Technical Note 199

Guidance for the design of temporary roads

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Queensland Government

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1 Introduction

The costs associated with temporary traffic management at roadworks sites has received extensive consideration in recent years with a significant push to establish more cost effective measures for managing traffic while maintaining safety for workers and road users. Recently there have been considerable changes to temporary traffic management guidance both Nationally and within Queensland. As part of this review, the Department has renewed its emphasis on development and implementation of cost-effective traffic guidance and reducing the over-use of many devices. As part of these considerations there has been a focus on the application of short term low impact temporary traffic management arrangements where suitable, in place of more expensive static work sites.

For many longer-term roadworks projects however, a significant portion of the project costs can be associated with the construction or retention of temporary roads to accommodate traffic while the permanent works are undertaken. Repeated industry concerns include that the design for temporary roads typically require compliance with current permanent road design guidelines. This can then result in:

- Design requirements for temporary road alignments exceeding the design standard of the pre-existing road being reconstructed or replaced.
- Substantial costs to construct temporary roads which in many cases are only required for a short duration of weeks or months (typically less than 12 months).
- Design and alignment requirements which are onerous and impact significantly on the constructability of the works in constrained urban environments. This is particularly the case where cross-sectional width for the works is restricted within the existing road corridor.
- Design requirements which do not support the temporary speed limits required at the site to protect the safety of workers and road users.

1.1 Background

During works on the Ipswich Motorway Upgrade between Dinmore and Goodna, the issues associated with temporary road design guidance were recognised and the potential for further relaxations in the design of temporary roads were considered. Millar & Lennie (2010) presented a paper at the Transport & Main Roads Engineering Technology Forum in August 2010 entitled "*An Evaluation Strategy for Design Exceptions*". This paper considered issues associated with the design of temporary alignments during the Ipswich Motorway Upgrade between Dinmore and Goodna. In this paper it was recognised that:

> *"High volumes of traffic in a very constrained corridor have necessitated the need to undertake a complete geometric design for the temporary traffic conditions. The Road Planning and Design Manual (RPDM) provided design criteria for permanent highway and street facilities. It does not however provide any detailed guidance for the design of high-speed highway construction work zones, for disciplines such as temporary geometrics (e.g., ramps, crossovers, diversions, and superelevation rates). The Manual on Uniform Traffic Control Devices (MUTCD) includes a chapter on temporary traffic controls, but there is no direct link with the RPDM. The RPDM does provide some information on design exceptions, however not specific to temporary works.*
>
> *…*

> *in some instances, designers and constructors encounter conditions (upgrade projects in difficult and constrained environments) where the use of NDD (normal design domain) or even extended design domain (EDD) values are not possible without incurring significant cost and impacts. In some instances, designing the temporary works using NDD or even EDD would have resulted in providing a road design that was better than pre-existing permanent design before construction started. In addition, the installation of safety barriers used to protect road construction personnel during construction had the effect of impeding sight distance. Accordingly, it was considered appropriate under certain conditions to retain a design exception."*

The constraints associated with the Ipswich Motorway project were such that the "opportunity to divert traffic during construction was very limited and resulted in complex and costly staging requirements". A series of design exceptions for the design of the temporary alignment as part of the Ipswich Motorway Upgrade were developed which could then be used for the alignment design in constrained urban corridors. This paper also recognised that there are a large number of issues relating to the design of temporary roads as part of road upgrade projects such as short service life, corridor restrictions, current design guidelines exceeding the existing alignment design standard, and the correct application for design exceptions.

The design exception process discussed in the paper by Millar and Lennie (2010) is now presented in the department's:

- *Road Planning and Design Manual Edition 2: Volume 3 Supplement to Austroads Guide to Road Design Part 1: Objectives of Road Design*.

Principles for mitigation measures for design exceptions for temporary works were also discussed which include:

- Improved design of temporary roadways.
- Improved work zone traffic control devices.
- Reducing the duration for design elements which retain a higher risk.
- Developing procedures for the effective management of work zones.
- Road Safety Audits.
- Procedures to manage the speed profile.

The design criteria Millar and Lennie (2010) discussed in further detail include:

a) Design Speed – ensuring that the 85th percentile speed is realistic in the circumstances.

b) Perception Reaction time - 1.5s could be justified on the temporary roadways as the constrained cross section and the provision of barriers/ anti gawk screens were expected to help keep motorists alert.

c) Deceleration Rate - EDD deceleration rates for wet conditions were applied due to project extending across a number of years.

d) Lane and Shoulder Width – Generally widths were required to conform with the requirements of the Queensland MUTCD Part 3 but where they could not, mitigating measures including, warning signage, improved line marking, barrier delineators and lighting were required.

e) Horizontal Alignment

   i. Mitigated with reduced (but credible) speed limits, warning signage, the appearance of a constrained cross section and anti-skid pavements.

   ii. Compound curves allowed.

   iii. Sight Distance calculated to an object at a horizontal offset of 0.5 m from the centre of the lane (to allow a driver to see one of the tail lights on a car).

f) Vertical Alignment (sight distance)

   i. In areas that are lit, car stopping in the wet (d = 0.46) was permitted to a 1.25 m object (which is representative of seeing to the top of a stopped car). No manoeuvre width provided for evasive action around smaller objects.

   ii. For unlit areas, car stopping in the wet (d = 0.46) was permitted to a 0.8 m object height (which is representative of seeing to the illuminated tail lights of a stopped car). No manoeuvre width provided for evasive action around smaller objects.

g) Entrance and Exit Ramps – to meet the sight distance criteria of the existing ramps.

Similar issues have been identified in other countries, most particularly in the US which identified that *"Temporary roads and bridges do not have to be designed as a permanent facility since they will only be in use for a short time (often only a few months or one construction season)."*

1.2 Purpose of this technical note

Design criteria for application in road design are described in the Transport and Main *Roads Road Planning and Design Manual Supplement to Austroads Guide to Road Design Part 3: Geometric Design* (RPDM Part 3) and *Austroads Guide to Road Design Part 3 – Geometric Design* (AGRD03). The RPDM Part 3 currently does not contain any specific variations to design guidance relevant to the construction of temporary roads for road works. Consequently, projects requiring the construction or retention of temporary road alignments to accommodate the works typically refer only to the RPDM Part 3. They therefore require that the temporary roads be constructed in accordance with design guidance for permanent roads.

However, as noted above, in many projects application of NDD, or even EDD, design criteria may not be practicable and a designer may be left needing to consider design parameters below EDD criteria. It is reported by many of Transport and Main Road's project managers that this can cause issues with RPEQ designers in cases unwilling to accept and sign off designs which are not supported by the RPDM Part 3.

Engineering and Technology Branch recognises that there may be opportunities to consider all geometric design parameters and guidance which may result in cost savings and efficiency improvements for temporary roads. This then considers that:

- Temporary roads have relatively short service lives.
- In many cases, the design of temporary roads (often work zones) is far more restricted than the design of permanent roads.
- Roads undergoing upgrades were built during previous eras in accordance with previous design guides. Prior to construction, the geometric standards of many of these roads do not meet the current design criteria, making it difficult for temporary works to conform.

- Careful application of the flexibility provided in the design guidelines and policies, appropriate use of design exceptions, and coordination with mitigation measures (other enhancements) can result in projects that provide relatively safe and efficient construction zones that are sensitive and responsive to the surrounding environment while being cost effective.

This technical note therefore has been prepared based on a review of National and International design guidance as well as consideration of case study examples from previous projects to document a basis and to present opportunities for alternatives on which Design Exceptions may be considered. This technical note also details design practices that have been applied elsewhere in Australia and Internationally which may provide support for a design exception.

It is emphasised that the design guidance in this technical note has been prepared in consideration of the design of temporary roads only. This guidance is not intended to apply for the design of permanent road alignments. Further this guidance has been developed in consideration of road traffic only as there is no documented practices for reducing design requirements for cyclists. Where cyclists are present within the traffic stream, these will need to be separately considered.

The design exception process will remain necessary for all parameters designed outside of the bounds of NDD and EDD parameters even if they are documented in this report. In all cases, the design of temporary roads to comply with road design parameters for NDD design is preferred, followed by judicious use of EDD criteria. Only, in constrained circumstances, or where it is impractical to comply with NDD/EDD design parameters should design exceptions be considered.

1.3 Design references

In researching national and international best practice, the following documents have been used and are considered useful resources for supporting variations to design practice outside of NDD and EDD parameters.

Transport and Main Roads:

- *Road Planning and Design Manual (2nd Edition)*
- *Guidelines for Road Design on Brownfield Sites*
- *An Evaluation Strategy for Design Exceptions* (Millar & Lennie 2010)
- Queensland *Manual of Uniform Traffic Control Devices, Part 3 – Works on Roads* (Queensland MUTCD Part 3)
- *Queensland Guide to Temporary Traffic Management* (QGTTM)

Austroads:

- *Guide to Road Design Part 3 – Geometric Design* (AGRD03)
- *Guide to Road Design Part 6 – Roadside Design, Safety and Barriers* (AGRD06)
- *Guide to Temporary Traffic Management Part 3 – Static Work Sites* (AGTTM03)

Main Roads Western Australia:

- *Temporary Alignments in Urban Areas* (available at) https://www.mainroads.wa.gov.au/BuildingRoads/StandardsTechnical/RoadandTrafficEngineering/GuidetoRoadDesign/Pages/Temporary_Alignments_in_Urban_Areas.aspx
- *SPECIFICATION 202 – TRAFFIC* (available at) https://www.mainroads.wa.gov.au/BuildingRoads/TenderPrep/Specifications/Pages/200Series.aspx
- *Traffic Management for Works on Roads CODE OF PRACTICE* (available at) www.mainroads.wa.gov.au

United States

- *National Cooperative Highway Research Program Report 581 - Design of Construction Work Zones on High-Speed Highways* (NCHRP 581)
- *AASHTO Policy on Geometric Design of Highways and Streets* (Green Book)
- Pennsylvania Department of Transport "*CHAPTER 18 - TEMPORARY ROADS AND BRIDGES*"

United Kingdom

- Department of Transport - *Traffic Signs Manual – CHAPTER 8, Traffic Safety Measures and Signs for Road Works and Temporary Situations*
- *Design Manual for Roads and Bridges* (DMRB)

1.4 Design exception process and monitoring

In all cases the Design Exception and monitoring process outlined in the RPDM Supplement to *Austroads Guide to Road Design Part 1: Objectives of Road Design*, should be applied for all variations to design practice outside of NDD or EDD parameters relating to temporary works. The key elements of this process include:

Design exception process:

- Determine the costs and impacts of meeting NDD requirements.
- Develop and evaluate multiple alternatives.
- Evaluate risk including the use of crash modification factors where appropriate.
- Evaluate mitigation strategies.

Monitoring and evaluation:

- Determine the appropriate monitoring regime.
- Determine resources required to monitor the design exception, such as:
  - CCTV
  - video monitoring
  - debris removal capability

  - disabled vehicle removals, and
  - crash reviews.
- Determine the remedial treatments to be implemented in case of unacceptable design exception performance.

A key element of the design exception process is a risk assessment of any proposed exceptions. In particular, it is recognised that temporary road alignments have a very different risk profile to permanent roads. In particular the key features of the works such as duration of time the temporary alignment is in operation, length of exposure, and any changes to traffic volumes or mix of traffic will all form part of the risk assessment process.

2 Design philosophy for temporary roads

In considering design parameters outside of NDD and EDD parameters for temporary road alignments, there are a number of overall considerations that should be incorporated into the design.

Main Roads WA identifies that all temporary alignments should have the following primary design objectives:

- Maximise safety for both the road users and road construction workers.
- Minimise costs associated with construction, maintenance and use of the route.
- Consider the planned ultimate layout (road and adjacent developments) in the vicinity of the works and ensure that it can be accommodated with a minimum of reconstruction in the future.
- Maximise operational efficiency, that is the ability to carry the required volume of traffic at a speed acceptable to the road user.
- Maximise opportunities to cater for the needs of all road user groups.

The *National Cooperative Highway Research Program Report 581 - Design of Construction Work Zones on High-Speed Highways* (NCHRP 581) identifies that:

> *The AASHTO Policy on Geometric Design of Highways and Streets (Green Book) provides design criteria for permanent highway and street facilities. It does not provide detailed guidance for design of high-speed highway construction work zones, for topics such as temporary geometrics (e.g., ramps, crossovers, diversions, and superelevation rates). Also, the Manual on Uniform Traffic Control Devices (MUTCD) includes a chapter on temporary traffic controls, but there is no direct link with the Green Book or guidance on many of the geometric decisions associated with work zones.*

The key elements considered relevant to the design of temporary roads as detailed in NCHRP581 include:

- Typically for temporary roads it is recognised that the feasible range of design alternatives is often constrained by cost and site constraints such as right-of-way and environmental features. Designs for temporary roads are often more restricted than designs for permanent roadways, since the work site must also accommodate construction operations and be closely aligned with the permanent road.

- Safety – a focus should be retained on achieving "substantive safety" recognising that temporary works result in a different level of exposure compared to a permanent design. As roadworks exist only for a finite period of time, it is therefore appropriate to consider exposure differently. A specific condition may exist for a period ranging from hours to years, but not indefinitely. For construction sites, exposure can be characterised by accounting for both exposure (e.g., AADT) and duration. Conditions that may not be acceptable indefinitely (i.e., as part of a permanent roadway) may be acceptable for a low level of exposure (i.e., for a short duration and low traffic volume).
- Design Consistency – should apply in the development of temporary road designs so the prevailing driver expectations are reinforced. Hence to design a temporary alignment in such a way that the experience aligns with a drivers expectation for a higher speed limit, it may be difficult to achieve a speed compliance with a lower temporary limit if the design cues do not reflect a reduction in design standard.
- Primacy – ensuring that drivers recognise and respond appropriately to the site features. Safety-critical and other important information should be clearly, conspicuously, and prominently presented to drivers.
- Speed Management and Design Speed – including the need to establish reasonable temporary speed limits, and the need to employ the appropriate measures to attain speed reduction through measures that are self-enforcing.
- Forgiving roadside.

