Technical Note TN205

Use of extended design domain for the lateral placement of road safety barriers

June 2023

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Feedback

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Contents

1 Background

This Technical Note is intended to provide guidance for the lateral placement of road safety barriers in both greenfield and brownfield sites / retrofit projects.

Specifically, guidance is provided for projects in constrained corridors, where accommodating the full design deflection width, along with other design aspects, is not possible without further widening the shoulder/verge.

This Technical Note provides clarification regarding the definition of the Normal Design Domains (NDD) and Extended Design Domains (EDD) for the lateral placement of the road safety barrier with respect to the hinge point, and key considerations when applying this EDD.

1.1 Related documents

The documents listed in Table 1.1 provide further information to that contained in this Technical Note.

Table 1.1 – Related documents

Publisher	Document Title
Department of Transport and Main Roads	*Accepted Road Safety Barrier Systems and Devices*
Department of Transport and Main Roads	*Road Planning and Design Manual 2nd Edition*, Volume 3 Supplement to Austroads Guide to Road Design*:* • *Part 1: Objectives of Road Design,* and • *Part 6: Roadside Design, Safety and Barriers*

This Technical Note is complimentary to the documents listed above. However, if there are any overlaps or conflicts, this Technical Note takes precedence.

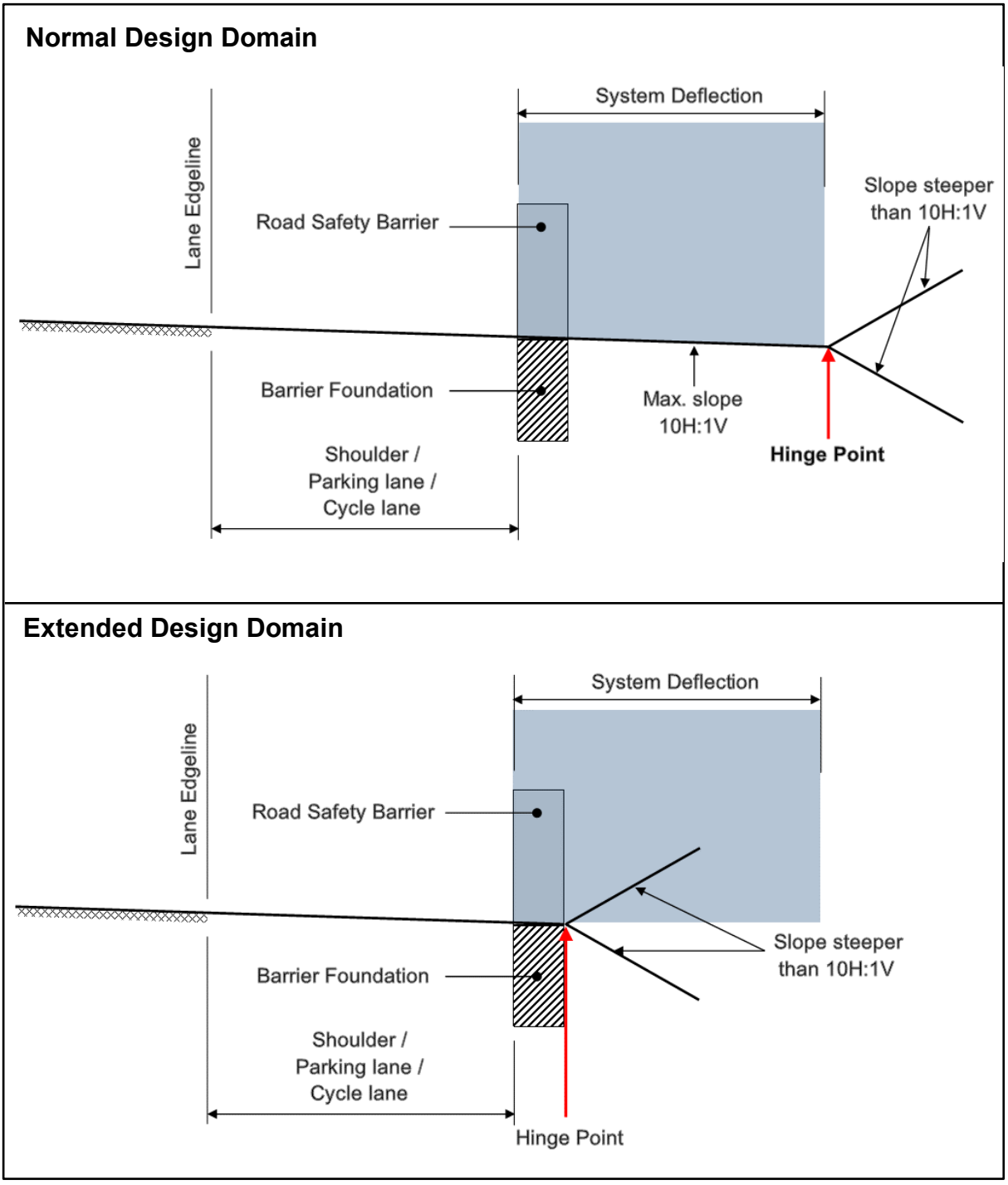
2 Normal Design Domain vs. Extended Design Domain

