TS 00143:1.0

Specification

Raised Safety Platforms – Use at Intersections

Issue date: 03 February 2025

Effective date: 03 February 2025

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Document information

Owner: Director Safe Systems and Programs
Transport Safety
Safety, Environment and Regulation

Mode: Road

Discipline: Road Design

Document history

Revision	Effective date	Summary of changes
1.0	03/02/2025	First issue

Preface

This specification is a first issue as TS 00143:1.0.

This document specifies requirements for planning and designing RSPs so the treatment can be planned to maximise safety benefits, designed to ensure smooth operation of traffic while achieving the desired speed reductions, and delivered to a consistent standard across the road network.

This document was developed to enable implementation of RSPs as a mass action road safety treatment at intersections, including signalised intersections of higher order road corridors such as Main Streets and Main Roads.

Intersections of Main Roads and Main Streets in urban and peri-urban environments present an ongoing road safety challenge. The mix of pedestrians and cyclists with vehicles at high speeds results in an unsafe environment where crashes are most likely to result in fatalities or serious injuries. In addition to the risk to VRUs, vehicles are also often exposed to right angle conflicts at speeds well above 50 km/h, which is widely considered as the survivable impact speed for side impact crashes, commonly known as ‘T-bone’ crashes. Although traffic signals significantly reduce the likelihood of crashes at these intersections, they offer no means of reducing the crash severity outcome if a crash was to occur due to human mistake (such as failing to notice a red signal) or design deficiencies (such as obstructed visibility of signal heads). While Safe System aligned treatments such as roundabouts are highly effective at reducing serious road trauma at intersections, they are often not feasible in built-up environments with significant space constraints. RSPs are a form of vertical deflection used to slow vehicles through critical conflict points at an intersection. RSPs can take the form of approach platforms, where at least a 6 m wide platform is placed on the approach arms of an intersection, or a raised intersection where the full footprint of the intersection is raised. When used in conjunction with traffic signals, RSPs offer a highly effective means of not only reducing the likelihood of a crash, but also preventing high severity outcomes should a crash occur.

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1 Scope

This document sets out key planning and design principles for the use of RSPs at intersections. RSPs are a form of vertical deflection designed to achieve slower vehicle speeds at critical conflict points. Detailed design elements specific to RSPs such as platform dimensions and orientation, ramp gradients, signage and delineation requirements are covered in this document.

This document does not cover pavement engineering and stormwater design associated with RSPs in detail. Potential solutions for storm water management are outlined at a concept level. It is expected that suitably qualified professionals (that is, subject matter experts) in their respective fields, combined with specific technical information provided through other relevant TfNSW and Australian standards, will determine these specific requirements at a project level to satisfy the planning and design principles of RSPs outlined in this document.

2 Application

This document is intended for use by practitioners who are seeking ways to improve road safety at intersections in urban and peri-urban environments. As a road safety intervention, RSPs can be used at intersections on roads of all hierarchies, hence this document is applicable to practitioners at TfNSW as well as local government road management agencies.

This document focuses specifically on the use of RSPs at signalised and priority-controlled intersections. Care should be taken, and sound professional judgement applied, if the principles outlined in this document are used for other RSP applications. For example, the ramp gradients recommended in this document are likely to be too shallow to achieve the desired speed reduction if an RSP is used midblock on a local residential street as a traffic calming measure.

3 Referenced documents

The following documents are cited in the text. For dated references, only the cited edition applies. For undated references, the latest edition of the referenced document applies.

Australian standards

AS 1742.2 *Manual of uniform traffic control devices – Part 2: Traffic control devices for general use*

AS 1742.10 *Manual of uniform traffic control devices – Part 10: Pedestrian control and protection*

AS/NZS 1158 (all parts) *Lighting for roads and public spaces*

AS/NZS 1428.4.1 *Design for access and mobility – Part 4.1: Means to assist the orientation of people with vision impairment – Tactile ground surface indicators*

Austroads guides

Austroads *Guide to Road Design – Part 3 Geometric Design*

Austroads *Guide to Traffic Management – Part 6: Intersections, Interchanges and Crossings*

Transport for NSW standards

TS 00043 *Pedestrian Crossing Guideline*

TS 03631 *NSW Speed Zoning Standard*

Other referenced documents

Australian Government, 2006, Australian Design Rule 43 – *Vehicle Configurations and Dimensions (all parts)*

Transport for NSW, *2026 Road Safety Action Plan – Toward zero trauma on NSW roads*

Austroads, 2020, *Effectiveness and Implementation of Raised Safety Platforms,* AP-R642-20

VicRoads, 2019, Road Design Note – *Raised Safety Platforms (RSPs),* RDN 03-07 – Issue C

4 Terms, definitions and abbreviations

The following terms, definitions and abbreviations apply in this document.

carriageway the portion of a road devoted particularly to the use of vehicles, inclusive of shoulders and auxiliary lanes

desire lines generally preferred route of cyclists or pedestrians; often, the shortest or flattest route between two locations or paths across the road section. Some desire lines can be discerned even if they are not observable by pedestrian counts, for example, a straight-line distance between a university gate and a bus stop on the opposite side of the road, where pedestrian fencing can be suppressing the pedestrian movement

divided carriageway for the purpose of this document, a carriageway where the opposing traffic lanes are separated by means other than linemarking, for example, solid median island, wide planted median, median safety barriers and so on

FSI fatal and serious injury

Main Roads road corridors with a primary function of moving people and goods and with less intense levels of place activity. Refer to *NSW Movement and Place Framework* for further details

Main Streets road corridors that have both significant movement functions and place qualities. They are found in centres where people gather to socialise, work, shop or access essential services, or around public transport nodes. Refer to *NSW Movement and Place Framework* for further details

operating speed for the purpose of this document refers to the 85th percentile speed of cars under free flowing conditions. For further details on operating speed, refer to Austroads *Guide to Road Design – Part 3 Geometric Design*

peri-urban large areas between built-up suburbs and rural landscapes that feature a diversity of uses, from residential to light industrial and agricultural, and a sparse network of streets

practitioner for the purpose of this document, TfNSW or NSW local government employees, or employees of other organisations representing or undertaking work for TfNSW or NSW local government agencies, who has a primary role of maintaining and improving road safety performance on NSW road network

RSP raised safety platform

RUM road user movement, a code that identifies the principal movement(s) of the vehicle(s) involved in the first impact of a crash

TfNSW Transport for NSW

TGSI tactile ground surface indicators

urban relatively dense inner neighbourhoods and precincts found in many cities, centres and towns in NSW with primarily a mix of residential and retail

VRU vulnerable road users, road users that are not within a vehicle, generally considered to include pedestrians, cyclists, motorcyclists, riders of other micro mobility devices such as scooters and skateboards and the users of mobility devices

5 Introduction to raised safety platforms

RSPs are a speed management treatment that makes it physically uncomfortable for passengers in a vehicle to drive over a platform faster than its design speed. Vehicle occupants will be subject to an uncomfortable level of abrupt vertical motion (that is, a jolt) if the platform is traversed at a higher speed. The design speed of the raised platform is displayed as an advisory speed in advance of the RSP, so drivers are aware what speed they need to slow down to in order to comfortably go over the RSP. Overall, RSPs are an effective safety intervention to reduce vehicle operating speeds at critical conflict points on our road network such as at intersections and pedestrian crossings.

Vertical deflection devices such as speed humps, speed cushions and wombat crossings (that is, zebra crossing marked on a raised platform) have been widely used on low-speed local roads. However, use of vertical deflection at intersections, particularly on higher order roads such as Main Roads and Main Streets, where the speed limit exceeds 50 km/h, is still relatively novel. There is however precedence for use of RSPs at major intersections on high-speed main roads in other Australasian jurisdictions, primarily in Victoria and New Zealand. Further afield internationally, raised platforms have been extensively used at intersections in the Netherlands, including at high-speed rural intersections. Monitoring and evaluation of sites already treated with RSPs in Victoria and New Zealand have provided robust evidence of their potential for reducing high severity crash risk at intersections (Austroads, AP-R642-20). Figure 1 shows an RSP at a major signalised intersection in Victoria.