3 Speed parameters for temporary roads

AGRD03 does not provide any specific guidance for the design of temporary works but describes a range of conditions which may be appropriate for the design of temporary works. It identifies that:

"Operating speeds for temporary works (including sidetracks) is described in section 3.8 with the need to ensure the design of the temporary road suits the operating speed". It is further noted that "Compared with permanent works, there will be markedly different trade-offs between cost, construction safety, operational safety and operational efficiency."

Temporary road design has historically and typically been based on application of a design speed 10 km/h greater than the nominated temporary posted speed given the lack of available speed data for the temporary alignment. This practice then provides a forgiving environment but perversely often results in an alignment that does not encourage self-compliance with the speed limit due to the apparent higher standard of the temporary road.

It is therefore a critical element in the consideration of any design exception that the design speed must align with the operating speed and cannot just be assumed as artificially low. Where design exceptions are included based on a design speed, appropriate mechanisms must be in place to ensure that there is a high level of speed compliance typically due to a supporting road environment. Where temporary speed limits are posted at speeds significantly lower than the permanent limit, there is a need to create a geometric environment which encourages lower speeds.

A key relevant issue is the selection of the design speed to be used in the design of all other parameters. It is however noted that the design speed should be selected on the basis of the speed at which traffic could be reasonably be expected to operate given the road design, alignment and roadside environment. It is noted that the desired speed for a section of road is influenced by the following elements:

- Roadside environment – topography in rural areas, development density and type (i.e. built environments) in urban areas.
- Road characteristics – geometric standard (predominately horizontal alignment; to a lesser extent, vertical alignment; and lane widths), frequency of intersections and accesses, sight distance, parking provisions etc.
- Speed limit.
- Road function – to the extent that on important roads such as motorways and highways, drivers are less willing to accept reductions in desired speed.

As a case example, the Ipswich Motorway upgrade – Rocklea to Darra (2020) included a temporary road alignment which included an aesthetically unpleasing alignment, very obviously within a worksite, and narrow offsets to the temporary road safety barriers. In this section of the works, operating speeds appeared to be close to the posted 80 km/h limits with high levels of driver compliance.

In other cases, it has been observed that a level of traffic congestion, greater than normal congestion levels, during the works also aids in improving compliance with posted speed limits. Customer requirements such as acceptable Level of Service for operation should be determined within the Traffic Management Plan with a consideration of the impacts on speed limit compliance.

Hence selection of a design speed which appears artificially low to drivers and is likely to result in low levels of speed compliance, would subsequently reduce the support for isolated reductions of the road design parameters for a temporary road. Design speed selection therefore should be based on the desired and operating speed for the temporary road, not based on a low posted speed that has low levels of self-compliance. Where design exceptions are introduced into the road design for the temporary road, the actual speeds of traffic should be monitored and measures taken to ensure suitable levels of speed limit compliance.

AGRD03 describes parameters around the operating speed for temporary works and notes that where the temporary road is in close proximity to construction works it is usually desirable and necessary for the operating speeds on the temporary road to be less than the operating speed on the approach section. The addition of visible cues will alert the driver to the need for reduced operating speed as well as the speed zoning. This may be achieved by a combination of:

- Signage, safety barriers and anti-gawking screens that reinforce the presence of road works.
- Narrower cross-section elements where practical to give the appearance of a lower standard of road.
- Different pavement surfacing appearance and/or type.
- Active traffic management, including temporary traffic signals and stop/go traffic control.

Several project managers on the Department’s projects reported a desire to select lower design speeds. However, it was often also noted that compliance with posted speed limits was low and that the requirements for temporary alignments do not encourage self-compliance with the posted limits.

It is re-emphasised that any application of the design exception opportunities discussed in this technical note should only be undertaken in coordination with the necessary measures to ensure a high level of driver compliance with the temporary posted speed limits at the roadworks project.

4 Road design considerations for temporary roads

Based on the review of current Queensland case examples, and documented practices both Nationally and Internationally, the following road design parameters have been identified where some guidance has been produced with regards to road design guidelines for temporary roads and there is evidence of design exceptions previously being successfully applied.

1. Road cross section – In this technical note, three elements of road cross section are considered being:
    a. lane widths
    b. shoulder widths, and
    c. barrier edge clearance.
2. Sight distance – particularly stopping sight distance
3. Coordination of horizontal and vertical alignment
4. Horizontal alignment
5. Vertical alignment
6. Site Access – acceleration and deceleration lanes for works vehicles at road worksites
7. Temporary road safety barriers – warrants for use.
8. Turn treatment warrants for unsignalised intersections with short periods of higher traffic volumes.
9. Road drainage.

Each road design parameter is discussed in further detail within this section with examples of design exceptions that may be applicable for use in the design of temporary roads for projects in Queensland. Where these example design criteria are being considered for use, the full design exception process shall be undertaken to analyse the alignment, and to identify and evaluate all safety risks that may arise as a consequence of the exception.

For temporary alignments that may be in place for 12 months or more, the design shall, as far as practicable, meet the NDD / EDD design guidelines for permanent roads.

4.1 Cross Section

Cross-section width of a temporary road can significantly impact both the costs of the construction of the temporary road and the constructability of the works in constrained sites. Increased cross-section width in these sites reduces the available width for construction activities potentially increasing construction inefficiencies and consequent costs. Project managers from a range of Transport and Main Roads projects identified that even small reductions in width of the temporary alignment could have significant beneficial impacts on constructability of the works in constrained situation.

The three key cross section design elements considered most relevant to the design of temporary roads, and in potentially reducing the width of the cross section are lane widths, shoulder widths and edge clearances. Shoulder widths and edge clearances are discussed together due to the close inter-relationship between these design parameters. All three parameters need to be considered together for potential design exceptions for cross section width to avoid combinations which lead to significant potential negative safety outcomes.

4.1.1 National / International guidance – literature review

The guidance within this section relating to lane widths may be considered for lanes used by motor vehicles and trucks up to and including semi-trailers only. The guidance within this section relating to shoulder widths and barrier edge clearances should be considered only in situations where the shoulder is not used by cyclists. The information in this section is therefore unlikely to be applicable for situations where:

- Larger heavy vehicles are present within the traffic flow. At sites where B-doubles, road trains and oversize loads are present, additional lane width is generally required to accommodate the tracking path of these vehicles. In these cases, contract specifications currently tend to specify NDD / EDD minimum lane widths for temporary alignments. Narrower widths should only be considered in specific circumstances where the risks can be managed through other means.
- On-road cyclists are present at the site. There is no design exception guidance considered in this technical note for the treatment of on-road cycle facilities. Hence where there are on-road cycle facilities present, or where an existing road shoulder experiences regular cyclist usage, NDD / EDD parameters for cycle facilities should continue to be applied.

In considering potential design exception criteria for lane and shoulder widths for temporary roads documented guidance has been reviewed and considered from Transport and Main Roads (existing guidelines and the adopted *Austroads Guide to Road Design*), Main Roads WA, USA and UK.

Shoulder widths and barrier edge clearances are typically considered separately in the development of design parameters but due to their inter-relationship at road work sites, they are addressed together in this technical note.

4.1.1.1 Queensland

4.1.1.1.1 Lane widths

Lane widths for the design of roads are described in the Transport and Main Roads *Road Planning and Design Manual Supplement to Austroads Guide to Road Design Part 3: Geometric Design* (RPDM Part 3) and the *Austroads Guide to Road Design Part 3 – Geometric Design* (AGRD03).

The RPDM Part 3 currently does not detail any supplemental guidance for lane widths relevant to the construction of temporary roads for road works. Hence all relevant current guidance for lane widths for temporary roads is typically based on the information with AGRD03.

AGRD03 Section 4.2.4 provides guidance generally for lane widths. This states that a *"standard lane widths of 3.5 m allows for large vehicles to pass or overtake, without either vehicle having to move sideways towards the outer edge of the lane."*

It is further stated that "narrower lanes (down to 3.3 m – Austroads 2009b) may be considered where any of the following apply:

- The road reserve or existing development form stringent controls preventing wider lanes.
- The road is in a low speed environment.
- There is little or no truck traffic.
- The alignment and safety records are satisfactory in the case of a reconstructed arterial."

AGRD03 Section 4.2.5 provides guidance for lane widths on urban roads with Table 4.3 identifying that lane widths as low as 3.0 m may be used *"for use on low speed roads with low truck volumes".* RPDM Part 3 describes that "*lane widths narrower than 3.3 m should only be used in circumstances described in Table 4.3 of Austroads Guide to Road Design – Part 3"*.

The *Austroads Guide to Temporary Traffic Management, Part 3 – Static Work Sites* (AGTTM03 as adopted by Transport and Main Roads) identifies minimum lane widths applicable to roadworks in Table 2.5 (reproduced below as Table 4.1.1.1.1) but "where lanes on the approach to the work site are less than 3.0 m in width, the approach lane width may be adopted". The AGTTM03 does not provide any additional guidance for lane widths required for larger vehicles.

Table 4.1.1.1.1 – Minimum lane widths (source AGTTM03 Table 2.5)

Posted speed limit during roadworks km/h	Minimum lane width (m)
60 or less	3.0
greater than 60	3.5

The Austroads Guideline AGRD03 notes that on urban roads, "within the range of practical lane widths (say 2.75 to 3.75 m), lane width itself has only a small effect on crash rates for urban arterial roads."

4.1.1.1.2 Shoulder widths / edge clearances

Both shoulder widths and edge clearances are applicable in cases where kerbed roads are not applicable.

Typical shoulder widths for application in road design are described in the Transport and Main Roads RPDM Part 3 and Austroads AGRD03. The RPDM Part 3 currently does not detail any variation to shoulder widths relevant to the construction of temporary roads for road works. Hence all relevant current guidance for shoulder widths for temporary roads is typically based on the information with AGRD03.

AGRD03 Section 4.3 provides guidance generally for shoulders and identifies a minimum shoulder width of 0.5 m for the lateral support of the pavement. There is no discussion with regards to shoulders applicable for roadworks and whether the sealed shoulder may be omitted for temporary roads required only for a short duration.

The Transport and Main Roads *Guideline for Road Design on Brownfield Sites* identifies that default minimum shoulder widths of 0.5 m for roads with low volumes of heavy vehicles and 1.0 m for roads with high volumes of heavy vehicles.

The department's Queensland MUTCD Part 3, QGTTM03 and AGTTM03 detail offsets between the edge of a lane and the nearest traffic management devices as follows:

1. Edge of traffic lane to line of traffic cones, bollards or longitudinal channelising devices:
    a. Posted speed limit during roadworks up to 60 km/h – 0.3 m.
    b. Posted speed limit during roadworks above 60 km/h – 0.5 m.
2. Edge of traffic lane to roadworks delineators or temporary hazard markers – 1.0 m.
3. Edge of traffic lane to road safety barrier system:
    a. Posted speed limit during roadworks 40 km/h or less – 0.3 m.
    b. Posted speed limit during roadworks 50 to 60 km/h – 0.5 m.
    c. Posted speed limit during roadworks 70 to 80 km/h – 0.5 m.
    d. Posted speed limit during roadworks greater than 80 km/h – 1.0 m.

The guidance in the QGTTM allows for narrower offsets than that described in AGTTM03, recognising that the wider offsets encourage traffic speeds higher than the posted limits.

4.1.1.2 Western Australia

4.1.1.2.1 Lane Widths

Guidance for temporary road lane widths in Western Australia states that a reduced cross section width may be appropriate when designing temporary alignments to minimise cost and the earthworks footprint. Lane widths for short term temporary alignments may be reduced but design checks shall be made in reference to pavement widening on horizontal curves where applicable. The geometry must enable the design vehicle to remain lane correct through the entire length of the temporary alignment.

Lane widths of 3.2 m are allowed for roads with speeds of 61-80 km/h. As an exception a minimum lane width of 3.3 m is required for B Double/Road Trains for design speed less than 60 km/h.

4.1.1.2.2 Shoulder widths / edge clearances

The Main Roads WA *Code of Practice* notes that "*it has been found to be impractical to follow the clearances given in AS 1742.3 - 2009. This is particularly evident when used in conjunction with the required lane widths in Clause 4.13.3 of AS 1742.3"*. Following a site specific risk assessment that supports the reduced clearance, the below widths are permitted:

1. Edge of traffic lane to line of traffic cones, bollards or longitudinal channelizing barricades:
    a. traffic speed up to 60 km/h—0.3 m, and
    b. traffic speed above 60 km/h—0.5 m.
2. Edge of traffic lane to roadworks delineators or temporary hazard markers:
    a. traffic speed up to 80 km/h – 0.5 m, and
    b. traffic speed above 80 km/h – 1.0 m.

3. Edge of traffic lane to road safety barrier system:
    a. traffic speed 40 km/h or less—0.2 m
    b. traffic speed 41 to 60 km/h—0.3 m
    c. traffic speed 61 to 80 km/h—0.5 m, and
    d. traffic speed greater than 80 km/h—1.0 m.

4.1.1.3 USA

4.1.1.3.1 Lane Widths

Design guidance in the USA recognises that it is often not reasonable or practicable to apply cross section parameters as they apply to permanent road design [However, it is noted that lane widths recommended for works in the USA typically exceed those applied in Australia]. Typical cross section diagrams show a lane width of 3.3 m for temporary alignments.

4.1.1.3.2 Shoulder widths / edge clearances

Design guidance in the USA does not explicitly provide design guidance for road shoulders or barrier offsets for temporary roads, however, a number of the examples shown in NCHRP 581 detail cross section options with no offset from the traffic and a road safety barrier [However, it should be noted that the associated lane widths recommended for works in the USA exceed those applied in Australia].