The difference between NDD and EDD for the lateral placement of road safety barriers is shown in Figure 2.

The NDD for the lateral placement of road safety barriers is achieved when the hinge point is located outside of the deflection width of the road safety barrier.

EDD applies when the hinge point is located within the deflection width, of the road safety barrier. This can include situations where the safety barrier is located on the hinge point, subject to supplier's minimum offset requirement.

Figure 2 – NDD and EDD for the lateral placement of a road safety barrier systems



2.1 Use of EDD on the state-controlled road network

Funding for projects that are scoped for the installation of road safety treatments are often focussed on delivering optimally targeted, value-for-money engineering treatments that contribute to the ongoing reduction of road trauma on the state-controlled road network. Therefore, in instances where in the standard (under NDD) lateral placement of the road safety barrier treatment cannot be achieved, consideration of locating the barrier to meet the Extended Design Domain (EDD) may still provide some safety benefits.

Some proprietary products are endorsed by their suppliers to be installed in close proximity to, or on a hinge point, within the EDD requirements of the road authority.

When considering the application of EDD to the lateral placement of road safety barrier treatments, the following should be undertaken:

- Select a barrier product from the Department of Transport and Main Roads' Accepted Road Safety Barrier Systems and Devices document.
- Locate the product specific restrictions relevant to installing the product close to or on the hinge point. This information is often included in the product manual, published by the supplier. At the time of publishing this Technical Note, the example products listed below were available and endorsed by their supplier for installation close to or on the batter hinge point. Requirements relating to the use of this EDD have been replicated to demonstrate how each product differs from each other. Please refer to the most recent supplier information when considering one of these products for your project.
- Consider the manufacturer's product specific requirements in conjunction with the design considerations noted in Section 2.2.

Example Products – Manufacturer's minimum offset to hinge point requirements.

The product details listed below have been provided to demonstrate the varying conditions in which w-beam products (as an example) are endorsed for installation close to or on the hinge point. When designing for road safety barrier, please ensure you refer to current versions of the department's Accepted Road Safety Barrier Systems and Devices document and product information provided by the accepted supplier.

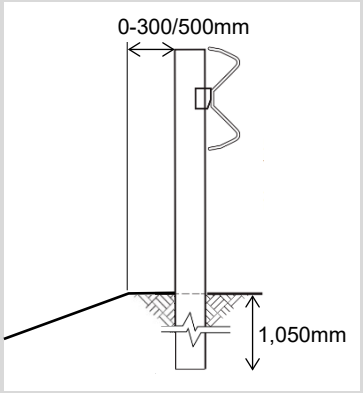
Ezy-Guard Smart

Tested for *Manual for Assessing Safety Hardware* (MASH) TL-3, with posts installed on hinge point of a 2H:1V batter.

