New Zealand Transport Agency

Whirokino Trestle and Manawatu River Bridge Specimen Design Road Safety Audit

July 2017

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1. Background

1.1 Safety Audit Procedure

This report has been prepared for the specimen design for the replacement of the 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 (SAT)

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
- Out of Scope New Zealand Transport Agency, Napier

A daytime site inspection was undertaken on 9th May 2016 when the weather was dry.

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 Detailed Design Stage Safety Audit of the specimen design of the Whirokino Trestle and Manawatu River Bridge.

The SAT has a copy of the preliminary design safety audit completed in December 2014.

1.5 Documents Provided

The Safety Audit Team (SAT) has been provided with the following documents for this audit:

- Whirokino Trestle and Manawatu River Bridge Specimen Design 142220/07, Bloxam Burnett & Oliver, April 2016, drawings 5000-5007, 5221-5223, 5251-5262, 5271-5273, 5281, 5291, 5351-5356, and 5361.
- Whirokino Trestle and Manawatu River Bridge Preliminary Design Safety Audit Report, GHD Limited, December 2014.

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. The specimen design proposes an alignment which is adjacent and parallel to the existing alignment. Figure 1 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 Matakarapa Road the running distance is from Link Road.

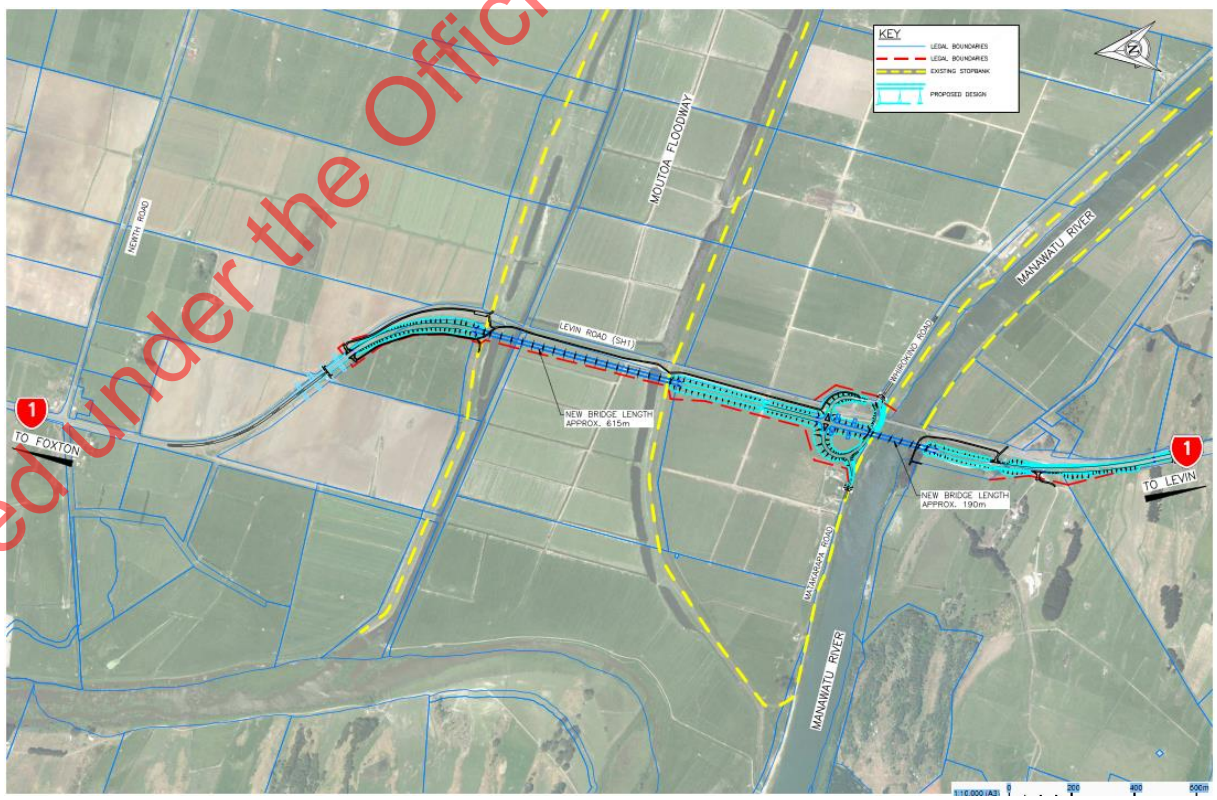


Figure 1: Project Elements and Road Layout (Drawing 5002)

The project includes:

- 615 m Whirokino Trestle bridge.