Figure 4.1.1.3.2 – NCHRP 581 example section of two way traffic on normally divided road

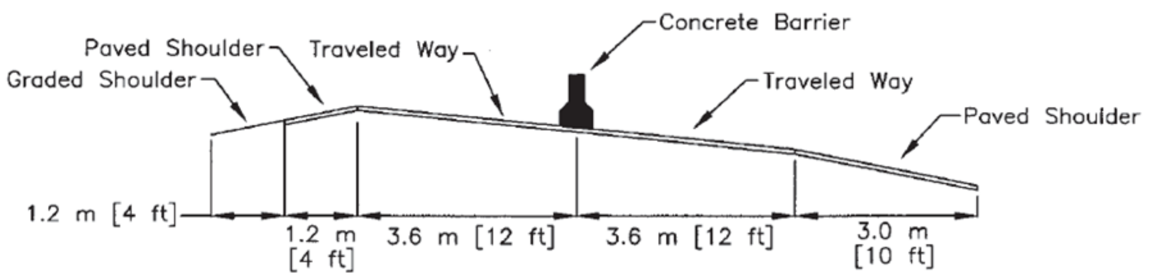


Exhibit 4-9. Typical section of two-way traffic on normally divided facility with barrier centered on existing traveled way.

4.1.1.4 UK

The UK *Traffic Signs Manual – CHAPTER 8, Traffic Safety Measures and Signs for Road Works and Temporary Situations* identifies a range of parameters with regards to lane width guidance for temporary roads.

- To provide the required lateral clearance, the running lane width may be reduced according to the expected type of usage. Where heavy vehicles, including public service vehicles, caravans etc. are expected, the lane width may be reduced to 3.25 m (desirable minimum) or 3.0 m (absolute minimum). Where two lanes are required for HGVs the near side lane should be 3.25 m (absolute minimum). [Note that HGVs in UK guidance typically relate to 19 m semi-trailers].

- On single carriageway roads, two-way operation of traffic should be maintained. This normally requires an unobstructed (sealed) width of carriageway of 5.5 m, but with other considerations relating to bus routes, and cyclists. Widths narrower than 5.5 m are not supported for maintaining continuous two-way traffic flow and the requirement is to reduce the width further and implement alternate one-way traffic (shuttle working). The minimum width lane for shuttle working is 3.0 m, but, car-only traffic can be maintained with a minimum of 2.5 m. However, where the traffic is expected to consist only of cars and other light vehicles the lane width may be reduced to 2.75 m (desirable minimum) or 2.5 m (absolute minimum).
- For works on minor roads where traffic speeds are restricted to 30 mph (48 km/h) or less, the width of a single lane may be reduced to an absolute minimum of 2.5 m, for cars and light vehicles.
- Works on dual carriageway roads may require some traffic lanes to be reduced in width to less than 3.0 m. Whenever this situation arises, advance warning of the narrow lanes should be given. In most situations it will be necessary to re-mark the carriageway showing the new lanes. If the lane width is less than 3.0 m the symbol indicating a temporary width restriction, should be included for the appropriate lane or lanes.

4.1.2 Case Examples

Case examples in the use of narrow lanes are presented from observed temporary alignment practices in Germany and of existing narrow lanes in Queensland.

4.1.2.1 Queensland – existing permanent road examples

Most roads across Queensland generally comply with the widths defined in the Austroads guidance, particularly on higher traffic roads. There are, however, examples of high-volume urban roads with lane widths less than 3.0 m as detailed below. These examples appear to support the finding that narrow lane widths can operate satisfactorily for specific circumstances.

Table 4.1.2.1 – Brisbane examples of existing narrow lanes

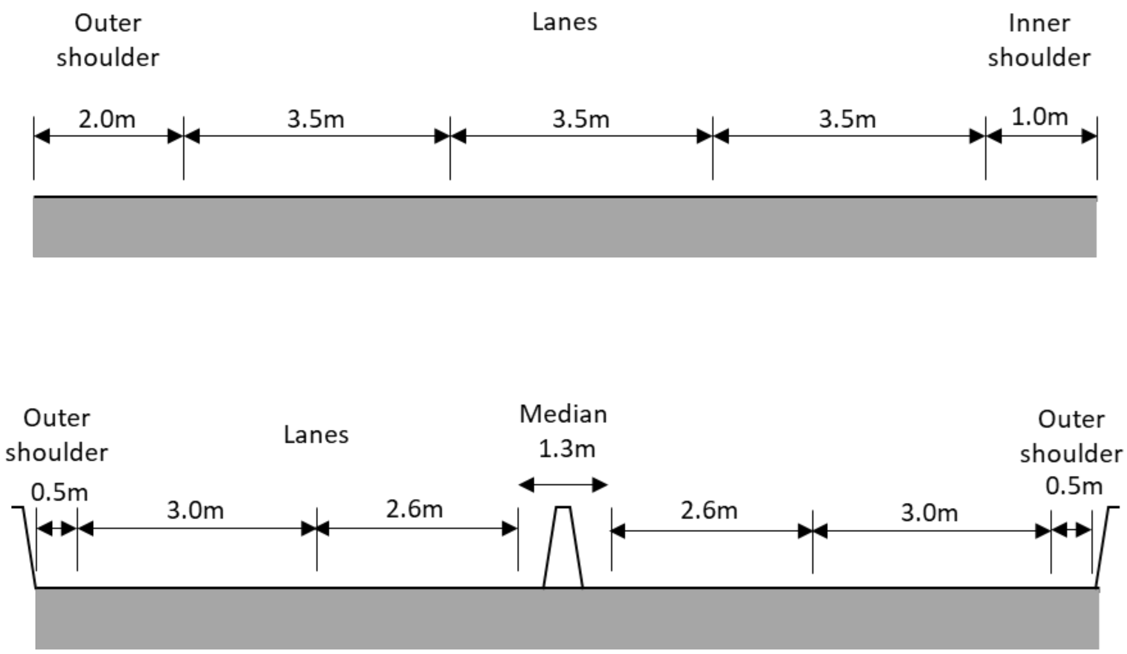
Road	Posted speed (km/h)	Lane width (m)
Milton Road, Milton, Auchenflower, Toowong	60	2.6 - 2.8 m
Ipswich Road, Annerley	60	2.8 m
Moggill Road, Toowong	60	2.8 m

It is also observed there are existing roads in constrained environments, most particularly on sections of the Pacific Motorway, Legacy Way, Clem7 and Airport Link where shoulder widths between lanes and permanent road safety barriers are as narrow as 0.5 m while maintaining a posted speed of 80km/h and it appears to be narrower in constrained sections. Further on bridge structures (eg Captain Cook Bridge, Centenary Highway Bridge, Houghton Highway and Ted Smout Memorial Bridges both 2.7 km in length) barrier offsets as narrow as 0.2 m are also observed for extended bridge lengths while maintaining posted 80 km/h speed limits.

4.1.2.2 Germany

An example of the use of narrow lanes at roadworks was observed on German Autobahns (January 2020). Works on the Autobahn utilised lane widths reduced to approximately 2.6 m while maintaining a 60 km/h speed limit. In these circumstances a three-lane single direction carriageway had been converted into two two-lane carriageways whilst works were being undertaken on the opposing carriageway.

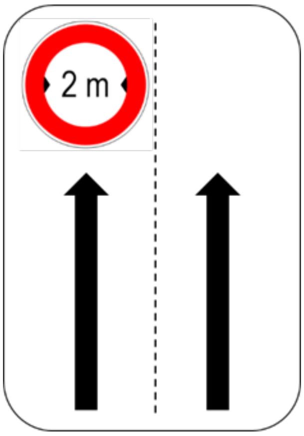
Figure 4.1.2.2(a) – Conversion of 3-lane carriageway to two 2-lane carriageways (Germany)



Note: Based on German Autobahn arrangement

A key mitigating factor applied at these works were signs banning vehicles wider than 2.0 m from the median side lane. It should be noted that the largest vehicles observed on these roads were 19 m semi-trailers.

Figure 4.1.2.2(b) – Vehicle width prohibition sign (Germany – driving on the right)



In this circumstance, the narrow lane widths appeared to result in high levels of compliance with the posted 60 km/h speed limit despite much higher speed limits on the approaches (110 km/h, 130 km/h, unlimited speed).

4.1.3 Design Exception opportunities – cross section

4.1.3.1 Lane Widths

The practices described in the UK guidance, and depicted in the example in Germany demonstrate that lane widths as narrow as 2.5 m can be maintained where the lane is not used by heavy vehicles and is limited to cars and motorcycles.

There may therefore be the opportunity on projects in Queensland, for lane widths as narrow as 2.5 m be considered for temporary road alignments in specific circumstances. Importantly, all the international examples with narrow lane widths preclude the use of these lanes for heavy vehicles. For road projects with significant portion of heavy vehicles, at least one lane in each direction should be maintained with a width sufficient to accommodate those vehicles. In addition, a range of mitigating factors will be required to support the use of narrow lanes to ensure their use is restricted to cars and motorcycles only.

A particularly critical mitigating factor in consideration of narrow lane widths is achieving speed limit compliance at the site. While the narrow lanes themselves potentially assist in reinforcing the posted speed limits, measures are required to ensure that vehicles are travelling at suitable speeds prior to entering any section with narrow lanes.

It is noted again that in the examples provided above, no allowance has been made for on-road cycle facilities. Where cyclists are present on the road, the further restrictions in lane width are not supported unless a suitable alternative facility for cyclists using the road can be provided.

Lane widths should only be considered in conjunction with shoulder widths as described in the following section. A summary of potential lane width design exceptions are therefore presented at the completion of the following section considering shoulder widths.

4.1.3.2 Shoulder widths / edge clearances

Existing permanent road design practices appear to support barriers at an edge clearance of 0.2 m or less in constrained locations such as bridges, tunnels and near piers for overhead structures. Further examples on German Autobahns also appears to support barrier edge clearances of 0.2 m or less for temporary alignments in conjunction with narrow lanes being used by cars and motorcycles only.

There may therefore be the opportunity on projects in Queensland, for shoulder widths / barrier offsets as narrow as 0.2 m be considered for temporary road alignments in specific circumstances. For road projects with significant portion of heavy vehicles, narrow shoulder widths / barrier offsets should not be used together with narrow lanes to avoid repeated nuisance impacts on the barrier.

A particularly critical mitigating factor in consideration of narrow shoulder widths / barrier offsets again is achieving speed limit compliance at the site. While the narrow shoulder widths / barrier offsets themselves potentially assist in reinforcing the posted speed limits, measures are required to ensure that vehicles are travelling at suitable speeds prior to entering any narrow section.

It is noted again that in the examples provided above, no allowance has been made for on-road cycle facilities. Where cyclists are present on the road, the further restrictions in shoulder widths / barrier offsets are not supported unless a suitable alternative facility for cyclists using the road can be provided.

Shoulder widths / barrier offsets should only be considered in conjunction with lane widths as described previously. A summary of potential shoulder widths / barrier offsets design exceptions are therefore presented in the following sections.

The evidence provided in the previous sections, suggest the following design exception opportunities may be potentially available for consideration for road cross section.

In each of these scenarios a risk assessment will need to consider the higher potential for side swipe type crashes and for nuisance impacts with temporary road safety barriers adjacent to the lane. The risk assessment would need to consider a range of parameters including:

- road alignment, horizontal and vertical
- length of narrow section
- duration of the works, and
- percentage of heavy vehicles.

4.1.3.3 Two-lane, two-way roads

Situation A – Road with light vehicles and semi-trailers only

For temporary alignments where traffic is substantially made up of light vehicles with only a small percentage of heavy vehicles no larger than a semi-trailer, projects typically apply lane and edge clearances in accordance with the department's Queensland MUTCD Part 3. This then leads to a minimum cross-section for a two-lane two-way temporary road as detailed in Table 4.1.3.3(a).

Figure 4.1.3.3 – Cross section width – 2-lane 2-way

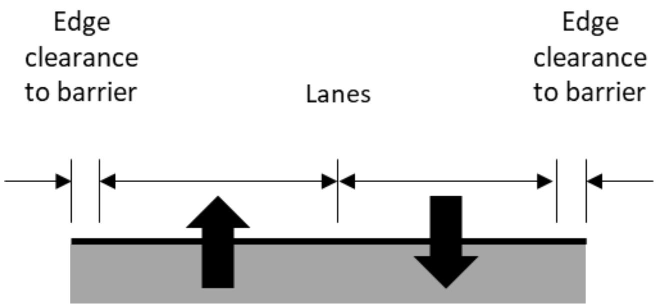


Table 4.1.3.3(a) – Cross section width – 2-lane 2-way, complying with QGTTM

Speed (km/h)	Lane width (m)	Edge Clearance width (m)	Total width (m)
40	3.0	0.3	6.6
60	3.0	0.5	7.0
80	3.5	0.5	8.0

The review of lane widths supported narrower widths in some cases but these were predominantly in situations where there were at least two lanes in a single direction. It is therefore not considered that further reductions in lane width are appropriate in circumstances with a single lane in each direction separated only by barrier line. There are however considered to be opportunities to reduce the edge clearance in line with the adopted Main Roads WA practice. These barrier offsets have some precedent in Queensland on sections of road in constrained situations and across bridges. This then results in the potential cross-section widths outlined in Table 4.1.3.3(b).