Longer 1,050 mm post embedment required, when posts are installed:

within 300 mm of the hinge point in standard soils; and

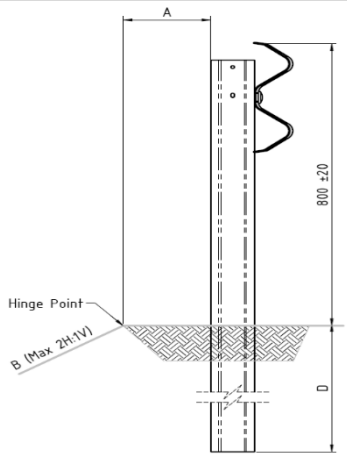
within 500 mm of the hinge point in weak soils.



Please contact Ingal Civil (www.ingalcivil.com.au) for current product advice.

Ramshield W-Beam

Endorses installation close to the hinge for the following post depth, soil strength and post spacing arrangements:

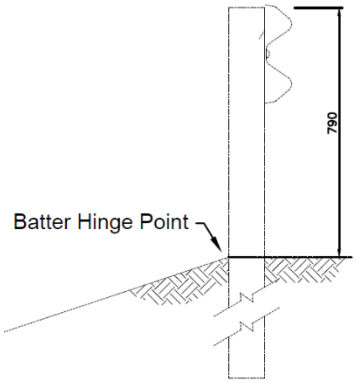


A	B	D	Post Spacing
≥ 200 mm	2H:1V Standard Soil	810 mm	2000 mm
≥ 200 mm < 400 mm	2H:1V Weak Soil	1110 mm	2000 mm
< 200 mm	2H:1V	1110 mm	1000 mm

Please contact Safe Direction (www.safedirection.com.au) for current product advice.

Sentry Barrier W-Beam

Endorsed for installation close to and on the hinge point, depending on the soil type and rate of the batter slope. Refer to the diagram below.



Minimum setback from hinge point	Batter Condition
0 mm	< 6H:1V
0 mm	≥ 6H:1V < 3H:1V AASHTO standard soil strength or greater
300mm	≥ 6H:1V < 3H:1V sub optimal soil conditions
200 mm	≥ 3H:1V < 2H:1V AASHTO standard soil strength or greater
400mm	≥ 3H:1V < 2H:1V sub optimal soil conditions

Note: Longer 2100mm posts required when installed on hinge point of 2H:1V batters and in weak soils.

Please contact ACP (www.acprod.com.au) for current product advice.

2.2 Key considerations

Key considerations when designing for the lateral placement of road safety barrier treatments close to the hinge-point include:

- Foundation stability – Irregular soil conditions or material that forms the existing shoulder or slope could have an impact on the effectiveness of the foundation design and subsequently the barrier itself. An integrity of post foundation due to proximity to hinge point and a risk of slope erosions over time should be considered.

- Design deflection – When barriers are installed at the hinge point, the deflection will be a function of the lateral restraint of the posts. If the system does not supply the required lateral restraint, then the deflection will be increased. Consideration should be given to any significant fixed hazards such as electrical cabinets, poles etc in proximity to barriers.
- Containment level – Unless specifically tested for the instance when the barrier is located on (or near) the hinge point, it is likely that the standard MASH Test Level (NDD installation) will not be achieved.
- TL-4 barriers - Even though installing a TL-4 system under EDD conditions will likely result in a diminished redirective capacity, the resultant redirective capacity would likely be greater than what a TL-3 system provides in the same conditions. Furthermore, the higher rail height of a TL-4 steel-beam barrier, could provide greater stability for high-centre-of-gravity and are potentially less prone to vehicles under-riding the system.
- Post Depth – Many proprietary products recommend a longer post depth when locating their barrier product close to or on the hinge point. It recommended that when longer posts are installed, that these locations are clearly identified to the District's Maintenance team.
- Safety in Design - Maintenance of the barrier and the area behind the barrier may be difficult and could affect the timeframes for repairs to damaged guardrail.
- Embankment condition post-impact – Installing the barrier posts close to the embankment increases the possibility that the embankment slope will be damaged on impact and will be more difficult to repair. Hence, every effort should be made to install barrier further away from hinge point if the site conditions allow.

