway approaches to intersection.
2.2.3 Long yellow no-overtaking advanced warning lines	Comment	N/A
2.2.4 Oversized Load Staging Area	Comment	N/A

Issues identified in the specimen design audit:

1. Typical Section Issues

1.1. Solid White Centreline Marking

SIGNIFICANT

1.2. Shoulder Width Consistency	MODERATE
1.3. Edge Marker Post Location	MINOR
1.4. Audio Tactile Profiled Markings on Bridges	MINOR
1.5. Bridge Delineation	COMMENT
1.6. Local Road Shoulder/Berm Layers	COMMENT
2. Specific Location Issues on SH1	
2.1. Right Turns at Intersections	SERIOUS
2.2. Farm Access at 2400 m	SERIOUS
2.3. Rest Area and Wetland Access at 2275 m	SIGNIFICANT
2.4. Cyclist Permanent Warning Signs	MODERATE
2.5. Warning and Directional Sign Frequency	MINOR
2.6. Northern Curve Super-elevation	COMMENT
2.7. Passing Lane Length	COMMENT
3. Local Road Issues	
3.1. Whirokino Road Curve at 200 m	MODERATE
3.2. Local Road Embankment Hazard Protection	MODERATE
3.3. Cyclist Warning Signs	MODERATE
3.4. Whirokino Road and Link Road Intersection	MINOR
3.5. Link Road SH1 Bridge Underpass Drainage	COMMENT
3.6. Local Road Directional/Guide Signage	COMMENT
4. Cyclist and Shared Path Issues	
4.1. Directional Guidance for Northbound Cyclists onto the Shared Path	SIGNIFICANT
4.2. Northbound Shared Path Bridge Clearance	MODERATE
4.3. Shared Path Northern Directional Guidance	MODERATE
4.4. Shared Path Central Stopbank Crossing	MODERATE
4.5. Shared Path Farm Gate	MODERATE
4.6. Shared Path Curves	MINOR
4.7. Shared Path Vehicle Exclusion	MINOR
4.8. Shared Path Southern Terminus	MINOR
4.9. Shared Path Maintenance	COMMENT
5. Other Comments	
5.1. Drawing Labels	COMMENT
5.2. Drawing Ambiguities	COMMENT

2. Safety Audit Findings

2.1 Barriers

2.1.1 Mountable kerb height at bridge expansion joints **MODERATE**

Frequency Rating	INFREQUENT	Severity Rating	LIKELY
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The mountable kerb will raise the height at which vehicles hit the median barrier, effectively reducing the height of the barrier. Vehicles should not strike a wire-rope barrier 50 mm below design height, as it will not perform to manufacturer's specifications, potentially causing wheel stags, overturning, etc. Impacts into wire-rope barriers redirect vehicles along the path of the barrier which reduces the impact severity, potentially allowing the vehicle to regain control and safely come to a stop or re-join the carriageway. With this device in place (Expansion joint cover and kerbing) effectively creating an abrupt obstacle within the path of the vehicle there's a high possibility that this will cause a significant accident.



Recommendation

Develop options that allow for vehicles to strike the barrier at the correct height. This could include extending and widening the mountable kerb and placing support post on top of the mountable kerb, or removing the need for a mountable kerb or cover.

Designer Response	<i>Novare:</i> The mountable barriers and cover plates provide protection to the joint upstand beneath. It is proposed that WRSB barrier posts adjacent to the mountable kerb are raised locally to meet minimum
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	<p>height requirements and transition to the general WRSB height each side of the joint.</p> <p><i>BBO</i>: AUSTROADS guidance which suggests WRSB height should be set relative to the top of kerb applies to the situation where the ground behind the kerb is at the same height as the kerb. In this case, the vehicle suspension will retract when the wheel hits the kerb, and the vehicle will engage with the barrier at the correct height. By the time the suspension extends the vehicle will be well engaged in the barrier and the wheels will likely be back over the road behind the kerb. Any changes to barrier height could reduce rather than improve the performance of the barrier. Propose no change be made.</p>
Safety Engineer	<p>Checking in with the Austroads Guide and referencing internal experts, the BBO recommendation that the suspension will compress is what would be expected, and the barrier will perform as designed.</p> <p>Considering the overall length of the barrier and the relatively short length of mountable kerb, the risk is low that it will be struck and if struck the risk will be low that the system will fail.</p>
Client Decision	Agree with BBO and Safety Engineer's responses. No further action required.
Action Taken	N/A

2.1.2 Mountable kerb at bridge expansion joints

MODERATE

Frequency Rating	INFREQUENT	Severity Rating	LIKELY
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The mountable kerb (concrete nose and metal side covering) at the expansion joint is a hazard. Impacts to the kerb nose (particularly when adjusted for barrier posts) and sides by errant motorcyclists or vehicles could cause harm, however infrequent they may be.