Table 4.1.3.3(b) – Cross section width – 2-lane 2-way, complying with Main Roads WA

Speed (km/h)	Lane width (m)	Edge Clearance (m)	Total width (m)	Cross section reduction compared to AGRD03 Table 5.1(m)
40	3.0	0.2	6.4	0.2
60	3.0	0.3	6.6	0.4
80	3.2	0.5	7.4	0.6

Situation B – Roads carrying larger vehicles

For temporary alignments where traffic includes a higher percentage of heavy vehicles and vehicles larger than a semi-trailer, projects typically apply lane and edge clearances more in accordance with permanent road design guidelines for lane widths and the barrier offsets in accordance with the Queensland MUTCD/QGTTM. Application of the Main Roads WA guidance for barrier offsets results in identical cross section reduction for each speed as detailed in Table 4.1.3.3(b) but with wider lane widths.

4.1.3.4 Two-lane, one-way carriageway

For temporary alignments where at least two lanes are maintained in a single direction, and in situations where traffic is made up of light vehicles and heavy vehicles no larger than a semi-trailer, projects typically apply lane and edge clearances in accordance with the Transport and Main Roads Queensland MUTCD Part 3. This then leads to a minimum cross-section for a two-lane two-way temporary road as detailed in Table 4.1.3.4(a).

Figure 4.1.3.4 – Cross section width – 2-lane 1-way

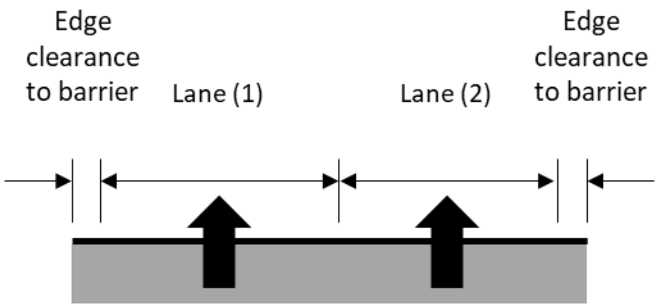


Table 4.1.3.4(a) – Cross section width – 2-lane 1-way, complying with QGTTM

Speed (km/h)	**Lane width (m)**		**Edge Clearance (m)**	**Total width (m)**
	Lane 1	**Lane 2**		
40	3.0	3.0	0.3	6.6
60	3.0	3.0	0.5	7.0
80	3.5	3.5	0.5	8.0

In this situation, there may be applications for the use of lane widths narrower than those specified in the Queensland MUTCD Part 3. A potential design exception that could be considered would be reducing one lane in each direction on multi-lane roads to a width below the 3.0 m minimum specified for a posted speed of 60 km/h, or below the 3.5 m width specified for 80 km/h. At least one remaining lane in each direction on these multi-lane temporary alignments should be maintained at the widths specified in the Queensland MUTCD Part 3 to accommodate heavy vehicles. In association with these reduced lane widths, it may also be possible to consider reduced edge clearances in line with those documented in the Main Roads WA guidelines. This then results in the comparative cross section widths detailed in Table 4.1.3.4(b).

Table 4.1.3.4(b) – Cross section width – 2-lane 1-way, potential design exception

Speed (km/h)	**Lane width (m)**		**Edge Clearance (m)**	**Total width (m)**	**Cross section reduction compared to Table 4.1.3.4(a) (m)**
	Lane 1	**Lane 2**			
40	3.09	2.75	0.2	6.15	0.45
60	3.0	2.75	0.3	6.35	0.65
80	3.5	2.75	0.5	7.2	0.75

Note: Lane widths for speeds of 60 km/h or less may be reduced to 2.5 m in specific circumstances

Where wider lanes are required for vehicles larger than a semi-trailer, the Lane Width specified for Lane 2 and the edge clearances could potentially be reduced in line with the dimensions detailed in Table 4.1.3.4(b).

4.1.4 Mitigating measures – cross section

The primary risks associated with narrower lane widths is reduced manoeuvrability space for larger vehicles and the increased potential for side swipe collisions. The element considered key to successfully implementing narrow lanes would be the restriction of wider vehicles to only use those lanes maintained at the lane widths specified in the Queensland MUTCD Part 3, or wider where required for specific projects.

QLD Road Rules Regulation 104 (reproduced below – in part) appears to allow the use of a "No Trucks" sign to apply to only some lanes on a road as per subsection (5). The relevant parts of the clause are highlighted.

Regulation 104 No Trucks Signs

(1) A driver (except the driver of a bus) must not contravene a no trucks sign that has information on or with it indicating a mass if the GVM of the driver's vehicle (or, if the driver is driving a combination, any vehicle in the combination) is more than that mass.

(2) A driver (except the driver of a bus) must not contravene a no trucks sign that has information on or with it indicating a length if the length of the driver's vehicle (or, if the driver is driving a combination, the length of the combination) is longer than that length.

(3) The driver of a truck must not contravene a no trucks sign that has no information on or with it indicating a mass or length.

(5) For subsections (1) to (4), a driver contravenes a no truck sign by—

(a) if the sign applies to 1 or more, but not all, marked lanes on a road—driving in a marked lane while the sign applies to the lane; or

(b) otherwise—driving past the sign.

Example of a no trucks sign—

No trucks sign

Hence the following sign assembly example may allow for trucks to be banned from the right lane.

Figure 4.1.4(a) – Sign assembly banning trucks from right lane

QLD Road Rules Regulation 159 (reproduced below) also appears to define the use of signs to require vehicles to use a particular lane. The relevant parts of the clause are highlighted.

Regulation 159 Marked lanes required to be used by particular kinds of vehicles

(1) If information on or with a traffic sign applying to a length of road indicates that a vehicle of a particular kind must drive in a particular marked lane, a driver driving a vehicle of that kind on the length of road must drive in the indicated lane, unless—

- (a) the driver is avoiding an obstruction; or
- (b) the driver is obeying a traffic control device applying to the indicated lane; or
- (c) the driver is permitted to drive in the indicated lane and also another marked lane under this regulation; or
- (d) the driver is intending to turn off the road or to make a U-turn and, in order to do so safely without disrupting other vehicles on the road, it is necessary to position the vehicle in another lane before starting or making the turn.

(2) A traffic sign mentioned in this section that is on a road applies to the length of road beginning at the sign and ending at the nearest of the following—

- (a) a traffic sign or road marking on the road that indicates that the first traffic sign no longer applies;
- (b) the next intersection on the road;
- (c) if the road ends at a T-intersection or dead end—the end of the road.

Examples of a traffic sign mentioned in the section and a traffic sign indicating that the first traffic sign no longer applies—

And finally, *QLD Road Rules Regulation 329* (reproduced below in part) define how the use of traffic control devices are to be considered as applying to a marked lane.

Regulation 329 Traffic control devices applying to a marked lane

1) A traffic control device (except a road marking) applies to a marked lane if—

- (a) it is above the marked lane; or
- (b) it is near the marked lane and the device, the position of the device, or information on or with the device indicates that it applies to the marked lane.

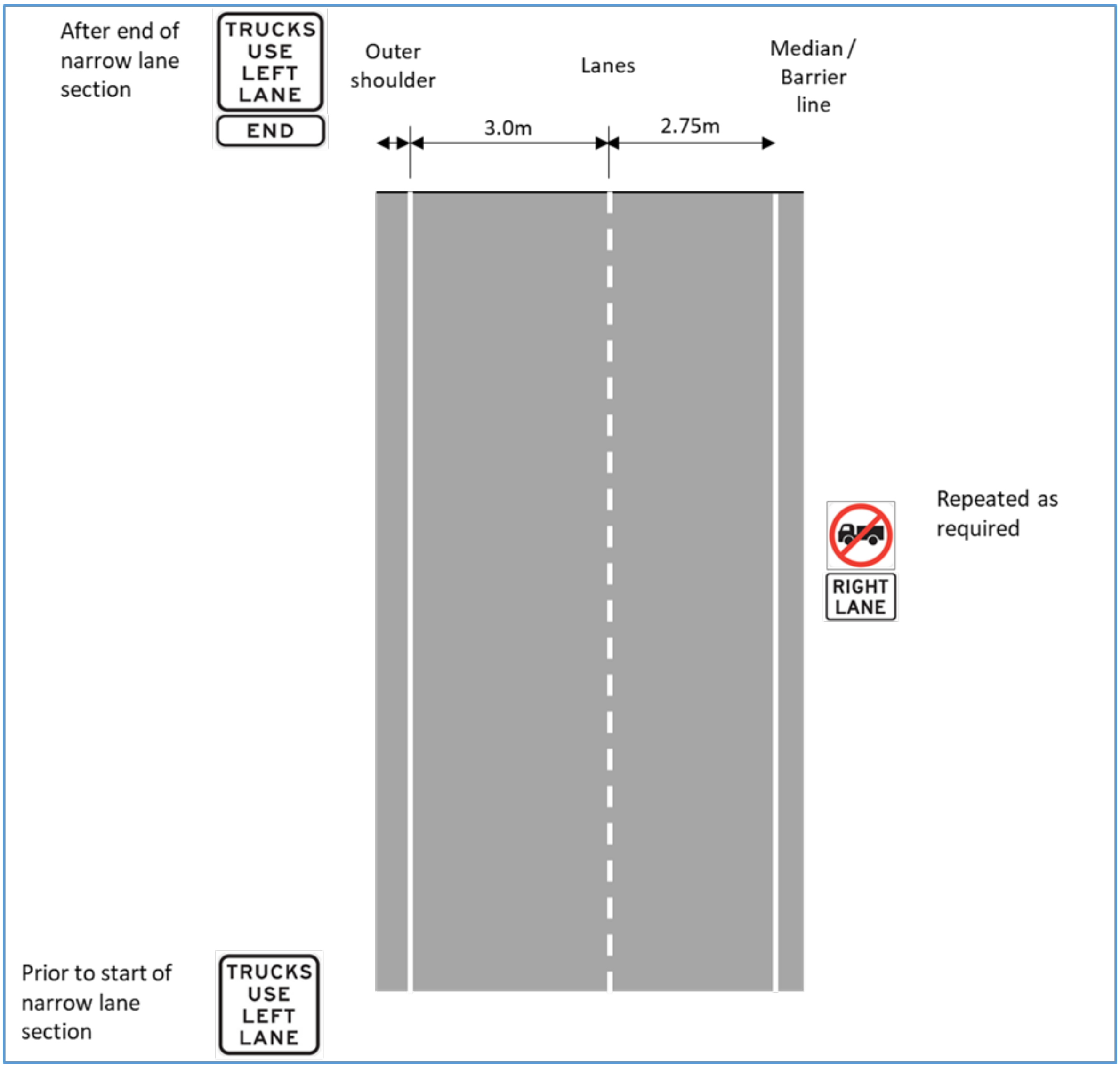
Example— An emergency stopping lane only sign applies to the marked lane indicated by the arrow on the sign.

A design exception reducing lane widths below those specified in the Queensland MUTCD Part 3 may be considered in circumstances where site constraints restrict available width. The arrangement would require consideration of the following:

- Speed limit compliance.
- Truck lane use compliance.
- Crash records and near incidents.
- Alignment – should not contain sharp curves or switches).
- Entering traffic – intersections and entering traffic should be restricted to limited locations.

In these circumstances, an arrangement similar to the following may apply.

Figure 4.1.4(b) – Potential Design Exception – lane widths for single direction carriageway (60 km/h)



Additional mitigating measures could include:

- signs
  - narrow shoulders
  - Speed detection and display.
- road lighting
- driver behaviour surveillance
- speed enforcement
- site surveillance and incident recording.

4.2 Sight Distance

Sight distance requirements for a temporary road have significant impacts on issues associated with the alignment of the road. Most particularly maintaining sight distance around horizontal curves can lead to substantial carriageway widening or requirements for larger radius horizontal curves. Both of these solutions to maintain sight distance can have a significant impact on both the costs of the construction of the temporary road and on the constructability of the works in constrained sites.

The following guidance relating to sight distance may be applicable to temporary road alignments.

4.2.1 National / International guidance – literature review

In considering potential design exception criteria for sight distance for temporary roads documented guidance has been reviewed and considered from Transport and Main Roads (existing guidelines and the adopted *Austroads Guide to Road Design*) and the USA. Case examples in the application of reduced sight distance are presented from projects in Queensland.

4.2.1.1 Queensland

RPDM Part 3 identifies that exceptions may be considered for sight distance at crest curves so long as the application of manoeuvre capability (manoeuvre width and manoeuvre sight distance) is maintained as opposed to stopping sight distance.

Millar & Lennie (2010) noted that for the Ipswich Motorway project sight distance was determined on the following basis:

- Perception Reaction time (1.5s), could be justified on the temporary roadways as the constrained cross section and the provision of barriers/ anti gawk screens were expected to help keep motorists alert.
- Deceleration Rate – EDD deceleration rates for wet conditions were applied due to project extending across a number of years.
- Horizontal Alignment:
  - Sight Distance calculated to an object at a horizontal offset of 0.5 m from the centre of the lane (to allow a driver to see one of the taillights on a car)

- Vertical Alignment:
  - In areas that are lit, car stopping in the wet (d = 0.46) was permitted to a 1.25 m object (which is representative of seeing to the top of a stopped car). No manoeuvre width provided for evasive action around smaller objects, and
  - For unlit areas, car stopping in the wet (d = 0.46) was permitted to a 0.8 m object height (which is representative of seeing to the illuminated taillights of a stopped car). No manoeuvre width provided for evasive action around smaller objects.