Figure 1 – RSPs at Dalton Road. and Spencer Street signalised intersection in Thomastown, Melbourne (Source: Austroads, AP-R642-20)

RSPs substantially differ from the conventional speed humps. The much gentler ramps and the longer flat top profile allow vehicles to continue through an intersection at the RSP design speed without having to brake hard and slow down to a very low speed as generally required at speed humps. The design speed of RSPs is typically only up to 20 km/h lower than the speed limit or the vehicle operating speeds through the intersection. This means RSPs can deliver significant safety benefits at intersections without noticeable impact on other transport outcomes such as travel time efficiency. When used at intersections RSPs can take the form of one of the following:

- approach platforms – placing platforms on approach to an intersection
- raised intersection – raising an entire intersection so that motorists ascend on approach to the intersection and descend on the departure from the intersection.

6 Safe Systems context

The NSW government has made a commitment to achieve zero fatalities and serious injuries (Vision Zero) on our road network by 2056, with an interim target to halve deaths and reduce serious injuries by 30% by 2030. The Safe System approach underpins these targets and is formally adopted in NSW as the primary enabler for achieving Vision Zero (Transport for NSW, 2026 *Road Safety Action Plan – Toward zero trauma on NSW roads)*.

The Safe System approach is regarded as international best practice in road safety and provides an outcome whereby death and serious injury are virtually eliminated amongst users of the road system. It acknowledges the physiological and psychological limitations of humans and puts ultimate responsibility on the designers and operators of the system to accommodate these human limitations. The approach is derived from an understanding that people make mistakes, and from an ethical standpoint no-one should be killed or seriously injured on roads. The focus is on adapting the road system to humans, rather than human behaviour to the roads.

Central to the Safe System approach is managing and designing the road system such that impact energy on the human body is firstly avoided or secondly managed at tolerable levels to reduce crash injury severity. Intersection RSPs contribute to a Safe System aligned road network by managing vehicle speeds and thereby reducing the risk of side impact (that is, T-bone), vehicle merge and pedestrian or cyclist related crashes at intersections.

RSPs provide a multifaceted approach to minimising crash risk at intersections as follows:

- Reduces the likelihood of a crash occurring – slowing down all motorists approaching an intersection regardless of whether they have right of way (that is, those who have a green signal at a signalised intersection or on the major road approaches at a priority-controlled intersection still have to slow down to go over the RSP) means there is a better chance for motorists to come to a complete stop and avoid a collision if another vehicle, pedestrian or a cyclist is reaching a conflicting position.
- Reduces the severity outcome if a crash was to occur – lower speeds correspond to less energy transfer, which is the primary determinant of the severity outcome in the event of a crash.
- Reduces crash likelihood by improving conspicuity of an intersection – drivers not having right of way failing to notice the presence of an intersection (often due to obstructed visibility to signal lanterns or intersection control signs at priority-controlled intersections) is a leading cause of side impact crashes. RSPs provide an additional visual cue for drivers to recognise the presence of an intersection.
- Potential to reduce red light running – approaching an intersection at a high speed to run through an yellow light is a leading cause for ‘right turn against’ crashes at signalised intersections with filtered right turns. An RSP will discourage such driver behaviour as speeds significantly above the advisory speed will result in high levels of discomfort to vehicle occupants. It is acknowledged that filtered right turns are not aligned with the Safe System principles in the first place, and ideally only fully controlled right turns should be provided at signalised intersections. However, filtered right turns are widespread on our road network and converting them all to protected right turns while balancing against other transport system outcomes will be complex and time consuming. RSPs provides a means for filtered right turns to operate comparatively safer.

RSPs are a primary Safe System treatment. It reduces both crash likelihood and severity outcome by managing vehicle speeds. The treatment physically impacts on vehicle speeds rather than simply imposing a speed limit or an advisory speed. Therefore, if implemented to achieve the appropriate design speed (RSP design speeds are further discussed in Section 7), RSPs virtually eliminate the possibility of death and serious injury at intersections.

In comparison to RSPs, roundabouts are more established and widely recognised as a primary Safe System treatment owing to the significant focus they have received in recent literature. Roundabouts generally tend to provide better safety benefits, particularly in terms of reducing vehicle to vehicle crash risk. However, implementing well designed roundabouts that provide for adequate vehicle deflection is impractical at most existing urban and peri-urban intersections due to their space intensive design, high costs associated with completely transforming an intersection and capacity related reasons (signalised intersections typically provide better capacity than roundabouts). Additionally, traditional roundabout designs have not served well for pedestrians and cyclists. Pedestrians often experience long wait times when crossing busy roundabouts, and gap judgement when crossing the departure lanes in particular can be challenging. Similarly, vehicles failing to see cyclists is often cited as a safety concern at conventional roundabouts. At traffic signals, VRUs are typically better catered for by separating them from vehicles through signalised crossings and thereby reducing crash likelihood. RSPs can further mitigate this risk by also reducing crash severity through reduced vehicle speeds. Overall, while roundabouts are an excellent primary Safe System treatment, RSPs might be more practical and a preferred option at intersections with high vehicle throughput, high volumes of VRUs and in space constrained urban or peri-urban road environments.

7 Raised safety platform design speed

Choosing an appropriate design speed for RSPs, which is the maximum speed that a regular vehicle should be able to comfortably traverse an RSP, is critical for effective performance of the treatment. RSP profile, specifically the ramp gradient and platform height dictates the design speed of the RSP. RSPs can be designed to achieve a speed reduction of up to 20 km/h, that is, the design speed of an RSP can be up to 20 km/h lower than the speed limit on the approaching road. While it is possible to design RSPs for even larger speed reductions, the steeper platform ramps required for this can increase the risk of undesirable outcomes such as hard braking and consequent increase in rear end crash risk and potential damage to low floor vehicles.

RSPs at intersections are mainly intended to reduce the risk of side impact crashes between vehicles and crashes involving pedestrians and cyclists at intersections. The Safe System critical impact speeds for these conflict types are 50 km/h and 30 km/h respectively. Safe System critical impact speeds are internationally regarded as survivable thresholds against impact speeds in the event of a crash.

The design speed of RSPs is driven by these Safe System limits, which means:

- At intersections where there are provisions for VRUs to cross (for example, signalised crossings, kerb cutdowns at priority controlled intersections) RSPs should target a design speed no higher than 30 km/h. The treatment intends to eliminate side impact and VRU related crashes with high severity outcomes.

- At intersections of high-speed roads (that is, speed limits exceeding 50 km/h) with no provisions for VRU to cross or where there are only very low volumes of pedestrians and cyclists due the surrounding land use or lack of continuous connections, the RSPs should target a design speed no higher than 50 km/h. The treatment intends to eliminate only high severity vehicle to vehicle side impact crashes and not VRU related crashes.

RSPs should be considered a primary Safe System treatment only if these design speed bounds are adhered to. However, noting that attempting to achieve speed reductions of more than 20 km/h solely from an RSP can potentially lead to other operational concerns, in practise, design speeds higher than 30 km/h may have to be adopted at intersections with VRU conflicts. For example, a majority of our urban Main Streets have a speed limit of 60 km/h with intersections that are frequently used by VRUs. In such instances, a step towards Safe Systems approach may be pursued by adopting a RSP design speed of 40 km/h. This provides some balance between side impact and VRU Safe System collision speed thresholds. RSPs with a 40 km/h design speed will still reduce vehicle speeds and make intersections safer for all road users, but will not completely eliminate the possibility of fatalities or serious injury associated with VRUs.

At intersections with a high VRU presence (for example, those in urban centres, close to establishments that generate high pedestrian activity such as schools and train stations, and along key cycling corridors) , or where the prevailing risk is dominated by VRU related crashes, high priority should be given to implementing RSPs to a design speed of 30 km/h or less, taking a primary Safe System treatment approach. On roads with speed limits exceeding 50 km/h, this will require slowing down vehicles prior to the RSP, so the speed differential at the RSP is no greater than 20 km/h. This can be done through an area based speed limit reduction that encompasses the RSP (and adjoining critical intersections and corridor sections) such as implementing a High Pedestrian Activity Area or a corridor wide speed limit reduction in accordance with the speed zoning review process outlined in TS 03631.

