Guidelines for the Extended Design Domain & Design Exception Process

Printed copies are uncontrolled unless marked otherwise. Refer to iRoads for current version.

March 2020

Contents

Document Control

Owner	Manager Road & Traffic Engineering
Custodian	Manager Road & Traffic Engineering
Document Number	D18#363228
Issue Date	15 June 2018
Review Frequency	5 Years

Amendments

Revision Number	Revision Date	Description of Key Changes	Section / Page No.
0	30/04/2018	First draft developed	1 - 47
1	15/06/2018	Final draft including Stakeholder comments	1 - 63
2	19/03/2020	Clause 6.2 modified: minimum requirements specified.	19
		Clause 6.3 (2nd dot point) modified to emphasise variance from NDD	20
		Section 6.5 modified: reference to TRIM no. changed in text and Figure 4. “Departures from standards” discussed.	23 - 27
		New Section 7 added: Assessment of Existing Rural Road Sections	28
		Appendix 7 Added	

1 INTRODUCTION AND PURPOSE

This document provides guidelines to be followed in the application of geometric road design parameters that are not considered part of the Normal Design Domain (NDD), i.e. are considered part of the Extended Design Domain (EDD) or outside of the EDD, i.e. Design Exceptions (DE).

The document should be considered as a Main Roads WA supplement to the Austroads "Guide to Road Design" (GRD) series of documents and shall be used by Consultants seeking to apply EDD and DE standards and principles for geometric road design parameters on roads controlled by Main Roads WA. The process should also be applied to variations from Main Roads' standards with respect to structures and materials, pavements and earthworks.

Main Roads acknowledges that this document is based on the Queensland Department of Transport and Main Roads document "Guidelines for Road Design on Brownfield Sites, July 2013" (Queensland DTMR, 2013), the FHWA document "Mitigation Strategies for Design Exceptions, Stein and Neuman, 2007" (FHWA, 2007) and the VicRoads draft document "Context-sensitive Design – The Application of Design Domains and Design Exceptions, 2017" (VicRoads, 2017) but has been customised to suit Western Australian circumstances and needs. As such Main Roads WA takes full responsibility for the content of this document.

2 SCOPE

The guidelines give an overview of the Design Domain Concept and discuss the principles directing the EDD and DE process. The EDD and DE process is given in detail including required documentation for submission to Main Roads for approval.

3 ROLES & RESPONSIBILITES

Within Main Roads, Clause 2.3 of the Delegation of Authority (DoA) manual establishes the roles and responsibilities with respect to "Designs varying from Main Roads' standards" as follows:

	Recommend	Review	Approve
Roads	Regional Manager, Director Metropolitan Operations, Director South West Operations, Branch Manager, Project Director	Manager Road & Traffic Engineering	Executive Director Planning & Technical Services, Executive Director Central & Northern Regions, Executive Director Infrastructure Delivery, Executive Director Metro & Southern Regions
Bridges	Regional Manager, Director Metropolitan Operations, Director South West Operations, Branch Manager, Project Director	Senior Engineer Structures	Executive Director Planning & Technical Services, Executive Director Central & Northern Regions, Executive Director Infrastructure Delivery, Executive Director Metro & Southern Regions

(Author's note: It is proposed to modify the above table from Clause 2.3 of the DoA Manual to include for any designs varying from Main Roads' standards with respect to "Materials, Pavement & Earthworks" to be reviewed by the Manager Materials Engineering and approved by EDPTS)

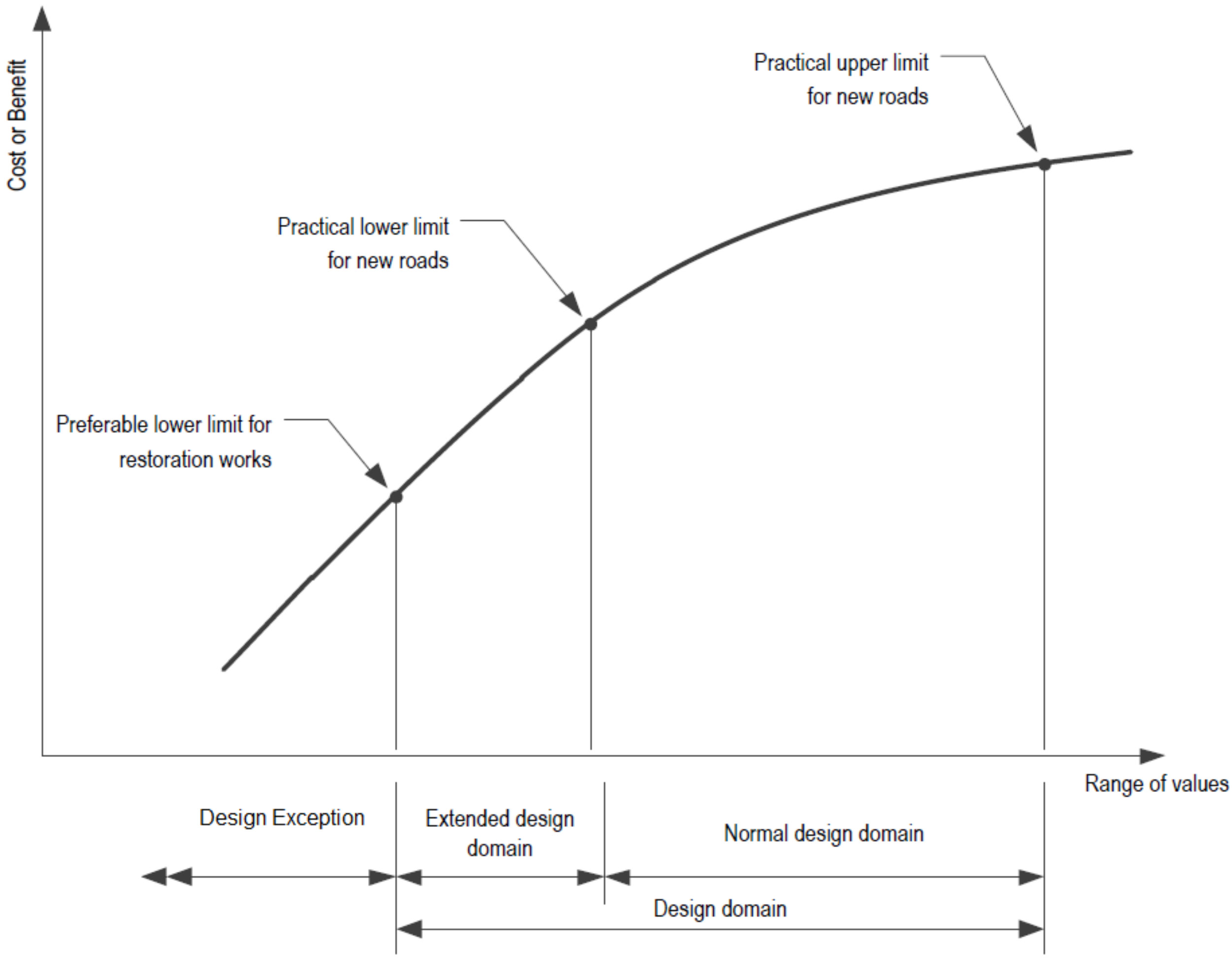
The DoA document clearly establishes the role of MRTE as the single officer responsible for reviewing all designs that vary from Main Roads' standards with respect to road geometry. This includes all road design parameters not considered part of the NDD.

As such the EDD and DE process nominates MRTE as the "delegated representative from the relevant road authority" (referred to in Appendix A of GRD Part 3 – Geometric Design (Austroads, 2016) and GRD Part 4A – Unsignalised and Signalised Intersections (Austroads, 2017)) who should approve in writing the use of any design values outside of NDD.

4 DESIGN DOMAIN

4.1 Design Domain Concept

Design domain can be thought of as a range of values that a design parameter might take. It is a range of design parameters that can be justified in an engineering sense (based on test data, sound reasoning, etc.) and therefore can have a reasonable level of defence if questioned. The design domain approach places emphasis on developing appropriate and cost-effective designs rather than providing a design that simply meets 'standards'. Figure 1 illustrates the concept that requires a designer to select a value for each design element from a range of values, considering the benefits and costs of each selection.



