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TECHNICAL NOTE SUBMISSION

REDUCING HIGHWAY OPERATING SPEEDS THROUGH LAYOUT TREATMENTS

Author: Mr. Jamie Povall
Qualifications: MSc, CEng (UK), CPEng, MIPENZ
Position: Transportation Team Leader
Design Team Leader – Investigation & Design Phases: Manakau and Ohau Safety Improvements
Employer: MWH Global, Christchurch
Email: Jamie.povall@mwhglobal.com

ABSTRACT

Manakau and Ohau townships are located on SH1 between Otaki and Levin approximately 80km north of Wellington. Despite a level of frontage activity and small communities in both townships, the 100km/h limit for SH1 in this locale is maintained through the entirety of both townships. There is a desire to implement a reduced 80km/h speed limit through both townships as a result of a poor crash history and to provide benefits for the local community (e.g. reduced severance). Given the long straight and relatively flat alignments, a speed reduction in isolation is not expected to be effective. Managing speed to safe levels is a key element of the Safe System approach and roads and roadsides need to demonstrate to road users what speed is appropriate.

Therefore, a new approach for reducing speeds is proposed where an element of lateral shift is combined with vertical relief measures (such as planting and median islands) and subtle narrowing to modify the environment. The projects are expected to deliver significant crash reduction benefits (and community satisfaction) with only moderate levels of expenditure. This paper explores the basis for the design of the improvements and expected effectiveness.

Disclaimer
This note represents the views and opinions solely of the author and does not represent the position of either MWH Global or any other organisation.

INTRODUCTION

This technical note describes the safety improvement works being implemented through Manakau and Ohau townships on State Highway 1, between Otaki and Levin, approximately 80 kilometres north of Wellington City.

The improvements include measures to support a proposed speed reduction through the townships in conjunction with physical measures to positively encourage lower operating speeds. The project is considered to be innovative, using lateral movement, lane and shoulder narrowing and the provision of regular vertical relief measures to change drivers perceptions for compliance with a reduced posted speed limit.

The objective of the project is to reduce the number (and risk) of fatal and serious crashes taking place in both townships, with a secondary objective of improving the environment for the local community (by reducing the level of severance that SH1 creates and providing environmental enhancements in each township).

BACKGROUND

Improvements through the townships of Manakau and Ohau were originally considered as part of the Otaki to North of Levin Roads of National Significance Investigation. Due to the level of positive support for improvements from the local communities, the NZ Transport Agency agreed to accelerate further investigations for both Manakau and Ohau, investigations road safety and traffic management improvements in the form of a Scheme Assessment Report (SAR).

The SAR progressed the investigations for the low cost safety treatments from preliminary to scheme design stage, and was completed in November 2013. The general form of the improvements was as follows; 100km/h to 80km/h posted speed reduction, entry threshold treatments, enhanced road cross section with 2.5 m sealed shoulders, 3.5 m traffic lanes and 2 m flush median, intersection upgrades and some pedestrian facilities. The project length in Manakau is 1400 m, while Ohau is 1100 m (between the proposed township thresholds).

Prior to moving to detailed design, it was determined that the form of the scheme stage design would not adequately produce the desired speed reduction because of the impression that the highway was being upgraded to a higher standard, yet speeds were expected to be reduced. Whilst the standard of the road would have been improved, it may have resulted in the perception of a high standard, open road type environment, which would not be commensurate with the reduced posted speed.

Accordingly, it was decided to overhaul the proposals and provide a more profound change to the road environment through the townships to develop a clear visual and perceptual change, to positively encourage safer speeds. Reducing speeds and improving driver awareness of the change in the road environment (from the open rural feel to a more peri-urban environment with roadside activity) was considered essential in achieving safe speeds (and a Safe System compliant outcome).

Speed surveys were undertaken in both townships using tube counters for a week long period in November 2013. The current speed environment in both townships is detailed in Table 1:

Location	Mean Speed (km/h)	85th Percentile Speed (km/h)
Manakau: Northbound	90	99
Manakau: Southbound	94	103
Ohau: Northbound	88	97
Ohau: Southbound	91	100

Table 1: Speed Survey Data

In addition to the speed data collected, lane position assessments were undertaken for the existing road layout using video recording and analysis to capture the current vehicle positions for post-implementation comparison.