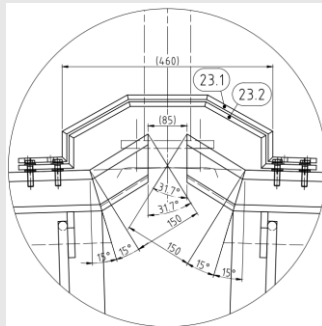


Recommendation

Consider developing options that remove the need for a mountable kerb or cover.

Designer Response

Novare: The cover plates are provided to mitigate the safety hazard caused by the upstands in the expansion joint as shown in the sketch below. The mountable kerb is provided to mitigate the hazard further. The kerb or plate cannot be removed as it will create a further safety issue.



The length of the mountable kerb can be increased along road centreline to increase the transition length of the mountable kerb and mitigate the impact risk.

BBO: Extending the mountable kerb nose will require relocation of the barrier posts. As discussed in 2.1.1 above, the existing system should perform adequately when impacted by cars. For motorcycles to hit the kerb they will already have impacted the WRSB so outcomes will already be severe. Propose no change be made.

Safety Engineer	Considering the overall length of the barrier and the relatively short length of mountable kerb, the risk is low that it will be struck and if struck the risk will be low that the system will fail.
Client Decision	Agree with BBO and Safety Engineer's responses. No further action required.
Action Taken	N/A

2.1.3 Barrier shear posts immediately adjacent to mountable kerb

MINOR

Frequency Rating	INFREQUENT	Severity Rating	UNLIKELY
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Wire-ropes barrier posts are placed within or immediately adjacent to mountable kerb. It is unclear if these posts are designed to shear or their bolt-connection with the bridge will shear on impact. This may result in performance different to manufacturer's specifications. Impacts into wire-rope barrier are redirected along the path of the barrier and so vehicles impacting the barrier prior to the mountable kerb will be directed into striking them.



Recommendation

Designer to confirm that NZTA has accepted the use of the shear-posts at this location.

Designer Response	<p><i>Novare:</i> The use of shear posts along the centreline is more generally approved through the acceptance of the design. Location specific approval is not noted. Depending on the solution reached for items 2.1.1 & 2.1.2 that may solve this issue. Otherwise, they can be moved away from the mountable kerb and reinstalled with a mechanical anchor closer to the edge of the expansion joint concrete apron.</p> <p><i>BBO:</i> WRSB posts are designed to yield and fold over (in the direction of travel) rather than shear off, in which case the posts will still perform that way mounted where they are. Propose no change be made.</p>
Safety Engineer	BBO's comments address the issue as they are not shear posts; rather their frangibility comes from a bending/folding action. Issue is cleared up and no change proposed.

Client Decision	Agree with BBO and Safety Engineer's responses. No further action required.
Action Taken	N/A

2.1.4 Median width and barrier deflection on northern curve

MINOR

Frequency Rating	INFREQUENT	Severity Rating	UNLIKELY
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Median shoulder width of 1.5 m is provided throughout the project extent. A vehicle that has lost control on the 450 m radius (approx.) curve at the northern end may deflect into oncoming traffic. When struck, the barrier debris could fall loosely within the northbound traffic lane.



Recommendation

Consider adjusting the median edge line on the southbound approach to the Moutoa Floodway Bridge (Whirokino) to increase the deflection zone of the barrier if struck.

Designer Response	BBO: Increasing the barrier offset on the right hand side by adjusting the median edge line will reduce the shoulder width on the left hand side, which is already minimal. The risk described in the audit concern may be less than the risk of reducing the left hand shoulder width (reduced sight distance; reduced space for cyclists and stopped vehicles). Propose no change be made.
Safety Engineer	The suggested remedy from BBO does not consider moving the outside barrier to accommodate the changed edge lines. The based on the layout and existing shoulder (behind the barrier), it may be possible to move the outside barrier and accommodate suggested increase in deflection zone without having to widen the seal width. However, the cost of adjusting the barrier needs to be weighted against mitigation of the minor risk. The risk is low enough that if the cost is too high no action is necessary.
Client Decision	Agree with BBO response. No further action required.