3 Documentation requirements

Where EDD is sought, the standard EDD process outlined in *Road Planning and Design Manual 2nd Edition* Volume 3 Part 1: *Objectives of Road Design* should be followed. Use of any EDD needs to be documented and included in the project design development report, including considerations and associated risk assessments undertaken in the decision-making process.

A hypothetical case study is provided in Appendix A. The case study demonstrates how the Extended Design Domain (EDD) can be applied to the lateral location of road safety barriers and the hinge point of a batter. An example EDD report is also included.

Whilst the product manufacturers provide the opportunity to apply EDD in constraint locations, practitioners should be mindful of local sites conditions over and above the key considerations provided in Section 2.2 above.

Appendix A – Case study – Beenleigh - Redland Bay Road [*108*]

This case study has been prepared to demonstrate how the Extended Design Domain (EDD) can be applied to the lateral location of road safety barriers and the hinge point of a batter.

To achieve this, a hypothetical scenario has been created to an existing intersection on the State controlled road network.

Details and figures regarding the intersection have been provided to create some context.

Background

This case study is focussed on the Beenleigh - Redland Bay Road [*108*] (Redland Bay Road) / Riedel Road priority-controlled t-intersection, located in Carbrook. General details of the Beenleigh - Redland Bay Road [108] and the case study location are summarised in Table A1.

Table A1 – General details of Beenleigh – Redland Bay Road [108]

Road	Beenleigh – Redland Bay Road [108]	**Local Name:**	Redland Bay Road
	Posted speed limit		80 km/hr
	Lane configuration		two-lane / two-way undivided rural road
	Terrain		flat to hilly terrain
	Horizontal road alignment		typically, straight with large radius curves
	AADT		approx. 5,000 vehicles per day (vpd) (both directions)
	Heavy Vehicle %		≤10% (both directions)
Location	Redland Bay Road / Riedel Road intersection, Carbrook		
Project T-Dist	10.04 km to 10.35 km		

Base Case intersection arrangement

At project inception, the intersection arrangement, as shown in Figure A1, included:

- a basic t-intersection arrangement, with no dedicated turn lane facilities
- lane widths of approximately 3.3 m wide
- shoulder widths varying from 1.0 m to 1.5 m
- short section of road safety barrier, installed on the southern side of Redland Bay Road, east of Riedel Road.

Figure A1 – Features of the Redland Bay Road / Riedel Road intersection, Carbrook

The following additional aspects of the project area are also relevant for the purposes of this case study:

- Riedel Road intersects with Redland Bay Road on the outside of a significant horizontal curve.
- Beenleigh-Redland Bay Road is a Priority Cycle Route. In accordance with the *Cycling Infrastructure Policy* 2017, cycling infrastructure in the form of a 2 m wide shared shoulder / cycle lane is desirable.
- The surrounding hilly terrain results in the land falling away from the southern side of Redland Bay Road and the Riedel Road approach to the intersection being at an incline.
- The southern edge of pavement on Redland Bay Road is located approx. 7.5 m from the property boundary, whilst Riedel Road is located approximately 2.5 m from the property boundary. As these narrow points were located at the intersection, opportunities to flatten out batters to safer grades without resuming land are not considered a practical option.

Project details

There is approved planning and construction of a new public boat ramp and floating walkway on Riedel Road, which is expected to increase the volume of car and trailer combinations turning into and out of Riedel Road. Furthermore, significant residential growth in Redland Bay was forecasted to occur within the next 10 years.

