

TRANSPORTATION CONFERENCE 2026 SMALL CHANGES, BIG IMPACTS: REIMAGINING ROUNDABOUTS FOR PEOPLE AND SAFETY: PRACTICE PAPER

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ABSTRACT

Roundabouts are one of the safest intersection forms for vehicle occupants. However, many urban roundabouts in New Zealand do not provide safe access for people walking and cycling despite their proximity to schools, shops, and other destinations. Retrofitting, rather than replacing, these roundabouts offer a resilient and cost-effective approach, making the most of existing infrastructure while meeting evolving community needs.

This presentation evaluates recently retrofitted roundabouts in Christchurch, focusing on low-cost speed reduction and crossing treatments and their outcomes. This includes approach speed humps or speed cushions, platforms, pedestrian refuges, and raised zebra/dual crossings.

Consistent reductions in vehicle speeds have been observed following implementation. At one major, busy roundabout, vehicle speeds prior to improvements were broadly distributed between 35 – 45km/h with some higher speeds in excess of 70km/h. Following implementation, most vehicles now travel between 20-35km/h with almost none exceeding 50km/h. Not only are these speeds survivable for pedestrians and cyclists in the event of a crash but the roundabout is far easier for pedestrians and cyclists to negotiate, with raised dual crossings giving them priority.

Preliminary crash data shows early signs of improved safety, although more time is needed to establish statistically significant trends.

Value for money is assessed qualitatively through the capital investment and observed outcomes, including measurable reductions in vehicle speeds and early reductions in reported crash frequency. Implementation costs ranged from NZD \$100,000 to \$700,000 per site, reflecting targeted retrofit treatments rather than full intersection reconstruction. These costs are substantially lower than full reconstruction, demonstrating the value of retrofit approaches.

Community feedback has also been encouraging, despite initial opposition at some sites. Schools have reported improved safety perceptions and increased active travel following the retrofits, and local business owners cite smoother traffic and improved customer safety because of the upgrades.

This work highlights how smart, targeted interventions on existing roundabouts can deliver measurable safety and community benefits. With constrained budgets and increasing public demand for safer streets, these projects provide a replicable and scalable model for future-focussed transport design.

INTRODUCTION

Roundabouts are widely recognised as one of the safest intersection forms for motor vehicle occupants, reducing severe crashes by eliminating high-speed, right-angle, and head-on conflicts (FHWA, 2020; IIHS, n.d.). International studies report reductions of up to 78% in severe crashes following conversion to roundabouts (Retting, Ferguson & McCartt, 2003). This safety benefit arises primarily from the geometry of roundabouts, which forces vehicles to slow down and travel in the same direction, reducing both conflict points and crash energy (FHWA, 2020; Florida DOT, n.d.).

However, the safety advantages for motor vehicles do not always extend to vulnerable road users. In New Zealand, roundabout design has historically prioritised traffic efficiency over low-speed environments, often resulting in tangential entry geometry and long sight distances that encourage approach speeds well above the Safe System threshold of 30 km/h for pedestrians and cyclists (Turner & Roozenburg, 2006; Waka Kotahi, 2022). Multi-lane roundabouts and those with insufficient deflection can see approach speeds exceeding 40–50 km/h, creating conditions where a crash involving a person walking or cycling is likely to result in serious injury or death. These challenges are particularly acute near schools and community destinations, where children and families are expected to cross or cycle through intersections daily. Research shows that children have limited ability to accurately judge vehicle speed and distance, making slower vehicle speeds critical for safety (Safe Routes Info, 2010).

The Safe System approach provides a framework to address these challenges by recognising that humans make mistakes and are physically vulnerable to crash forces. Its core principles - that death and serious injury are unacceptable, humans make mistakes, humans are vulnerable, responsibility is shared, and safety is proactive - shift the focus from preventing all crashes to eliminating fatal and serious injuries (Wegman & Aarts, 2006; US DOT, 2023). This approach means designing intersections that anticipate human error and manage kinetic energy so that crashes, if they occur, are survivable. Applying Safe System principles to roundabouts involves speed management, safe crossings, and separation for vulnerable users. Raised safety platforms, approach speed humps, and priority crossings are proven interventions that reduce impact speeds to survivable levels (Waka Kotahi, 2022).