4.2.1.2 Australia – National guidance (AGRD)

Stopping sight distance is the parameter considered most critical within a temporary road alignment. The key parameters in the determination of stopping sight distance include:

- Object height (refer AGRD03 Table 5.1):
  - 0.2 m Normal stopping sight distance for cars and trucks to hazard on roadway.
  - 0.8 m Stopping sight distance to hazards over roadside safety barriers in constrained locations.
  - 1.25 m Stopping sight distance to hazards over roadside safety barriers on a horizontally curved bridge with road lighting.
- Driver reaction time (refer AGRD03 Table 5.2):
  - 2.0 to 2.5s is used in most circumstances.
  - 1.5s Absolute minimum value. Only used in very constrained situations where drivers will be alert.
- Longitudinal deceleration ((refer AGRD03 Table 5.3):
  - 0.26 Comfortable deceleration on sealed roads for cars.
  - 0.29 Maximum value for calculating truck stopping sight distance for most urban and rural road types.
  - 0.36 Desirable value for calculating minimum stopping sight distance for cars for most urban and rural road types.
  - 0.46 Maximum value for calculating absolute minimum stopping sight distance for cars. Only to be used in constrained locations.
  - 0.61 Specific applications where the normal stopping sight distance criteria for cars applied to horizontal curves produce excessive lateral offsets to roadside barriers/structures.

As identified in Section 4.2.2 of this technical note, existing temporary road alignments have been approved as a design exceptions on the basis of stopping sight distance based on a reaction time of 1.5s, an object height of 0.8 m and longitudinal deceleration factor of 0.46.

4.2.1.3 USA

Sight Distance - For work zone design speeds less than 60 km/h, the stopping sight distance values tabulated in the Green Book and corresponding to work zone design speed are recommended. For work zone design speeds of 60 km/h and greater, the Green Book design speed-corresponding values do not necessarily represent the minimums that can be accepted, and a minimum sight distance of 90 m [300 ft] is recommended using a driver eye height of 1,080 mm and an object height of 600 mm.

4.2.2 Case Examples

Pacific Motorway upgrade - The horizontal alignment of the temporary road and the presence of temporary road safety barriers immediately (0.5 m) adjacent to the edge of lane resulted in stopping sight distance, in accordance with the RPDM, not being achieved to an object 0.2 m high. The reduced sight distance was accepted as a design exception on the basis of mitigating factors which included lighting of the site, regularly monitoring and patrol of the site by contractor staff. A design exception was developed with sight distance provided to a 0.8 m high object (vehicle tail light). To support the design exception, surveys which demonstrated a high levels of speed compliance. The stopping sight distance was calculated on the basis of a driver reaction time of 1.5s, and a deceleration coefficient of 0.46 in accordance with AGRD Table 5.3. Additional manoeuvring width was not provided.

4.2.3 Design Exception opportunities – sight distance

The evidence provided in the previous sections, suggest the following design exception opportunities may be potentially available for consideration for sight distance.

In each of these scenarios a risk assessment will need to consider the higher potential for potential rear end crashes, crashes with objects on the road, and side swipe crashes with vehicles in adjacent lanes or nuisance impacts with temporary road safety barriers adjacent to the lane as drivers manoeuvre to avoid an object in lane. The risk assessment would need to consider a range of parameters including:

- speed limit compliance
- road alignment, horizontal and vertical
- length of reduced sight distance
- duration of the works, and
- percentage of heavy vehicles.

The three key parameters relating to stopping sight distance that have previously been the focus of approved design exceptions are object height, reaction time and coefficient of deceleration. Based on AGRD03 Table 5.5, the minimum Stopping Sight Distance reduction can be achieved as shown in Table 4.2.3.

Table 4.2.3 – NDD and absolute minimum sight distance requirements

Roadworks Posted Speed km/h	**Design Speed km/h**	**NDD Stopping SD D=0.36 RT = 2.0 (m)**	**Minimum Stopping SD D=0.46 RT = 1.5 (m)**
40	50	55	42
60	70	92	71
80	90	139	107

Note: Design speed equals the posted speed limit for sites where a high level of speed compliance is achieved.

Application of these sight distance requirements would typically be considered an EDD design. Applying these minima together with using an object height of 0.8 m / 1.25 m would therefore represent a design exception if manoeuvre capability is not provided. Additional consideration of the risks associated with this combination of minima would be required.

In these circumstances, the use of object height greater than 0.2 m would typically require the provision of manoeuvring sight distance and additional carriageway width to allow a driver to manoeuvre around an object on the road. However, in most temporary road situations, the site constraints will typically not permit this to be provided.

Hence a design exception applying absolute minimum sight distance and an object height of 0.8 m or 1.25 m would therefore need to consider the additional risks associated combination. These risks typically will relate to increased probability of a vehicle either colliding with the object / vehicle in the lane, colliding with a vehicle in the adjacent lane as they manoeuvre to avoid the object, or colliding with a temporary road safety barrier or roadside delineation as they manoeuvre to avoid the object.

It is particularly noted that use of an object height greater than 0.2 m in combination with EDD parameters requires full evaluation and justification from the designer to ensure that unacceptable safety risks do not arise. It should also be noted that these sight distance design exceptions would not be suitable on the approach to the worksite or within the queuing zones within the project as many historic crashes occur at these locations. The application of these sight distance design exceptions should only apply once the temporary road alignment within the site has been established and a high level of speed compliance has been achieved.

4.2.4 Mitigating measures – sight distance

The design exception would require consideration of the following elements and potential mitigating factors:

- Speed limit compliance – to ensure that the majority of traffic is travelling at or below the posted speed limit.
- Lighting of the alignment – to ensure that drivers can see objects ahead as opposed to relying on headlight sight distance (typically low beam).

- Wet weather conditions – Stopping sight distance for dry pavement conditions (d=0.61) reduces to 37 m, 61 m and 90 m respectively for Design speeds of 50, 70 and 90 km/h. Some jurisdictions sign speed limits to be dependent of weather conditions (Figure 8) with permanent and variable speed limit signs displaying wet weather speed limits. Consider the use of variable speed limit signs with rain / wet road surface sensors to apply reduced speed limits in wet weather conditions.

Figure 4.2.4 – Example signs varying speed limit based on weather conditions

a) Victoria – Australia

b) France

- Crash records and near incidents – should be assessed regularly to establish if a lower speed limit needs to be implemented on a permanent basis with additional design measures introduced to address vehicle speeds should crash records be unacceptable.
- Ongoing monitoring, vehicle breakdown and debris removal – to ensure that any debris greater than 0.2 m height is identified and removed promptly including towing facilities to remove disabled vehicles. This requirement would need to be agreed to and committed to within the project contract.
- Variable message signs to alert drivers to the presence of hazards ahead when they are identified.
- High skid resistance pavement to reduce stopping distances for braking vehicles in wet conditions.
- Changes in alignment, high visibility visual cues and delineation close to the alignment should all be considered to increase the awareness of drivers to the site and to assist in accepting reductions in driver reaction time.
- Removal of anti-gawk screens on the insides of curves with reduced sight distance to improve visibility to rear of vehicles ahead over the top of the temporary road safety barrier.

4.3 Coordination of horizontal and vertical alignment

Horizontal and vertical design parameters for roads include a set of criteria with regards to the coordination of horizontal and vertical alignment. For temporary roads this can have significant impacts on issues associated with the alignment of the road. This in turn can have a significant impact on both the costs of the construction of the temporary road and on the constructability of the works in constrained sites.

4.3.1 National / International guidance – literature review

The following guidance relating to horizontal and vertical coordination may be applicable to temporary road alignments.

Austroads AGRD03 details three overall considerations associated with the coordination of the horizontal and vertical alignment being:

- Safety – in particular it is noted that a major safety risk is associated with the sight distance to a horizontal feature that the driver needs to react to (curves, cross section changes, start of median etc) which can be obscured if it is located within a vertical curve.
- Aesthetic – design features which create the most pleasing appearance.
- Drainage – to ensure water flow paths do not result in excessive water depths within the road alignment.

There is no existing guidance detailed in State / Territory or international road design guidelines relating to horizontal and vertical coordination for temporary roads. However, in considering potential design exception criteria for horizontal and vertical coordination for temporary roads the Department considers the following to be appropriate for consideration with regards to the three overall considerations for horizontal and vertical alignment.

4.3.1.1 Safety considerations

For temporary road alignments, design considerations relating to safe operation of the road remain applicable. This design requirement primarily relates to the visibility of horizontal alignment features which may be potentially hidden by a vertical alignment feature such as a curve.

The primary mechanism by which safety is achieved is by providing sufficient visibility to the line marking or kerb line for the change of alignment, cross section or introduction of median islands.

4.3.1.2 Aesthetic considerations

For permanent road alignments, aesthetic considerations relating to combined horizontal and vertical alignment are predominantly focussed on providing a pleasing appearance to the road alignment and limiting sudden changes in lateral and vertical acceleration experienced by vehicle occupants. For temporary road alignments, these may not need to be considered. In fact, the lack of a pleasing appearance may assist in ensuring that drivers remain alert to the changed traffic conditions and may play a role in encouraging higher speed limit compliance.

4.3.1.3 Drainage considerations

For temporary road alignments, drainage considerations relating to horizontal and vertical are predominantly focussed on water flow paths across the alignment. These considerations should continue to be observed but may take into account factors and mitigating measures such as:

- Duration of the works and the likelihood of wet weather during the works.

- Variable message signs to alert drivers to the presence of wet pavement and water on road hazards ahead.
- Crash records and near incidents – should be assessed regularly to establish if a lower speed limit needs to be implemented with additional design measures introduced to address vehicle speeds should crash records be unacceptable.
- Ongoing monitoring – to identify emergent safety issues associated with the lack of horizontal and vertical coordination.

4.3.2 Case Examples

No case studies were identified where design exceptions for the coordination of horizontal and vertical alignment were implemented.

4.3.3 Design Exception opportunities – horizontal and vertical alignment coordination

Horizontal and vertical alignment considerations should continue to be applied for safety and drainage considerations with some of the mitigating measures identified below potentially allowing alternative means of achieving these coordination requirements.

Aesthetic considerations for horizontal and vertical alignment may not need to be observed for temporary road alignments.

Any design exception would require consideration of the following safety and drainage considerations:

- Speed limit compliance – to ensure that the majority of traffic is travelling at or below the posted speed limit.
- Lighting of the alignment – to ensure that drivers can see objects ahead including devices used to delineate changes in alignment.
- Crash records and near incidents – should be assessed regularly to establish if a lower speed limit needs to be implemented with additional design measures introduced to address vehicle speeds should crash records be unacceptable.
- Duration of the works and the likelihood of wet weather during the works.

4.3.4 Mitigating measures – horizontal and vertical alignment coordination

To ensure that safety considerations are addressed, for temporary road alignments there may be an opportunity to use the following to highlight changes in alignment or potential hazards relating to water flow across the carriageway:

- Alignment markers placed along barriers or delineating devices.
- Use of illuminated arrow boards or variable message signs to advise of alignment changes.
- Delineation devices such as bollards and temporary road safety barriers.
- Variable message signs to alert drivers to the presence of wet pavement and water on road hazards ahead.
- Ongoing monitoring – to identify emergent safety issues associated with the lack of horizontal and vertical coordination.

4.4 *Horizontal alignment*

Horizontal alignment requirements can place significant constraints on the potential road alignment for temporary roads. This can have a significant impact on both the costs of the construction of the temporary road and on the constructability of the works in constrained sites.

The following guidance relating to horizontal alignment may be applicable to temporary road alignments.

4.4.1 National / International guidance – literature review

In considering potential design exception criteria for sight distance for temporary roads documented guidance has been reviewed and considered from Transport and Main Roads (existing guidelines and the adopted *Austroads Guide to Road Design*), Main Roads WA and the USA.

4.4.1.1 Queensland

The department's *Guidelines for Road Design on Brownfield Sites* (2013) identifies that specific design elements that are considered and which appear relevant to the application on temporary roads include: horizontal alignment. However no particular parameters are discussed.

4.4.1.2 Australia – National guidance (AGRD)

AGRD03 notes that *"the horizontal curvature should be used to control operating speeds through a transition section, since horizontal curvature has the greatest effect on operating speed"*. No relaxations to permanent road design parameters are discussed for application at temporary roads.

Section 7.8 of AGRD03 discusses that adverse crossfall may also be used on temporary roads and side-tracks. In these cases, superelevation and side friction factors may not align with NDD design practice.

4.4.1.3 Western Australia

Main Roads WA design guidance identifies that *"temporary alignments in place for up to twelve months that cannot meet the Main Roads Horizontal Curve Tables criteria shall apply superelevation at a rate based on the Main Roads Supplement to Austroads GRD Part 3: Geometric Design using the desirable friction factor but with no distribution of e or f ie:- E = V2/(127R) - fdes"*.

It further identifies parameters related to:

- Superelevation - A minimum superelevation and/or crossfall of 2% is required to cater for drainage on sealed surfaces.
- Adverse crossfall = If adverse crossfall is to be used then Fdes shall be limited to 50% of Fdes, as recommended by the Main Roads Supplement to Austroads GRD Part 3: Geometric Design.

4.4.1.4 USA

The road alignment design parameters that are discussed in the context of temporary road design include:

- Superelevation and side friction – these parameters are typically chosen on the basis of driver comfort criteria. For temporary roadways, parameters which are based on typical vehicle – pavement interactions can be used which approach maximums, particularly for side friction. The use of adverse crossfall may be appropriate in these circumstances to reduce the need to introduce superelevation.
- Horizontal Alignment and Superelevation – as cost and impacts of a side track relate to the length of the alignment between tie-in points on the permanent roadway, it is preferred to use the smallest curve radii that satisfy all design considerations.

4.4.2 Case Examples

Case examples from projects in Queensland included design exception on the basis that:

- The horizontal alignment for a temporary road at a site was restricted due to the site constraints and a diversion of the road alignment was implemented with no separation between reverse curves.
- On a curve with adverse crossfall, curve radii of R400 was adopted which complied with the desirable maximum side friction for cars but not for trucks. Additional VMS were applied to advise truck drivers of the road geometry and appropriate warning speeds.