As a result of these changes to the traffic conditions, the following improvements to the Redland Bay Road / Riedel Road have been identified:

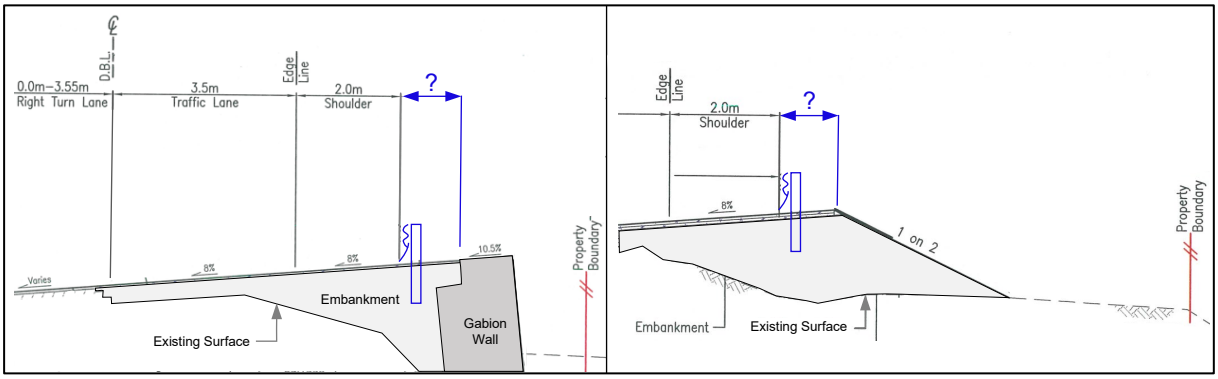
- Installation of a dedicated right turn lane for vehicles turning right from Redland Bay Road onto Riedel Road.
- Modification of the Riedel Road connection to improve the drivability of the intersection for car + trailer combinations that are negotiating the turns at the intersection.
- Improved cyclist infrastructure at the intersection to improve rider safety at the intersection.

Road Safety Barrier Design

The Risk Evaluation Process as detailed in Transport and Main Roads' *Road Planning & Design Manual – 2nd Edition*: Volume 3 Supplement to *Austroads Guide to Road Design* Part 6: *Roadside Design, Safety and Barriers* has been followed. This process identified that the installation of road safety barrier along the southern side of Redland Bay Road was necessary to mitigate the risks associated with roadside hazards. These hazards include a lack of recoverable slopes within the road reserve, and large trees within the corridor and adjacent private properties.

Widening of the road formation is already required to accommodate the additional turning lane width and widened shoulders. In addition, the project designers are required to determine the width of the verge that would accommodate the road safety barrier, either under Normal Design Domain (NDD) or EDD. Subsequently, as shown in Figure A2, the width of verge will form part of the overall formation widening required at the intersection.

Figure A2 – Typical road safety barrier placement at locations with steep batter slopes



NDD and EDD options

With regards to the lateral placement the NDD and EDD are defined as follows:

- NDD – when the hinge point is located outside of the deflection width of the road safety barrier.
- EDD - when the hinge point is located within the deflection width of the road safety barrier

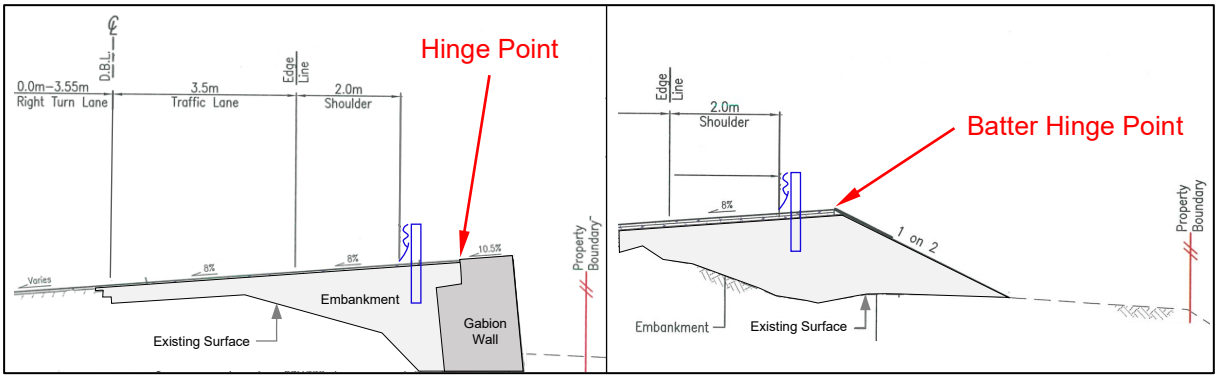
Refer to RPDM Part 6 and this Technical Note for further clarity on NDD and EDD for the lateral placement of road safety barriers.