Notes:
- The value limits for a particular criterion define the absolute range of values that it may be assigned.
- The design domain for a particular criterion is the range of values, within these limits, that may practically be assigned to that criterion.

Source: Based on (Austroads, 2015)

Figure 1: The Design Domain Concept

Figure 1, shows that the design domain comprises a normal design domain (NDD) and an extended design domain (EDD). In the Austroads' GRD series of documents, NDD criteria are discussed in the body of the document and EDD criteria are discussed in the appendices. The lower regions of the design domain represent values that would generally be considered less safe or less efficient, but usually less expensive than those in the upper regions of the domain. The decision on the values to adopt should be made using objective data on the changes in cost, safety and levels of service caused by changes in the design, together with benefit-cost analysis.

Such data is not always available, particularly data that relates to changes in the values associated with specific design elements and parameters to safety performance. Designers should therefore refer to relevant documents, including the Austroads GRD series of documents and research reports, to assess the potential effects of changes in values for the various design elements involved. The data chosen should also consider the importance of incorporating Safe System principles in the design.

Using this concept provides the following benefits to the designer:

- It is more directly related to the road design process, placing a greater emphasis on developing appropriate and cost-effective designs rather than merely following prescriptive standards.
- It reflects the continuous nature of the relationship between changes in the design dimensions and service, cost and safety, as the designer must consider the impacts of trade-offs throughout the domain and not just where a standard threshold is crossed.
- It provides an implied link to the ‘factor of safety’, a concept commonly used in civil engineering design processes where risk and safety are important.

A *design exception* (DE) is a design that adopts values outside the design domain (that is, outside both the NDD and the EDD). They are unlikely to provide reasonable road-user capability. (Reasonable road-user capability is the capability a court of law decides a road user should reasonably expect to have when they are taking reasonable care for their own safety.) The EDD offers some latitude in road design and, in many cases, road-user capability will still be adequate with a design that incorporates EDD criteria. However, when a design incorporates a DE, road-user capability is largely unknown. A high level of technical judgement is needed to inform and review the design. Any use of such values must be formally approved by Main Roads after due consideration of all constraints, criteria and risks. It should be noted that a “Pilot Project” or “Trial” may often be considered to be a Design Exception because the performance of the treatment in WA may be largely unknown.

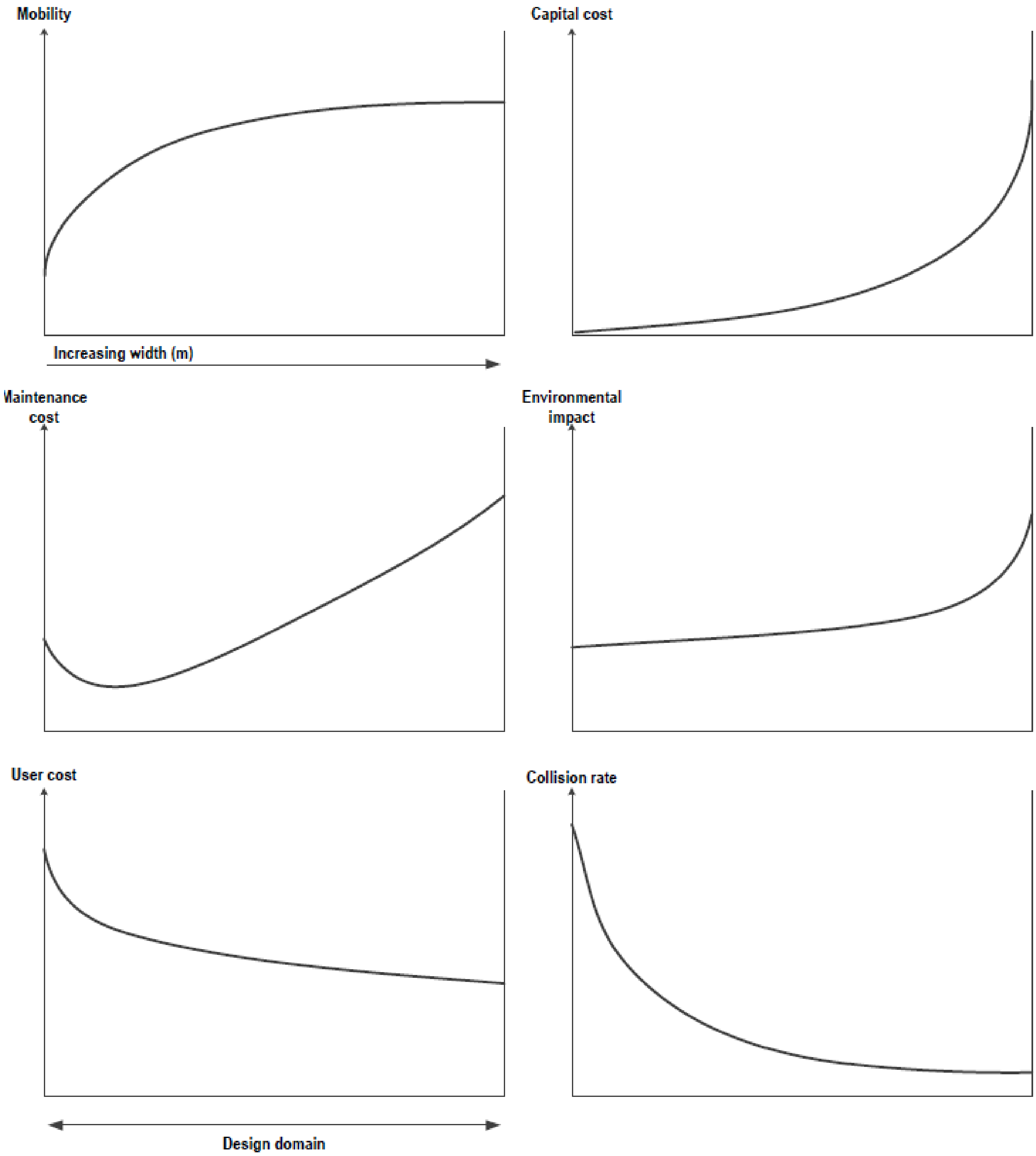
Designs should comply with sound engineering principles and **NDD criteria should be used wherever practical**. The flexibility inherent in these criteria should be fully exploited in attempting to achieve a balanced, safe and context-sensitive design. If EDD criteria are unavoidable, the resulting reduction in desirable design criteria should only be because of the constraints imposed by the local conditions.

To be formally approved, a decision to use EDD (or DE) criteria must be supported by a well-documented risk assessment that gives careful consideration to appropriate mitigation strategies. The risk assessment must be unbiased, clearly demonstrate the proposed benefits and show how risks will be managed. Further, any proposed mitigation measures must comply with relevant standards and be appropriate to the risk identified.

Figure 2 illustrates how the design domain concept might be applied to a single design parameter, the example used being shoulder width. The graphs show that a value for shoulder width might be chosen that optimises the balance between costs and safety. Selection of a value within the domain will depend on a trade-off between the various benefits and costs. In other cases, values for several design parameters must be selected, these parameters working together to optimise the design.

However, the designer must take into account the nature and significance of controls and constraints on the design. Often the designer will not be able to choose design dimensions that will satisfy all of the controls and constraints and compromise will be required. These engineering decisions call for knowledge, experience, insight and a good appreciation of community values.

To some extent, the design domain approach formalises the means by which previous manuals have defined the range of values within which the designer should operate. However, the design domain approach clarifies the extent of trade-offs and highlights the inter-relationship between the various elements of design. It encourages a holistic approach to design.



Source: Austroads 2015

Figure 2: Design Domain Example – Shoulder Width

4.2 Normal Design Domain

The design domain for a new road is referred to as the 'normal design domain' (NDD). **The extent of the NDD defines the normal limits for the values of parameters that have traditionally been selected for new roads**.