The crash history in Manakau during the five year assessment period resulted in five Death & Serious injury (DSi) crashes (including two fatalities). In Ohau, this was two DSi, though immediately after the assessment period a fatal crash occurred resulting in two further DSi casualties. The crash types vary and there is no overarching clear crash type or causation factor. However, the high risk crash types of head-on, runoff road and intersection crashes account for around half of the total crashes in each township[1].

The traffic volume through each township is 14,600 per day (AADT -2013) with 10% heavy vehicles. This data is from a permanent telemetry site located close to Ohau.

The topography in both townships is generally flat and straight, though Ohau does offer limited horizontal curvature and a long gradual grade level change. The straight flat nature of Manakau is compounded by the parallel North Island Main Trunk rail line which further accentuates the straight geometry.

DESIGN PRINCIPLES

To better achieve the desired outcomes around speed reduction and safety, a more innovative approach to the design was adopted. The principles agreed upon have been selected with the intention of substantially altering the driving environment through both townships. The basic premise is to provide sufficient perceptual measures such that drivers will clearly recognise the change in road environment and reduce their speeds accordingly – thereby achieving better compliance with the posted speed reduction, and creating more uniform vehicle speeds[2] (and hopefully greater driver awareness). Ultimately, the design needed to ensure the roadway was self-explaining for road users.

The design features were agreed upon in liaison with NZ Transport Agency's lead safety advisors, and a human factors behaviour expert. The use of a human factors advisor is considered to be a relatively novel approach and provided guidance on the likely impact and effectiveness of the measures on driver perception.

The human factors expert advised on the measures proposed and their expectation of the effect that these design features would have on drivers perceptions of the road environment, and ultimately, drivers choice of travel speed. Key to changing driver perception was the creation of a sense of 'place' which was an obvious change from the rural feel of the approaches. Narrowing of the effective cross section with reduced width shoulders and narrower traffic lanes together with pedestrian refuges was deemed important in the creation of a clear change. Additionally, regular vertical relief provided through frangible measures (signage, planting, lighting columns) were also considered necessary. These measures, combined with the level of activity that is already taking place in the townships, is considered sufficient to create the necessary shift in driver perception to support a speed limit reduction that the advisor expected to be (generally) complied with.

Details of the key design features are provided below.

Road Cross Section

The existing road cross-section through both towns consists generally of two 3.5 m wide traffic lanes with shoulders of varying widths. It is proposed to substantially change this with a standard cross-section as follows:

[1] 50% of all crashes in Manakau and 42% in Ohau.

[2] Frith & Patterson (2001) concluded that variation in vehicle speeds is not desirable for safety (provided that interaction between vehicles where there is a distribution in speed occurs)

- Two 1.5 m sealed road shoulders[3]
- Two 3.3 m traffic lanes
- 2.0 m flush median increasing to 2.4 m at the pedestrian crossing places in Manakau, 1.0 m at the gated threshold repeaters, and increasing to 3.0 m for right turn bay provision at intersections

The cross section has been carefully considered and is expected to offer the best balance between providing for all road users but still removing the very 'open', wide rural feel. The 1.5 m sealed shoulder is considered the minimum for providing for cyclists through the townships[4]. This width is unlikely to encourage parking. Where parking on the highway currently exists (or is expected), two inset parking bays are provided (in Manakau only).

The traffic lane widths have also been reduced to 3.3 m to give a more constrained impression whilst still adequately providing for the high volumes of heavy vehicles.

The flush median will provide some protection for vehicles turning into and out of accessways, as well as providing some recovery area in case of emergency manoeuvring, without entering the oncoming traffic lane.

Lighting

Both townships presently contain a level of street lighting, though this is limited and in most places substandard. Enhanced street lighting[5] through the township provides better illumination of the road and road users but is considered necessary for additional reasons. New lighting will help signal a change in the road environment from the rural unlit sections either side. The lighting is also considered essential to ensure the median islands (discussed below) are highly conspicuous.

Thresholds

New threshold features are proposed in both townships at their extents to signal to motorists the change in both speed limit and road environment. The thresholds have been designed to be substantial features that would be difficult for drivers to fail to notice. The threshold lengths are approximately 50 m of fully developed threshold, plus a taper on either side.