For the purposes of this case study, the hinge point for both the gabion wall and the unrecoverable batter slope locations have been identified in Figure A3.

As a gabion wall is often designed to provide support to an embankment, it may not be able to support the dynamic forces experienced by an errant vehicle impacting the barrier. As a result, the gabion wall has not been considered part of the verge width in this case study.

It is recommended that in these situations, advice from an appropriately qualified engineer be sought prior to assuming the location of the hinge.

Figure A3 – Hinge point locations



Key considerations

In this case study, the following aspects of the design are considered relevant in determining how an EDD option compares with a NDD option.

Cost considerations

MASH tested, proprietary supplied road safety barriers that are accepted for installation on State-controlled roads are listed in the department's Accepted Road Safety Barrier Systems and Devices document. At the time of publishing this Technical Note, accepted MASH tested steel beam road safety barriers have deflection widths that range from 0.8 m to 1.65 m when tested under normal MASH conditions.

In this situation, the additional road formation required to accommodate road safety barrier could be significantly reduced if designed under EDD, as demonstrated in Table A2.

Table A2 – Offset comparison

Design Domain	Distance from face of barrier to the hinge point	Verge Width
NDD	Design Deflection of the barrier product 0.8 m to 1.65 m	1.16 m to 1.65 m
EDD	Less than design deflection, and Minimum proximity to the hinge point from back of the post recommended by the product supplier is met, that is,0 m to 0.4 m	0 m to 0.4 m plus system width and any traffic offset

Barrier design and performance considerations

It should be noted that moving the barrier closer to the hinge point, where the lateral placement of the barrier falls under EDD there is:

- increased risk of the barrier failing if its lateral support is insufficient
- reduced ease for the maintenance crews to inspect and reconstruct the barrier
- increased risk that the vehicle will become unstable on the shoulder or has a more unstable redirection, and
- increased possibility that the embankment slope will be damaged on impact and will be more difficult to repair.

Other design considerations

Road corridor and PUP impacts

Due to the proximity of the adjacent property boundaries to the intersection, the ability to widen the verge to accommodate NDD for the lateral placement of the road safety barrier, may not be achieved without resuming land and relocating an existing telecommunications line. If required, the project would likely incur a significant increase in project costs and project delivery timeframes.

Environmental

The project site has a number of environmental overlays, including multiple matters of state environmental significance (MSES) and koala habitat related overlays.

Any widening of the existing road formation may trigger the need for additional environmental review, reporting, permits and mitigation measures.

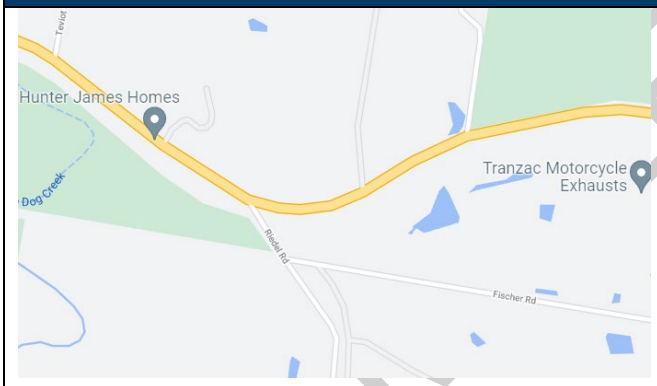
Appendix B – Example EDD Report

If an EDD option is chosen, sufficient justification to support the EDD option needs to be documented in the report. The EDD report should provide sufficient information for the Road Authority's delegate to be comfortable in taking on any additional risk associated with each application of the EDD to the design.