For any design parameter there is a practical upper limit beyond which incremental benefit diminishes. The practical upper limit for a new road shown in Figure 1 corresponds to the maximum value for any particular parameter (where applicable) in the *Guide to Road Design* series. For example, the practical upper limit of lane width for a rural road is given as 3.7 m, exclusive of curve widening (Austroads 2016). In some cases, an increase in a parameter above a particular value may result in a dis benefit in terms of road safety (e.g. shoulder width above 3.0 m).

The practical lower limit for a new road shown in Figure 1 corresponds to the minimum values given for any particular parameter in the *Guide to Road Design* series. For example, the practical lower limit of lane width for a rural road is 3.5 m (Austroads 2016). As a general rule, values below the practical lower limit should not be chosen for a new road unless constraints apply and they can be justified.

The extent of the NDD within the various manuals and guidelines is usually based on the experience and judgement of practitioners, even where the relationship with safety has been identified by research. This can vary over time, depending on current subjective thinking and on changes in road/traffic characteristics. For example, vehicle fleet changes have led to a decrease in the design value for driver eye height and a consequent increase in the minimum length of crest vertical curves.

NDD criteria should be used wherever practical. They are those for which there is the strongest justification. They are not arbitrary, but based on experience, research and engineering judgement (and hence defendable in court). NDD criteria cover a wide range of design situations and contexts. They also promote consistent road-user behaviour and expectation. But such criteria are not necessarily static. They are subject to ongoing review as more experience is gained from meeting the challenges of road design.

The NDD specifies desirable criteria and minimum criteria. This criteria must be met, or surpassed, for all new road projects, duplication projects and roads that meet the following criteria:

- **When designing for new roads, particularly those in greenfield sites**
- **When designing for significant lengths of reconstruction of existing roads**
- **When designing for roads with high traffic volumes**
- **When designing more important roads**
- **When other parameters at the same location are approaching the minimum**
- **When little additional cost is involved in the use of these values**
- **When a significant crash history exists at a particular location.**

4.3 Extended Design Domain

As shown in Figure 1, the EDD is a range of values below the lower bound of the NDD. Therefore, EDD is a range of design values below the minimum values traditionally specified for new roads or greenfield sites in road design guidelines. Where used, EDD refers only to this extended range of values.

The EDD concept uses values smaller than the practical lower limit in certain circumstances, leading to less conservative designs. These criteria should be adopted only in circumstances where context-sensitivity demands it, and only when they can be justified and defended on engineering grounds and operating experience. In addition, the use of EDD values should be in conjunction with mitigation measures that offset any potential safety risks. The use of an EDD criterion is not considered a design exception. EDD criteria will have been subjected to some analysis and can support designs that offer an acceptable level of safety.

To be formally approved, the use of EDD criteria must be documented in an EDD / DE report (refer to Section 6.5 and Appendix 6). The use of EDD values for design purposes should be supported by a documented risk assessment that:

- justifies and recommends the values to be adopted for various design parameters
- demonstrates that the adoption of NDD values is not practical or possible because of physical, environmental, heritage, social or economic constraints
- demonstrates that adoption of lower values is in the overall community interest with respect to investment strategies, road safety strategies, and other strategies that relate to roads and road networks
- demonstrates the use of mitigating measures to offset any potential safety risks
- verifies that responsibility for the use of values within the EDD is taken corporately by Main Roads and is not placed on an individual designer.

Most road design guidelines are based on theoretical safety models because of the inherent difficulty in determining standards based on objective safety evidence. The lower-bound values used in the EDD approach recognise that models developed for the design of new roads can produce values that are conservative for some situations. The concept of EDD uses less conservative values for some input parameters on the basis that they can be supported by comprehensive engineering test data and deliver reasonable outcomes.

The use of EDD may be limited to particular parameters (e.g. sight distance) where research has demonstrated that the adoption of EDD will not result in significantly higher crash rates. While the use of design values from within the EDD may not be preferred, it may be necessary in certain circumstances, usually for existing roads in constrained situations. Improving existing roads, particularly the geometry of existing roads, is relatively expensive. Furthermore, the cost differential between upgrading a road to a level within the NDD compared to a level within the EDD is likely to be high in these cases. In contrast, the relative cost differential between providing a road that conforms to the NDD, compared to the EDD, is likely to be relatively less for a new road (i.e. at a greenfield site).

EDD criteria are the minimum to be adopted for road restoration projects. They generally apply to the following:

- **improving or rehabilitating existing roads or existing intersections (including modifying or realigning geometric elements in constrained locations)**
- **constructing new intersections on existing roads in constrained locations (which may include modifying the intersection type)**
- **constructing new carriageway of a duplication in constrained situations**
- **building temporary roads or intersections**
- **temporary situations (e.g. projects where it is known that imminent development will cause a permanent reduction in the operating speed)**
- **where there is no crash history associated with the design element being considered**
- **where there are other significant constraints.**

The application of EDD values might be acceptable for the types of road design projects outlined in Appendix 2.

Designers should be aware that simply adopting minimum values (including EDD values) for several design elements simultaneously may produce an unsafe and/or unsatisfactory result. For example, combining a minimum radius horizontal curve with a minimum radius vertical curve and a minimum formation width may be a hazard to road users. Where a minimum is adopted for one geometric element, it is desirable to adopt a standard that is above the minimum for other elements (e.g. increase the pavement width to allow vehicles to manoeuvre on an absolute minimum radius vertical curve). This principle is particularly relevant when applying the EDD concept.

Corresponding EDD criteria do not exist for all documented NDD criteria. Design elements for which there are EDD criteria include:

- cross-sections - GRD Part 3 (AustRoads 2016)
- sight distance on roads - GRD Part 3 (AustRoads 2016)
- adverse superelevation on horizontal curves in urban areas - GRD Part 3 (AustRoads 2016)
- sight distance at intersections - GRD Part 4A (AustRoads 2017)
- intersection turn treatments - GRD Part 4A (AustRoads 2017)

4.3.1 EDD and Design Speed

Main Roads practice is to use a design speed that is 10km/h above the legal or posted speed limit for the design of urban roads up to a maximum of 110km/h.

Where the operating speed of a rural road is not determined using the Operating Speed Model then Main Roads practice is to use a design speed that is 10km/h above the legal or posted speed limit for the design of rural roads to a maximum of 110km/h. For example, where the posted speed limit is to be 100km/h or 110km/h then the design speed is 110km/h.

Where designers may be having difficulties in getting a design to work based on NDD values, it is common for designers to request a “relaxation of the standards” with respect to adopted design speed. Frequently, the request will be to adopt a design speed equal to the posted speed limit in urban areas. In rural areas the request may be to adopt a design speed of 100km/h in both cases.

For EDD purposes, the Design Speed should not be less than the Operating Speed, which is taken to be the 85th percentile speed of cars at a time when traffic volumes are low and drivers are free to choose the speed at which they travel. The adopted Design Speed shall be justified in the EDD / DE report.

Ideally, the 85th percentile speed should be determined by measurement on existing roads, or similar roads if the design is for a new road. The Operating Speed Model may also be used to determine the operating speed of a rural road.

4.3.2 EDD and Stopping Sight Distance

In the case of the application of EDD for Stopping Sight Distances (Section A.3 in the Guide to Road Design Part 3: Geometric Design, Austroads, 2016) the Designer shall develop and justify the base case prior to applying the checking cases.

Designers should consult with MRTE to get “sign-off” of the base case before applying the process to the check cases.

4.3.3 EDD and Auxiliary Lanes for Driveways

Main Roads' "Driveway" policy states that:

"A left and/or right turn auxiliary lane shall be provided at property owner's cost in accordance with:

- *The warrants for turn lanes as described in Austroads' Guide to Road Design Part 4A: Unsignalised and Signalised Intersections, Section 4.8, or*
- *When the presence of heavy or slow turning vehicles may impact the performance or safety of the road network.*

The whole left turn auxiliary lane shall be located within the property frontage, unless written approval from affected property owners is provided."