- 190 m Manawatu River Bridge.
- Embankment between the two bridges over farmland with a stock underpass.
- A new road (Link Road) from the northbound side of SH1, opposite Whirokino Road, in a crescent shape joining onto Whirokino Road via an underpass of SH1. Matakarapa Road connects to Link Road at a T junction approximately half way along with priority given to Link Road.
- Realignment of Whirokino and Matakarapa Road with new intersection connections.
- A rest area and wetland at the southern side of the Manawatu River Bridge.
- Shortening of a southbound passing lane.
- Improved facilities for cyclists using the existing cycle path adjacent to the Whirokino Trestle.

The specimen design resembles Option 2 from the preliminary design, with some alterations.

2. Safety Audit Findings

2.1 Typical Section Issues

2.1.1 Solid White Centreline Marking SIGNIFICANT

Frequency Rating	COMMON	Severity Rating	LIKELY

Outside of the project area, solid/continuous white centrelines and lane lines are typically used where overtaking is not permitted, but has a lesser perception than no passing lines by the public at large. Examples of solid white lines not permitting overtaking are; approaching intersections, level crossing, pedestrian crossings, raised islands, or flush medians. Using solid white centrelines within the project will confuse users regarding if overtaking is, or is not permitted.

Recommendation

Alter wide centreline marking to either dashed white if overtaking is permitted or solid yellow if overtaking is not permitted. Alternatively, a median treatment such as a wire-rope barrier or flexible posts could be provided if overtaking is not permitted.

Designer Response	The NZTA Draft Wide Centreline Traffic Note allows for continuous or dashed wide centreline markings. We chose continuous markings for maximum effectiveness as a head on crash countermeasure. NZTA Draft ONRC cross section guidelines specify median barriers or wide centreline for moderate volume National Strategic Highways and 3 or 4 lanes. In this case we have 2 lanes because of the high cost of bridging. Presumably the ONRC guidelines envisage a median barrier when there is overtaking opportunity provided (3 or 4 lanes) and a wide centreline when there are 2 lanes, so that overtaking can occur during periods when traffic volumes are low. However this does not comply with the safe system approach. Our recommendation is to adopt a median barrier to provide a new section of highway where head on crashes cannot occur. A median barrier would also address issue 2.2.1 below. Accordingly, a wire rope median barrier would be our recommended centreline treatment. Otherwise, we have no issues with providing a dashed wide centreline instead of continuous wide centreline to address this audit concern.
Safety Engineer	High Speed Passing - If vehicles overtaking one and other at high speed are not vital to the function of this bridge, it may be best to prevent it through the design by including the median wire rope. The location of the nearest passing opportunities to the bridge should be part of this deliberation. The road will however have a clear view along its length so high speed passing is not necessarily dangerous (compared with a section with poor visibility). Low Speed Passing - Low speed agricultural vehicles (tractors), may

	frequent this road and this is quite a long length to follow there is insufficient room to pass. Encroachment onto a wide centreline is an option for the following drivers, and still may be possible if there is a median barrier system at a low speed. In my opinion, if we believe that high speed head on crashes will be a problem long term, I would rather see a wire rope barrier installed as part of the design rather than taking a "wait and see" approach. If a median barrier cannot be used as the passing opportunity is needed (either high or low speed) then we stick with the typical wide centreline design using the standard configuration for consistency (dashed lines or solid/dashed yellow). There are two other considerations for the use of a median barrier. The first is that a barrier will restrict the sight lines at some of the side accesses and there may be a condition on the consent around this. Second there are maintenance issues around traffic control if a barrier is installed.
Client Decision	The NZTA is currently investigating the installation of a central median WRB.
Action Taken	Awaiting NZTA decision on whether to incorporate the wire rope median barrier.

2.1.2 Shoulder Width Consistency MODERATE

Frequency Rating	INFREQUENT	Severity Rating	VERY LIKELY

Shoulder widths between the bridge sections (1.5 m) and embankment sections (2.0 m) are inconsistent. Variable widths will introduce a suddenly narrowing pinch point pushing vulnerable users towards traffic. This variation in shoulder width was identified in the preliminary design safety audit as issue 2.2.4 with a minor consequence. The detailed design shoulder widths appear to have been reduced from the preliminary design Option 2.

Recommendation

Narrow the width of the marked shoulders at decision points (south of Culvert 9651 and south of Link Road). Or; standardise the shoulder widths to provide a more consistent cross-section.

Designer Response	A path for vulnerable users is provided, except for on the Manawatu River bridge. The other mitigating factor is that a wide centreline provides additional road space for vehicles to shy away from cyclists. Widening the bridge shoulders is desirable but unaffordable. There are numerous safety benefits from having wide shoulders off the bridges so narrowing these shoulders to match the bridge width is not recommended.
Safety Engineer	The approaches are straight and sight lines appear to be good, so a cyclist or other vehicle on the verge is observable well in advance of the narrowing. A more gradual transition could be part of the design.