If a speed limit change is to accompany an RSP, the reduced speed limit shall be implemented at least two months prior to the RSP. This will provide time for drivers to adapt to the new speed limit and thereby overall vehicle operating speeds to stabilise. Such an adjustment period is important to minimise the risk of vehicles regularly approaching the RSP at speeds higher than the limit and experiencing higher levels of discomfort, which can result in the treatment being perceived negatively by road users.

8 Raised safety platforms planning

8.1 Site selection

Suitable intersection locations for RSPs are where:

- there is potential for collisions to occur at non-*Safe System* speeds, that is, above 50 km/h for vehicle-to-vehicle side impact crashes and above 30 km/h for collisions involving VRUs
- the operating speed of approaching vehicles are no higher than 70 km/h.

However, to ensure that treatment benefits are maximised and any unintended adverse impacts on safety or other operations of the transport system are avoided, the following factors shall be taken into account when choosing sites.

- Notable horizontal or vertical curves on approach to the intersection – whether there are clear sightlines to the RSP and associated signage needs to be assessed when the approach road alignment is not straight or flat. Adequate advance visibility to the treatment is important to avoid hard braking too close to the platform. The intention of an RSP is that drivers notice its presence in advance and take foot off the accelerator or gently brake rather than abruptly braking at the platform ramp.
- Emergency vehicles – consultation should be undertaken with responsible agencies such as Fire and Rescue NSW, NSW Ambulance and NSW Police Force at the early stages of investigation and planning for RSPs, particularly for locations that are frequented by emergency vehicles (for example, intersections in immediate proximity to hospital or fire station accesses). RSPs can be perceived as causing delay and inconvenience to emergency response vehicles. However, it is worth noting that emergency vehicles are likely to be required to slow down at certain conflict points such as signalised intersections and pedestrian crossings regardless of any vertical deflection being present.
- ‘Rat running’ potential – when RSPs are installed at multiple closely spaced intersections along a corridor, some motorists may divert to alternative routes, potentially resulting in new concerns elsewhere on the network. For example, if more vehicles are added to local roads from a main road or street, it presents an inferior outcome both in terms of safety and traffic operations, likely undermining any benefits gained from the RSP. As such, when multiple RSPs are used as a corridor treatment, ‘rat running’ possibility shall be assessed, and if identified as a viable risk, local area traffic management measures should be considered on the lower order roads that are likely to be impacted to deter traffic from using these alternative routes.
- RSPs shall be avoided on light rail routes.
- Vertical clearance – at sites with vertical restrictions such as power lines, signal mast arms and bridges the change to the clearance shall be assessed considering the type of vehicles using the road.

8.2 Risk based prioritisation

Any intersection that aligns with the site selection criteria and considerations noted in Section 8.1 would benefit from RSPs. However, taking into account realistic limitations around the availability of funding, targeted safety improvements such as RSPs should be prioritised at high-risk locations where they are most likely to prevent fatalities and serious injuries. This will enable a more optimal path for achieving road safety targets by maximising the benefits that safety treatments can deliver. As such, practitioners should undertake a systematic networkwide assessment in selecting treatment sites rather than purely reacting to perceptions or isolated events such as recent crashes.

RSPs should be prioritised at intersections with a history of crashes, particularly where the crash trends are dominated by:

- side impact (T-bone) crashes and intersection merge crashes (RUM code 10, 11, 13, 14, 16, 21)
- pedestrians or cyclists crossing an intersection being hit by a vehicle (either travelling straight through the intersection or turning).

As a speed management treatment, RSPs will likely also reduce the risk of other crash types such as loss of control or intersection run through crashes. However, if the risk is dominated by such crash types, RSPs may not be the most optimal way of addressing the existing risk. For example, if ‘overshooting’ an intersection (vehicle approaching from the minor road failing to stop, likely due to not having noticed the presence of an intersection and continuing through it) is overrepresented, improving the conspicuity of the intersection and the intersection control are likely to address the crash problem more directly and at a much lower cost than an RSP. RSPs also have no impact in reducing rear end crash risk at intersections. Overall, when analysing the existing risk at intersections to determine suitable sites for RSPs, side impact and VRU related crashes should be prioritised over other crash types and rear end crashes should be specifically omitted from assessment. This approach will ensure that site selection is not influenced by crash types which cannot be effectively addressed through the treatment.

Statewide intersection risk assessment data such as intersection Collective risk and Personal risk (see Appendix A regarding further details relating to these intersection risk metrices) are calculated based on the most recent five-year crash period and are readily held within the Safer Roads Risk Assessment spatial application managed by the Safer Roads team at TfNSW. Practitioners undertaking networkwide risk assessments to identify suitable sites for RSPs are encouraged to contact the Safer Roads team (safer.roads@transport.nsw.gov.au) to discuss how these already available intersection risk profiles can assist in identifying optimal sites for RSPs.

While systematic assessment of past crashes provides a robust framework to prioritise sites for RSPs, proactive risk identification is also integral in reducing serious road trauma under a Safe

Systems approach. If an elevated risk of side impact or VRU related crashes has been identified through a systematic proactive risk assessment process such as road safety audits, Safe System assessments, crash prediction modelling and so on. RSPs can be considered for mitigating risk at such locations. Proactive applications of RSPs without the locations being classified high risk based on past crashes can include, but are not limited to:

- intersections with high pedestrian volumes, for example, those in urban centres, close to establishments that generate high pedestrian activity such as schools, train stations, shopping centres
- intersections along key cycling corridors
- priority-controlled intersections where pedestrian priority is warranted across one or more approaches, but cannot be safely provided due to the speed environment
- locations where new VRU desire lines have been introduced due to land use changes or other infrastructure projects, for example, a new cycleway or a shared path crossing through an intersection
- clusters of sites with the aim of achieving lower speeds along a section of a corridor or within an area for safety improvements or to support place making initiatives
- intersections with low levels of speed compliance
- intersections on any newly constructed roads.

8.3 Types of raised safety platforms at intersections

RSPs when used at intersections can either be in the form of approach platforms or raised intersections. Approach platforms include placing raised platforms that are generally at least 6 m wide on approach to an intersection, whereas a raised intersection requires the entire footprint of the intersection to be raised so that motorists ascend on approach to the intersection and descend on the departure. While both these design options achieve the treatment's key objective of reducing vehicle speeds through critical conflict points at intersections, their suitability is largely dependent upon the individual site conditions.

8.3.1 Approach platforms

Approach platforms are more appropriate for divided carriageways as the presence of a median or a traffic island allows for the platform to be applied only in the direction of travel approaching the intersection. If approach platforms are used on undivided carriageways, the platform shall be extended across both approaching and departing lanes. Given the treatment is intended to reduce vehicle speeds at the conflict points within an intersection, a platform on the departure lane will be an unnecessary impedance to motorists.

At intersections with large footprints, drivers can start accelerating right after they have passed the approach platform and can reach the regular operating speeds by the time they get to the pedestrian crossing on the departure lane. This can reduce the overall safety benefits of the treatment. The same concern is less likely with raised intersections, as having to descend the platform on departure is more likely to make drivers maintain a lower speed throughout the intersection.

A major benefit of the approach platforms over raised intersections is that they have a small footprint and hence are less expensive and easier to construct.

8.3.2 Raised intersections

Raised intersections are appropriate for both divided and undivided carriageways. A key benefit of raised intersections over approach platforms is that they are well suited for the majority of urban intersections on lower order roads which typically tend to have undivided carriageways. Raised platforms create a more pedestrian friendly environment with the pedestrian or cyclist crossing paths raised closer to the footpath levels.

Raised intersections are generally significantly more expensive than approach platforms, due to their increased footprint and potential impact on services and drainage.

9 Design of raised safety platforms at intersections

9.1 Raised safety platform profile

9.1.1 Shape

RSPs shall have a flat top profile as shown in Figure 2. Watts, Sinusoidal or other ramp shapes shall not be used.