4.4.3 Design opportunities – horizontal alignment

The following horizontal alignment elements are considered relevant to the consideration of temporary roadways:

- Types of Horizontal curves:
  - Compound curves, broken back curves and reverse curves while undesirable but can be accepted in constrained situations and are all likely to be more common for temporary alignments at roadworks. The key risk associated with these horizontal design features is an increased risk of drivers misjudging the path to follow to negotiate the curves.
  - The design of these curves should continue to be undertaken in accordance with the guidance in the RPDM Part 3 and AGRD03 and hence does not represent a Design Exception.
- Side friction and minimum curve size:
  - The factors associated with establishing the minimum curve size include the pavement superelevation (e) and the side friction factor (f). The desirable and absolute maximum side friction factors are presented for cars and trucks in AGRD3 Table 7.5. Consider use of the absolute maximum side friction factor (f) for horizontal curves for temporary alignments. The application of absolute maximum side friction and inclusion of adverse crossfall is considered to be an EDD design parameter. However care needs to be taken to ensure that use of fmax considers the changes in friction between horizontal alignment features and is not applied on an isolated curve. However, as identified in the case study examples previously applied in Queensland, a design exception has previously been approved on the basis of meeting side friction requirements for cars but not for trucks.

- Curves with adverse crossfall:
  - AGRD03 states that adverse crossfall on curves should normally be avoided except on curves of very large radius relative to the operating speed that can be regarded as straights. Table 7.12 of AGRD03 gives minimum radius curves for various operating speeds for which adverse crossfall may be considered. In constrained temporary roadworks sites it is considered more likely that difficulties will arise in creating the necessary superelevation for curves, particularly for reverse curves at the start and end transition areas between the temporary alignment and the permanent alignment.
  - While not desirable, the design of these curves with adverse crossfall should continue to be undertaken in accordance with the guidance in the RPDM Part 3 and AGRD03 and hence does not represent a Design Exception.

4.4.4 Mitigating measures – horizontal alignment

In situations where side friction requirements may not be met for heavy vehicles, the primary risks are associated with these vehicles either not negotiating the curves, or potentially overturning. The application of and design exception relating to side friction requirements for heavy vehicles would require consideration of the following potential mitigating factors:

- Speed limit compliance – to ensure that the majority of traffic is travelling at or below the posted speed limit.
- Speed limit compliance for heavy vehicles. The *QLD Road Rules Regulation 104* (reproduced below – in part) appears to allow the use of a “No Trucks” sign to apply to only some lanes on a road as per subsection (5). The relevant parts of the clause are highlighted.

  QLD Road Rules Regulation 317 (reproduced below in part) define how the use of traffic control devices can apply to a particular vehicle.

> Regulation 317 Information on or with traffic control devices
>
> 1) A traffic control device may, by the use of words, figures, symbols or anything else indicate any of the following—
> (a) the times, days or circumstances when it applies or does not apply;
> (b) the lengths of road or areas where it applies or does not apply;
> (c) the persons to whom it applies or does not apply;
> (d) the vehicles to which it applies or does not apply;
> (e) other information

An example of the application of such a sign from Great Western Highway in the NSW Blue Mountains is shown at Figure 4.4.4.

Figure 4.4.4 – Example signs varying speed limit for heavy vehicles

- Additional warning signage to alert heavy vehicle drivers to the presence of the curves and the appropriate warning speed.
- Crash records and near incidents – should be assessed regularly to establish if a lower speed limit needs to be implemented on a permanent basis with additional design measures introduced to address vehicle speeds should crash records be unacceptable.

4.5 Vertical alignment

Vertical alignment requirements typically are not reported as creating significant constraints on the potential road alignment for temporary roads.

4.5.1 National / International guidance – literature review

The following guidance from the USA relating to vertical alignment may be applicable to temporary road alignments.

The vertical alignment design parameters that are discussed in the context of temporary road design include:

- Grades greater than maximums applying to the permanent alignment may be appropriate for short lengths within road work zones.
- Development of crest curves on the basis of sight distance criteria.

4.5.2 Case Examples

No case studies were identified where design exceptions for the vertical alignment were implemented.

4.5.3 Design opportunities – Vertical Alignment

Based on the information documented in the USA, the following vertical alignment elements may be considered for temporary roadways:

- Grades greater than maximums applying to the permanent alignment may be appropriate for short lengths within road work zones.
- Development of crest curves on the basis of sight distance criteria.

Historically, Transport and Main Roads recognised that for temporary roads sag vertical curves should be designed to at-least the comfort criterion of 0.1 g, if the context is suitable.

4.5.4 Mitigating measures – vertical alignment

No mitigating measures are recommended to address the above design exception opportunities.

4.6 Site Access – deceleration & acceleration lanes

A key element regularly reported to lead to difficulties for temporary road alignments relates to the acceleration and deceleration profiles for vehicles entering and exiting a worksite and the typical requirements for extended lanes to comply with permanent road design standards. Extended lengths of acceleration and deceleration lanes can have a significant impact on both the costs of the construction of the temporary road and on the constructability of the works in constrained sites.

A number of past projects have identified the requirements for deceleration and acceleration lanes as a significant issue where there is little impact on the operation of the through lanes. In many cases it was noted that despite reduced speed limits on the through road, speed compliance was generally low and consequently designers were reluctant to consider reductions. The extended lengths required for these acceleration and deceleration lanes consequently result in high costs and additional traffic impacts in comparison with shorter access and egress arrangements.

4.6.1 National / International guidance – literature review

In considering potential design exception criteria for acceleration and deceleration lanes documented guidance has been reviewed and considered from Austroads and from existing case studies.

4.6.1.1 Australia – National guidance (AGRD)

AGRD04A Section 5.2, notes that *"it is generally accepted that a design based on the performance of trucks would not be cost-effective and that it is generally acceptable for trucks to commence deceleration in the through lane".*

AGRD04A Sections 5.3 and 5.4 notes that *"the speed of heavy vehicles needs to be considered when designing acceleration lanes" and that "it is preferable that the design heavy vehicle has sufficient length to accelerate to a speed no less than 20 km/h below the mean free speed of the through road"*. However it is further noted that it can remain difficult in many permanent situation to provide a sufficient length of acceleration lane to allow truck to accelerate to a sufficient speed.

The difficulty in achieving the required lengths for deceleration of vehicles entering the site and vehicles accelerating as they exit the site is a common issue. Parameters for these auxiliary lanes are however well defined.

4.6.1.2 US guidance

Guidance in the USA recognises the difficulties associated with provision of full length acceleration and deceleration lanes and therefore describes that:

- Entrance ramps – recognises that accelerations lanes in work zones can often not practicably meet design criteria for permanent facilities. "Rule of thumb" practices described include use of a minimum 90 m acceleration lane, or alternatively 70% of the length required for a permanent design. Appropriate traffic control devices are required to mitigate the risks associated with speed differential between entering and through traffic.
- Exit ramps – while it is desirable to meet the criteria for permanent exit ramps, deceleration should be determined based on critical design features. Hence some deceleration may be required on the through road prior to exiting.

4.6.2 Existing case examples

On several projects (Pacific Motorway and Bruce Highway) an acceleration lane and right to left lane merge shorter than that required by the RPDM was approved on the basis of low departing vehicle numbers (only 10 semi-trailer movements per day) and all departing vehicles being unloaded within the site. A VEHSIM analysis for a lightly loaded semi-trailer determined a shorter distance required for these vehicles to accelerate to the required entry speed. Additional mitigation was introduced with the flashing truck warning sign as developed in the supplement to the Queensland MUTCD Part 3.

4.6.3 Design opportunities – deceleration and acceleration lanes

4.6.3.1 Deceleration lanes

Existing Austroads guidance identifies that it is acceptable for decelerating vehicles to begin decelerating while still in the through lane approaching the entry to the deceleration lane.

It is therefore considered that this does not represent a design exception for deceleration lanes into a worksite. However, it represents less than desirable design and the risks associated with site vehicles decelerating prior to entering the deceleration lane include increased potential for crashes:

- Involving vehicles running into the rear of the decelerating site vehicle.
- Involving vehicles side swiping vehicles in the other lane or delineation / barriers on the outside of the lane as drivers manoeuvre to avoid the decelerating site vehicle.
- Should the site vehicle enter the site at a speed too high to stop in sufficient distance within the site.

It is not identified how much it is permissible for site vehicles to slow down prior to entering the deceleration lane but any deceleration lane should aim to be as long as possible to ensure the minimum risks of crashes with through traffic. Other mitigating measures are detailed below.

4.6.3.2 Design opportunities – Acceleration lanes

Existing Austroads guidance identifies that while it is desirable that entering vehicles accelerate to within 20 km/h of the mean free speed, that this is often difficult to achieve for heavy vehicles. Further guidance on acceptable speeds that heavy vehicles achieve is not provided and hence a risk assessment and design exception should be documented for all situations where site vehicles entering the traffic cannot accelerate to the required speed. Where vehicles cannot accelerate to the required speeds, there is an increased potential for crashes:

- Involving vehicles running into the rear of the accelerating site vehicle after it has merged into the through lane.
- In the merge area between the site vehicle and vehicles in the through lane or between the site vehicle and delineation / barriers on the outside of the lane.

Similar to above, it is not identified how much it is permissible for site vehicles to still be accelerating prior to end of the acceleration lane but any lane should aim to be as long as possible to ensure the minimum risks of crashes with through traffic. Other mitigating measures are detailed below.

4.6.4 Mitigating measures – deceleration and acceleration lanes

To consider deceleration or acceleration lanes less than NDD parameters, mitigating measures are required to form part of the assessment for the design exception:

- Speed limit compliance – to ensure that the majority of traffic is travelling at or below the posted speed limit.
- Number of vehicles entering and exiting the site per day – a risk based assessment for sites with only a low number of vehicles may indicate that a full length deceleration and / or acceleration lane is not required.
- Volume of through traffic – will determine the level of interaction between site traffic and through vehicles. At sites where traffic volumes are low and sufficient gaps exist in the traffic stream, the potential for incidents is reduced. It should also be considered if vehicles entering or exiting the site can do so:
  - in low flow conditions, or alternatively
  - if the through road experiences regular congestion at defined periods of the day, it may be safer for site vehicles to enter the site during these periods of congestion when traffic speeds are lower.
- Ability to time site vehicle movements in traffic gaps introduced by traffic control features. At sites where traffic on the approaches is controlled by traffic signals, either at an intersection or temporary roadworks traffic signals, or by manual traffic control, site traffic can be assisted to enter (decelerate into) and exit (accelerate out of) the site during gaps in the traffic stream.
- Ability to assist site vehicles with shadow and tail vehicles (may include truck mounted attenuators) to reduce the speed of through traffic on approach to the site entry / egress. This may take the form of a rolling blockade or a mobile works convoy.
- The loading profile of vehicles exiting the site. Typically, acceleration lanes designed for truck entry speeds are based on the acceleration profile for fully laden trucks. However, where heavy vehicles are delivering materials to a site, they will then typically be departing with little or no load. In these circumstances, the vehicles typically can accelerate at rates faster than those used in the calculation of acceleration lane lengths. Use of VEHSIM or similar tools can be used to establish more realistic acceleration profiles which may support the proposed design exception.
- The use of active warning signs on the approaches to the site entry and exit that are triggered either automatically or manually as vehicles are accessing the site. Sign TC2063 was previously developed by Transport and Main Roads for this purpose.

Figure 4.6.4 – Transport and Main Roads TC Sign 2063

4.7 Temporary Road Safety Barrier Warrants

Temporary road safety barriers are regularly used at many sites, particularly those in place for longer periods of time. However, the use of temporary road safety barriers for shorter term works (weeks instead of months) or for sites where the works move progressively along the length of the road such as in pavement reconstruction on rural roads, can lead to issues in both the costs of the construction of the temporary road and on the constructability of the works in constrained sites. Transport and Main Roads project managers identified that the requirements for road safety barriers can be onerous and can result in large cross section widths allowing for offset from the face of the barrier, barrier width and deflection zones.

It has been identified that there is relatively little guidance relating to temporary road safety barriers other than the material currently contained within the Queensland MUTCD Part 3.

4.7.1 National / International guidance – literature review

In considering potential design exception criteria for temporary road safety barriers adjacent to temporary roads documented Transport and Main Roads (existing guidelines and the adopted *Austroads Guide to Road Design*) guidance for permanent road safety barriers and case examples are presented from projects in Queensland.

4.7.1.1 Queensland

Requirements for temporary road safety barriers within the department's Queensland MUTCD Part 3 typically require barriers for the following situations:

- to provide a physical barrier between the travelled path and the work area, and/or
- between traffic and a severe hazard such as a deep excavation, a bridge pier or a hazardous stockpile, and/or
- for the protection of workers and non-vehicular road users in vulnerable situations, and/or
- to separate opposing traffic.

The Queensland MUTCD Part 3 requirements for the protection of excavations were originally developed by Main Roads WA in 2001 in response to a request for guidance on the matter from industry as water filled and other temporary road safety barrier systems became more commonplace. The guidance was developed as interim guidance only and was intended to be reviewed following a 12-24 month period following application by industry. This research review was not completed due to competing priorities and the guidance was subsequently adopted in AS 1742.3 (2002) and the subsequent Queensland MUTCD Part 3 and has remained unchanged since. This guidance from Table E1 in the Queensland MUTCD Part 3 is reproduced in Table 4.7.2.2.