Client Decision	Agree with Safety Engineer's response. Maintain variable shoulder width (as described by the Designer) subject to suitable transitions between variations in width.
Action Taken	The current Principal Supplied Design incorporates the Client Decision, with a transition in width over the length of the concrete barrier to W-Beam terminal transition. No further action is required.

2.1.3 Edge Marker Post Location MINOR

Frequency Rating	INFREQUENT	Severity Rating	UNLIKELY

Edge marker posts have been included on the embankment sections of the new alignment located 1.5 m from the edgeline, and 0.5 m from the wire-rope edge barriers as shown in Figure 2 below; it should be noted that Figure 2 does not include planned edgeline ATP marking. Edge marker posts at this location are a hazard/obstruction to road users on the shoulder such as confident cyclists and hinder and increase required maintenance activities.

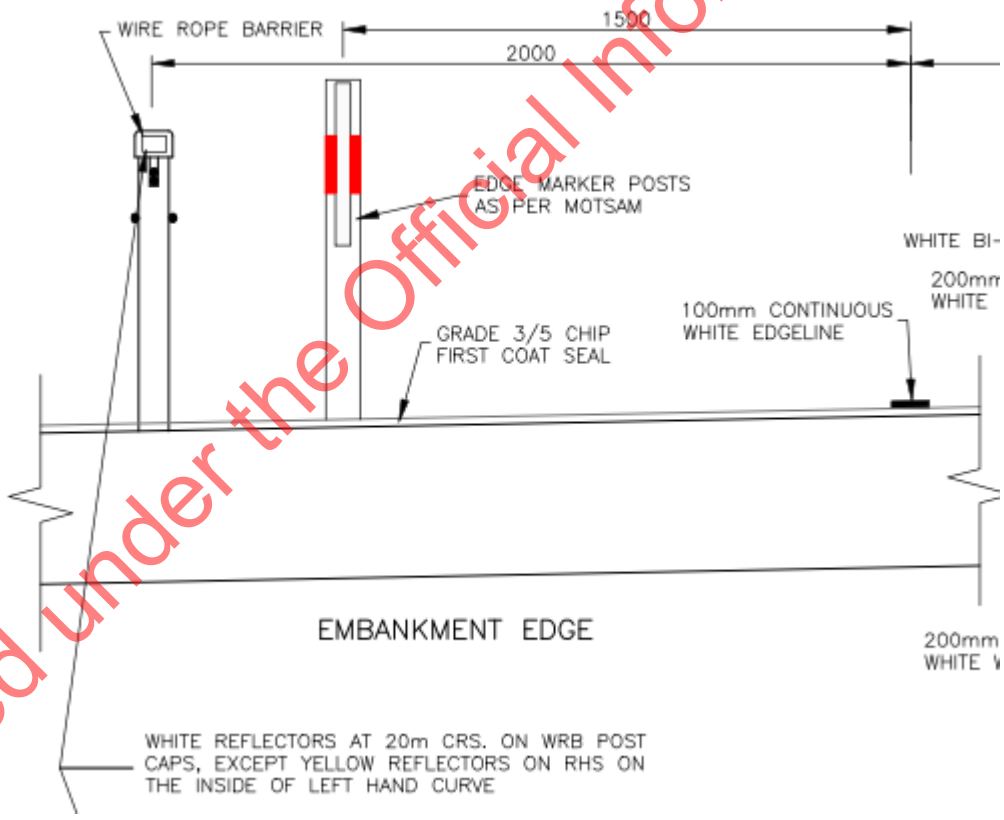


Figure 2: Embankment Shoulder Delineation Treatments

Recommendation

Include edge marker posts as an attachment on the outside of the wire-rope barriers.

Designer Response	We agree with the audit recommendations because otherwise the edge marker posts at 1.5m offset negate some of the benefits of providing a

	2.0m wide shoulder.
Safety Engineer	Support the auditors' and designers', recommendation.
Client Decision	Agree with the Safety Engineer's response.
Action Taken	The current Principal Supplied Design incorporates the Client Decision to move the EMP's behind the barrier. No further action is required.

2.1.4 Audio Tactile Profiled Markings on Bridges MINOR

Frequency Rating	INFREQUENT	Severity Rating	UNLIKELY

The bridge and embankment sections of the realignment have different surfacing types. The bridge sections (stone mastic asphalt – SMA) appears to be a single application, embankment sections have two coat chip specified which are typically installed approximately 12 months apart. Both the embankment and bridge will eventually have ATP marking, however there is no economic reason to delay ATP marking on the bridge sections.

Recommendation

Install ATP on bridge sections after surfacing.