An example EDD report has been prepared on the following pages based on the case study in Appendix A, where EDD for the lateral placement of road safety barrier has been chosen.

Basic information

Road:	Beenleigh – Redland Bay Road [108]	**Local Name:**	Redland Bay Road
	Posted speed limit	80 km/hr	
	Lane configuration	two-lane / two-way undivided rural road	
	Terrain	flat to hilly terrain	
	Horizontal road alignment	typically, straight with large radius curves	
	AADT	approx. 5,000 vpd (both directions)	
	Heavy Vehicle %	≤10% (both directions)	
Location	Redland Bay Road / Riedel Road intersection, Carbrook		
Project T-Dist	10.04 km to 10.35 km		

Job Number	**Road**	**Report No.**
XXX-XXX-XXXXX	Beenleigh - Redland Bay Road [108]	001
Location		
Intersection of Beenleigh - Redland Bay Road [108] and Riedel Road, Carbrook		
Locality Map	**Chainages**	
	10.04 km to 10.35 km	

Posted Speed	**V85 Speed**	**AADT**	**Projected AADT**	**% HV**
80 km/h	90 km/h	5,000 vpd	5500 vpd over 10 years	≤10% (both directions)

Design Class	
	Justification
☐ A	
☒ B	Project includes significant widening of the road formation, including shoulder widening.
☐ C	
☐ D	

Work Description

The installation of road safety barrier along the southern side of Redland Bay Road has been identified, in accordance with the Hazard Mitigation Process as detailed in the department's *Road Planning & Design Manual – 2nd Edition*: Volume 3 Supplement to Austroads *Guide to Road Design* Part 6: *Roadside Design, Safety and Barriers* to mitigate the risks associated with roadside hazards. These hazards include a lack of recoverable slopes within the road reserve, and large trees within the corridor and adjacent private properties.

There is an existing project to widen the road formation required to accommodate the additional turning lane width and widened shoulders.

Commentary: As part of the due diligence, project designers are expected to determine the available width of the verge that would accommodate the road safety barrier, either under Normal Design Domain (NDD) or EDD. The width of verge will form part of the overall formation widening required at the intersection.

Site Considerations

Beenleigh-Redland Bay Road is a Priority Cycle Route. In accordance with the *Cycling Infrastructure Policy* 2017, cycling infrastructure in the form of a 2 m wide shared shoulder / cycle lane is desirable.

The surrounding hilly terrain results in the land falling away from the southern side of Redland Bay Road and the Riedel Road approach to the intersection being at an incline.

The southern edge of pavement on Redland Bay Road is located approx. 7.5 m from the property boundary, whilst Riedel Road is located approximately 2.5 m from the property boundary. As these narrow points were located at the intersection, opportunities to flatten out batters to safer grades without resuming land are not considered a practical option.

The intersection arrangement included a lane width of approximately 3.3 m wide, shoulder widths varying from 1.0 m to 1.5 m, short section of road safety barrier installed on the southern side of Redland Bay Road east of Riedel Road.

Accident History

There were five crashes, consisting of one hospitalisation, three medical treatment and one minor injury along the section in last 10 years.

Existing geometry analysis

Category *	Potential Considerations *	Classification	
Cross Section	**Shoulder / medians / batters / formation widths**	**EDD**	**Design Exception**
Element 1	0 m distance from back of the post to the hinge point	☒	☐
Element 2	-	☐	☐
Element 3	-	☐	☐
Element 4	-	☐	☐
	Total		
** Populate as required for each element and show detailed analysis for each element if below NDD*			

Manufacturer's product manual (version XXX) for the product A specifies the post can be installed on hinge point with no offset from hinge point to back of the post.