Action Taken

N/A

2.1.5 Northbound edge barrier south of river bridge

MINOR

Frequency Rating

INFREQUENT

Severity Rating

UNLIKELY

There is a sharp change in direction greater than 1:30 taper rate of the edge barrier between the farm access and the motorists service sign.



Recommendation

Reinstall barrier with appropriate taper rate.

Designer Response

Contractor: The taper has been installed as per design but extended an extra 2 rails away from the shoulder to step over the Chorus fibre. It then runs parallel with the fibre as can be seen in the near part of the photo. It is difficult to determine a barrier taper as the lane alignment is on a horizontal curve and the barrier is tapering outwards as the shoulder widens. The taper was measured as 1:16.8 which is not the sharpest on the project. The taper looks much smoother with the line marking in place.

BBO: The barrier is 3.0m from the edge line at the start of the taper which is outside the shy line (refer AGRD Part 6 Table 6.4). For barriers outside the shy line a flare rate of 1:17 is acceptable for a design speed of up to 110km/h (refer AGRD Part 6 Table 6.5). Propose no change be made.

Safety Engineer	As the barrier is outside the shy line 1:17 should be the max flare rate. At 1:16.8, this is steeper than acceptable. If a decision is made to change the flare rate, it is recommended that the change be made to flatten the flare beyond 1:17 as going to the expense of making the change should try to improve it beyond the minimum.
Client Decision	Agree with BBO response. No further action required.
Action Taken	N/A

2.1.6 Barrier installation

COMMENT

The wire-rope barrier on the northbound edge line between Link Road and the Moutoa Floodway Bridge (Whirokino) had not yet been tightened at the time of the audit.

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2.2 Bridge shoulders

2.2.1 Attachment system for plates covering expansion joints

SERIOUS

Frequency Rating	COMMON	Severity Rating	VERY LIKELY
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Metal plates covering the expansion joints have been provided on the shoulders to be traversable by cyclists. These metal plates are attached on the leading edge only with short screws approximately 2 cm in length. During the line marking inspection screws were observed to be loose and easy to loosen. With traffic passing over the bridge and other sources of vibrations, these plates are likely to become detached becoming a hazard for all road users if kicked up by vehicle traffic and caught in the wind.



Recommendation

Revisit this detail of how this is going to be mounted so that it does not vibrate loose and become a hazard for cars driving over/next to the plate.

Designer Response	<p><i>Novare:</i> All the screws have been tack welded at the cover plate to ensure it is securely in place and the issue has not been observed since.</p> <p><i>BBO:</i> Suggest this is monitored and thoroughly inspected at the end of the DNP before accepting as a permanent solution.</p>
Safety Engineer	Recommend this is monitored <u>during</u> the defects period as this issue should be fixed immediately. Loose plates and loose screws are hazardous to traffic immediately, especially motorcyclists.
Client Decision	Agree with BBO and Safety Engineer's responses. No further action required.
Action Taken	<p>Plates to be carefully monitored during DLP.</p> <p>November 2020 update: Plates are being monitored. Bolts are holding well to date.</p>

2.2.2 Sump form and depth

SIGNIFICANT

Frequency Rating	COMMON	Severity Rating	VERY LIKELY
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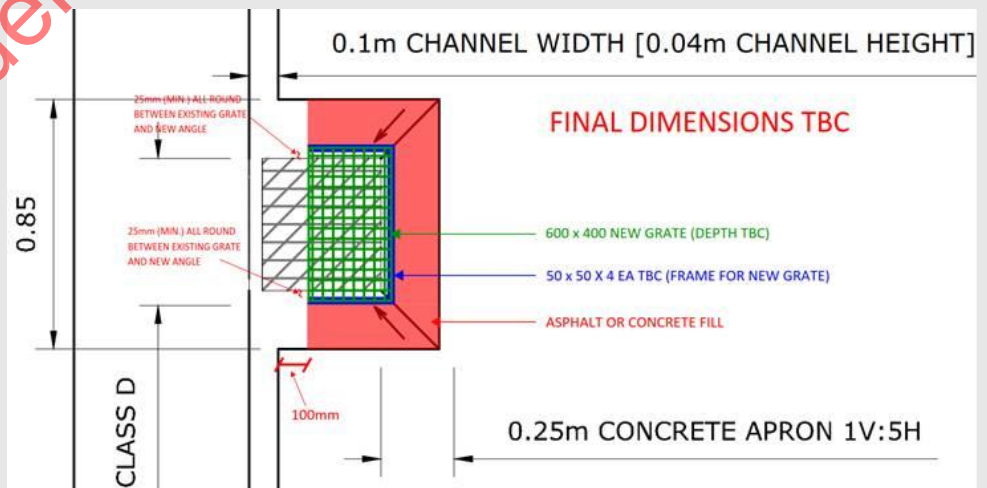
Sumps along the sealed shoulders of the bridges are located approximately 50 mm below the seal surface. On the Moutoa Floodway Bridge (Whirokino) sumps are spaced approximately every 50 m. “Confident and courageous” type of cyclists will use the shoulder rather than the shared path. The dips at 50 m spacing will create an uncomfortable ride for cyclists who consistently use the shoulder, and will cause them to ride on the non-undulating surface closer to the traffic lanes, increasing their risk.