Designer Response	While we agree with the audit concern, the cross section and road marking dimensions are unique to this project and it may be preferable to delay application of long life markings until satisfactory operation is confirmed.
Safety Engineer	I understand the designer's reluctance to install the long life markings with elements of the layout being untested. I recommend that there is a short timeframe for a post construction review of the edge lines and once completed, install the ATP markings as soon as possible.
Client Decision	Agree with the Safety Engineer's response.
Action Taken	An instruction will be issued to apply the ATP markings on the bridges a short time after initial marking, rather than in sync with the markings on the chipseal as stated in PR A9.2.4.

2.1.5 Bridge Delineation COMMENT

Frequency of delineators on the bridge sections have not been indicated on drawing 5361. These should be consistent with wire-rope barrier delineators on embankment sections.

2.1.6 Local Road Shoulder/Berm Layers COMMENT

Drawing 5222 shows typical sections for the local roads (Whirokino Road, Matakarapa Road, and Link Road). The pavement layer and Topsoil & Grass Berm are shown to overlap. A thick layer of topsoil overlapping the pavement layer increases maintenance costs.

2.2 Specific Location Issues on SH1

2.2.1 Right Turns at Intersections SERIOUS

Frequency Rating	FREQUENT	Severity Rating	LIKELY

Whirokino Road and Link Road are proposed to operate as left-in left-out connections to SH1. No Right Turn signs (RG-7) are used to discourage right turn movements. These measures are not effective as a deterrent for determined right turn movements made for convenience.

Recommendation

Consider a physical restraint in the median area to prevent right turn movements such as flexible posts or a wire-rope barrier.

Consider an expressway style schematic advanced directional sign, similar to AD-4 or AD-5, (which might be out of context for the rural road environment).

Designer Response	In this case, right turn movements are able to be made as left turn movements, via the underpass. The key will be to get people to use the underpass, rather than risk turning right. We think the guide signs at the Matakarapa and Whirokino Road intersections with Link Road will provide sufficient information for drivers to use the intersections correctly if they choose to do so. However, in practice, people may turn right when traffic conditions are light, but would use the grade separation when traffic is heavy. Safe hit posts could be installed in the wide centreline if right turns prove to be a problem however no overtaking lines would then need to be marked for a considerable distance in either direction to prevent overtaking vehicles from running into them. A median barrier continuous throughout the length of the project would provide the ultimate solution to this safety issue.
Safety Engineer	As the right turns are not necessary due to the underpass configuration, there is no problem using a median barrier to preclude right turn movements. If the median barrier is not part of the final design, the use of signage to direct the traffic is OK; they will only cross right if the traffic is light and the sight lines will be adequate for the right turn if they opt for this.
Client Decision	The NZTA is currently investigating the installation of a central median WRB.
Action Taken	Awaiting NZTA decision on whether to incorporate the wire rope median barrier.

2.2.2 Farm Access at 2400 m SERIOUS

Frequency Rating	COMMON	Severity Rating	VERY LIKELY

Access to the farm (1187 SH1, Levin) will be provided from the northbound side of SH1 at 2400 m. This location is at the beginning of the southbound passing lane. The access will be constructed according to a modified diagram D, and will not have right turn provision.

Diagram D in the Planning Policy Manual has at least 6 m of carriageway space from the centreline for 90 m either side of the access (excluding the nearside departure), this is not achieved at this location with the wire-rope barrier located 5.5 m from the centreline on the northbound side at 2400 m and 2450 m in drawings 5260 and 5261.

This access is located in a high speed environment between a long straight with a wide road and a 110 km/h design speed curve with passing lane.

The location of this access will cause confusion as vehicles indicating to turn right into the access could be mistaken for indicating that they are going to overtake, resulting in rear-end impacts. While rear-end crashes typically have lower occurrence of death or serious injury outcomes, at this location the right turning vehicle would most likely be pushed into the northbound lane and increase the likelihood of the crash becoming a head-on impact.

Recommendation

Consider how this access could interact with neighbouring access at 2275 m on the southbound side of the road as a system and prevent right turn movements with a median treatment (see recommendation 2.1.1 and 2.1.2).

Designer Response	While the layout is not ideal, the existing road layout has the entrance within the actual passing lane which arguably is less safe than what is proposed. On the southbound side the edge barrier is offset 3.0m. This could be widened to say 3.5m over a distance of 90m either side of the entrance, giving additional space for through vehicles to manoeuvre around a vehicle turning right. On the northbound side the barrier offset could similarly be increased to 3.5m over a distance of 90m either side of the entrance. The wide centreline or median barrier could be extended further south across the entrance. This has not been investigated in detail. There could be design issues and safety issues associated with tapering back to a standard centreline within the passing lane and within a curve. In terms of interaction with the entrance at 2275m there are no direct turning conflicts however ideally these entrances would be spaced further apart to prevent any interaction between decelerating and accelerating vehicles and through traffic. A median barrier to prevent right turns at these access ways would require a safe turn around facility to be provided. To the north the new Whirokino/Matakarapa Road intersection would provide a suitable turning facility. Currently there is no equivalent safe turn around facility to the south.
Safety Engineer	Ultimately, the design is an improvement over the existing situation. The increase in offset described by the designer is an option that should be considered at this stage.