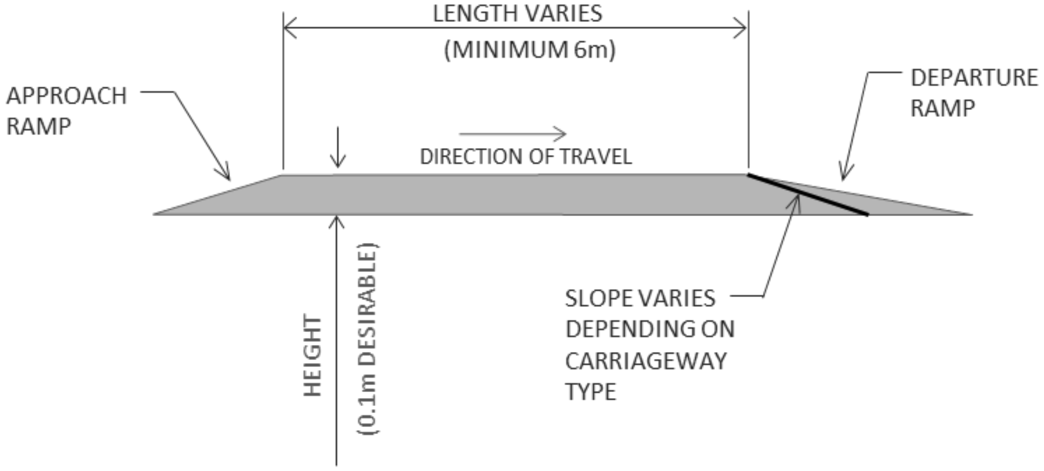


Figure 2 – Typical RSP shape (Source: VicRoads Road Design Note RDN 03-07, modified. © Copyright State Government of Victoria)

9.1.2 Platform height

The platform height for an intersection RSP should typically be 100 mm. Platform heights of 75 mm may be considered at sites where the traffic composition necessities the ramp profile to be 'gentler' (for example, very high volumes of low floor heavy vehicles). Platforms with a height lower than 75 mm will not be effective at reducing speeds and therefore shall be avoided.

Platforms higher than 100 mm and up to 150 mm may be considered on lower order roads, with low traffic volumes and a high place value such as in designated high pedestrian activity areas, on local roads predominantly in residential areas and closer to schools. Platforms heights exceeding 100 mm shall not be used on higher order roads such as Main Roads and Main Streets.

9.1.3 Ramp grade

Ramp grade is a critical design element of the treatment that determines its effectiveness. Grades that are too low will not induce the desired change in vehicle operating speeds, whereas grades that are too steep may increase the risk of heavy braking, vehicle damage and undue discomfort to vehicle occupants.

Approach ramp grades that shall be used to achieve the RSP design speeds described in Section 7 are specified in Table 1.

Table 1 – Raised safety platform ramp grades

Vehicle operating speed (km/h)	RSP design speed (km/h)	Approach ramp gradient	Departure ramp gradient – divided carriageways	Departure ramp gradient – undivided carriageways
50	30	1:15 (6.7%)	1:35 (2.8%)	1:15 (6.7%)
60	40	1:20 (5%)	1:35 (2.8%)	1:20 (5%)
70	50	1:25 (4%)	1:35 (2.8%)	1:25 (4%)

Note: On roads with an operating speed close to 70 km/h, RSPs may result in increased motorists' discomfort. Hence a higher level of rigour is required in planning and designing RSPs in such environments. Practitioners considering RSPs on roads with a posted speed limit above 60 km/h should contact Safer Roads team at TfNSW (safer.roads@transport.nsw.gov.au) at early stages of treatment planning.

Where possible the departure ramps should be designed to provide a smooth exit from the RSP. This will minimise concerns relating to bus passenger discomfort (particularly for those seated towards the rear of a bus) and potential excessive noise and vibration from heavy vehicles. However, providing a gentler grade on the departure ramp is only an option if the carriageway is divided, so ramps of different grades can be installed on the approach and departure lanes. If the carriageway is undivided, the departure ramp grade shall be the same as the approach ramp, so a uniform ramp profile is maintained across the full width of the carriageway. When implementing RSPs at intersections on undivided carriageways, especially at locations with frequent bus services, practitioners should consider introducing a short section of carriageway separation. This can be achieved using a narrow median island leading to the intersection, allowing for ramps with different grades to be applied on the approach and departure directions. Care shall be taken when providing new carriageway separation on designated Oversize or Overmass (OSOM) routes to maintain the minimum required ground contact width of approved oversize and overmass vehicles on the route.

The existing longitudinal grade of a road shall be taken into account when constructing RSP ramps. Approach ramp grades specified in Table 1 assumes RSPs are installed on a flat terrain. If the section of the road leading to an RSP is on an incline or decline, the grade of the ramp shall be appropriately adjusted to achieve an equivalent change in grade (see example in Figure 3). RSP ramps, whether it is approach or departure ramps, shall maintain a uniform grade throughout (that is, the grade shall be consistent between the top and the bottom of the ramp).

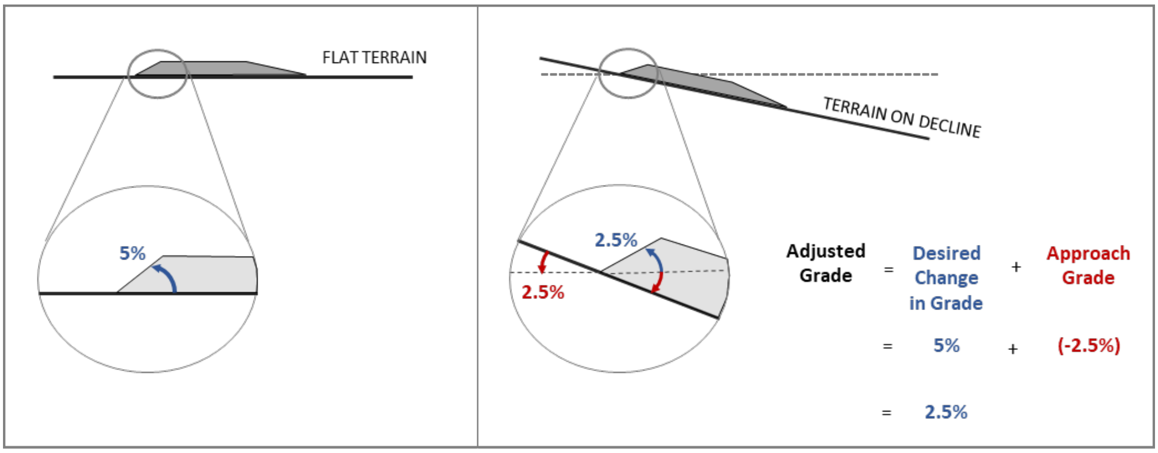


Figure 3 – Adjustments to RSP ramp grades for roads that are not on a flat terrain (Source: VicRoads Road Design Note RDN 03-07, modified. © Copyright State Government of Victoria .)

9.2 Raised safety platform location and orientation

RSP ramps shall be:

- placed clear of the through lanes of the intersecting road
- orientated perpendicular to the direction of traffic flow to ensure both front wheels of a vehicle begin to rise or fall on the ramps concurrently. Should this not occur, vehicles could traverse the ramps with wheels at different levels, potentially causing instability and affecting the driver's ability to safely operate the vehicle
- when installed on turning lanes, placed in a location that allows a turn to be commenced or completed, prior to crossing the ramp.

9.3 Stop line location

When RSPs are used at intersections, as shown in Figure 4 the stop line should be located at either of the following:

- prior to the beginning of the RSP ramp
- on the platform prior to the beginning of the departing ramp (for approach platforms) or marked foot crossing (for raised intersections).