Recommendation

Consider a sump solution level with the surfacing.

Designer Response: *Novare:* A solution has been proposed. If we get a go-ahead from everyone, we can start working on the details.



BBO: The Contractor has also been asked to investigate using a concrete planer to reduce the slopes surrounding the sump, as an alternative to the above solution. If feasible, this would be preferred by BBO.

Safety Engineer	In deciding between the two options, the Novare solution would be superior with respect to cyclist comfort. Rising the grate would also deal with the issues in 2.6.1 where Novare recommends raising the sump grate height to deal with the likelihood of the drain blocking due to debris.
Client Decision	Agree with the Safety Engineer's response. Given the shoulder width is only 1.5m, from a safety perspective, the full width needs to be available for cyclists at all times and at present, this is not the case. Furthermore, the planning option (without raising the level of the sump grate) is really only a partial mitigation measure as the perceived hazard still remains. Very careful thought needs to be given to the final solution, as any works will result in delay and disruption to road users and is likely to attract negative feedback if the comms are not handled appropriately.
Action Taken	June 2021 update: Grates have been raised level with the road surface. No further action required.

2.2.3 Grip on metal plates covering expansion joints **MODERATE**

Frequency Rating	OCCASIONAL	Severity Rating	LIKELY
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Metal plates cover the expansion joints on the shoulder of the two bridges within the project. These metal plates have marco-grip pattern on their top side, but lack grip between and so have lower grip than typical surfacing, particularly when damp/wet. This reduced grip will increase the likelihood of cyclists or motorcyclists riding on the across the joint losing control.



Recommendation

Consider methods to increase the grip on the metal plates.

Designer Response	<i>Novare:</i> The plates can have a grit filled coating applied to the top to increase slip resistance.
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	<i>BBO</i> : Agree with the Novare proposal.
Safety Engineer	The grit filled coating is expected to mitigate this issue.
Client Decision	Agree with <i>BBO</i> and Safety Engineer's responses.
Action Taken	November 2020 update: Coating to be applied during closures for second coat sealing. June 2021 update: Work completed, no further action required.

2.3 Signs

2.3.1 Rest area northbound signage

SIGNIFICANT

Frequency Rating	OCCASIONAL	Severity Rating	VERY LIKELY
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In a previous phase Road Safety Audit, concern around right turn movements into the rest area was identified, the accepted solution was to only signpost the rest area for southbound traffic. However the rest area has now been signed for northbound traffic as well.



Recommendation

Remove the northbound facing rest area sign, or explain what mitigation has been implemented to reduce risk for the northbound right turn movements.

Designer Response	<i>BBO</i> : The Client Decision and Action Taken for Item 2.2.3 of the Specimen Design Road Safety Audit was to increase the edge barrier offsets, to provide road space for through vehicles to manoeuvre around slowed or stopped vehicles turning into and out of the entrance . On the one hand the sign for northbound traffic could encourage right turns in and out. On the other hand, omitting the sign might result in drivers making late decisions to turn into the entrance. Weighing up the risks, <i>BBO</i> preference is to remove the signs for northbound traffic.
Safety Engineer	Remove the sign for northbound traffic.
Client Decision	Agree with the Safety Engineer's response.
Action Taken	Sign to be removed.

November 2020 update: Signs have been removed, no further action required.

2.3.2 Manawatu bridge cyclist warning

MODERATE

Frequency Rating	INFREQUENT	Severity Rating	VERY LIKELY
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All cycle users are required to use the Manawatu River bridge shoulders on the southbound approach. Cyclist warning signs are considered inadequate as they located on the outside of a wide shoulder.