Client Decision	Agree with the Safety Engineer's response.
Action Taken	The current Principal Supplied Design incorporates the Client Decision, including the increased offset. No further action is required.

2.2.3 Rest Area and Wetland Access at 2275 m SIGNIFICANT

Frequency Rating	COMMON	Severity Rating	LIKELY

Access to the rest area and wetland will be provided from the southbound side of SH1 at 2275 m. This location is where the wide centreline is tapering back to a normal centreline. The access will need to be constructed according to diagram D, and will not have right turn provision.

Diagram D is not achieved at this location with the wire-rope barrier located 5.5 m from the centreline on the northbound side from 2350 m to 2200 m in drawings 5259 and 5260.

This access is located in a high speed environment between a long straight with a wide road and a 110 km/h design speed curve with passing lane.

Recommendation

Consider the provision of a right turn bay. Or, how this access could interact with neighbouring access at 2400 m on the northbound side as a system and prevent right turn movements.

Designer Response	Irrespective of the above issues being addressed, a reduction in movements by moving the rest area to an alternative site within the Link Road loop could be considered. A median barrier would introduce the need for a safe turn around to the south and potentially issues with providing a safe transition back to the standard centreline (refer above). To provide road space for through vehicles to manoeuvre around slowed or stopped vehicles turning into and out of the entrance, barrier offsets could be increased over a distance of 90m either side of the entrance.
Safety Engineer	Consider moving the site as discussed by the designer as avoidance is better than any likely mitigation. Increase the offsets as described if this is unable to be undertaken.
Client Decision	Agree with the Safety Engineer's response. Also, the NZTA is currently investigating the installation of a central median WRB.
Action Taken	The current Principal Supplied Design incorporates the Client Decision, including the increased offset. No further action is required.

2.2.4 Cyclist Permanent Warning Signs MODERATE

Frequency Rating	INFREQUENT	Severity Rating	LIKELY

Permanent warning signs have not been provided on the approaches at the locations where cyclists re-join SH1 from the shared path. Cyclists re-join SH1 at 120 m for northbound, and 1700 m southbound.

Recommendation

Provide PW-35 signs 160 m prior to cyclists re-joining SH1 as per MOTSAM.

Designer Response	Agree with safety audit recommendations.
Safety Engineer	Agree with the auditors and designers' recommendations.
Client Decision	Agree with the Safety Engineer's response.
Action Taken	The current Principal Supplied Design incorporates the Client Decision to add PW-35 signs. No further action is required.

2.2.5 Warning and Directional Sign Frequency MINOR

Frequency Rating	INFREQUENT	Severity Rating	UNLIKELY

There is a high frequency of road signs in both directions between the Whirokino Road and Link Road intersection and the southbound passing lane. Closely spaced signs can obscure or detract from other signs.

The following sign sequences are closely spaced:

- Northbound; RG-7 (1750 m), Cycle path closure sign, Link Road Motorist Service & Street Name signs (1710 m)
- Southbound; Motorist Service sign (1840 m) and IG-14 (1845 m)
- Northbound; PW-48 (1880 m) and PW-9 (1845 m)
- Southbound; PW-48 (2005 m) and IG-6 (2045 m)

Recommendation

Consider sign configuration along SH1 with regards to longitudinal, vertical, and horizontal placement along the roadside in accordance with MOTSAM. Particular concern should be used with permanent warning signs and directional information signs.

Designer Response	We agree that sign locations could be improved and will update the sign drawings to address these issues as far as practicable.
Safety Engineer	Support the designers reviewing of sign placement.
Client Decision	Agree with the Safety Engineer's response.
Action Taken	The current Principal Supplied Design incorporates the Client Decision, including revised sign locations. No further action is

	required.

2.2.1 Northern Curve Super-elevation COMMENT

The northern curve (from 85 – 580 m) has a super-elevation of 7%. The Whirokino Trestle bridge starts at 575 m. The curve super-elevation returning to typical elevation occurs on the Whirokino Trestle. While this is not a safety issue it does add construction difficulties.