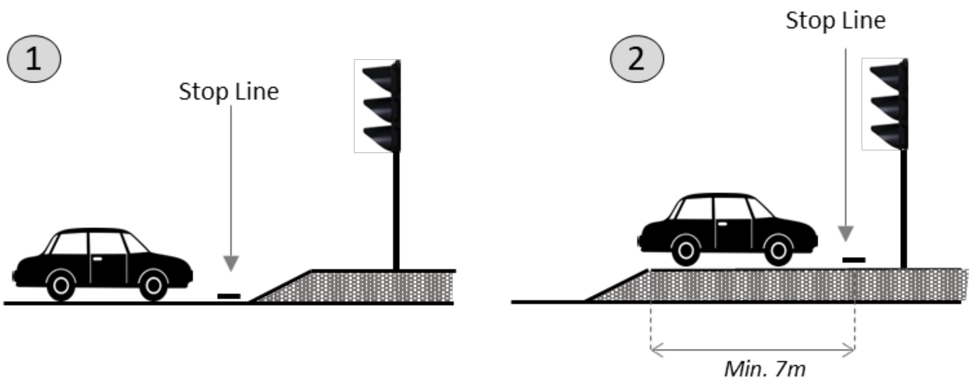


Figure 4 – Stop line placement on RSPs (Source: VicRoads Road Design Note RDN 03-07, modified. © Copyright State Government of Victoria)

The second option, that is, placing the stop line on the platform is generally preferred for operational efficiency reasons. If marked prior to the RSP, the stop line can be further back from the intersection than it would normally be. This increases the size of the intersection footprint and the time needed for vehicles to travel through it. It also may result in some motorists getting stuck beyond the stop line (and detector loops) during a red phase, particularly in right turning lanes.

If the stop line is marked on the platform, a minimum clearance of 7 m shall be provided between the start of the platform plateau and stop line to ensure that a standard passenger vehicle can be comfortably stored in advance of the stop line. If there is a higher percentage of heavy vehicles using the road, providing a longer platform may be considered, so a larger vehicle can be stored on the platform prior to the stop line. However, in doing so, the RSP approach ramps, which provide the speed calming effect, can be positioned further from the intersection conflict points. Practitioners should therefore consider the potential trade-offs (that is, reducing the effectiveness of the treatment) if taking this approach.

9.4 Considerations for visually impaired pedestrians

Potential safety concerns for visually impaired pedestrians arising from the lack of a level difference between the footpath and the trafficable carriageway shall always be adequately mitigated through the design process. At standard intersections, the transition line between the between the kerb ramp and the flared sides of the ramp (sloping areas next to the ramp to prevent pedestrians tripping on to the ramp edges) can be relied up on to guide visually impaired pedestrians in the correct direction across the road. This is particularly crucial at locations where the crossing direction is not perpendicular to the kerb face. As such, if an RSP results in a flush surface between the footpath and the road space, directional and warning TGSIs shall be appropriately installed at crossings to guide visually impaired pedestrians in the right crossing direction. TGSI installations shall be undertaken in accordance with AS/NZS 1428.4.1.

In some instances, especially when the intersection stop line is provided on the RSP, the platform will extend further back onto the approaches increasing the area that the footpath will be flush with the trafficable carriageway. This increases the risk of pedestrians, particularly visually impaired pedestrians, inadvertently tracking on to the road. To mitigate this risk, TGSIs or other visual and tactile cues such as mountable kerbs, grated drainage covers, street furniture and garden beds should be provided to clearly separate the pedestrianised area form the trafficable carriageway.

9.5 Considerations for heavy vehicles

9.5.1 Truck stability

RSPs designed and constructed appropriately in accordance with this document will not pose an undue dynamic stability (or roll-over) risk for heavy vehicles at most standard sites. However, more detailed assessment of truck roll-over risk shall be required if:

- the site has a high proportion of heavy vehicles (for example, >12%)
- there are existing road characteristics that, when combined with vertical deflection, can potentially exacerbate dynamic stability risk. This can include transverse gradients across the carriageway or roads intersecting at acute angles resulting in the need for sharp turning manoeuvres for heavy vehicles.

For sites where an elevated heavy vehicle roll-over risk is identified, computer simulated 3D dynamic modelling should be undertaken to assess how the RSPs would impact on heavy vehicle stability. The assessment should be carried out using the critical unstable vehicle, which is site specific and should be determined by the designers considering the traffic composition, traffic volumes, designated heavy vehicle routes and permitted types of heavy vehicles in the area (for example, 19 m prime mover and semi-trailer, 25 m B-double, other low-profile combinations such as low loader trucks, or vehicles with an elevated stability risk due to their height). The assessment should be undertaken on designs both with and without RSPs to clearly understand the additional level of impact from the treatment beyond just the existing intersection geometry or terrain.

If an elevated vehicle stability risk is identified, the following mitigative measures shall be adopted:

- Provision of truck tilting warning signs (W1-8-1) along with an appropriate advisory speed prior to the turning lanes at a clearly visible location. The advisory speed shall be site specific and be informed by the outputs of a vehicle stability assessment.
- Where heavy vehicle volumes are very high on a specific movement path, a flatter grade may be adopted on the respective approach ramp. It is acceptable to use flatter grades on critical approaches while maintaining standard grades (as specified in Table 1) on other approaches.

Adopting a reduced ramp grade to accommodate heavy vehicles will likely result in most other vehicles being able to traverse the RSP relatively comfortably, thus reducing its effectiveness. Nevertheless, the treatment on the whole can still deliver some level of safety benefits given that other approach ramps can retain the standard grade and induce the desired reduction in vehicle speeds. However, if the high volumes of heavy vehicles are not confined to a specific movement, requiring multiple approach ramps to adapt a reduced grade, the safety benefits are then likely to be diminished to a point where the cost of the treatment is not justified.

Truck tilting signs at RSPs can often lead to sign clutter and the advisory speed may cause some driver confusion as there are also other warning signs for regular vehicles, which typically will display a different advisory speed. On this basis, truck tilting warning signs or flatter approach ramps shall only be considered if a demonstrable vehicle stability risk is identified through an appropriate assessment. They shall not be used as a blanket addition or modification to RSPs simply due to high volumes of heavy vehicles at a site.

9.5.2 Low floor vehicles

In accordance with Australian Design Rule 43, the minimum ground clearance for low floor vehicles, including heavy vehicles, under the conditions of ‘maximum loaded test mass loading’ is 100 mm. When fully loaded, low loader trailers often operate close to the minimum ground clearance of 100 mm. Therefore, to mitigate the risk of bottoming out, roads that accommodate low loader trucks should have RSPs designed such that the axle groups of the low-loader combination span the flat section of the RSP. In most cases, this can only be practically achieved by raising the full intersection rather than providing approach platforms.

If the site has very high volumes of heavy vehicles (>15%), with a noticeable proportion being low loader trucks, consideration should be given to reducing the height of the platform to 75 mm. The approach grades detailed in Section 9.1.3 should still be maintained where possible (this will result in a shorter ramp length) to ensure the effectiveness of the treatment is not excessively compromised by the reduced platform height.

9.6 RSPs at unsignalised intersections

RSPs can be installed at unsignalised intersections regardless of the type of intersection control, whether it is give-way, stop-controlled, or where priority is not designated through signs and line markings. The installation of an RSP should not affect the determination of the intersection control type. This decision should follow the standard process based on the guiding principles noted in Austroads *Guide to Traffic Management Part 6* and Stop Control warrants noted under AS 1742.2. RSP design requirements and principles specified in Sections 9.1 to 9.5 of this document applies to RSP installations at unsignalised intersections as well.

RSPs provide a safer means of implementing pedestrian priority at unsignalised intersections. In addition to the reduced vehicle speeds, a platform can make a zebra crossing more conspicuous, which further reduces the likelihood of a crash. The following design matters shall be taken into account when providing zebra crossings on raised platforms:

- Using coloured surfacing, including light coloured paving blocks, can reduce the contrast between the roadway and the crossing bars of a zebra crossing. Additionally, zebra crossing marking may wear off quicker on a textured surface.
- Zebra crossing marking shall be distinct from RSP ramp line marking (Piano Key markings) to avoid the ramp markings being mistaken for zebra crossings. To minimise this risk, a minimum of 1 m separation shall be provided between edge of the zebra crossing marking and the top end of the platform ramp.
- At priority-controlled intersections, the zebra crossing shall be set back to provide space for a turning vehicle to yield to pedestrians out of the through traffic stream.
- When providing a raised crossing across a slip lane, sufficient storage for at least one medium sized car (minimum 7 m) shall be provided between the lower end of the platform ramp and the terminus of the slip lane. This provides opportunity for the left turning vehicle to firstly focus on the conflicts at the crossing, and then to come to a complete stop after the crossing to look for a suitable gap in the traffic stream that they are turning to. This arrangement minimises the risk of a left turning vehicle focusing on finding a gap prior to the crossing and failing to notice a pedestrian approaching a conflicting position.