Related but not within the issue: encouragement for cyclists to use the off-road cycle-path could be provided at the northbound left turn into Link Road and southbound left turn onto the river bridge.

Recommendation

Designate the southbound shoulder from Whirokino Road over the Manawatu River bridge as a cycle lane. Consider the use of green surfacing at the intersection and provide cyclist symbols on the shoulder on the bridge.

Designer Response	<p><i>BBO</i>: BBO are neutral regarding whether a southbound cycle lane should be marked between Whirokino Road and the southern end of the bridge. The design intent was that the cycle route ends at the point the diversion around the floodway bridge re-joins the SH1 shoulder. However, BBO are happy to defer this to the Transport Agency's cycle design specialists for a decision.</p> <p>Marking of short lengths of green surfacing to guide cyclists through important junctions is supported, including the turn from the SH1 southbound shoulder onto the off road cycle path at the northern end of the floodway bridge, and the turn from the SH1 northbound shoulder into Link Road to access the off road path.</p>
Safety Engineer	<p>Agree with designation of the cycle lane over the Manawatu Bridge, but a decision needs to be made with marking the remaining section. If the markings are carried on, it may divert cyclists from the far safer off road cycle path.</p>
Client Decision	<p>GP to discuss with BBO</p>
Action Taken	<p>November 2020 update: No action, pending resolution of existing MRB retention for an alternative cycle route over the river. If the existing MRB is retained, it may be better not to mark a cycle lane over the road bridge.</p> <p>June 2021 update: No further action required as part of the RSA. Now that the decision has been made to demolish the existing MRB, any safety improvements for cyclists on the new MRB, will be dealt with as part of this phase of the project.</p>

2.3.3 Cycle-path closed sign

MODERATE

Frequency Rating	INFREQUENT	Severity Rating	VERY LIKELY
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Users are informed that the cycle-path is closed by a single sign at each end prior to the cycle-path. It is possible that users may miss or ignore this sign and continue onto the cycle-path / floodway while in flood, mistaking the depth or speed of water and the consequential hazard (or being unwilling to turn back). While this is considered to be very infrequent, its consequence would very likely result in death or serious injury.

Recommendation

Provide a gate at the southern end of the pathway at Whirokino Road and at the northern end at the floodway stopbank to prevent access when the cycle-path is closed.

This could also prevent the public travelling through the cycle-path while it is being maintained.

Designer Response	<i>BBO</i> : Flood velocities are low and there is no sudden drop into deep water, so the risk of serious harm is very low. A warning sign should be sufficient.
Safety Engineer	The use of a gate raises problems for the long-term operation of the cycle path as our contractor must open and close it pre- and post-flood. It is also difficult to construct a pedestrian/cyclist proof fence and people may still use it if they slip past. Straying off the cycle path may result in a cyclist entering deep water areas, so we need to ensure the existing fencing will be adequate in flood conditions to protect cyclists if no gates are installed. Would suggest that an information sign explaining the risks before entering the danger zone could be an option provided its position was not distracting/observable to the bridge traffic.
Client Decision	Agree with <i>BBO</i> response. However, there may be benefit in providing a supplementary sign explaining the hazard, as suggested by the Safety Engineer.
Action Taken	Investigate supplementary warning sign. November 2020 update: Sign not yet installed. June 2021 update: Sign currently ordered and awaiting installation. No further action required.

2.3.4 Sign text sizing and spacing

MINOR

Frequency Rating	OCCASIONAL	Severity Rating	VERY UNLIKELY
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Throughout the project extent there are numerous site specific signs which have text size and spacing not compliant with the traffic control devices manual. Generic signs such as Passing Lane Ahead did not seem to have the same text issues.

Instances include:

- Whirokino Road and Matarapa Road text height on directional sign approaching Link Road.



- Manawatu River Bridge place sign (IG-14) has narrowly spaced lettering making it difficult to read.



Recommendation

Recommend reviewing all of the signs within the project extent to confirm they meet TCD / MOTSAM requirements.

Designer Response

Contractor: The font used on the dual name IDS sign was done in 120mm HIROAD D as Specified in MOTSAM.

Street name lettering should be Series D Capitals in the same size as the lower-case letters of the destination. This would be 160/120mm.

The normal HIROAD EM font for destinations is Capital of 160mm and lower case of 120mm.

As for the compression for the bridge signs, they have been compressed for size reasons within the 15% maximum as specified in MOTSAM/TCD.