Initially the thresholds were designed to be 90 m length, which would equate to 3 seconds of travel time for a vehicle travelling at 100 km/h, with 3 seconds being sufficient time for a driver to recognise the change in environment and react accordingly. However, the thresholds have subsequently been reduced to 50 m (plus tapers) in length as this is considered to be of sufficient length for driver recognition and response, based on the advice of NZTA safety experts.

The inclusion of substantial planting[6] is also proposed within the threshold. Such planting will reinforce the vertical relief within the threshold. Similarly, the new street lighting proposed in each township commences and ceases at the thresholds, and should reinforce a change from the open road, more rural environment.

The threshold layout detail is shown in Figure 1:

[3] Kerb and channel is also provided in some locations where considered beneficial - for the provision of planting behind the kerb (such as at thresholds), for footpath / parking bay provision, drainage or added delineation

[4] Shoulders of 1.5 m meet the dimensions of the Transit's Draft State Highway's Geometric Design Manual. However it is recognised that 1.5 m shoulders may not be considered sufficient by some cyclists and would not comply with the Austroads GTRD Part 3 shoulder width for specific bicycle demand. Providing wider shoulders has been discounted because of the effect of 'opening up' the constrained feel of the road – which would not help to constrain speeds. Wider shoulders may also encourage parking which would then force cyclists into the traffic lane. Cyclist volumes are expected to be low from site observations though no cycling counts have been undertaken.

[5] To category V3 requirements of AS/NZS 1158.1.1 and NZTA M30:2014, using LED luminaires.

[6] Further planting detail is provided in the section titled Vertical Relief below

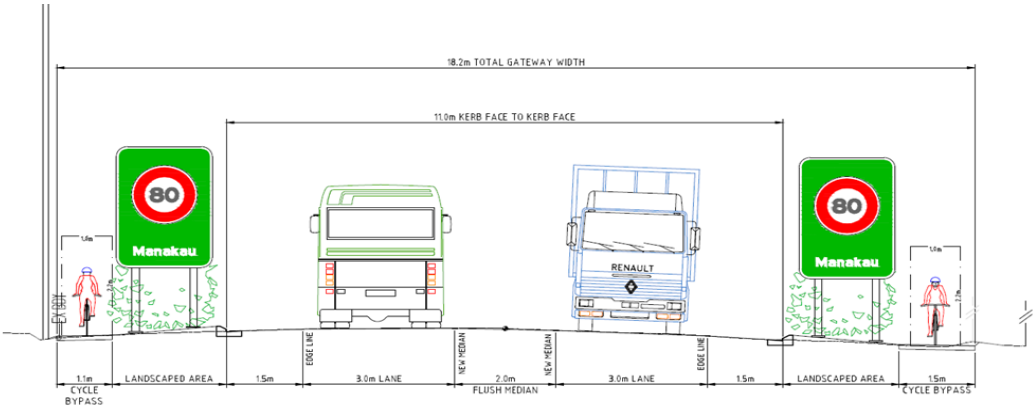

Figure 1: Typical Detail of Entry Threshold Treatment

Vertical Relief

A further aspect of the improvements also relates to reinforcing to drivers the less open nature of the road through the townships. The thresholds themselves do this, but are likely to lose effectiveness quickly once drivers have passed through the vertical elements (signs / landscaping / lighting columns). To combat this loss of effectiveness, additional vertical elements are proposed throughout both towns, spaced not less than 250 m apart, that should reinforce the driver messaging from the thresholds. The spacing was provided by the human factors expert as their experience was they will lose effectiveness beyond this distance.

Some of the vertical elements between the thresholds are similar to the thresholds themselves. They include a number of large frangible shrubs (such as Hebe Stricta / Koromiko) behind new kerb lines, and in close proximity to the edge line. In some cases these features are provided only on one side of the road, but in others they are provided on both sides for a gating effect.

For additional vertical relief, a total of six physical median islands are proposed in both Manakau (4) and Ohau (2). In Manakau, two of the islands are pedestrian refuges to assist pedestrian movements where a known demand exists (with the other two islands being landscaped with low level planting). In Ohau neither island is designed to provide for pedestrian movement (due to a lack of demand where they are situated, together with an existing pedestrian underpass). The median islands have been lengthened to 15 m to be more substantial features.