The preceding information specifically relates to installing zebra crossings on raised platforms at intersections. It is not an exhaustive list of safety and other transport planning or design matters to consider when providing zebra crossings. Standard pedestrian safety best practice such as not providing zebra crossings across multi lane roads and free-flowing slip lanes shall still apply. Additionally, the suitability of a zebra crossing at any location from a transport planning, urban design and network operations perspective should be independently assessed based on the standard practices and guidelines noted in TS 00043.

The lack of a level difference between the footpath and the road surface can lead pedestrians to mistakenly perceive that the platform is a continuation of the footpath, leading them to assume that they have priority over all vehicle movements, even when a zebra crossing is not provided on the RSP. To avoid such misinterpretation, when a zebra crossing is not provided, the design of the treatment should provide clear visual cues to separate the footpath from the crossing area. This should be achieved by:

- the material on top of the platform being significantly different in colour or texture from the footpath
- providing a clear demarcation between the roadway and the footpath. This could include tactile pavers or clearly marked kerb line.

These design features also assist motorists to differentiate pedestrian spaces from the road space. At raised intersections, including at signalised raised intersections, energy absorbing bollards or street furniture at the road edges may be considered to further minimise the risk of vehicles encroaching on the pedestrian spaces.

10 Traffic control devices

10.1 Warning signage

When there are no pedestrian priority treatments at an intersection, that is, at signalised intersections or priority-controlled intersections with no marked zebra crossings, the following scheme of warning signs shall be used regardless of whether the RSP is in the form of approach platforms or a raised intersection:

- Road Hump Ahead sign (W3-4) along with an Advisory Speed Sign (W8-2), based on the RSP design speed as noted under Section 7, installed 40 m to 60 m in advance of the platform. See Figure 5 for sign layout. In accordance with TS 03631, advisory speed signs shall end in the numeral 5. However, the design speed of RSPs will typically be a factor of 10, given that it is generally 20 km/h lower than the speed limit of the road. In this case, the sign posted advisory speed shall be 5 km/h lower than the RSP design speed. For example, on a 50 km/h road, the RSP design speed will typically be 30 km/h. The advisory speed to be displayed on the W8-2 sign in this case should be 25 km/h.

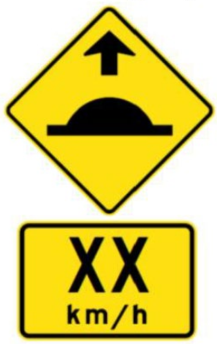


Figure 5 – Warning signs in advance of the RSP

- Road Hump Sign (W5-10) along with an Advisory Speed Sign (W8-2) installed at the RSP approach ramp. See Figure 6 for sign layout.

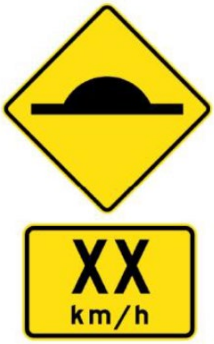


Figure 6 – Warning signs to be used at the RSP

Care shall be taken that these warning signs do not obstruct drivers' advance visibility of traffic signal lanterns, or Give Way and Stop control signs at priority-controlled intersections. On the minor road approaches of priority-controlled intersections that require vehicles to stop or give way, the warning signs at the RSP may be omitted to avoid any potential visibility obstructions to the intersection control sign.

At priority-controlled intersections, if a pedestrian priority treatment, that is a marked zebra crossing, is incorporated with the RSP, the following scheme of warning signs shall be used:

- Pedestrian Crossing Ahead Sign (W6-2) and Road Hump Ahead sign (W3-4) along with an Advisory Speed Sign (W8-2). The displayed advisory speed, when a zebra crossing is marked on the RSP shall be no higher than 25 km/h, even if the design speed of the platform is higher than 30 km/h. See Figure 7 for an example.

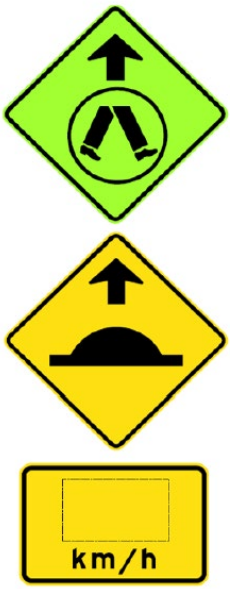


Figure 7 – Warning signs in advance of an RSP, when a pedestrian crossing is incorporated with the RSP

- Pedestrian Crossing Sign (R3-1) installed at the zebra crossing or RSP approach ramp. Road hump or advisory speed signs shall not be provided at the RSP when a zebra crossing is incorporated with the RSP. This is intended to ensure that drivers remain fully focused on potential pedestrian conflicts rather than being focused on reacting to the RSP. The warning signs in advance of the RSP and the ‘piano key’ line marking on the RSP ramp (discussed in Section 10.2) means motorists still receive adequate warning of the vertical deflection.

Note: other general signs associated with a zebra crossing regardless of it being raised or not, such as those indicating areas of no parking adjacent to the crossing, shall be provided in accordance with AS 1742.10.

10.2 Linemarking

Road hump linemarking in accordance with the requirements specified in AS 1742.2 shall be provided on RSP ramps. However, the transverse line which generally accompanies the ‘piano keys’ and is used to emphasize the toe of the RSP shall be removed when used at intersections to avoid potential confusion with the stop line (See Figure 8 which shows RSP line marking at intersections). This is particularly important at signalised intersections when the stop line is marked on the platform to avoid vehicles stopping at the base of the RSP and potentially failing to activate the signal detector loops. When zebra crossings are incorporated into RSPs, at priority-controlled intersections or on slip lanes, the transverse line accompanying the ‘piano keys’ shall be reinstated to further emphasise the toe of the RSP.

On divided carriageways where the departure ramps are built to a flatter gradient, the ‘piano keys’ markings can be omitted from the departure ramp to minimise linemarking clutter.

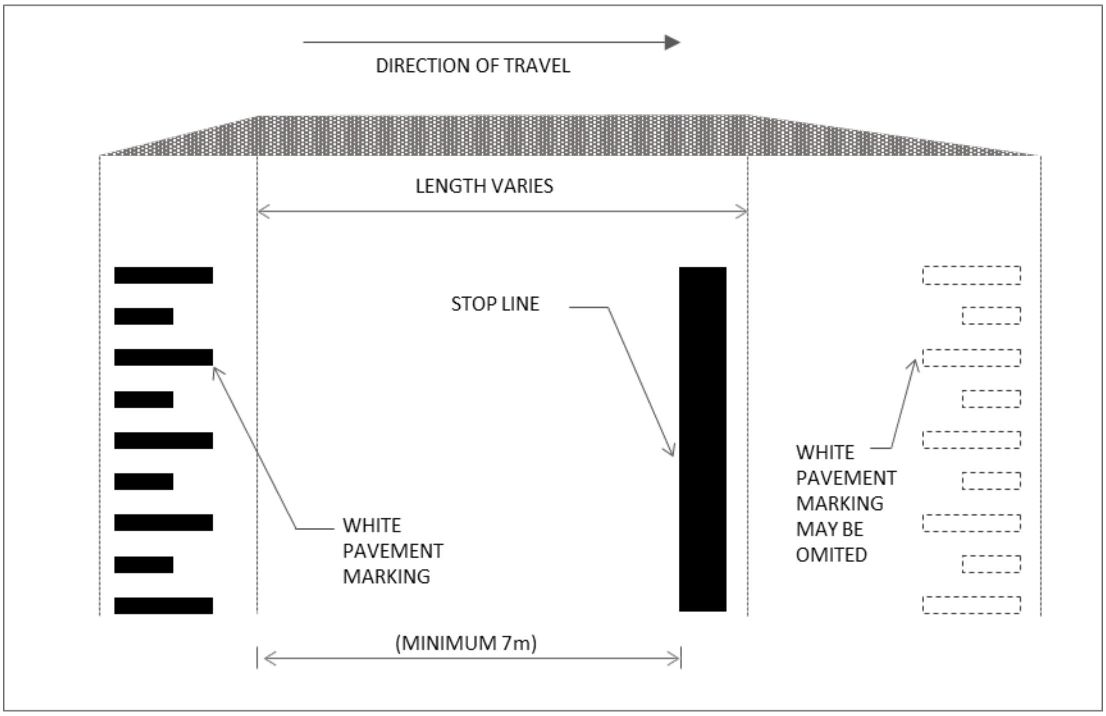


Figure 8 – Typical RSP line marking at intersections (Source: VicRoads Road Design Note RDN 03-07, modified. © Copyright State Government of Victoria.)