2.2.2 Passing Lane Length COMMENT

The existing passing lane from 2400 m onwards currently has a length of 750 m (excluding tapers). This project will reduce the passing lane length to 650 m (excluding tapers). While this is above absolute minimum standards, its effectiveness will be reduced and impact SH1 safety downstream (outside of the project extent).

2.3 Local Road Issues

2.3.1 Whirokino Road Curve at 200 m MODERATE

Frequency Rating	OCCASIONAL	Severity Rating	LIKELY

This curve, which will retain the current alignment and form, is short and has low radius (approximately 50 m) and is located at the end of a straight. Link Road is proposed to joining the apex of this curve. Approach speed to this curve was identified in the preliminary design safety audit as issue 2.3.7 with a moderate consequence, with advisory speed signs as the recommendation.

Recommendation

Provide curve advisory speed sign and chevron curve indicators. And/or; realign the existing curve and extend the Link Road connection.

Designer Response	Curve realignment would require an alteration to designation. A curve advisory speed sign and chevron curve indicators are therefore recommended to address this risk.
Safety Engineer	Install curve-warning signs as recommended by designer.
Client Decision	Agree with the Safety Engineer's response.
Action Taken	The current Principal Supplied Design incorporates the PW-17 / PW-25 sign combination but not the chevron Board. An instruction will be issued to add a PW-66 chevron board.

2.3.2 Local Road Embankment Hazard Protection MODERATE

Frequency Rating	OCCASIONAL	Severity Rating	LIKELY

Whirokino Road and Link Road approaches to SH1 are on embankments. The W-section barrier on SH1 extends around the intersection curve for the first 20 m of these two roads. This leaves the remainder of the approach embankments with unprotected slopes. Unprotected slopes on the approach roads were identified in the preliminary design safety audit as issue 2.3.2 with a significant consequence, with barrier protection or reduced embankment slope as the recommendation.

Recommendation

Extend w-section barrier around the outside of the approach curves on Whirokino Road and Link Road.

Designer Response	Ideally barrier would be provided however batter slopes are traversable for light vehicles (4:1) and speeds are low.
Safety Engineer	The 4:1 batter slope is the maximum gradient and 6:1 is recommended in the SH design manual (part 6). In this case, 4:1 is adequate as the actual speeds on these road will be quite low and crashes will be

	unlikely, though care will need to be taken to consider if this slope is a risk to errant vehicles on the main road.
Client Decision	Agree with the Safety Engineer's response.
Action Taken	No action required. The slopes are shielded from main road traffic by continuous side barriers.

2.3.3 Cyclist Warning Signs MODERATE

Frequency Rating	OCCASIONAL	Severity Rating	LIKELY

The northbound and southbound cycle routes traverse Whirokino Road and Link Road between SH1 and the shared path. Link Road is only 6 m wide at the underpass which is very narrow to accommodate north bound cyclists as well as vehicle traffic in both directions.

Cyclist numbers on these roads near SH1 will be out of context with the surrounding rural road network in Horowhenua and cyclist presence maybe unexpected for vehicle drivers.

Recommendation

Provide warning to vehicle operators of the presence of cyclists at the narrowing of Link Road.

Provide PW-35 signs on Whirokino Road and Matakarapa Road prior to the Link Road intersection.

Designer Response	Agree with audit recommendations.
Safety Engineer	Agree with the auditors and designers' recommendations.
Client Decision	Agree with the Safety Engineer's response.
Action Taken	An instruction will be issued to add the PW-35 signs.

2.3.4 Whirokino Road and Link Road Intersection MINOR

Frequency Rating	INFREQUENT	Severity Rating	UNLIKELY

The Link Road approach to Whirokino Road has a downward gradient of 7.3% for the final 17 m i.e. the super-elevation of the Whirokino Road curve. This downward slope and the transition onto Whirokino Road may create a tipping risk for high-sided vehicles turning right from Link Road onto Whirokino Road.

Recommendation

Consider realigning the existing curve on Whirokino Road and extend the Link Road connection to achieve a shallower approach slope.

Designer Response	Curve realignment would require an alteration to designation.

Safety Engineer	Contemplate the likelihood of high-sided vehicles using this link road and if it is frequent, consider making the required adjustments to the designation.
Client Decision	Agree with the Safety Engineer's response.
Action Taken	Very few high sided vehicles will use the intersection, so no action taken.

2.3.5 Link Road SH1 Bridge Underpass Drainage COMMENT

The planned Link Road passes underneath the SH1 Manawatu River Bridge. At this location the Link Road is at a low point, and consequently prone to flooding. A culvert drain has is indicated on Drawing 5222 but it is unknown if this is sufficient to clear surface water at this location

2.3.6 Local Road Directional/Guide Signage COMMENT

On the local roads, directional and guide signage provides guidance for northbound and southbound cyclists and vehicles using "Foxton" and "Levin". Using town names will assist local users who are familiar with the area, however could provide confusion for users unfamiliar with the area such as cycle tourists.