Christchurch City Council (CCC) has embraced these principles through its Way Safer Streets programme, which aims to make streets safe for all modes - walking, cycling, scooting, public transport, and driving. The programme focuses on lower speeds, safer crossings, and improved active travel connections, particularly near schools and community hubs. Projects include installing speed humps, raised platforms, tactile paving, pedestrian refuge islands, and cycle lanes to create self-explaining streets that encourage safe behaviour (Christchurch City Council, 2024). Initiatives such as the Bromley Transport Action Plan and Good-to-Go School Travel Programme demonstrate a citywide commitment to reducing traffic speeds and improving safety for tamariki, enabling more families to choose active travel (CCC, 2025; Waka Kotahi, 2024).

This paper explores how Christchurch's retrofit programme aligns with these goals by implementing low-cost, scalable interventions at urban roundabouts. These projects demonstrate how designing for human vulnerability and all modes of travel can transform existing infrastructure into safer, more inclusive, and future-ready spaces.

TREATMENT DESIGN

Programme Overview

In 2023, CCC began a citywide retrofit and upgrade programme across multiple urban roundabouts identified through crash analysis, school proximity, and network function. Six upgraded roundabouts are included in this study, as outlined in Table 1.

Design Principles

The retrofit designs reflect Safe System principles, prioritising survivable speeds and reducing crash risk for vulnerable users. Research shows that reducing approach speeds to 30 km/h dramatically improves survival outcomes in a collision—from around 20% at 50 km/h to approximately 90% at 30 km/h (CCC, 2024). To achieve these speeds, CCC adopted physical speed management measures, such as Watts profile speed humps and raised platforms, instead of relying solely on regulatory signage or enforcement. The upgrades were also guided by a commitment to minimise disruption and maximise value. Devices were selected to avoid impacts on overland flow paths and underground services, reducing construction complexity and cost.

Typical Treatments

In addition to speed management measures, the upgrades filled gaps in the pedestrian network, for example, by providing refuge crossings by enlarging the splitter islands or upgrading pedestrian refuges to raised zebra or dual crossings. Sharrows were applied on approaches to guide cyclists into the traffic lane and alert drivers to their presence, while coloured surfacing (red or green) was added around central islands and exit lanes to improve visual cues and reinforce slower-speed behaviour.

The treatments applied at each of the roundabouts, as well as their implementation dates and costs are summarised in Table 1. Note, the implementation costs include horizontal and vertical elements as well as signs, markings and coloured surfacing. The project philosophy was to minimise implications on stormwater to keep costs as low as possible whilst noting that the last three projects in Table 1 did incorporate some minor stormwater changes where kerbs were re-aligned.

Table 1 Upgraded roundabouts

Location	Treatment	Implementation date	Implementation cost
Wilsons / Centaurus / Albert	Approach speed humps, pedestrian refuge improvements, sharrows and green cycle lanes on exits, central island hatching and red surfacing	Feb 2023	\$106,000
Merrin / Withells	Approach speed humps, enlarged splitter islands, sharrows, central island coloured surfacing	Dec 2023	\$272,000
Merrin / Avonhead	Approach speed humps, enlarged splitter islands, sharrows, central island red surfacing, kerb extensions on approaches	Dec 2023	\$303,000
Clyde / Ilam	Approach speed humps, enlarged splitter islands, kerb extensions, removal of two-lane approach sharrows, central island coloured surfacing	Mar 2024	\$754,000
Bower / Travis / Rookwood	Approach and departure speed humps, enlarged and lengthened splitter islands, kerb extensions, sharrows, central island hatching and red surfacing	May 2024	\$590,000
Colombo / Cashmere / Dyers Pass	Raised dual crossings on two approaches, approach and departure speed humps, enlarged splitter islands, sharrows, enlarged central island	July 2024	\$700,000 for transport (additional cost for underground services)

Design Outcomes

The upgraded roundabouts were designed to create self-explaining, low-speed environments that encourage drivers to approach and circulate at safe, predictable speeds. Horizontal design elements included narrowing traffic lanes by increasing the size and length of splitter islands; and visually increasing the size of the central island through paint marking.