11 Street lighting

All RSP treatments shall be illuminated in accordance with AS/NZS 1158 (all parts).

12 Drainage

RSPs will introduce new high and low surface points onsite, with the RSPs themselves acting as barriers to existing drainage lines. This increases the risk of stormwater ponding at the base of the platform ramps and potentially on the platform itself. Stormwater ponding on the pavement surface can result in significant safety concerns, particularly for motorcyclists and cyclists causing them to lose traction. It is therefore important to evaluate how drainage will be impacted and adopt suitable modifications within the design to mitigate any issues.

Table 2 outlines drainage design solutions at a concept level that can be considered by designers.

13 Construction management

Achieving the desired outcome from an RSP is highly dependent on the design details being precisely implemented onsite. The platform height, length and particularly the ramp grades shall be constructed to exactly reflect the design. Certain construction practices such as gradual rounding of the grade change locations may make the treatment less effective. Since most transport infrastructure does not have the same level of sensitivity to minor design details, the level of precisions that RSPs require in construction can often be overlooked by contractors and project managers.

To ensure the accurate RSP profile is constructed onsite the following practices should be applied:

- Project designer should clearly depict the proposed RSP profile within the design drawings, including specific mention of the proposed approach and departure ramp grades, platform heights and lengths.
- Project manager should discuss the ramp profile with the contractor prior to commencement of construction, emphasising the critical need for high levels of precision. The importance of ramp profiles to achieve the desired safety benefits and to avoid any other operational concerns (such as hard braking and bottoming out risk if the grades are too steep) should be clearly communicated to the contractors.
- Close attention should be paid to the formation and construction of RSP approach and departure grades by both project and surveillance managers.

In order to further ensure that the RSP design is accurately constructed on site, the following practices should be followed:

- Project managers liaise with their counterparts previously involved in delivering RSP sites to share lessons learnt relating to construction. This can include local councils who have experience in constructing wombat crossings and raised platforms on the local road network as part of local area traffic management schemes. Although the use of RSPs at major intersections is a noticeably different treatment, construction related insights will still be relevant and useful.
- As part of the tendering process, request proposed construction methodology from contractors to determine suitability to deliver the scope of works or provide necessary guidance prior to award of works.
- In contractor appointments, the quality of previously undertaken work and experience specifically relating to constructing raised platforms (wombat crossings, RSPs at priority-controlled intersections on local roads and so on) should be considered.

14 Performance monitoring and evaluation

Monitoring is the systematic collection of data about the performance of road safety treatments after their implementation. Evaluation is the statistical analysis of that data to assess the extent to which the treatment (or a wider treatment program) has met the safety objectives. Given that RSPs at intersections are a relatively novel treatment, their performance should be monitored and evaluated for future direction on the use of the treatment. It is also vital in establishing reliable crash modification factors for the treatment (a quantifiable indicator of the number of crashes that the treatment is expected to reduce), which is foundational for road safety planning and strategic level decision making.

The primary performance indicator to be monitored for RSPs in the short-term post implementation period is vehicle speeds approaching and departing the intersections. Traffic volumes and vehicle composition should also be monitored to understand if the RSPs have resulted in any traffic diversion, particularly of heavy vehicles, which are often perceived as being most impacted by RSPs. Depending on the context of individual sites, other variables such as vehicle braking behaviour can also be monitored through video recording technology. However, collection and analysis of such data is likely to be resource intensive. For a robust evaluation, the monitoring should be undertaken over a sufficient length of time both prior to and after implementation of the treatment. Data should be collected at selected control sites as well to minimise the evaluation results being influenced by extraneous factors.

> Note: Control sites are similar in characteristics to the treatment sites but without any treatment being applied for the duration of monitoring. Comparing the before and after results from the treatment sites to that of control sites will minimise the influence of wider environmental factors on the evaluation outcome. For example, low vehicle

speeds during the period after the treatment may be partly attributed to factors other than the treatment itself. Without monitoring of control sites for comparison, the level of influence just the treatment has had, as opposed to together with other factors, cannot be accurately determined.

The monitoring period should commence sometime after the initial system implementation. The novelty of any treatment, particularly one that is still not commonplace on our road network, can influence driver behaviour. This 'novel effect' will wean off with time and hence should not be allowed to influence monitoring and evaluation, which aim to assess sustained effects of the treatment. As such, post-implementation monitoring for formal evaluation purposes shall not commence any earlier than four weeks after implementation.

Monitoring should be planned for a minimum period of two continuous weeks. This allows any data irregularities, such as days of wet weather that can have a marked influence on vehicle speeds, to be excluded if needed and still retain a sufficiently large sample of data to draw upon and obtain meaningful conclusions during evaluation.

Overall, undertaking accurate and robust monitoring and evaluation requires significant levels of planning, and should be initiated before the implementation of the treatments. Practitioners planning to implement RSPs at signalised intersections are encouraged to contact the Safer Roads team at TfNSW (safer.roads@transport.nsw.gov.au) at the early stages of treatment design to understand the needs for post implementation evaluation and to systematically plan for the required monitoring.

15 Other applications of raised safety platforms (in addition to at intersections)

This document specifies the use of RSPs at intersections (signalised and priority-controlled). However, as a speed management measure, RSPs can also be more widely used to accompany a range of other treatments to achieve Safe System outcomes. Several such emerging applications of RSPS with demonstrated safety benefits are summarised in this section. Principles outlined within this document, particularly those relating to RSP design speed (specified in Section 7) and RSP profile design (specified in Section 9.1) are applicable for the use of RSPs other than at intersections.

- **Rural roundabouts** – RSPs can be used on approach to roundabouts to reduce vehicle operating speeds, particularly in instances where the horizontal deflection through the roundabout is inadequate to achieve the desired speed reduction at conflict points. Space availability is often a major deterrent for implementing roundabouts as conventional designs providing for sufficient horizontal deflection typically requires very large footprints. RSPs provide a means of implementing roundabouts in compact spaces, while still achieving Safe System outcomes. See Figure 9 for an example.

Figure 9 – Raised compact roundabout at Lance Creek, Victoria (Source: Austroads, AP-R642-20)

- **Urban roundabouts** – RSPs can be used to provide priority for pedestrians and cyclists at urban roundabouts by implementing shared user crossings on RSPs through all legs of the roundabout. This design significantly mitigates common safety concerns for VRUs at conventional roundabouts such as vehicles failing to see cyclists on the circulating lane. See Figure 10 for an example.

Figure 10 – Cyclists and pedestrian protected roundabout in South Melbourne (Source: Austroads, AP-R611-20)

- **Signalised mid-block crossings** –similar to intersections, midblock crossings when placed on RSPs not only reduces the crash likelihood, but also the severity outcome if a crash was to occur. RSPs will also improve the conspicuity of the crossings, thereby further reducing the crash risk. See Figure 11 for an example.