The design of auxiliary lanes for driveways shall be based on NDD values. Designers should determine the need for an auxiliary lane based on the warrants before establishing the on-site circulation layout as well as the required auxiliary lane lengths based on NDD values. By following this process the position of the driveway can be established from the beginning to meet safety and operational requirements of the main roadway and becomes a constraint for the site layout, rather than the site layout being a constraint on the position and/or length of the auxiliary lane.

The use of EDD values will only be approved where it can be demonstrated that the position of the driveway, as dictated by the auxiliary lane, conflicts with other safety requirements such as proximity to a signalised intersection or roundabout or other driveways. Under these circumstances, the Designer acting on behalf of the Developer shall discuss the proposed design with the Manager Statutory Road Planning prior to submitting a Development Application.

4.4 Design Exceptions (DE)

A DE occurs when a criterion that is in neither the NDD nor the EDD is used to support a proposed design element. There is generally no engineering justification, research or testing to support or defend it (e.g. Pilot Project or Trial for research purposes). DEs must be carefully assessed, as their adoption can have adverse consequences. For example, in a mountainous area, a design exception may be proposed as flattening the grades and lengthening vertical curves to achieve a vertical alignment that meets minimum design criteria could have serious environmental and economic impacts.

A "non-conformance" differs from a DE. It is a departure from a contract-specified requirement. This could occur either during construction (when an element is not constructed as per the specified design), or during detailed design (when an element is not designed as specified).

It is the designer's responsibility to provide advice on the risks involved in deviating from the prescribed requirements of the project.

Note that if a design criterion is specified and cannot be met and the criterion actually adopted is outside of the range of design criteria set out in the guidelines, then the new criteria might be both a "non-conformance" and a DE. Appropriately documented approvals will need to be sought.

Common reasons for considering a design exception include the need to, or desire to:

- avoid adversely impacting the natural environment
- improve the natural environment
- avoid adverse social effects
- avoid land acquisitions
- preserve right-of-ways
- preserve historical or cultural resources
- accommodate the context of the site (such as community values related to the site) and
- limit construction costs

DEs must never be considered the norm, even for brownfield projects. DEs have the potential to adversely affect the safety of road users and the operational efficiency of the road. Every location is unique. Thus a consideration of a DE should be thorough, resulting in a clear understanding of its potential effects (and especially the risks involved). If it is adopted, it is important that mitigation measures are considered and, where appropriate, implemented.

The justification for adopting a design exception must be documented. Further, the justification must demonstrate that all impacts of the design exception have been thoroughly evaluated and that the substantive safety of the road will not be reduced by its adoption.

Alternative options, including as a minimum ones that meet NDD or EDD criteria, must be developed, and to a stage that enables a reasonable comparison of costs and effects to be undertaken.

While an exception for one design element might be justified, more than one exception at the same site is less likely to be justified. For example, the combination of sub-standard horizontal *and* vertical geometry cannot be justified and should be avoided. (See Appendix 1 for more examples of design element combinations that must be avoided.)

When a DE is proposed, other elements at the location should be designed to better than NDD minimum criteria so as to mitigate the substandard element.

A justified combination of design elements at one site does not imply that this same combination would be suitable across the entire network. It should be considered a precedent for use elsewhere *only after careful consideration of the specific context of the project and providing that it is supported by an evaluation of road safety performance*.

Generally there are three types of Design Exception:

- A pre-existing Design Exception
- A Design Exception based on similar designs elsewhere on the road network
- A new Design Exception

4.4.1 Pre-existing Design Exception

This typically occurs on an upgrade project when it is proposed to retain an existing substandard design element. Examples include:

- a vertical crest curve not meeting sight-distance requirements on a section of road to be resurfaced or widened on the existing formation
- a short-length merge on a constrained exit from a signalised intersection that is to be upgraded, and
- narrow lanes in a constrained urban area being retained with the reallocation of the roadside space to a bus lane

4.4.2 Design Exception based on similar designs elsewhere on the road network

While not meeting desirable design criteria, similar designs have been implemented elsewhere that perform to an acceptable level of safety and performance. Note that *unsupported* examples of precedence do not justify a design exception. (Over time, engineering justification might become available – after sufficient monitoring and evaluation – and the criteria then added to official design guides, but until then the design exception needs specific and explicit justification.)
Examples of design exceptions that could be used to support adopting a similar exception include:

- a short merge on the exit to a roundabout that has been converted from one to two lanes
- an intersection approach to provide additional lanes where lane widths and/or alignment do not meet EDD criteria

- a vertical crest not meeting sight-distance criteria in a constrained location but with mitigating treatments similar to nearby locations on the same road.

4.4.3 New Design Exception

This situation might arise when an innovative design concept is proposed, or when constraints force designers to develop a design that has not previously been applied on the network. These projects are to be assessed as Pilot Projects or trials. Due to lack of supporting data, these design exceptions present unknown levels of risk to road users. Therefore they require a much more rigorous level of assessment and post-implementation monitoring to ensure that risks are managed appropriately.

Design exceptions might be acceptable for the types of road design projects outlined in Appendix 2. Some examples are:

- On rural restoration and urban projects in very constrained situations where:
    - a disproportionate amount of funding is required to improve a particular geometric element (for example, cost to relocate major services or excavate hard rock)
    - land acquisition is not permissible, or
    - there are prohibitive environmental or heritage constraints.

- Where the NDD:
    - is impractical or unreasonable to apply (as determined by Main Roads and a suitably qualified technical expert)
    - is overly conservative for a particular context based on demonstrated safety evidence but not necessarily research and test data
    - makes a recommendation that is not relevant in the particular case.

- Where there is no available EDD criterion but research or experience shows that one is justified.

4.4.4 Limits on the use of Design Exceptions

Design exceptions should not be used where any one of the following applies:

- **There is a crash history linked to the use of the DE (particularly if there has been more than one crash and/or there are mitigating devices in place).**
- **The use of the same or similar DE has caused safety problems elsewhere on the network.**
- **The value of the DE is well outside the range of values in the design domain (that is, the degree or severity of the exception is high).**
- **The DE is an isolated case and not consistent with road-user expectation (i.e. a driver could not reasonably be expected to adequately perceive and negotiate the substandard element). An example is a substandard curve when all others on the same road are generous.**
- **On-road restoration or low-volume projects where the pavement is being replaced (particularly if minimal earthworks are required to provide safety improvements).**
- **On-road restoration of higher function and/or higher traffic volume roads. (In these cases, consideration should be given to improving existing standards rather than retaining substandard design elements.)**
- **For intersection sight distance. In this case, EDD criteria are the lowest that should be adopted.**
- **Where the DE can be avoided with minimal effort or expense.**
- **Where the design is not sufficiently developed to reveal the potential effects on safety and traffic operations.**
- **Where alternatives with improved substantive safety have significant long-term benefits.**
- **The DE is combined with other minimum geometric design criteria. The greater the number of minima combined, the lower is the likelihood that the exception will result in a successful design.**
- **Where the DE leads to unacceptable risk to those who need to maintain the asset.**

5 PRINCIPLES

5.1 Legal Aspects

From a legal point of view, the principles that can be found in a literature search of other Road Agencies' concerns (DTMRQ 2013) are:

- Designs cannot be undertaken blindly following a manual or guidelines – appropriate engineering judgement and experience must be applied.
- Design decisions should be properly documented in a manner that will provide sufficient information many years after the design has been implemented.
- Certifications should be worded to state that the design "complies with reasonable engineering principles" not that it "complies with a particular guideline or standard".
- Nominal safety is achieved by compliance with the values stated in the design guidelines (i.e. the GRD series of documents and Main Roads WA supplements). If a design meets minimum values, it is considered to offer nominal safety. By definition, a design that adopts values outside these limits is not "nominally safe" and adoption of those values will have to be justified and that justification documented. Given that EDD values have been subjected to rigorous analysis before placing them in the Austroads' GRD documents, they may provide for nominal safety by definition provided they are used in the circumstances defined in the guidelines.

