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TECHNICAL NOTE SUBMISSION

ADAPTING A STATE HIGHWAY UPGRADE TO RONS REQUIREMENTS

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APPROVED ABSTRACT

This technical note considers how the detailed design for the State Highway 1 Groynes to Sawyers Arms Road 4-laning project has developed over the duration of the design phase to meet new and evolving Roads of National Significance requirements. The project, awarded just weeks before the initial RoNS design requirements were first released, includes the four laning and median separation of 4km of SH1 in Christchurch.

The changing approach involved amending the scheme stage design to improve route reliability / journey times and providing side protection and wider shoulders to better meet Safe System principles. Other aspects that required adaptation included improved horizontal curve radii requirements and limiting direct highway access. Managing access and providing suitable alternatives has been a fundamental aspect of the design due to the number of residential and commercial properties currently served, some of which have been extremely challenging and resulted in major design changes.

The implications and Value for Money of these design philosophy changes will be discussed with commentary provided on the issues faced and how these were ultimately resolved innovatively and successfully. The project contains key learning's when attempting to balance retrofitting high operating standards with maintaining an acceptable level of adjacent access.

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INTRODUCTION

This technical note considers the implications in moving from a traditional state highway upgrade to the superior Roads of National Significance (RoNS) design standards that were required on a section of State Highway 1 (SH1), as part of the Christchurch Western Corridor upgrade. The Western Corridor upgrade involves four laning all of SH1 between Belfast and Hornby. This note considers one section of this upgrade, Johns Road, between The Groynes and Sawyers Arms Road (G2S).

A Scheme Assessment Report (SAR) which considered four laning all of the Christchurch Western Corridor was completed in 2003. The SAR was used as the basis for the design when the project was progressed to detailed design phase in 2009, and a design consultant commissioned to complete the design and project documentation (D&PD) phase.

This paper considers the design alterations necessary to move from a traditional state highway upgrade, to a standard that meets or exceeds the specific RoNS standards, or the general premise of RoNS and the wider Safe System principles. The alterations required are specific to this particular project but could be applicable elsewhere.

BACKGROUND

The original SAR considered the entire Western Corridor in its entirety, with the investigation for the corridor completed by a single consultant. This provided a level of consistency across the planned corridor improvements. At detailed design stage, a decision was taken to divide the entire corridor into a number of smaller, though still significant, sized projects. The timing of the projects was also staged, with some projects released to market, awarded, designed and constructed in series rather than as a vast single project of over 13 kilometres.

The G2S section was originally the northernmost section of the Western Corridor improvements. However, since the SAR was completed, a further section has been added, known as the Western Belfast Bypass (WBB). The WBB connects G2S to SH1 further north onto the Christchurch Northern Motorway, thereby bypassing the existing SH1 / SH74 traffic signal T intersection in Belfast (as well as a length of SH1 Main North Road).

The G2S project is approximately 4km in length. The southern extent is the existing Sawyers Arms Road roundabout (though the project extent does not include the intersection) and in the north the RFT specified a particular location for the four laning to terminate and transition back to two lanes. The northern extent was subsequently changed to co-ordinate with the WBB project and avoid sacrificial construction costs.

The project RFT requested the detailed design for the upgrade to be generally in accordance with the earlier SAR stage design. However, within three months of the contract being awarded, it was deemed that the new RoNS design standards and guidelines should be applied. This obviously had a significant effect on the overall project and the detail of the scheme to be designed and constructed together with increased property impacts.

The G2S project length is currently posted as 80 km/h with no change in the posted speed being proposed for the upgrade in the short term. However, the design was based upon a 100 km/h operating speed on the basis of potential future speed increases along the corridor, should it be determined appropriate to raise the posted limit.

Traffic flows along this length of the corridor have increased significantly. In 1998 the AADT was 11,500, almost doubling to 21,100 in 2012. It should be noted that flows between 2005 and 2010 were reasonably stable with no growth; however since the Canterbury earthquakes traffic pressure has risen significantly on the western side of the city.

Figure 1: G2S Project Extents Overview

DESIGN ALTERATIONS

A variety of design changes were required between the SAR and detailed design phase. Whilst this is not unusual, particularly given the time period that had elapsed between the scheme and detailed design stage, this was further influenced by the introduction of the RoNS specifications. Whilst this has had implications for the project, the change itself is a positive one, resulting in a highway of higher design quality, with associated safety and operational benefits.