Table 4.7.1.1 – Queensland MUTCD Part 3 - Protection / delineation adjacent to excavations

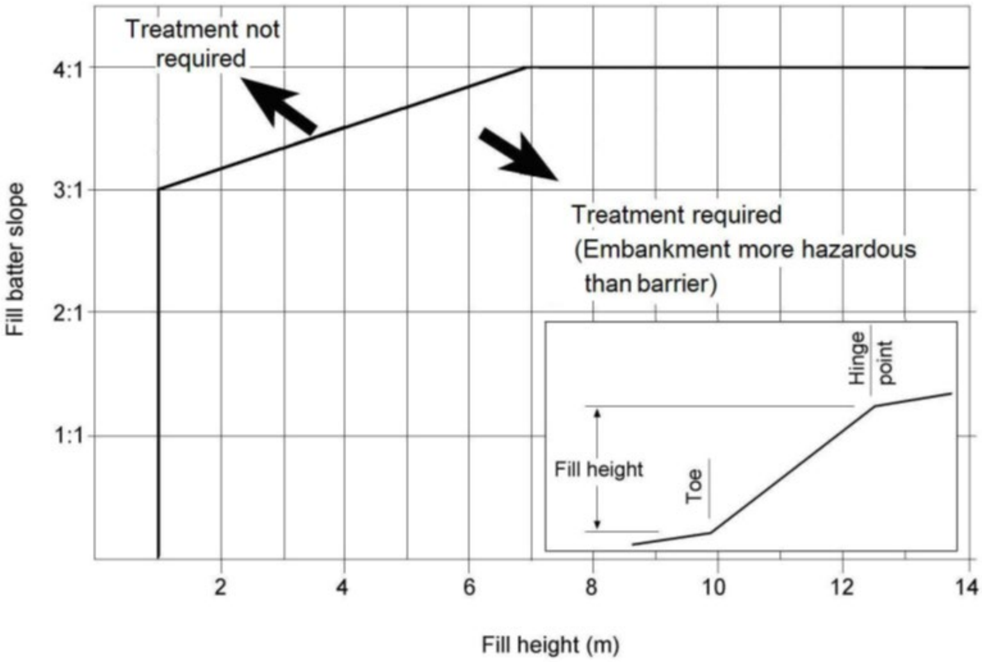
Speed of traffic km/h	Traffic volume vpd	Clearance to excavation m	Depth of excavation, mm		
			50 to 250	> 250 to 500	> 500
< 70	All	< 2.5	Standard delineation	Close delineation	Safety barrier
		2.5 to 5.0	Standard delineation	Standard delineation	Close delineation
		> 5.0	None	None	None
≥ 70	≤ 1500	≤ 5.0	Standard delineation	Close delineation	Safety barrier
		> 5.0	None	None	None
	> 1500	≤ 6.0	Standard delineation	Close delineation	Safety barrier
		> 6.0	None	None	None

It is noted from this guidance that any excavation of more than 500 mm in depth therefore requires protection with a temporary road safety barrier when the traffic volume and separation requirements dictate.

4.7.1.2 Australia – National guidance (AGRD)

To assist in consideration of options for temporary road safety barrier warrants, the existing guidance for the lateral location of permanent road safety barriers as detailed in AGRD06 should be considered. AGRD06 describes that protection of a 1.0 m high embankment with a road safety barrier introduces more hazards than the unprotected excavation as detailed in Figure 4.7.1.2.

Figure 4.7.1.2 – AGRD06 - Embankment warrant for intermediate-speed and high-speed roads



For excavations between 500 mm and 1.0 m in depth therefore, the requirements for road safety barriers for the protection requirements of a temporary alignment appear more onerous than for a permanent situation.

4.7.1.3 US

Roadside safety needs to consider the risks associated with any hazardous features and the benefit cost assessment for each of the proposed treatment options. Factors considered for determining roadside protection include:

- duration of construction activity
- traffic volumes
- nature of hazard
- length and depth of drop-offs
- work zone design speed
- length of hazard
- proximity of traffic to construction workers and equipment, and
- adverse geometrics.

A risk assessment process is recommended for assessment of proposed treatment options which may result in a lower level of protection compared with permanent roadside features.

Barrier offset - A range of design scenarios are also presented for shoulder or lane closure which depicts barriers located at the edge of the 3.6 m wide lane with no offset. It is noted that the AASHTO Roadside Design Guide indicates that the minimum desirable offset from the edge of the travel lane to the temporary concrete barrier is 0.6 m, but that a number of agencies use lower minimum values.

4.7.2 Case Examples

On the Bruce Highway Benaraby to Calliope River, pavement subgrade reconstruction required a section of the existing pavement to be boxed out to a depth of 900 mm for parts of the project. Given the proximity of these works to traffic, and the posted 60 km/h limit, compliance with the MUTCD required temporary road safety barriers for any excavation of more than 500 mm vertical depth within 2.5 metres of the nearest lane of traffic. The cross-section requirements allowing for barrier width and offset from the face of the barrier would have required that traffic be reduced to a single lane with reversible traffic flow for the duration that the excavation was open.

In comparison it was noted that the requirements for a permanent road safety barrier as outlined in AGRD06 identifies that the relative severity of the embankment versus a w-beam barrier and consequently for vertical drops of 1 m or less, the presence of the road safety barrier results in larger overall safety risks compared to the unprotected drop off.

Hence, by applying permanent barrier guidelines, a significant reduction in works cross section was required enabling two way traffic flow to be maintained for the duration of the works. This in turn reduced the risks associated with end-of-queue collisions associated with operating shuttle traffic flow for the duration of the works.

Other project managers also identified issues with the current guidelines as applied in the design of temporary roads. In many cases it was reported that the requirements for the design of the temporary alignment exceeded the standards of the existing road alignment that was being reconstructed. In addition to being onerous to apply this was also reported as resulting in difficulties in achieving speed compliance through the work site.

4.7.3 Design Exception opportunities – temporary road safety barriers

Barriers are often specified at long term sites for the separation of the work site and workers from adjacent traffic. In highly constrained urban environments, it is considered unlikely that these requirements will change.

However, barriers are also required in the MUTCD to protect short term hazards, and most explicitly excavations as outlined in Appendix E of the Queensland MUTCD Part 3. For excavations that may only be open for short duration of time, these requirements can create additional costs for the works, and also increase the cross-sectional width required to maintain traffic and separate the worksite from the nearest lane of traffic.

A design exception in this case therefore involves a design which does not include a temporary road safety barrier in accordance with the Queensland MUTCD Part 3. As has been approved in a past case example, a design exception was developed on the basis that the warrants for barriers next to shallow excavations, less than 1.0 m, appear to be more onerous than the requirements for permanent road design.

On this basis it may be considered that the following design exception may be considered to Table E1 in Appendix E of the Queensland MUTCD Part 3.

It is considered that the requirements for barriers could be modified to align with the requirements for permanent road barriers as detailed in Table 4.7.3.

Table 4.7.3 – Design Exception to Table E1 of the Queensland MUTCD Part 3

Speed of traffic km/h	**Traffic volume vpd**	**Clearance to excavation m**	**Depth of excavation, mm**			
			50 to 250	**> 250 to 500**	**> 500 to 1000**	**> 1000**
< 70	All	< 2.5	Standard delineation	Close delineation	Close delineation	Safety barrier
		2.5 to 5.0	Standard delineation	Standard delineation	Close delineation	Close delineation
		> 5.0	None	None	None	None
≥ 70	≤ 1500	5.0	Standard delineation	Close delineation	Close delineation	Safety barrier
		> 5.0	None	None	None	None
	> 1500	≤ 6.0	Standard delineation	Close delineation	Close delineation	Safety barrier
		> 6.0	None	None	None	None

Note –Warrant requirements remain unchanged for excavations shallower than 500 mm.

4.7.4 Mitigating measures – temporary road safety barriers

A design exception may also be considered for situations where either these modified warrants are met or where not using barriers could be suitable on the basis of a risk assessment considering:

- Duration of exposure – an excavation which is only open for a short period of time (eg a few days).
- The length of excavation – a short length excavation may pose less of a risk than the placement of a barrier adjacent to traffic. In particular, excavations which run perpendicular to the direction of traffic (e.g. a trench for services crossing the road reserve) may only have an exposed length of 1.0 m to traffic.
- The depth of excavation and ability to trap or overturn a vehicle.
- The ability to protect the excavation through other means (e.g. road plates).
- Speed limit compliance – to ensure that the majority of traffic is travelling at or below the posted speed limit.
- The angle of approach of traffic – an excavation located opposite right hand bend may be directly in the path of approaching vehicles, while an excavation on the inside of a left hand curve may have relatively little direct exposure.
- Lighting of the alignment – to ensure that drivers can see the trench and any delineation devices.

4.8 Turn treatment warrants for unsignalised intersections with short periods of higher traffic volumes

Intersections in regional areas across Queensland are at times subject to a limited period of heavier traffic due to construction or mining activities. During these periods the traffic volumes may be substantially higher than the base traffic conditions. However, in many cases it is not considered appropriate to upgrade the intersection just for the short period of high use.

Sullivan & Arndt (2014) used a balanced design life assessment of the Crash Reduction potential of the upgraded intersection treatment, to develop a set of warrants for a shorter period of high turn volumes. The resultant warrants for these situations are presented in Figures 4.8(a) to 4.8(c) and describe the boundary between a BAR/BAL and a CHR(s)/AUL(s) intersection type.

Figure 4.8(a) – Warrant Analysis for short term high volume use of intersection – High Speed

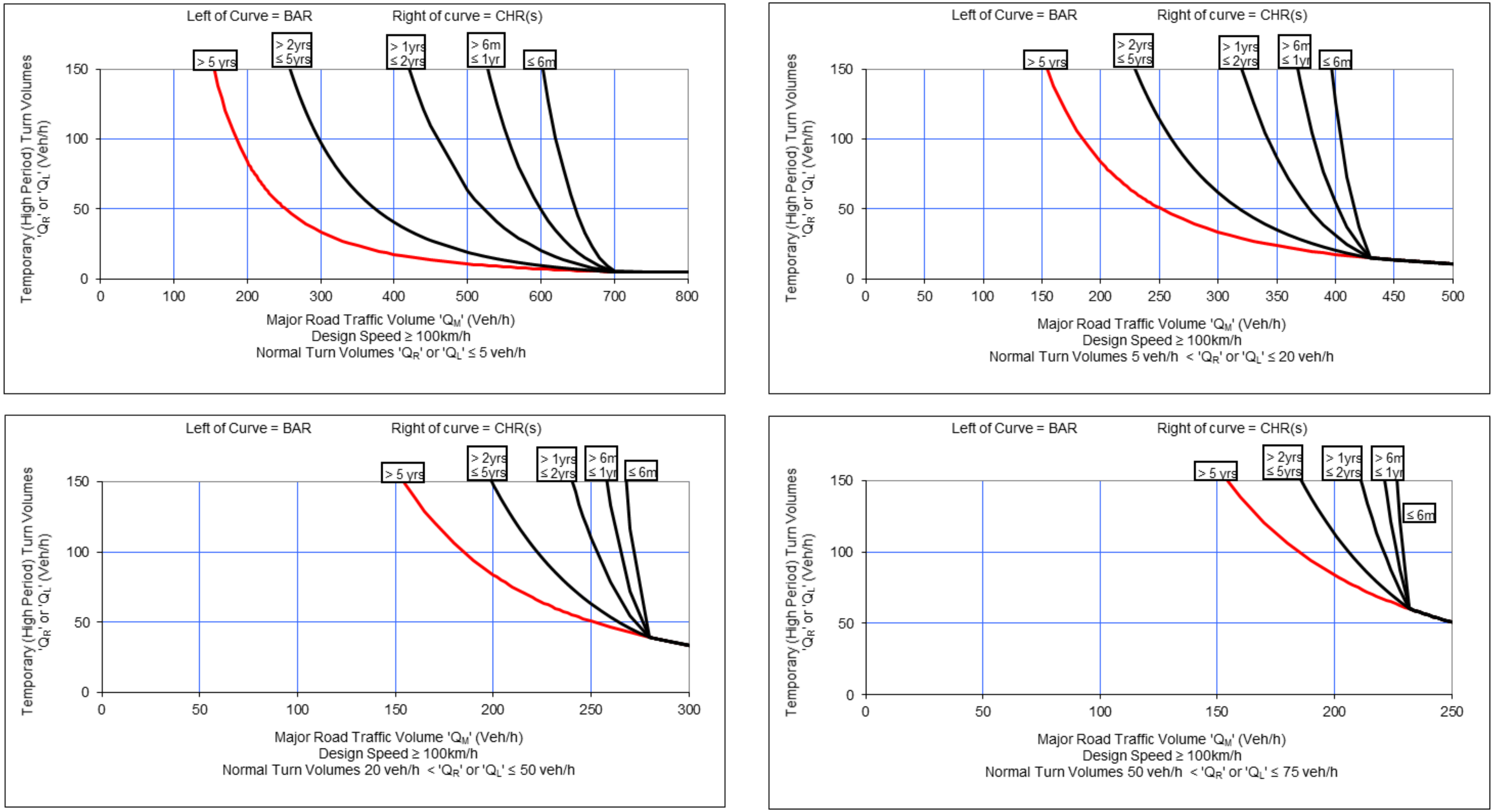


Figure 4.8(b) – Warrant Analysis for short term high volume use of intersection – Mid Speed