This was combined with vertical elements such as Watts profile speed humps immediately prior to pedestrian crossing points encouraging vehicles to slow precisely where conflicts are most likely to occur. This not only reduces impact risk but also improves comfort and confidence for pedestrians and cyclists.

Furthermore, the addition of departure-side speed humps at several sites has created consistently lower speeds through the entire intersection. This design feature discourages rapid acceleration upon exiting and enhances safety for cyclists travelling straight through the roundabout or entering from side roads.

An aerial view of one of the roundabouts before and after the treatments is illustrated in Figure 1.



Figure 1 – Bower / Travis / Rookwood roundabout (left – before, right – after)

EVALUATION OF TREATMENTS

This study adopted a mixed-methods evaluation framework combining quantitative analysis of vehicle speeds and crash data with qualitative community feedback to assess the effectiveness of roundabout retrofits. Vehicle speed data from TomTom Traffic Analytics obtained before and after construction were analysed to identify changes in approach, circulating and departure speeds. Reported crash data was extracted from the Waka Kotahi Crash Analysis System (CAS) for the five years prior to and up to two years following implementation, allowing for early identification of safety trends.

Complementary insights were gathered through on-site observations and feedback from local schools, businesses, and community boards to understand user perceptions and behavioural changes.

Together, these sources enabled a comprehensive assessment of the treatments' performance against Safe System objectives - specifically, reducing kinetic energy at conflict points, improving safety for vulnerable users, and delivering value through cost-effective, scalable design interventions.

Vehicle speeds

Vehicle speed data were obtained from TomTom Traffic Analytics, which provides aggregated

GPS-based travel speed data for defined road segments. For each site, 85th-percentile speeds were analysed over a three-month period before and after construction to identify changes in approach, circulating and departure speeds through the six roundabouts. Figure 2 below shows the range in 85th percentile speeds entering the roundabout, whilst circulating, exiting and for the full journey through the roundabouts.

Orange Before = before upgrades

Green Y App N Depart = approach speed humps installed

Blue Y App Y Depart = approach and departure speed humps installed

Purple Y Zebra = raised priority crossing (dual crossing)