  On the other hand, "substantive safety" is the measured or expected crash frequency and severity. According to (FHWA, 2007):

  > "*The substantive or long term safety performance of a roadway does not always directly correspond to its level of nominal safety. It is not uncommon for a roadway to be nominally safe (i.e., all design elements meet design criteria) but at the same time substantively unsafe (i.e., it demonstrates or reflects a high crash problem relative to expectations). Similarly, some roadways that are nominally unsafe (one or more design elements do not meet design criteria) can and do function at a high level of substantive safety. There are many reasons for this—primary among them is the fact that the criteria are based on many factors (safety being just one) and are derived from simplifying models and assumptions that are broadly applied.*"

- **Design decisions must be defendable in litigation. The expectation would be that the documentation would contain, as a minimum, the process and reasoning that led to the decision, including the circumstances of each project, the choices available, and the considerations reviewed, as well as a complete explanation for the decision itself.**

5.2 Design Domain

All design decisions should be appropriately documented. NDD values can be assumed to be documented by the project documents (drawings and specifications) and the Austroads' guidelines. All other design decisions will need specific documentation as defined in Section 6.5 of these guidelines. While the overall documentation required for EDD and DE are similar, the EDD values have already been subjected to rigorous analysis and the documentation is about recording the circumstances that required such values to be used.

Design exceptions, however, have to be justified in their entirety. That is, the values adopted have to be justified in terms of their necessity as well as their impact on safety, environmental values and cost.

It will be necessary to demonstrate that adoption of the DE does not worsen the substantive safety of the road in question and that level of safety is reasonable.

Thirteen criteria, commonly referred to as the *13 controlling criteria*, have been identified by the Federal Highway Association (FHWA, 2007) as having "*substantial importance to the operational and safety performance of any highway such that special attention should be paid to them in design decisions*". These criteria are listed below (1 – 13) along with four others considered critical for design purposes in WA (14 – 17):

1. Design speed
2. Lane width
3. Shoulder width
4. Bridge width
5. Horizontal alignment
6. Superelevation
7. Vertical alignment
8. Grade
9. Stopping sight distance (including Approach Sight Distance at intersections)
10. Cross slope
11. Vertical clearance
12. Lateral offset to obstruction
13. Structural capacity / design vehicles
14. Acceleration lane length
15. Deceleration lane length
16. Waterways capacity / serviceability requirements
17. Pavement design

Any proposed variations from NDD values (using EDD or DE) for any of the above 17 controlling criteria must be approved in writing through the EDD and DE approval process.

5.3 Project Types

It is important that designers first identify the most appropriate type of road design for a project, given the context of the project, the project values and the competing objectives.

It is reasonable to define the types of projects where existing features are to be retained and the level of justification required for their retention. It is also reasonable to determine which types of projects are not suitable for the consideration of the application of EDD or DEs.

The table in Appendix 2 – adapted from *Guidelines for Road Design on Brownfield Sites* (DTMRQ 2013) – sets out the recommended minimum design criteria for typical geometric parameters (or design elements) for various road types. Designers should strive to achieve the best possible outcomes considering context rather than adopting minimum criteria.

5.4 Mitigation Strategies

Some form of mitigation of adverse effects must be incorporated to offset the lower design values used when adopting EDD or DE. This ranges from higher than normal values for other elements of the design to providing additional signage and marking. In some cases, reduction of the speed limit may be appropriate.

The Safe System approach may be helpful in providing guidance for selecting appropriate mitigation strategies. Principles of the Safe Systems approach are discussed in the Guide to Traffic Management Part 13: Road Environment Safety, (Austroads, 2017):

"The Safe System approach demands a holistic approach to the safety of the road system, with the aim of no person being killed or seriously injured on the road network.", and

"The Safe System takes human errors and frailty into account, acknowledging that crashes will continue to occur but seeking to avoid death and serious injury as outcomes. Speed is

a critical element in this approach. Speeds must be contained so that in the event of a crash the impact forces remain below human injury tolerance."

The major methods to achieve this are to reduce the potential speed of a crash and/or to make the roadside as forgiving as possible to allow drivers who make an error to recover without crashing into a hazard. Designers will need to determine the most appropriate way of achieving this.
In order to determine appropriate mitigation measures, it will be necessary to have a thorough understanding of the crash history at the site and other similar situations. The types of crashes and their relationship to the design elements should be determined. It is not acceptable to adopt any form of design exception for an element that is related to the cause of crashes at the site.

At times, it will be decided that the "design" is to leave the road in its present geometric form even though upgrading might be normally required. In these circumstances, mitigation strategies may be applied to reduce the level of risk until the road profile can be upgraded. Obviously the timing of the upgrade will be an essential input (refer to Section 6.3.5).

Potential mitigation strategies are shown in Appendix 3 of these Guidelines (adapted from Stein and Neuman, (FHWA, 2007) for each of the 13 controlling criteria mentioned in Section 5.2. These strategies are applicable to WA conditions

6 THE EDD AND DESIGN EXCEPTIONS (DE) PROCESS

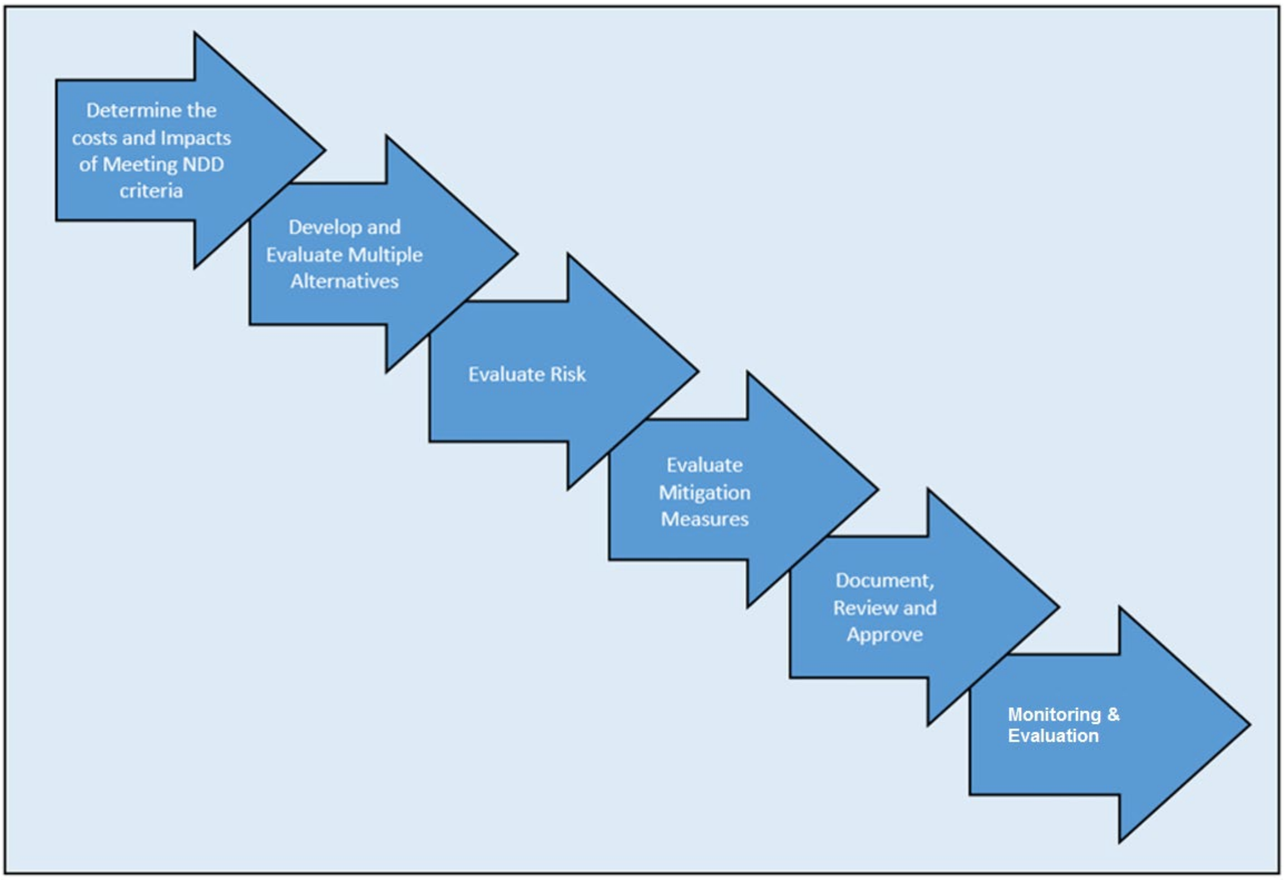
This section of the guidelines has largely been taken from the document "Mitigation Strategies for Design Exceptions", Stein and Neuman (FHWA 2007), in turn adapted by the Queensland Department for Transport and Main Roads (DTMRQ 2013).