2.4 Cyclist and Shared Path Issues

2.4.1 Directional Guidance for Northbound Cyclists onto the Shared Path SIGNIFICANT

Frequency Rating	OCCASIONAL	Severity Rating	VERY LIKELY

Northbound cyclists crossing the Manawatu River Bridge lack clear directional signs indicating the safe routes for them to access the shared path. This could result in northbound cyclists accessing the shared path by turning right at the SH1 Whirokino Road intersection.

Recommendation

Provide clearer signage for northbound cyclists to the presence and access method for the shared path. This could be a schematic sign in combination with vehicle users.

Designer Response	Cycle guide signs will be reviewed. "Cycle Route North" could be used in lieu of the "Cycle Path Open" sign. Various map signs have been considered for motorists and cyclists and our conclusion has been that these are too complex to be read by motorists.
Safety Engineer	Clear signage is being planned. Post construction, monitor the cyclists feedback and make the necessary alterations if needed.
Client Decision	Agree with the Safety Engineer's response.
Action Taken	The current Principal Supplied Design includes the guide sign "Cycle Path North" at the point where northbound cyclists will need to turn left into Link Road to access the cycleway. This may or may not be sufficient to address the issue. No further action is proposed until post construction feedback from users is available.

2.4.2 Northbound Shared Path Bridge Clearance MODERATE

Frequency Rating	INFREQUENT	Severity Rating	LIKELY

The northbound connection of the shared path to SH1 (at 600 m to 120 m) passes under the Whirokino Trestle bridge while climbing the Moutoa Floodway stopbank. The height between the shared path and bottom of the bridge deck has not been provided. Cyclists require adequate space

Recommendation

Consider the clearance height for shared path users on the northbound shared path.

Designer Response	The vertical alignment design of the path was not complete at time of the audit. We are confident that clearance of at least 2.2m can be provided which meets AUSTROADS cycle envelope requirements. The horizontal alignment of the path can be adjusted if necessary to achieve

	this.
Safety Engineer	Adjust horizontal alignment if required during design. 2.2m minimum is recommended.
Client Decision	Agree with the Safety Engineer's response.
Action Taken	The current Principal Supplied Design has the required clearance. No further action is required.

2.4.3 Shared Path Northern Directional Guidance MODERATE

Frequency Rating	OCCASIONAL	Severity Rating	LIKELY

There has been no provision of directional guidance at the northern end of the shared path where the northbound and southbound path splits. This could lead northbound path users to take the southbound path and emerge on the incorrect side of SH1.

Recommendation

Provide directional guide signs on shared path.

Designer Response	An appropriate sign can be added.
Safety Engineer	Recommend sign is added.
Client Decision	Agree with the Safety Engineer's response.
Action Taken	The current Principal Supplied Design has a sign at the fork directing cyclists onto the correct branch of the path to Foxton. No further action is required.

2.4.4 Shared Path Central Stopbank Crossing MODERATE

Frequency Rating	INFREQUENT	Severity Rating	LIKELY

The shared path appears to retain the existing alignment when crossing the Moutoa Floodway southern stopbank. At this location there is low forward sight distance due to the vertical and horizontal alignment. Southbound and northbound users travelling at speed may not have time to see and react to users travelling in the same or opposite direction.

Recommendation

Consider the alignment, approach slope, width, and centreline delineation of the shared path to achieve separation of users at this location.

Designer Response	Conflict with opposing direction users could be avoided by applying a

	centreline (locally, over the stop bank only) and keep left signs. Conflicts in the same direction are less likely and we think have a low risk of occurrence and injury.
Safety Engineer	Support the use of signage in this case advising keep left. Arrows on the surface of the shared path could also be considered.
Client Decision	Agree with the Safety Engineer's response.
Action Taken	The current Principal Supplied Design includes centreline marking over the stopbank. An instruction will be issued to add cyclist keep left signs.

2.4.5 Shared Path Farm Gate MODERATE

Frequency Rating	OCCASIONAL	Severity Rating	LIKELY

At 1500m two gates cross the shared path. These gates appear to connect farmland with the agricultural underpass. These gates have permanent warning (PW-37) signs in advance as well as "Please Close Gate" signs at the gate. Stopping and dismounting a bike to open and close two gates is a significant hindrance to travel time and will detract cyclists from using the shared path, and instead continue along SH1 across the Whirokino Trestle bridge and embankment. It must be remembered that a shared path is effectively a legal road and the users have the legal right of way.

Recommendation

Provide gates for the farmer to operate rather than putting the onus on shared path users and/or provide cyclist safe cattle stops on the shared path approaches.