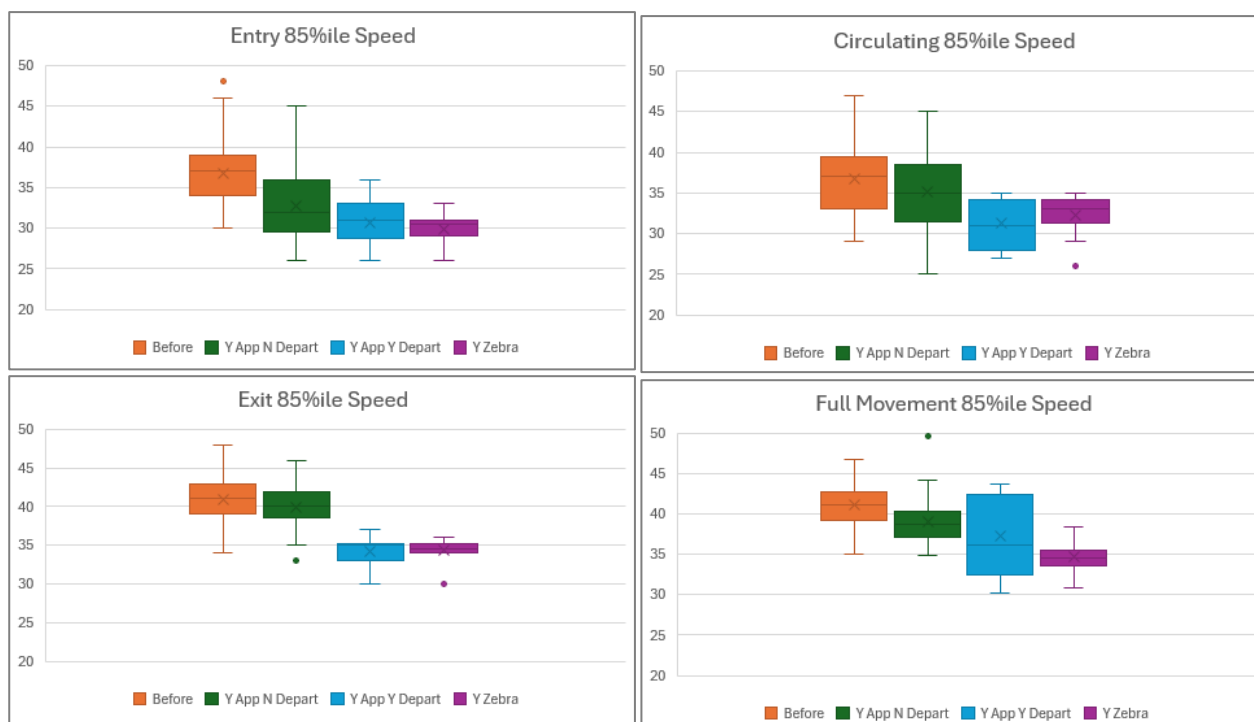


Figure 2 – TomTom speed analysis

The graphs show that roundabouts with approach speed humps (in green) experienced a significant reduction in vehicle entry speeds, a small reduction in circulating speeds and little reduction in exit speeds. Speed humps on the approach and departures to the roundabouts (in blue) appeared to have a significant effect on vehicle speeds entering, travelling through and exiting the roundabouts.

Analysis of TomTom Traffic Analytics data shows that the upgraded roundabouts achieved substantial reductions in approach and circulating speeds, particularly where physical devices such as Watts profile humps or raised platforms were installed. Across all sites with approach speed humps, the average reduction in 85th percentile approach speeds was 4 km/h, with several of the approaches achieving 85th percentile speeds of 30 km/h or lower - a critical Safe System threshold. Approaches with raised dual crossings installed achieved an average 8km/h reduction in 85th percentile approach speeds.

The presence of departure-side treatments proved particularly effective. Vehicle speeds are more consistent through the roundabouts with reduced acceleration when exiting the roundabouts. This uniformity supports safer crossings for people walking and cycling and indicates higher driver compliance with the intended 30 km/h design environment.

While vertical speed management devices appear to be the dominant factor in achieving these reductions, the horizontal design changes applied at some sites, including enlarged splitter islands

and visually enlarged central islands through painted surfacing, are also likely to have contributed to lower speeds by reinforcing a narrower, lower-speed environment. As all study sites combined horizontal and vertical treatments, the contribution of horizontal treatments cannot be isolated; however, their role in supporting self-explaining, low-speed behaviour is consistent with Safe System design principles.

Crash analysis

Crash data from CAS for the six Christchurch roundabouts were analysed to assess early outcomes following the installation of targeted safety treatments between February 2023 and July 2024. Across all sites, the total number of reported injury crashes in the five years prior to treatment ranged from five to twenty, with the majority being non-injury or minor crashes. This suggests that the interventions primarily aimed to address crash frequency and user safety perception, rather than a high rate of severe injury crashes.

Table 2 Crash data analysis

Site	Crash period before	Reported crashes pre-implementation					Crash period after	Reported crashes post-implementation				
		F	S	M	NI	Total		F	S	M	NI	Total
Wilsons / Centaurus / Albert	2018-22	0	1	3	3	7	2024-25	0	0	0	1	1
Merrin / Withells	2018-22	0	1	3	1	5	2024-25	0	0	0	0	0
Merrin / Avonhead	2018-22	0	0	3	4	7	2024-25	0	0	1	0	1
Clyde / Ilam	2019-23	0	0	4	4	8	2025	0	0	1	0	1
Bower / Travis / Rookwood	2019-23	0	4	5	11	20	2025	0	0	0	0	0
Cashmere / Colombo / Dyers Pass	2019-23	0	3	3	7	13	2025	0	0	1	0	1

Preliminary analysis indicates a consistent reduction in crash frequency at all sites following treatment installation. While the post-treatment observation period is relatively short, ranging from one to two years, early indications are positive. Several sites show a complete absence of reported crashes since installation, while others have seen noticeable declines in minor injury and non-injury crashes¹.