Nevertheless, a variety of changes were warranted, either explicitly required through the higher design standards required in RoNS projects, or due to the general ethos of a higher standard road upgrade, requiring alterations from the SAR to ensure a cohesive and consistent upgrade.

Curve Geometry

A number of horizontal curves originally proposed in the 2003 SAR had to be revisited following the initiation of the RoNS geometric design standards. These standards require an absolute minimum horizontal curve radius for 100km/h design speed of 550m. Whilst being reasonably straight for much of the length, the G2S portion of SH1 does have a series of reasonably low radii back to back horizontal curves.

Four curves in particular were identified as being problematic, travelling north to south, the SAR proposed these four curves to be provided with the following radii; 440m (northern project extent near The Groynes), 375m (Clearwater), 470m (Gardiners North) and 400m (Gardiners South).

To meet RoNS standards (as defined by the RoNS Design Guidelines, an internal, unpublished NZTA document) it was necessary to consider alternative options for the geometrics for these now non-compliant curves. Alternatives were investigated and all four of the low radii curves have been improved. The two curves at Gardiners have been combined into a single longer (820m radius) curve, whilst the Clearwater curve has also been improved to provide a 550m radius[1]. The

[1] This curve was then subsequently increased to 600m to better provide for approach stopping distance for southbound vehicles approaching the proposed Clearwater Roundabout limit line. It is also important to recognise that the design of

northern most substandard curve has since been removed from the project, and the transition into the adjacent WBB project designed such that a low radius curve is no longer required.

The effect of this on the overall design standard for the project is positive as curve radii are larger and more consistent throughout the project length (and along the entire Western Corridor) which will aid driver readability providing a coherent and easy to understand highway environment. Similarly, as the curve radii have been increased, consequently it has also been possible to reduce the superelevation proposed in the SAR from a previous maximum of 7.5%, down to a range of between 4.0-6.0% (with 6% now being the maximum superelevation generally permitted in RoNS projects) across the project.

Direct Vehicle Access to Highway

As the detailed design was developed for the G2S project, the proliferation of residential accessways directly onto SH1 was undesirable from both an operational and safety perspective. Given the high standard of both the cross section and geometry proposed, reducing the number of accessways was a desired outcome of the project.

This length of SH1 is presently a Limited Access Road (LAR), but nevertheless has 78 licensed accessways throughout the project extent. The design has sought to close or combine a number of these accessways where opportunities exist to do so. However a significant number will remain.

An area of particular concern is the eastern side of the highway between Gardiners Road and Wilkinsons Road where 20 accessways are located along a 900m road length, within which there is a length of significant accessway density (with 17 residential accessways located along a 375m length).

It was therefore deemed that for a project subject to the enhanced RoNS design standards, such a level of side friction was not appropriate, resulting in the consideration of a local service road. The provision of a local service road would intuitively provide benefits in terms of limiting direct access and removing side friction, with obvious benefits in terms of turning vehicles and differential speeds. However, as no service road was proposed in the SAR, it was clear that the provision would have implications for both the designation (established during the SAR) and also the physical works costs.

Therefore, an economic evaluation was undertaken to determine the viability of the service road along this length and it was concluded that this would result in improved project economics (on the basis of reduced conflict by removing vehicles turning directly onto or off SH1 from private accessways). A one-way local service road has since been included in the project design[2].

Careful signposting has also been an important element of the project design due to the restricted turning movements resulting from the provision of median barrier / service road.

Road Cross Section

At the SAR stage, the road cross section was to include a 4.5m central median (inclusive of 0.5m shoulders either side), two 3.5m traffic lanes in each direction, a 2.5m sealed shoulder on both sides as well as a berm or swale of varying width (indicative range of 2.3-4.2m), giving a total cross section of 30m maximum. The sealed shoulder and berm/swale in combination were considered as a ‘clear zone’ provision.

this curve is particularly important as when WBB is constructed this will be the first at-grade intersection that motorists experience following their exit from the motorway environment. The provision of approach sight distance is therefore critical, and the proposed design achieves in excess of 220m.

[2] Providing a local service road along other lengths of the project was also considered; however no others lengths were found to be economically justified based upon the reduced density of accessways combined with the length of service road required to connect into the existing local road network.