The following are basic questions designers should ask when contemplating the use of EDD or DE:

- If this is an existing location and the use of design values outside of NDD is being considered, how good (or poor) is the existing substantive safety performance?
- If this is new construction or reconstruction and the use of design values outside of NDD is being considered, what should the long term safety performance of the roadway be?
- Given the specifics of the EDD or DE (geometric element, degree/magnitude of the variance, length of highway over which it is applied, traffic volume, etc.) what is the difference in expected substantive safety if the EDD or DE design values are implemented?

In developing a case for the use of EDD or DE, it is essential that these questions be addressed during the EDD and DE process.

Figure 3 indicates the steps required in the EDD and DE process. The extent of work required during each step depends on the size of the project as well as the degree of the non-conformance anticipated. However, all of the elements need to be addressed to ensure that the outcome is robust and able to be defended in any litigation that may arise.



Source: Stein and Neuman (FHWA 2007)

Figure 3: EDD and DE Process

6.1 Determine the Costs and Impacts of Meeting NDD Criteria

The design process should begin with the presumption that the selected geometric design elements will meet or exceed the design criteria. Before considering using EDD or a DE, the following questions should be asked and evaluated:

What would it take to fully meet NDD criteria? What would the implications be to fully meet NDD criteria?

Issues to consider when making this evaluation include:

- How well does a design that meets full criteria fit in with its surroundings?
- What are the impacts to the natural environment?
- What are the social impacts—impacts to neighbourhoods, communities, historic and cultural resources?
- What are the construction and land resumption costs and impacts of fully meeting design criteria?
- What is the expected safety and operational performance of the design that meets full criteria?

Some costs and impacts, such as construction and land costs, are relatively easy to quantify. Impacts to communities or the natural environment may be more difficult to quantify but are still very important. These impacts should at least be identified and an understanding of their level of magnitude should be developed. A full understanding of impacts can best be obtained through stakeholder involvement that is early, ongoing, and an integral part of the project development process. Following the principles of context-sensitive solutions is important.

In summary, the first step should be investigating what it takes to fully meet design criteria and developing a clear understanding of the costs and impacts.

6.2 Develop and Evaluate Alternatives

If it appears that meeting design criteria may not be feasible at a particular location, alternatives should be developed, evaluated, and compared. As a minimum, the alternative that meets full NDD criteria should be developed.

Good design involves making trade-offs and achieving a balance between cost, safety, mobility, and impacts. Examining multiple alternatives provides a way to understand and evaluate these trade-offs. From the standpoint of risk management and minimising exposure to potential liability, evaluating multiple alternatives demonstrates the complex, discretionary choices involved in road design.

Evaluation and assessment will require (modified from (Parker, 2012)):

1. Presentation of information to demonstrate the impacts of meeting the minimum or lower design criteria. This can include but is not limited to:
   - construction costs
   - environmental consequences
   - right-of-way impacts, and
   - community involvement/concerns.
2. Sufficient information to demonstrate the consequences of using a design value that does not meet the minimum criteria must be provided. Where appropriate, this may include but is not limited to:
   - impacts on traffic serviceability (i.e. level of service)
   - impacts on safety (i.e. crash history)
   - impacts on traffic operations, and
   - impacts on future maintenance.
3. A written summary of the information is required and has to be submitted for review.

This will require sufficient design to allow a reasonable estimates of cost to be developed and the impacts to be assessed. In the case of an upgrade to an existing road, it is not sufficient to assume that retention of the existing non-conformance is the only solution that needs to be evaluated.

6.3 Risk Assessment

Risk assessment is an essential part of all design but especially so for a design incorporating EDD and in particular for a design incorporating Design Exceptions. There are two fundamental types of risk when dealing with designs than do not conform to NDD standards. The first involves the risk of the solution not performing as expected. The second involves the risk concerning Main Road WA's ability to defend itself against potential legal actions as a result of its decisions.

There is always some risk of lawsuits arising from crashes alleged to be associated with a design or other problem created by a Road Authority. Use of EDD and DE design parameters may represent a potential future risk to the Road Authority if not handled properly. When designing roads in areas with difficult site constraints, designers should first acknowledge that the inability to meet NDD criteria may increase the risk of safety and/or operational problems. The degree of risk of these problems should be evaluated before moving forward with the use of EDD or a DE.

The following questions need to be addressed both singly and in combination in order to assess the risks involved:

- What are the traffic volumes, the composition of traffic, and speeds?
- What is the degree/severity of the EDD or DE? i.e. How much do the selected values of the EDD / DE parameters vary from the NDD values?
- Are there multiple EDD or DE elements at the same location?
- What is the length of the road section subject to EDD or DE?
- What is the expected duration of the use of EDD or DE design values?
- Where is the location of the section relative to other risk factors?
- What is the substantive safety at the EDD or DE location?

6.3.1 Traffic

Important inputs include the total volume (exposure), the type of traffic (composition) and traffic speed.

6.3.1.1 Total volume (exposure)

Exposure to traffic is one of the most critical factors in measuring the safety risk of any road element or feature. The more traffic to which the location is exposed, the greater the risk of a crash and/or measurable traffic operational problems. A designer may reasonably accept a design exception for curvature on a two-lane rural road with low traffic, but be less inclined to do so in a geometrically or physically comparable context with significantly higher volumes.

6.3.1.2 Type of traffic (composition)

The type of traffic refers both to the types of vehicles (specifically the heavy vehicles) and the type of user (e.g. tourist drivers unfamiliar with the road; commuter traffic; local agricultural users).

The type of heavy vehicles is important because longer/heavier vehicles will require greater distances to manoeuvre and are less capable of deviating from their course when confronted by a situation requiring such action. There will also be a higher level of risk for narrowed lane widths on a road with a high percentage of large trucks than a road that carries predominantly passenger vehicles.

From a road user perspective, the expectations of drivers unfamiliar with the road will be different from those of commuter traffic. Unfamiliar drivers require greater reaction and decision times than regular commuters.

6.3.1.3 Speed

The speed or anticipated speed (for proposed designs) is another factor that influences risk. From a Safe System point of view, the probability of a severe crash will increase as speeds increase.

The speed of traffic in the section should be assessed from measurements at the site and the 85th percentile speed determined. **This will provide an accurate assessment of the required design speed, assuming that the proposed works do not result in an increase in that speed.**

6.3.2 Degree or Severity of the Non-conformance

How much the proposed EDD or DE parameter deviates from the NDD criteria is one measure for evaluating risk. The probability of safety or operational problems developing may increase as the deviation from NDD criteria increases. For example, the ability to provide 135m of stopping sight distance when 150m is specified may be acceptable, but providing only 75m may not be. Designers should be able to translate variable dimensions to meaningful operational or substantive safety measures to help make these judgments.

6.3.3 Multiple EDD or DE Elements at the Same Location

The combination of design elements at a site should always be considered.

While an exception in one element may be able to be considered, more than one at the same site will be difficult to justify and should not be adopted.

The combination of sub-standard horizontal and vertical geometry together is not acceptable. In all cases, other elements at the site should be designed to better than minimum standards to compensate for the sub-standard element. For example, a wider pavement should be provided where a crest vertical curve of a low standard must be adopted. Also, on sub-standard curves with a tight radius, because of the friction required to traverse the curve, less friction is available for stopping, evasive manoeuvres and correction of steering path errors.

Appendix 1 provides more examples of design element combinations that must be avoided.