Figure 11 – Raised midblock signalised crossing on Pukete Road in Hamilton, New Zealand (Source: Austroads AP-R642-20)

- **Midblock applications as a threshold treatment** – RSPs can be used as a midblock treatment on higher order roads, that is, beyond their use on local roads for local area traffic management, to reinforce a speed limit reduction. This could include entry to a high pedestrian activity area, signifying a transition to a town centre environment or entry to a school speed zone. Care shall be taken that such RSP applications are not misinterpreted by pedestrians as a form of a crossing facility, unless they are in a highly pedestrianised, low-speed environment (30 km/h or lower), in which case it may be safe to allow RSPs to operate as courtesy crossings. In all other such midblock applications, the RSP shall be physically separated from the footpath through a pedestrian fence or high grown vegetation. Courtesy crossings are intended to facilitate eye contact between pedestrians and drivers resulting in a mutually negotiated position over who goes first. They should provide a place where drivers can stop safely to allow pedestrians to cross. Drivers however are not legally required to stop at courtesy crossings. Therefore, courtesy crossings are only appropriate to be used in highly pedestrianised environments where posted speed limits are low, typically no higher than 30 km/h.

Appendix A Intersection risk metrices

A.1 Intersection collective risk

For the purpose of assessing intersection risk, the collective risk is described as the sum of FSI equivalents per intersection in a crash period (typically five years). FSI equivalents is a way of illustrating all crashes in terms of a corresponding number of FSIs. FSI equivalents are determined by multiplying each crash at an intersection by the average number of FSIs for that crash type, which is known as a severity index. Severity indices can also be interpreted as the probability that any given crash type, in a given road environment will result in a fatality or serious injury. Severity indices have been determined by assessing the severity outcome of different crash types in different road environments from a large sample of crashes and they differ by the crash type, form of intersection control and the speed environment. For example, drivers turning right out of a side road are particularly vulnerable to being hit in the driver's side door from the right, which typically results in a high severity outcome and hence carries a high severity index. In contrast, rear-end collisions rarely result in death or serious injury and hence has a low severity index.

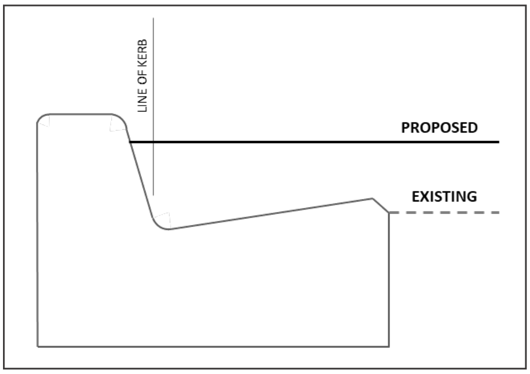
Overall, this approach provides a more robust way of assessing the crash risk by minimising the bias from a very small number of high severity crashes, which are intrinsically rare events. For example, the underlying safety risk at an intersection that has had several minor or moderate injury side impact crashes will not be overlooked under this approach, as it acknowledges the common crash type at the location typically carries a high risk of a serious injury or fatality. The fact that in the past the crashes have been of low severity is not necessarily a reflection of safe infrastructure (it could be due to a range of other factor such as lower operating speeds due to weather conditions, higher quality vehicles). Similarly, this approach would not allow a single high severity crash at a location to overinfluence the risk profile.

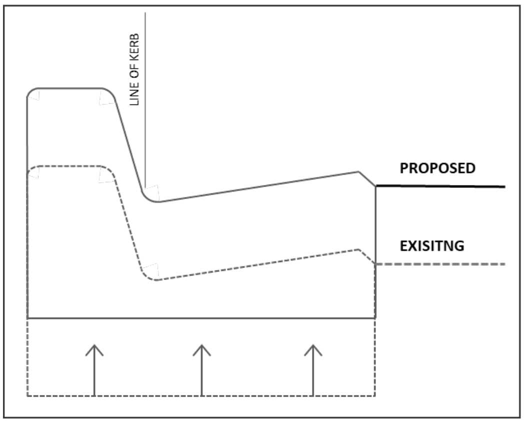
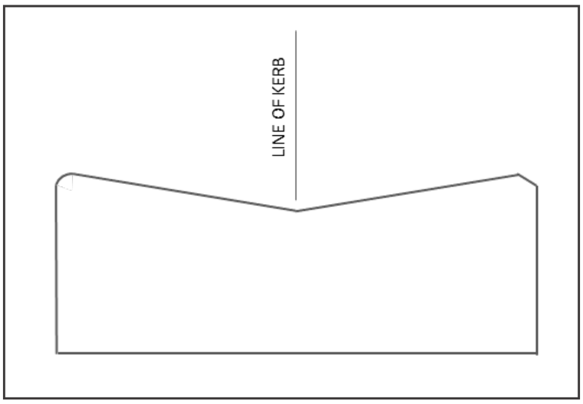
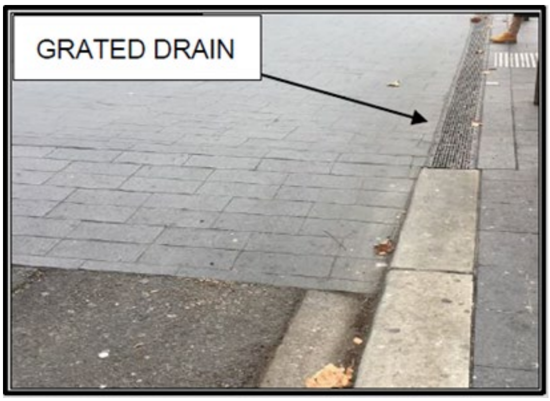
A.2 Intersection personal risk

Personal risk is the risk of death or serious injury to the passengers in each vehicle entering the intersection and is derived by dividing the collective risk by a measure of traffic volume exposure.

Appendix B Drainage design considerations (normative)

Table 2 – Examples of drainage design (Source: VicRoads Road Design Note RDN 03-07, modified. © Copyright State Government of Victoria.)

Design solution	Context	Considerations
Kerb inlets		Where it is anticipated that drainage lines will be impeded by RSPs, additional kerb inlets can be installed to allow water to drain away prior to reaching the RSP. This will minimise the risk of water pooling at the face of the RSP. This treatment shall be taken into account in conjunction with solutions addressing RSP interaction with adjacent land.
Retention of existing kerbs		Kerb and Channel drains are a common feature across the main roads and streets network. This solution looks to utilise the existing kerb and channel facility by either: • Tapering the platform down to the existing lip line of the kerb and channel, maintaining existing drainage capacity; or, • Burying' the existing kerb and channel beneath the newly laid RSP asphalt, resulting in a reduction in drainage capacity. When adopting the tapered solution, practitioners shall adopt a cross-fall no greater than 16.67% (1 in 6) and ensure the tapered segment terminates prior to the traffic lane, avoiding any adverse impact on vehicle stability.

Design solution	Context	Considerations
Raising kerbs (like for like)		As the RSP raises the pavement by approximately 100 mm, raising the adjacent kerbs by this height would allow for the full capacity of the existing channel to be maintained. This option essentially provides a like-for-like solution. Existing kerbs would need to be demolished and replaced. Further, adjacent land behind the back of kerb would need to be regraded to tie in with the new top of kerb level. If an existing footpath sits behind the kerb, this shall be demolished and a new footpath constructed to match the raised kerb height.
Raising kerbs (mountable kerbs)		This option would involve removing existing kerbs at the intersection and replacing them with mountable kerbs laid flush with (or close to) the existing, adjacent land. The installation of mountable kerbs would allow the water to shed from the RSP and be collected. Water would then be distributed into existing drainage lines or pits further downstream. Transition kerbs from the existing conditions to the mountable kerbs would need to be procured and installed as part of this treatment. The mountable kerbs (if precast) shall be accurately measured for their radius to ensure they will fit the existing intersection.
Grated drainage systems		A grated drainage system that could be adapted to facilitate RSP drainage. To install such a system, existing kerb and channel would similarly need to be removed. The grated system allows water to drain from the road surface while also providing pedestrians a flush, anti-slip surface. This treatment would be especially beneficial where proposed platforms are flush with existing, adjacent land or there are high levels of pedestrian traffic or both. The lengths of grated drain would similarly tie in to the existing down-stream drainage line or pits.