If they were not compressed the final size would be larger.

Compression is normal practice with bridge signs - due to their location they can protrude onto the road.

BBO: All signs are compliant.

Safety Engineer	<p>According to the designers, these signs are compliant. Safety audits are not about compliance, but addressing the issues brought up by the SAT. In this case, the fundamental question would be about legibility of the sign and the effects of this on safety.</p> <p>The compression and legibility of the bridge name signs are unlikely to be a safety risk.</p> <p>Arguably the Whirokino Road and Matarapa Road may have a safety effect as they need to advise drivers of their destination well in advance of deciding to turn. Suggest a review at normal travel speeds of these signs to see if they are sufficiently legible for alert drivers who may be searching for them.</p>
Client Decision	Agree with BBO and Safety Engineer's responses.
Action Taken	<p>Carry out site inspection to confirm legibility at normal travel speeds.</p> <p>November 2020 update: Inspection not yet carried out.</p> <p>June 2021 update: Inspection completed and sign considered legible. No further action required.</p>

2.3.5 Median barrier northern end RG-17 sign

MINOR

Frequency Rating	OCCASIONAL	Severity Rating	UNLIKELY
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The RG-17 "keep left" sign mounted on the southbound approach to the northern end of the median barrier is slightly off-set to the right of the barrier terminal. This could cause a slight perception issue for the location of the barrier.



Recommendation

Shift the RG-17 sign slightly left to align the centre of the sign with the barrier terminal.

Designer Response	The barrier terminal is part way around the curve so the apparent offset may be a visual effect. The situation will be checked now that the road has been marked and the sign will be relocated if the location is misleading.
Safety Engineer	Review as suggested by the designers at normal approach speeds.
Client Decision	New posts have been installed. No further action needed.
Action Taken	N/A

2.3.6 Floodway bridge sign height

COMMENT

The sign for the northbound facing Moutoa Floodway Bridge (Whirokino) is too low on its support post and is obscured behind the barrier.



BBO Comment: The sign height should be adjusted by the Contractor.

Client Decision: Agree with BBO response.

November 2020 update: Bridge number sign added on top. Height set to top of Texas rail to avoid moving sign out to 7.5m for heavy haulage. No further action required.

2.3.7 Side-road speed limit signs

COMMENT

Speed limit signs on the side-road have not yet been installed at the time of the audit.

2.4 Line-marking and delineation

2.4.1 Link Road limit line visibility

MODERATE

Frequency Rating

INFREQUENT

Severity Rating

LIKELY

Visibility through to the limit line is short due to the curve of the throat island and the elevation profile change of the road.

Visibility of the giveway sign is obstructed by both the position of the lighting column and the no right-turn sign.

The advanced warning giveway pavement marking is too close to the limit line to be visible.

The giveway sign size appears to be 600 mm, and should be 900 mm.



Recommendation

1. Gate the giveway sign so that approaching road users do not overshoot the intersection and hit the median barrier.
2. Raised intersection chevron board sign for opposite intersection to improve intersection visibility.

Designer Response	<i>BBO</i> : Agree with audit concerns. All recommendations will be addressed.
Safety Engineer	Agree with the audit concerns. Make and check adjustments to the sign both day and night.
Client Decision	Agree with <i>BBO</i> and Safety Engineer's responses.
Action Taken	All signage changes to be implemented. November 2020 update: 900mm size Give-way signs installed, gated at both intersections. Chevron signs installed. No further action required.

2.4.2 Over-dimension vehicle staging area

MODERATE

Frequency Rating	INFREQUENT	Severity Rating	LIKELY
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The northbound over-dimension vehicle staging area south of the start of median barrier is a significantly wide shoulder currently hatched. The purpose of this area could be unclear for most road users and could encourage undesirable road user behaviours, and at night may even be mistaken as the actual live lane. This issue was previously identified as a comment in the previous audit.



Recommendation

Consider providing some form of delineation and / or separation, either in the form of a mountable island between the carriageway (incl. standard hard-shoulder) and over-dimension vehicle staging area, with edge marker posts and red edgeline RRPMS at the entry.

Designer Response	<i>BBO</i> : Agree with audit concerns. Final markings will include ATP edge lines which will provide better delineation than the initial markings. Additional diagonal bars could also be applied. They are currently at 50m centres. Suggest two additional bars in between each current pair of diagonal bars, giving 16.7m spacing.
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Safety Engineer	Agree with the designer's solution.
Client Decision	Agree with BBO and Safety Engineer's responses.
Action Taken	All road marking changes to be implemented. November 2020 update: Additional bars to be applied after second coat sealing. June 2021 update: Additional bars have been installed. No further action required.