Providing a reasonable number of median islands was considered essential to avoid the appearance of single isolated features that could surprise drivers who would not expect islands to be present at these locations. New street lighting should also augment the other vertical relief measures.

Lateral Shift

Geometrically, there is very little reason at present for drivers to be inclined to slow down through either township. Both towns have little horizontal curvature, though Manakau is worse than Ohau in this regard. In Ohau there is at least some horizontal and vertical curvature.

There can be a pull-through effect with straight alignments where, due to the linearity, drivers are less inclined to take notice of the environment and slow down. Therefore, the design has reduced the effect of the linearity by introducing slight, but crucial, lateral deflections in the traffic lanes so that there is some visual deviation from the straight alignment. This is achieved through the towns by using a variable flush median width. Whilst a 2 m standard flush median has been applied, this is not uniform due to the widening applied for turning bays (to 3.0 m) and median islands (to 2.4 m) and narrowing to 1.0 m at where gated threshold repeaters are provided.

The 3.3 m traffic lanes, 1.5 m sealed shoulders and lighting offset follow the varying median width alignment, which creates some lateral deflection for vehicles and breaks up the visual linearity.

The inset parking bays provided also assist in breaking up the uniformity in the road layout.

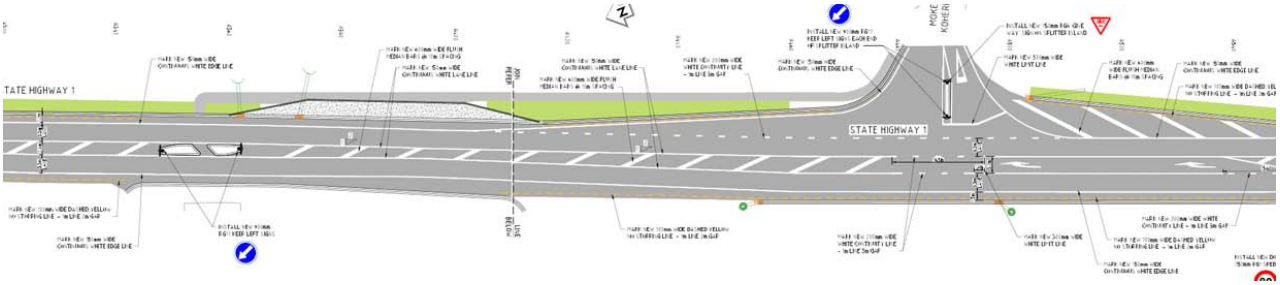

Figure 2: Excerpt from design plans showing lateral shift

CONCLUSIONS

The safety projects are intended to provide a step-change improvement through both townships by promoting safer vehicle speeds. Lower speeds are expected to reduce both the likelihood and severity of fatal and serious injury crashes.

The works proposed in the townships are considered to be a change in approach from the traditional safety type improvements on high volume rural / semi-rural high state highways. The key design principles applied to support a self-enforcing and accepted speed reduction rely upon the provision of lateral movement and vertical relief, with increased side friction.

Of particular note is the significant benefit cost ratio that these projects are anticipated to return. The return on the safety spend is significant and calculated as equating to 20 and 36 DSi savings per $100M spend for Ohau and Manakau respectively. This is a high return in comparison to most safety projects. The calculated KiwiRAP average star rating will also be improved for both townships, with the main benefits derived from the provision of the flush median (reducing head-on collisions).

These projects have been designed to be sensitive to residents and businesses concerns and have received very little negative feedback from the communities, with most being highly supportive of the proposals. The minor negative feedback has been reflected in modifications to the design. Avoiding the need for land acquisition has been positively received, with the associated benefit of projects that can be delivered more quickly without the need for property negotiations or new highway designations.

Once the physical works have been fully completed, further speed surveys and lane position assessments will be undertaken and compared against the pre-implementation data. The actual effect on crashes will also be closely scrutinised to better understand the actual effect on the crash history compared to the theoretical benefits.

References:

Frith, W .J, Patterson, T. L. (2001) *Speed variation, absolute speed and their contribution to safety, with special reference to the work of Solomon*, IPENZ Transportation Group, Technical Conference Papers.

Acknowledgments:

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