Across all locations prior to treatment, the majority of crashes were non-injury (50%) or minor injury (35%), with relatively few serious crashes (although most serious crashes involved a person travelling outside a vehicle). The decline in total crashes post-treatment therefore represents a reduction in both frequency and risk exposure, even though the change in severe injury outcomes is less pronounced due to low baseline numbers.

Overall, the results show that the installed safety treatments have led to fewer crashes across all sites.

¹ Recognising that non-injury crashes are less likely to be reported, and it appears that fewer non-injury crashes are being reported by Police in the last few years.

Observations of road user behaviour

The Watts profile speed humps have generally been located immediately prior to the pedestrian crossing points as shown in Figure 3. This slows vehicles at the point where they are most likely to conflict with pedestrians crossing. Anecdotally, the location and speed reduction effect of the speed humps leads to a higher incidence of vehicle drivers yielding to pedestrians particularly on roundabout approaches.



Figure 3 – Speed hump immediately prior to pedestrian crossing point (Wilsons / Centaurus)

Community feedback

Community engagement undertaken after implementation found high levels of acceptance and satisfaction. Residents reported improved crossing comfort, particularly for children and older pedestrians, while school principals noted calmer traffic environments and greater parent confidence in students walking or cycling to school.

An informal interview of students from Merrin School who walk, cycle, or scoot through the Merrin / Withells roundabout was undertaken in October 2025. Feedback in general was positive, with students saying they find it easy to cross the roundabout when walking and scooting to and from school. However, some of the children who had tried to cycle through the roundabout, had felt uncomfortable taking the lane. This is in line with other research indicating that sharrow treatments encouraging cyclists to take the lane are not suitable for less confident cyclists.

Example quotes from the students included:

'There is a proper space to wait in the middle now which makes it easier to cross both sides.'

'The speed humps before the crossing point means vehicle drivers often stop and let me cross.'

'I tried cycling through the roundabout once and it was chaos because cars still travel too fast and I can't work out which way they're going to turn. I haven't cycled through there again.'

Evaluation limitations

While the evaluation provides valuable early insights, several limitations should be acknowledged. The post-implementation monitoring period is relatively short, ranging from one to two years, meaning that observed crash reductions may reflect early trends rather than statistically significant long-term outcomes. TomTom Traffic Analytics, while effective for identifying speed patterns, relies on aggregated GPS data that may under-represent short trips, cyclists, and local traffic movements.

Similarly, reported crash data capture only incidents recorded through official channels, potentially excluding minor or unreported events. Behavioural changes such as pedestrian crossing behaviour were not formally measured through video or conflict analysis, limiting understanding of micro-level safety interactions. Despite these constraints, the combination of speed, crash, and community feedback data provides a robust initial indication of the safety and operational performance of the roundabout retrofit programme.

LESSONS LEARNT

The Christchurch roundabout retrofit programme has provided valuable insights into the practical application of Safe System principles within an urban environment. The experience demonstrates how targeted, low-cost design interventions can meaningfully reduce crash risk and improve safety for all users.

Physical speed management is essential

Relying on signage alone does not achieve Safe System speeds. The use of vertical speed management measures such as Watts profile speed humps and raised platforms was found to be a key driver of reductions in approach and departure speeds towards, or below 30 km/h. These vertical elements were supported by complementary horizontal design changes, including enlarged splitter islands and visual narrowing. Together, these reinforced a lower-speed, safer environment for pedestrians and cyclists particularly at crossing points.

Approach and departure treatments both matter

Sites with only approach humps achieved lower entry speeds but saw limited reductions on exit. The inclusion of departure-side devices delivered consistently low-speed environments through the roundabout, significantly improving overall safety performance.