Designer Response	Land owner agreements do not allow the priority to be changed.
Safety Engineer	Consider the cycle safe cattle stops.
Client Decision	Agree with Designer's comments.
Action Taken	The Principal Supplied Design includes the gates, in keeping with the property agreement. Cattle stops would potentially allow cyclists to conflict with stock. No action taken.

2.4.6 Shared Path Curves MINOR

Frequency Rating	OCCASIONAL	Severity Rating	UNLIKELY

Two sharp curves on the shared path at 600 m and 1675 m. These two curves do not appear to have considered radius or superelevation to meet cyclists' speeds. Cyclists consequently have the risk of crashing on these curves.

The curve at 600 m which is for southbound users appears to use the existing northbound shared path connection to SH1.

Recommendation

Consider cyclists speeds when providing low radius curves on the shared path. If the intention of these low radius curves is to prevent motorised vehicles from using the path then consider using barriers with a narrow opening rather than low radius curves. See Figure 3 below.

Figure 3: Example Vehicle Exclusion Barriers

Designer Response	Agree with audit concerns. The curves will be eased.
Safety Engineer	Support easing of the curves.
Client Decision	Agree with the Safety Engineer's response.
Action Taken	An instruction will be issued to amend the Principal Supplied Design to increase the curve radii at these locations.

2.4.7 Shared Path Vehicle Exclusion MINOR

Frequency Rating	INFREQUENT	Severity Rating	UNLIKELY

No provision for the exclusion of vehicles from the shared path has been provided in drawings.

Recommendation

Provide mechanisms which do not hinder cyclists, to exclude non-maintenance vehicles from the shared path at the southern end and on the northbound and southbound connections to SH1 at the northern end (see example in recommendation 2.4.6 above.

Designer Response	Agree with audit recommendations.
Safety Engineer	Agree with audit recommendations.
Client Decision	Agree with the Safety Engineer's response.
Action Taken	The Principal Supplied Design includes barriers/bollards at the start of the path on each side at the northern end, and at the southern end. No further action required, other than to specify the type of barrier/bollard. An instruction will be issued to clarify, based on the exclusion barriers illustrated in Figure 3.

2.4.8 Shared Path Southern Terminus MINOR

Frequency Rating	INFREQUENT	Severity Rating	UNLIKELY

The southern terminus of the shared path joins Whirokino Road between SH1 and the Link Road. This requires cyclists to turn right across Whirokino Road at a mid-block. Vehicle drivers would have increased awareness of cyclists turning at intersections.

Recommendation

Consider relocating the shared path terminus on Whirokino Road to opposite Link Road.

Designer Response	The intention is to minimise the length of the route from path to road shoulder for southbound cyclists, which will encourage more use of the path. Moving the path junction to the intersection adds 100m and is not recommended given that traffic volumes and speeds on Whirokino Road are low and good sight distance is provided.
Safety Engineer	An extensions to a route which requires human powered is not recommended if you want cyclists to prefer it to the bridge. If the sight lines are adequate and the speed is low, this should not be a problem.
Client Decision	Agree with the Safety Engineer's response.
Action Taken	Sight lines are adequate and speeds are low. Accordingly, no action is required.

2.4.9 Shared Path Maintenance COMMENT

The existing shared path has a low level of maintenance which makes the pathway unattractive. Grass is growing in cracks throughout the path, at the farm stock crossing, a considerable layer of mud and excrement appears to have built up. Cyclists need facilities which are safe, convenient, and attractive to utilise.

2.5 Other Comments

2.5.1 Drawing Labels COMMENT

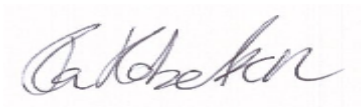
- Drawing 5206: Longsection of MC10 labelled Whirokino Road instead of Link Road.
- Drawing 5207: Longsection of MC20 labelled Link Road instead of Whirokino Road.

2.5.2 Drawing Ambiguities COMMENT

- Drawing 5201: Swale drawn on western side of embankment and at no other locations throughout drawing set. This swale has not been included in the key.
- Drawing 5204: Parallel blue lines on either side of SH1 near New Wetland Access label. It is unclear what these lines mean.
- Drawing 5206: Link Road does not include w-section barriers included in drawing 5222.

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:  Dated: 20 May 2016

s 9(2)(a) , GHD Limited

Signed:  Dated: 20 May 2016

Out of Scope New Zealand Transport Agency

Designer: Name…….. Position……..

Signature……Date…….

Safety Engineer: Name…… Position……..

Signature…….. ……Date…….

Project Manager: Name…… Position……..

Signature…….. Date…….

Action Completed: Name……Position……..

Signature…….. Date…….

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

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
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