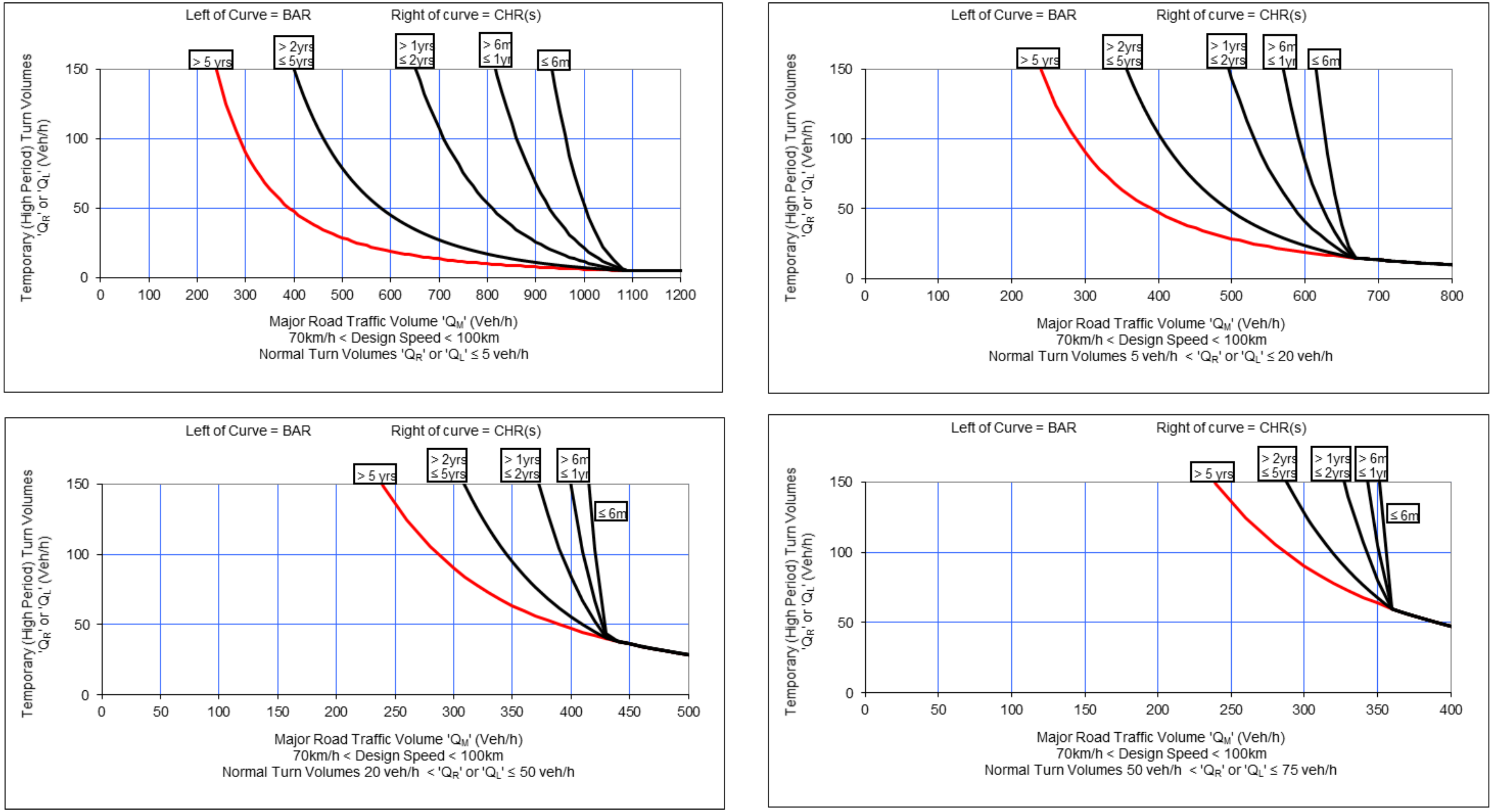
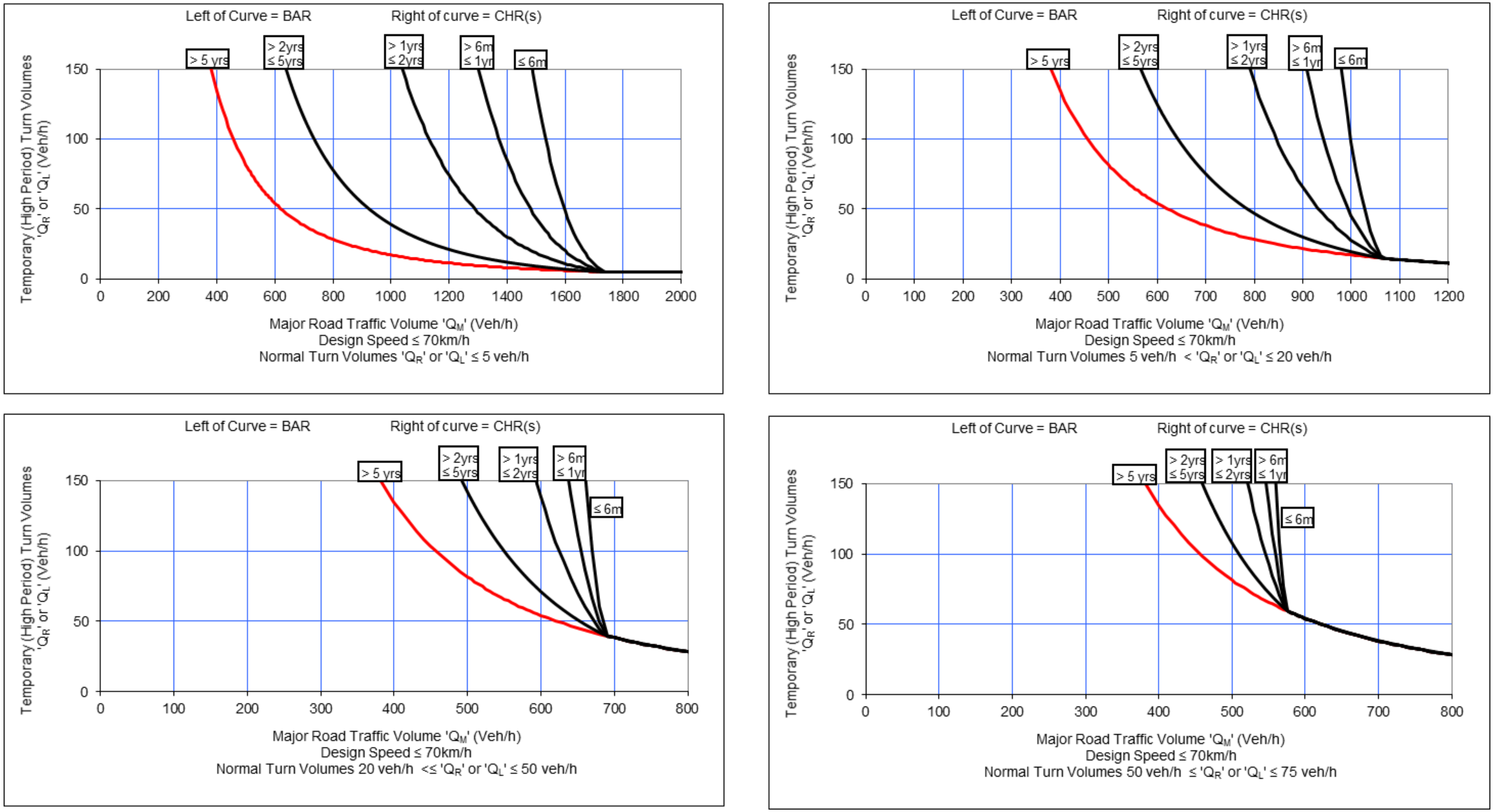


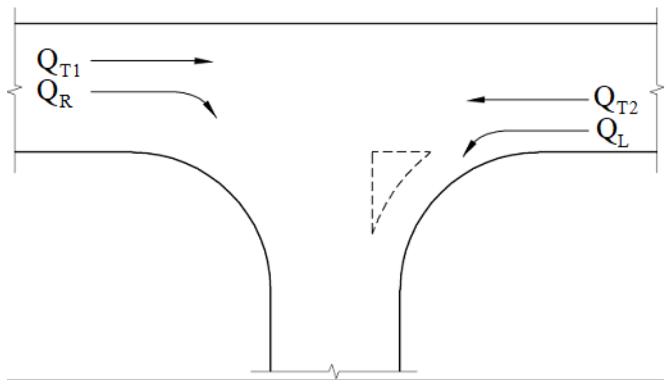
Figure 4.8(c) – Warrant Analysis for short term high volume use of intersection – Low Speed



The following notes apply to Figures 4.8(a) to 4.8(c):

1. The warrants apply to 2-lane, 2-way roads only.
2. The warrants apply to turning movements from the major road only (the road with priority). For turns from the minor road, turn treatments are determined through an operational performance evaluation applying gap acceptance analysis and an evaluation of acceptable delays and queues.
3. Figure 4.8(d) is to be used to calculate the value of the major road traffic volume parameter (QM) and is the total through traffic flow in both directions (QT1 + QT2).
4. Traffic flows applicable to the warrants are peak hour flows, with each vehicle counted as one unit (i.e. do not use equivalent passenger car units [pcus]). Where peak hour volumes or peak hour percentages are not available, assume that the design peak hour volume equals.
5. Transport and Main Roads – 15% of the AADT for 500 hours each year, use 5% of the AADT for the rest of the year.
6. Austroads – 8% to 10% of the AADT for urban situations and 11% to 16% of AADT for rural situations.
7. If a turn is associated with other geometric minima, consideration should be given to the adoption of a turn treatment of a higher order than that indicated by the warrants.
8. Consideration must also be given to the operational performance of the intersection which may require a higher-level turn treatment, or alternative intersection control, particularly for higher traffic volumes.

Figure 4.8(d) – Calculation of the Major Road traffic Volume Parameter 'Q_M'



Turn Type	Splitter Island	Q_M (veh/h)
Right	No	$= Q_{T1} + Q_{T2} + Q_L$
	Yes	$= Q_{T1} + Q_{T2}$
Left	Yes / No	$= Q_{T2}$

4.9 Drainage

Temporary roads are typically required for durations of less than 12 months. Recommendations for drainage design in Western Australian and the US both allow use of a storm event frequency of 1 in 2 years for temporary roads in use for periods of less than 12 months.

The guidance in Western Australia further states that in situations for temporary alignments in place for up to twelve months the following guidelines shall apply to temporary drainage systems:

- Where culverts are provided for drainage they shall be designed for an Annual Exceedance Probability (AEP) of 39%.
- Spread limits; Retain the widths accepted by the jurisdiction with the AEP event being 39% rather than 10%.
- Underground piped network system being designed for an AEP 39% event.
- Check on failure mechanisms and impacts on property damage. A risk assessment should be undertaken to determine the consequences for the temporary road and surrounding environment should the design event be exceeded (extreme event), and measures implemented to mitigate any unacceptable risks. Furthermore a risk assessment of any additional hydraulic impacts due to the temporary road/works should also be undertaken and evaluated against the likelihood of occurrence for the period the temporary road/works are in place.

Guidance in the US also suggests the use of an AEP 39% design frequency for temporary drainage facilities for a temporary roadway in use for less than one year and an AEP 18% design frequency for a road in use for more than a year.

5 Summary – design exception opportunities

Table 5 – Design exception opportunities and mitigating measures

<table>
<tr><th>Design Parameter</th><th colspan="2">Design Exception Opportunity</th><th>Mitigating measures</th></tr>
<tr><td rowspan="2">Cross section (Section 4.1)</td><td>Two lane two way roads</td><td>• Reduced lane widths and edge clearance - potential cross section reduction of 0.2 m to 0.6 m.</td><td>• Signs:
– narrow shoulders
– speed detection and display.
• Road lighting
• Driver behaviour surveillance
• Speed enforcement
• Site surveillance and incident recording</td></tr>
<tr><td>Two lane one way carriageway</td><td>• Narrow right lane with larger vehicles restricted to the left lane – potential cross section reduction of 0.45 m to 0.75 m for each carriageway</td><td>• In addition to the measures above, regulatory signage to restrict larger vehicles to using the left lane only</td></tr>
<tr><td>Sight distance (Section 4.2)</td><td colspan="2">• Combined use of:
– Deceleration parameter D = 0.46
– Reduced driver reaction time of 1.5 s
– Increased object height = 0.8/1.25 m
• Resultant reduced sight distance requirement of approximately 24%</td><td>• Speed enforcement/ compliance
• Lighting
• Variable speed limits based on weather conditions
• Ongoing incident monitoring and debris removal
• Variable message signs
• High skid resistance pavement
• Removal of anti-gawk screens on the insides of curves</td></tr>
</table>

Design Parameter	Design Exception Opportunity	Mitigating measures
Coordination of horizontal and vertical alignment (Section 4.3)	• Aesthetic considerations for horizontal and vertical alignment may not need to be observed	• Speed enforcement / compliance • Lighting • Alignment markers • Arrow boards or variable message signs • Delineation devices such as bollards and temporary road safety barriers • Ongoing monitoring
Horizontal alignment (Section 4.4)	• Compound curves, broken back curves and reverse curves may be acceptable • Absolute maximum side friction values for cars not meeting heavy vehicle requirements • Adverse crossfall may be acceptable	• Speed enforcement / compliance • Reduced speed limit for larger vehicles • Additional warning signage to alert heavy vehicle drivers to the appropriate warning speed
Vertical alignment (Section 4.5)	• Grades greater than maximums for short lengths within road works. • Development of sag curves, on the basis of sight distance criteria without meeting comfort criteria	Nil identified
Acceleration / deceleration lanes (Section 4.6)	• Deceleration lanes – allow increased speed reduction prior to entry of deceleration lane	• Speed enforcement / compliance • Risk based approach considering number of site vehicles and volume of through traffic • Timing of site vehicle movements in traffic gaps introduced by traffic control features • Ability to assist site vehicles with shadow and tail vehicles • Risk based approach considering actual vehicle loads • Active warning signs
	• Acceleration lanes: – Assessment of vehicle speeds based on empty loads – Allow lower entry speed based on lower entry volumes compared with normal entry ramps	
Road Safety Barriers (Section 4.7)	• Risk based approach to remove barrier requirements • Application of permanent road risk considerations for temporary barriers	• Risk based approach – Duration of works – Length of exposure to traffic – Depth of excavation – Angle of approach – Lighting of alignment • Other protection methods (eg road plates after hours) • Increased delineation devices • Lighting

6 References

1. AASHTO (2011). *A Policy on Geometric Design of Highways and Streets*. The American Association of State Highway and Transportation Officials, AASHTO Green Book, Washington DC.
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