Raised priority crossings improve yielding behaviour

The installation of raised zebra and dual crossings markedly increased driver compliance and pedestrian priority. These features directly align with Safe System principles by lowering kinetic energy at conflict points and reinforcing pedestrian visibility.

Community engagement is critical

Initial opposition was common, especially from drivers concerned about noise, comfort, or potential delay. However, post-implementation feedback from schools, residents, and local businesses highlighted improved safety perceptions, calmer traffic, and greater willingness to walk or cycle. Early engagement and clear communication about safety objectives were key to building lasting community support.

Retrofit solutions are cost-effective and scalable

Implementation costs ranged from NZD \$100,000 to \$700,000 per site, significantly less than full

reconstruction. The programme demonstrates that incremental, evidence-based upgrades can deliver measurable safety gains within existing budgets - showing that meaningful outcomes do not necessarily require major capital investment.

Design for all modes, not just vehicles

Complementary measures such as sharrows, tactile paving, refuge islands, and improved surfacing enhanced comfort and accessibility for cyclists and people with mobility or vision impairments. These inclusive design elements support the community's vision of streets that are safe and intuitive for everyone - walking, cycling, scooting, or driving.

Data-driven evaluation is vital

Use of TomTom Traffic Analytics enabled objective measurement of speed outcomes, confirming significant reductions in 85th percentile speeds after implementation. Early crash data from Waka Kotahi's Crash Analysis System suggests positive safety trends, reinforcing the need for continued monitoring to confirm long-term effectiveness.

Safe System principles work in practice

Sites combining physical speed management, safe pedestrian crossings, and geometric refinements delivered the strongest results. These outcomes validate the Safe System philosophy: designing for human vulnerability and error can effectively prevent serious harm and create safer, more forgiving streets.

CONCLUSIONS AND RECOMMENDATIONS

The Christchurch roundabout retrofit programme demonstrates that targeted, low-cost interventions can substantially improve safety for vulnerable road users while maintaining the inherent operational benefits of roundabouts for motor vehicles. By applying Safe System principles the programme achieved measurable reductions in approach and circulating speeds, improved yielding behaviour, and enhanced accessibility for all road users.

A key finding is that meaningful safety outcomes do not require full reconstruction. Retrofit solutions, utilising existing infrastructure, delivered significant benefits at costs ranging from NZD \$100,000 to \$700,000 per site, highlighting the potential for scalable, cost-efficient implementation across urban networks. Combining physical speed management, raised priority crossings, and geometric refinements produced the greatest safety gains, demonstrating that Safe System principles can be successfully applied in practice.

Recommendations

- 1. Prioritise speed management in all roundabout upgrades**
Aim for approach and departure speeds to be below 30 km/h to reduce kinetic energy at conflict points and protect vulnerable users.
- 2. Integrate Safe System principles into design standards**
Design roundabouts anticipating human error, reducing crash severity, and supporting all modes of travel.
- 3. Expand retrofit programmes to other high-risk intersections**
Focus particularly on areas near schools, community hubs, and active travel corridors to maximise safety and support walking and cycling uptake.

4. **Enhance monitoring and evaluation**
Continue speed, crash, and behaviour analysis to build an evidence base for ongoing improvement and long-term validation of safety outcomes.
5. **Engage communities early and proactively**
Address concerns about traffic flow, comfort, and delays, and highlight safety benefits to build understanding and long-term support for interventions.
6. **Design inclusively for all modes**
Incorporate tactile paving, refuge islands, sharrows, and cycle lanes to create accessible, intuitive, and self-explaining streets.
7. **Leverage retrofit strategies as a first option**
Recognise that tactical, low-cost interventions can deliver high-impact outcomes without the expense or disruption of full reconstruction.

By embedding these lessons and recommendations into future projects, councils can deliver safer, more accessible intersections that promote active travel and demonstrate that smart, targeted retrofits can achieve substantial safety gains without large budgets. Christchurch's experience provides a replicable and scalable model for other urban centres seeking to improve intersection safety quickly, effectively, and inclusively.

AUTHOR CONTRIBUTION STATEMENT

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