The Transport and Main Roads *Approved Road Safety Systems and Devices* document indicates for Product A installation within the design deflection of X m is considered EDD.

As a result, no offset has been nominated along the road section to avoid significant earthworks which is also constrained by the cycling infrastructure in the form of a shared shoulder / cycle lane.

Design considerations

Alternatives			
• Review capability • Specify extents			
Location and description	**Adopt NDD**	**Adopt EDD**	**Adopt Design Exception***
Element 1			
Option 1 Achieve NDD deflection width of X m behind barrier	✓		
Option 2 Achieve minimum offset (for example, between 0 m to 0.4 m) to hinge point from back of the post, and meet minimum embankment slope (for example,1 in 2) requirement, as per manufacturer's specification		✓	
** Provide detail in report if design exception*			

Impacts Assessment			
• Cost and time • Social, environmental, safety and traffic • Maintenance			
Location and description	**Adopt NDD**	**Adopt EDD**	**Adopt Design Exception****
Element 1			
Option 1	Total widening required for NDD offset is X m from existing pavement edge. Due to the proximity of the adjacent property boundaries to the intersection, the ability to widen the verge to accommodate NDD for the lateral placement of the road safety barrier, may not be achieved without resuming land and relocating an existing telecommunications line. If required, the project would likely incur a significant increase in project costs and project delivery timeframes. The project site has a number of environmental overlays, including multiple matters of state environmental significance (MSES) and koala habitat related overlays. Any widening of the existing road formation may trigger the need for additional environmental review, reporting, permits and mitigation measures.		

Impacts Assessment			
• Cost and time • Social, environmental, safety and traffic • Maintenance			
Location and description	**Adopt NDD**	**Adopt EDD**	**Adopt Design Exception****
Option 2		No road formation widening is required if designed for EDD offset behind the barrier. The manufacturer's specification recommends a longer post depth when locating barrier close to or on the hinge point, so a lateral restraint is available for the posts. Considerations has been made on a risk of slope erosion over time, barrier maintenance provision and so on. These locations will be clearly identified to the District's Maintenance team.	
*** Provide detail within report*			

Design proposal

Recommendation
It is recommended that Option 2 (0 m offset to hinge point) be adopted for the following reasons: 1. Extent of earthworks required for the installation of barrier is reduced, avoiding conflict with the existing telecommunications line. This also reduces time and costs for construction. 2. The Product Manual for Product A / The supplier's email dated dd/mm/yyyy specifies the post can be installed on hinge point with no offset from hinge point to back of the post. 3. The Transport and Main Roads *Approved Road Safety Systems and Devices* document indicates installation within the design deflection can be considered under EDD.
Mitigating Treatments
EDD locations will be clearly identified to the District's Maintenance team.

Post implementation management

Proposals
Where design exceptions have been implemented, site(s) will be systemically monitored to validate the decisions made and to provide information to make improvements to the process in accordance with *Road Planning and Design Manual* (RPDM). The maintenance requirements will be undertaken in accordance with the department's current processes, procedures and standard practices.

Supporting information

Technical Resources
• *Road Planning and Design Manual* Volume 3 Part 6 • Austroads *Guide to Road Design* Part 6 • Product A Product Manual • Transport and Main Roads *Approved Road Safety Systems and Devices*

RPEQ certification

I consider the technical mitigating treatments appropriate and the decision to adopt this EDD and/or design exception proposal as acceptable.

RPEQ Name and Signature		Reg no.	Date

District Director "Approval to use"

☐ I approve the use of the mitigating treatments for this EDD and/or design exceptions proposal in this project as detailed. ☐ I reject the use of the mitigating treatments and submit the following alternative for RPEQ consideration:

District Director Name and Signature			**Date**

Attachments

☐ Attachment A	
☐ Attachment B	
☐ Attachment C	
☐ Attachment D	
☐ Attachment E	