6.3.4 Length of the Road Section subject to EDD or DE

The length of road section affected by the EDD or DE influences the degree of risk. Length is another fundamental measure of exposure. The extent of this influence depends on many factors, including the magnitude of variance from NDD values (Section 6.3.2).

An isolated element (e.g. crest curve) may be provided with mitigation more easily than a series of sub-standard elements over some distance. On the other hand, if the series of elements occurs within a section where the speed is modified by the horizontal geometry, then the operating speed may be reduced and the retention of the geometry made more acceptable. Reduction of the posted speed in these circumstances may provide an acceptable mitigating option.

In other cases, a design exception may extend for several kilometres. An example would be an area with constrained cross-sectional width where narrower lane and/or shoulder widths are used over an extended segment of the highway. Designers should recognise that the use of EDD or DE design values over an extended length of highway greatly increases the risk of operational or safety problems to drivers exposed to it.

6.3.5 Duration of the Use of EDD or DE Design Values

Is it intended that the current geometry be retained for a considerable time or is it intended to reconstruct the section in the reasonably near future (say within five years)? A long term requirement provides a significantly different perspective to the problem.

6.3.6 Location of the Section Relative to Other Risk Factors

The combination of other geometric features was discussed in Section 6.3.3. These do not necessarily all need to be minima or sub-standard to be undesirable.

The location of roadside furniture and/or trees also has to be considered. If the use of EDD or DE is to be applied, then action to address these features will be required.

6.3.7 Substantive Safety at the EDD or DE location

The substantive safety will be determined by the crash history of the site (and similar sites elsewhere) and the types of crashes that have occurred. These details must be obtained and a careful analysis of them carried out.

It is necessary that the proposed works do not make the substantive safety any worse; preferably, the works should improve the situation.

The likely effects of the proposals may be assessed using such tools as the ARRB Road Safety Risk Manager and the Highway Safety Manual (AASHTO, 2010). Appendix 4 provides two examples of crash modification factors from NCHRP Report 500.

Crash Modification Factors for intersection types and countermeasure treatments are also given in the MRWA ROSMA "Road Trauma Treatments" guideline (MRWA, 2016). (TRIM no. D15#686638)

Austroads Reports AP-T146/10 (Austroads, 2010a) and AP-T151/10 (Austroads, 2010b) also provide data on crash modification factors. (Troutbeck, 2012) provides a summary of additional research on recommended crash modification factors.

6.3.8 Main Roads WA risk management process

The Main Roads "Risk Management Process" available on iRoads should be used to ascertain the level of risk for all EDD and DE proposed. The latest Transport Portfolio Risk Reference Table shall be used. A link to a Risk Assessment spreadsheet is given here (D18#363243).

The initial risk analysis should be undertaken for the proposed EDD or DE design, without the application of mitigation measures. It is expected that this would demonstrate a High or Very High risk rating, based on unacceptably high consequences for one or more categories. The second part of the assessment assumes that some (or all) mitigation measures are in place to give a "residual" risk score.

The residual risk rating (including the mitigation strategies discussed in the next section) for proposed alternatives using EDD or DE values should generally be classified as low to medium.

6.4 Mitigation

For alternatives that incorporate one or more design elements that do not meet NDD standards, the designer should have an understanding of the potential adverse impacts to safety and operations. Equipped with this understanding, measures should be evaluated that are targeted at mitigating those impacts. This should be done in conjunction with the "Risk Assessment" process discussed in Section 6.3. Specific actions to mitigate the effects of a proposed EDD or DE have to be assessed for each case and costed as part of the works proposed. Each case will need to be treated on its merits

It should always be remembered that the use of EDD or DE values have been adopted to reduce the total cost of the works and that the mitigation required is only using part of this reduction in cost. That is, the saving that can be achieved must always be the difference between the cost to achieve the NDD and the cost using EDD or DE design values (including all mitigation costs).

Mitigation measures may include providing advance notice to the driver of the condition, enhancing the design of another geometric element to compensate for a potentially adverse action, implementing features designed to lessen the severity of an incident or action, or some combination of these.

Potential mitigation strategies are shown in Appendix 3 (adapted from Stein and Neuman, (FHWA, 2007) for each of the 13 controlling criteria mentioned in Section 5.2. The goal is to implement mitigation measures that will maximise the probability of a nominally unsafe design operating at a high level of substantive safety and operational efficiency.

The EDD processes detailed in the Appendices of the Austroads' Guide to Road Design Series of documents (particularly GRD Part 3 and GRD Part 4A) make provision for mitigating strategies for some of the EDD parameters. For example, use of an object height higher than 0.2m for cars and 0.8m for trucks requires supplementary manoeuvre capability (minimum shoulder /traversable width and minimum manoeuvre times).

The Queensland Brownfield Design Guidelines (Queensland DTMR, 2013) provide mitigation strategies for each of the EDD parameters discussed.

6.5 Document, Review and Approve

6.5.1 Documentation

Effective documentation of designs using EDD or DE design values (hereinafter referred to as the EDD / DE Report) is important for several reasons (FHWA, 2007).

- Important decisions related to EDD and DE require review, oversight, and approval, from multiple levels of management. Requiring complete documentation using prescribed formats and technical references is an effective means of maintaining quality control over decisions and outcomes.
- Documentation offers an historical benefit for future designers. If a safety or operational problem arises or if the location is being reconstructed, understanding the thought process and reasons for the decisions that were made in earlier projects can be valuable information for designers, particularly where EDD or DE design values were used. For this to be useful, an archive system is needed that allows designers to quickly and easily find historical documentation for decisions made at their project locations. (It is expected that documentation related to EDD and DE design values would be included in the various project-related files. However, any approvals for the use of EDD or DE for geometric design parameters should also be included on TRIM file no. 20/1894 for any designs that include a DE or 20/1896 for any designs that only include the use of EDD values. These folders also contain registers for DE and EDD approvals respectively).
- If a design decision is questioned in a lawsuit and design negligence is alleged, documentation on the EDD / DE approval process provides proof that the decision was made in a deliberative, thorough manner after fully evaluating the impacts and the alternatives. In most states, designers are afforded some level of discretionary immunity for their design decisions. Regardless of the level of immunity, documentation and retention of such documentation for later reference is essential to limiting an agency's liability should a lawsuit over design negligence be filed. Crashes and resultant legal action may occur many years after the highway was constructed.

The Designer or Project Manager would be expected to prepare the EDD / DE Report because they are normally very familiar with and knowledgeable about the project and the design. The goal should be to prepare a clear and concise explanation of the design recommendation - one that will provide the person(s) in charge of review and approval, who usually has much less detailed knowledge of the project, enough information to understand the decision and make an informed judgment on whether it should move forward. Length of documentation is not important. The key is to provide clarity and completeness to someone not familiar with the project or the element being considered.

Future designers should also be considered. They should be able to clearly understand the Designer's reasons for the use of EDD or DE design values, even many years after construction.

According to Stein and Neuman (FHWA, 2007):

> *Documentation should demonstrate the designer's clear understanding of the design criteria and their functional relationships, the unique context, careful consideration of alternative solutions, and a reasonable weighing of impacts and effects in support of a recommendation to deviate from the adopted criteria. Critical to this documentation and the ultimate recommendation is a record of the consideration and application of strategies and features to mitigate the potential risk of the design exception* (and use of EDD values).

The amount of documentation required and the content will vary according to the complexity of the EDD and DE elements. For EDD it will also be influenced by the level of intrusion. Table 1 over the page (FHWA, 2007) shows the required information that should be provided as part of an EDD / DE Report. Regardless of the level of detail required this information should be captured in the form of an independent formal report.