2.4.3 Wire-rope barrier edge marker posts

MINOR

Frequency Rating	INFREQUENT	Severity Rating	UNLIKELY
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The edge marker posts on the wire rope barrier can move under force, or during adverse weather conditions, at a time when they are required the most. This will result a slight offset discrepancy between the opposite edge marker posts. Additionally during the audit the spacing between edge marker posts was inconsistent.



Recommendation

Identify a solution to reduce movement of edge marker posts between wire rope barrier supports.

Provide edge marker posts at consistent spacing.

Designer Response	<i>Novare:</i> It is understood that this is the standard that is being used across the country. To ensure a sturdier connection, another clamp could be attached the lower wire. <i>BBO:</i> The attachment needs to be improved so that posts don't slide during weather events, cleaning etc. Spacings need to be uniform.
Safety Engineer	The need for the spacing to remain consistent is important and we recommend that the Novare solution is explored.
Client Decision	Agree with BBO and Safety Engineer's responses.
Action Taken	November 2020 update: Edge marker posts are not moving. Spacing to be checked; otherwise no action required.

2.4.4 Night-time traffic island visibility

MINOR

Frequency Rating	OCCASIONAL	Severity Rating	UNLIKELY
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Poor visibility to the left turn northbound onto Link Road. Additional delineation may assist with visibility of the edgeline and traffic island.

Note that street lighting at the intersection was not operating during the time of the audit and may alter intersection and turning visibility.



Recommendation

Provide white hatched marking as per MOTSAM.

Consider red RRPMs on the edgeline around the traffic island to help guide road users through the turn and kerb face reflectivity.

Designer Response	BBO: Agree with audit concerns. Chevron marking should be added in accordance with MOTSAM 2.08.03. A review of the lighting and delineation will be carried out after final markings have been applied.
Safety Engineer	Add chevron markings. Please note that island should be lit as well.
Client Decision	Agree with BBO and Safety Engineer's responses.
Action Taken	All road marking changes to be implemented. November 2020 update: Additional markings and RRPM's to be applied after second coat sealing. June 2021 update: Work completed. No further action required.

2.4.5 Night-time edgeline visibility

MINOR

Frequency Rating	INFREQUENT	Severity Rating	VERY UNLIKELY
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There are several locations within the project extent with very wide shoulders, this provides a significant offset between edge marker posts (free standing or barrier mounted) and the edgeline.



Recommendation

Additional night time delineation of the edgeline should be provided where there is a shoulder wider than 2.0 m. This could be red RRPM or other edgeline delineation methods.

Designer Response	BBO: Agree with audit concerns. Final markings will include ATP edge lines which will provide better delineation than the initial markings.
Safety Engineer	Agree with BBO's plan for final markings.
Client Decision	Agree with BBO and Safety Engineer's responses.
Action Taken	All road marking changes to be implemented. November 2020 update: High performance markings to be applied after second coat sealing. June 2021 update: ATP installation on both the median and shoulder edgelines is imminent. No further action required.

2.5 Miscellaneous

2.5.1 Loose chip on shoulders and traffic lanes

MINOR

Frequency Rating	OCCASIONAL	Severity Rating	UNLIKELY
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There is a build-up of loose chip in front of Scruffy Dome sumps at either end of the bridge, this should be cleared away to reduce potential ponding.

There is also a large amount of loose chip at the northern end of the bridge where the seal changes from the bridge surfacing back to chip seal, creating a bump when driving over at low speeds.



Recommendation

Sweep up loose chip on shoulders and traffic lanes of the project extent.

Designer Response	BBO: Agree with audit concerns. Contractor to address.
Safety Engineer	Address issues so that they do not crop up again during the operation long term.
Client Decision	Agree with BBO and Safety Engineer's responses.
Action Taken	Contractor has already undertaken additional sweeping and is monitoring the situation closely. No further action required.

2.5.2 Potential vegetation

MODERATE

Frequency Rating	OCCASIONAL	Severity Rating	LIKELY
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There is a potential for future vegetation growth on the embankment north of the Moutoa Floodway Bridge (Whirokino) to reduce sight distance to the farm access.



Recommendation

Ensure that low grow plants are used on the embankment.