This was maintained into the detailed design process but was subsequently reconsidered as the stormwater design progressed which indicated a wider cross section would ultimately be required for the management of stormwater. For the front swale slope to be 'recoverable' then a minimum slope of 4H:1V would be required, with a gentler 6H:1V being desirable. This has a subsequent effect on the land requirement for the cross section to be provided.

The design philosophy for protecting errant vehicles running off road by providing clear zones and recoverable batter slopes developed throughout the course of the design progression. Ultimately, the provision of side protection was deemed to be preferable rather than attempting to provide clear zones with associated land impacts (and associated costs, diminishing overall value for money).

Side protection is discussed in greater detail below; however it is important to note here that this design alteration has a consequential effect on the proposed cross section. With the side protection lateral barrier provision, a minimum 3m offset was required for the shy line to the barrier. This resulted in a wider sealed shoulder being necessary (providing 3.0m as opposed to 2.5m previously proposed). It was however possible to avoid additional land acquisition by re-profiling the swale batter slopes (front and back) which could be steepened given errant drivers would be protected by a wire rope barrier.

Side Protection

A late addition to the project was the implementation of lateral vehicle barrier to provide side protection. Central median wire rope barrier (Test Level 4) was always proposed, and is a RoNS requirement. However, the addition of side protection was proposed late during the design phase and was a decision applied to a number of Western Corridor projects not currently under construction.

The decision to introduce side protection provides greater containment for a vehicle that would otherwise runoff road. Runoff road crashes tend to result in higher severity injuries and are therefore a key focus of the Safe System approach. The implications for the design in attempting to introduce side protection is considerable though importantly did not affect the overall corridor width required which was critical in avoiding delay to the project (due to the need to acquire extra land).

Providing side protection without additional corridor width is described above and relies on re-profiling the drainage swale and longer barrier foundations given reduced width behind the barrier before the hinge point of the swale batter.

The provision of side protection has also been further complicated due to the number of vehicle accessways along the project length. A decision was taken to only provide side protection where a minimum length of at least 100m of barrier could be provided. This has resulted in reasonable coverage (noting that with the provision of service lane between Gardiners and Wilkinsons Road, side protection barrier is now possible along this length).

Local Road Access

Given the general design improvements resultant from the application of the RoNS standards, further consideration was given to the treatment of local road intersections. This was also necessitated on the basis of the decision to include the local road service road along a section of the highway length.

Originally, a roundabout was proposed at Greywacke Road. A decision was taken to completely remove this roundabout on the basis of highway efficiency and reliability. There was a desire to avoid two roundabouts in close proximity (1.3 km) and, furthermore, a roundabout at Greywacke Road, when combined with the proposed Clearwater Roundabout, would have resulted in three SH1 roundabouts within 2.7 km. Therefore, this roundabout was removed during detailed design and the Greywacke / SH1 intersection restricted to left in / left out movements only.

The removal of this roundabout has also resulted in the likelihood of more traffic using Gardiners Road, further north, where left turns in from SH1 will still be permitted. Therefore, the design of both the Gardiners Road and Greywacke Road intersections have been improved catering for left turning vehicles existing SH1.

CONCLUSIONS

The application of RoNS standards to the G2S project length has certainly resulted in a higher standard of design. This is important to ensure the prolonged success of the RoNS projects by building resilience, safety and capacity into such highway projects. Furthermore, the co-ordination of standards along the entire Western Corridor is essential for route consistency for motorists, providing coherent road design that supports the 'self-explaining' roads concept and Safe System approach.

A considerable difficulty has been achieving the balance between the desire to implement a very high standard four lane divided highway whilst still providing for essential access to local roads and directly to residential and business frontages. Ultimately this is a decision that has to be balanced economically, socially and environmentally as local road service lanes or alternative access provision can be provided, but this impacts on economic efficiency and affordability.

A further challenge in implementing RoNS standards has been in gathering support and acceptance from affected residents and businesses; the project has substantially changed from the 2003 SAR proposal and this has resulted in amendments to the design and associated impacts on property and access.

Ultimately, the application of RoNS standards should result in significant improvements to the G2S section of SH1 in terms of safety and operation and as such the additional design effort to move from a standard highway upgrade to RoNS requirements is clearly justified on such a critical section of highway.

References:

NZTA (2012) *Guidelines for Edge Protection and Medians on Dual Carriageway Roads, incorporating a Safe System Philosophy* Technical Memorandum Road Design Series

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