Designer Response	The embankment has been planted in grass so driver's eye to vehicle body sight lines should not be obstructed.
Safety Engineer	The grass proposed should not grow to high, but this needs to be reviewed at the end of the maintenance liability period so that the actual effects on visibility can be checked.
Client Decision	Agree with BBO and Safety Engineer's responses.
Action Taken	Monitor during DLP.

2.5.3 Shoulder width approaching Link Road

MODERATE

Frequency Rating	OCCASIONAL	Severity Rating	LIKELY
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Barrier is over 3.0 m back from edge line prior to the intersection, which will encourage drivers to use the shoulder as a deceleration lane or slow vehicle bay. This is unsafe as drivers overtake turning traffic will be obscured from drivers at the intersection turning left out.



Recommendation

Consider methods of reducing the effective shoulder width, this could include:

- flexible delineator post marking
- hatch marking with red RRPMS on the edgeline
- Relocation of the barrier.

Designer Response	<i>BBO</i> : Agree with audit concerns. Diagonal shoulder bars should be applied between the bridge and Link Road. Combined with ATP final
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	edge line markings, this should discourage vehicles from using the shoulders as an auxiliary lane.
Safety Engineer	The approach recommended by BBO is adequate.
Client Decision	Agree with BBO and Safety Engineer's responses.
Action Taken	All road marking changes to be implemented. November 2020 update: Diagonal shoulder bars to be applied after second coat sealing. June 2021 update: Additional bars have been added. No further action required.

2.5.4 Surfacing toe the barrier edge

COMMENT

There is a gap in the surfacing at the northern bridge expansion joint.



2.6 Maintenance comments

2.6.1 Sump drain size

COMMENT

The drain outlets within sumps on and near the bridges appear to have a very small diameter outfall, and could easily clog with vehicle and wind-blown debris. Clogged drains can cause ponding on the bridge surface. With no visible access from the underside of the bridge for the northbound traffic lane sumps and scruffy dome at bridge abutments, there is concern that

sumps on and near the bridge do not have adequate space for maintenance without closing the lane.

Novare Comment: Downpipe nominal diameter is 150mm. In some locations a portion of the pipe is partly obscured beneath the edge of the TL5 barrier. Full access to the top of the 150 dia pipe is available when the sump grate is raised and the pipe inlet is not partially blocked.



2.6.2 Traffic lane width and maintenance

COMMENT

There is approximately 5.75 m of carriageway space each side of the wire-rope barrier on the bridges. To carry out maintenance with a shoulder closure, a 2.75 m traffic lane and 1 m lateral safety zone are required to pass work vehicles. The remaining space for work vehicles is 2.0 m including any shy space between the work vehicle and the barrier. It is likely that lane closures will be required for any maintenance activities and consideration should be given to operational practises and timing.

2.6.3 Surfacing at stock underpass

COMMENT

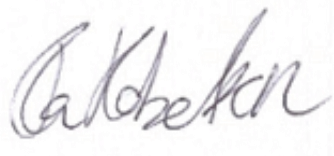
Surfacing at the stock underpass appears to be failing, this will require maintenance. In the right hand photo below, there is a crater in the surfacing exposing base course.



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3. Audit Statement

We certify that we have used the available plans, and have examined the specified roads and their environment, to identify features of the project we have been asked to look at that could be changed, removed or modified in order to improve safety. The problems identified have been noted in this report.



Signed:
2019

Dated: 17 April

s 9(2)(a) GHD Limited



Signed:
2019

Dated: 17 April

s 9(2)(a) GHD Limited



Signed:
2019

Dated: 17 April

s 9(2)(a) GHD Limited

Designer: s 9(2)(a) Senior Civil Engineer, Bloxam, Burnett & Olliver Ltd

Signed:

Dated:

Safety Engineer:



Signed:

Dated: 29 July

Out of Scope Team Leader – Safety Engineer, New Zealand Transport Agency

Project Manager: Out of Scope Position...Principal Project Manager (NZTA).....

Signature.......... Date..... 05/07/21.....

Action Completed: Name... **Out of Scope**Position... Project Manager

Signature.....  Date..... 05/07/21

Project Manager to distribute audit report incorporating decision to designer, Safety Audit Team Leader, Safety Engineer and project file. Date:.....05/07/21.....

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GHD

Level 1, Grant Thornton House
215 Lambton Quay


T: 64 4 472 0799 F: 64 4 472 0833 E: wgtmail@ghd.com

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
1	s 9(2)(a)					17/4/20

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