Basic Information	Identify the location where EDD or DE design values are to be used, including the length or beginning and ending points, if applicable. A map or graphic may be appropriate.
	State the design speed.
	State the traffic volumes and the composition of traffic.
Design Element(s) and Criteria	State the design element(s) to which the EDD or DE design values apply.
	State the minimum value or range of the EDD / DE parameter being considered.
	State the resource that was used to obtain the design value and its year of publication (for example, Guide to Road Design Part 3: Geometric Design, Austroads, 2017
	State the value being proposed.
Explanation	Describe the reasons for the proposed use of EDD or DE design values.
	Describe the site constraints.
	Describe and, if possible, quantify the costs and impacts involved with fully meeting NDD criteria. Some costs, such as construction and right-of-way costs, are relatively easy to quantify. Social costs, such as impacts to communities or the natural environment, are more difficult to quantify but are still very important. Use tables, charts, and drawings as appropriate to illustrate and clarify the impacts.
	Describe the other alternatives that were considered.
	Discuss the potential impacts to safety and traffic operations.
	Document the Risk Management Process (without mitigation)
Mitigation	Describe the mitigation measures that were considered.
	Describe the mitigation measures that will be implemented. Include drawings if appropriate.
	Document the Risk Management Process (residual risk)
Supporting Information	For locations where an existing feature that does not meet criteria is being maintained and current crash data are available, quantify the substantive safety of the location and how it compares to similar facilities.
	If any research or other technical resources were consulted as part of the evaluation process, identify them.
Monitoring	For any design where DE values (including “trials” or “pilot projects”) are proposed to be used, the Designer shall document the monitoring requirements.

Source: Adapted from Stein and Neuman (FHWA 2007)

Table 1: Potential Content of an EDD / DE Report

For all Road Design Types given in Appendix 2, an EDD / DE Report is required if the applicable geometric parameters and/or elements require assessment and an EDD or DE is being proposed. The table in Appendix 2 details the minimum assessment for each Road Design Type. For Road Design Types “Minor Restoration Projects” and “Maintenance Projects”, a detailed EDD / DE Report will only be required for those parameters and/or elements mentioned since a geometric assessment of the other parameters is not usually required.

A template for an EDD / DE Report is given in Appendix 6 (D18#363238). This template is suitable for those projects where there are a few (≤ 5) isolated geometric elements for which EDD / DE values are proposed. For long sections of existing rural road, the assessment methodology and associated template described in Section 7 would normally be more appropriate.

Many design elements not included in the list of 15 controlling criteria (Section 5.2) are also important for the safety and operation of the road. Providing a clear zone, turn lanes, acceleration and deceleration length, and barriers that meet current crash test standards are a few examples. Any non-controlling criteria which do not meet NDD standards should also be identified, justified, and documented, taking into consideration the effect of any deviation from NDD values on safety. This information should be included in the Design Report.

All EDD and DE documentation prepared should ideally form part of the Design Report. As a minimum, the geometric elements for which EDD / DE design values are proposed, (and the actual values) should be summarised in the Design Report, and the TRIM reference shall be provided.

6.5.2 Review and Approval

The EDD / DE review and approval process is illustrated over the page in Figure 4. It should be noted that if the proposed design values do not meet Main Roads' "desirable" maxima or minima but do meet the Austroads' NDD requirements, then the proposed values should be treated as a "departure from standards" and not as an EDD or DE. "Departures from standards" are approved by MRTE.

The EDD and DE process is anticipated to take place at either the Preliminary Design (15%) or Detailed Design (85%) stages. The process is not expected to commence at Concept Design (5%) stage because it is deemed to be too early to apply standards that do not conform to NDD design values. Similarly, the process is not anticipated to commence at Final Design (100%) stage because it is deemed to be too late in the design process to apply standards that do not conform to NDD design values.

It should be noted that the use of any EDD or DE design values that are proposed during construction will not be picked up by this this procedure, but nevertheless should be addressed via a similar approach through an appropriate method of communication (Design/Technical Query or a Request for Information).

For works being carried out on behalf of Main Roads, the EDD and DE process is initiated by the Designer (Consultant or Internal) or Project Manager / Director. The first step would be to contact the Manager Road & Traffic Engineering (MRTE) to discuss the issue and ascertain the best way forward[1].

For works being carried out on behalf of a Developer or Local Government Authority which impact on a Main Roads' asset, the EDD and DE process is initiated by the Designer (Consultant or LGA staff member). The first step would be to contact the Manager Statutory Road Planning, who may or may not involve MRTE**.**

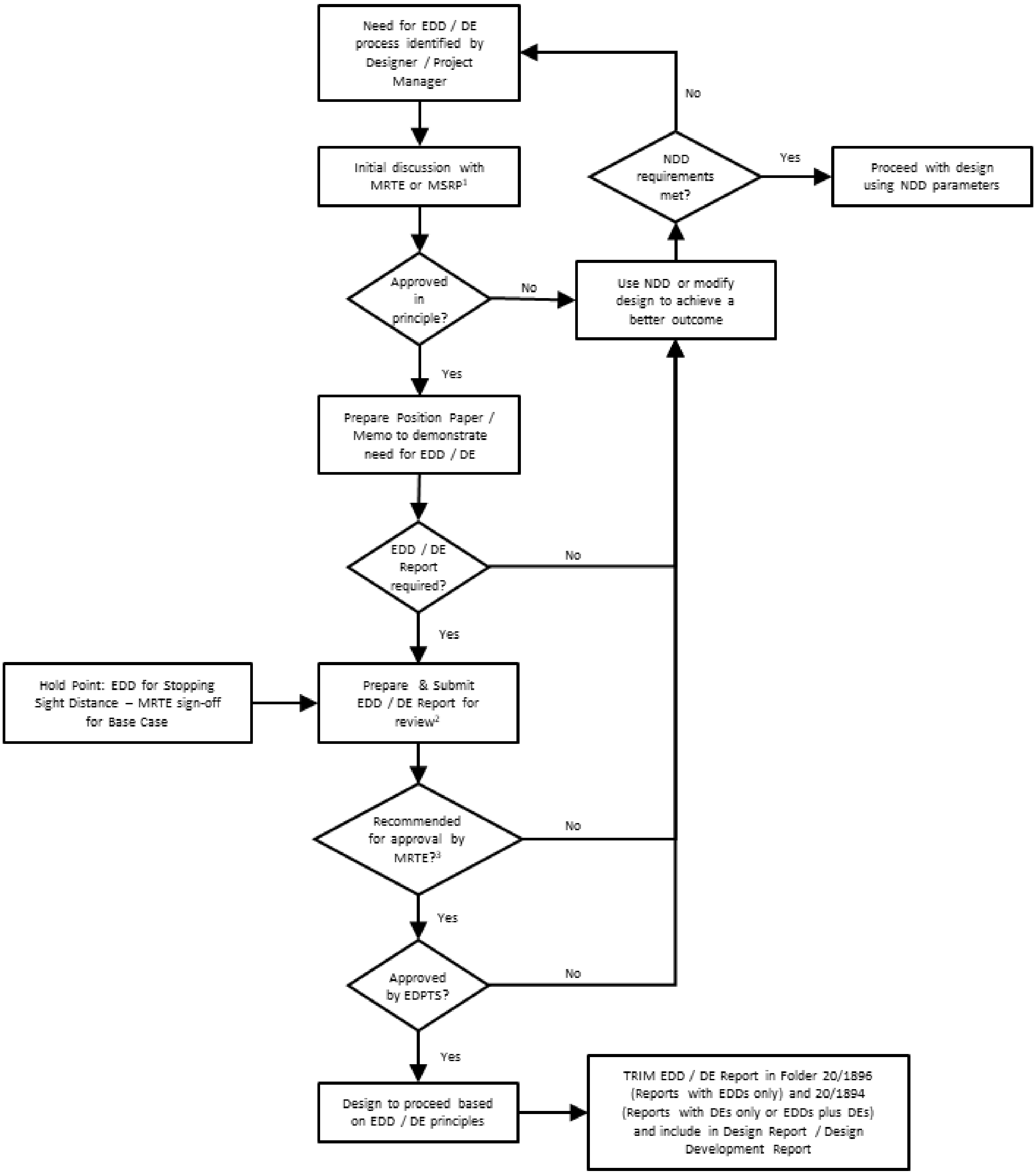
It is especially important that for any proposed developments, issues related to standards for driveway access be resolved early in the planning and design stage before the internal footprint and on-site circulation is locked away. This can reduce subsequent significant potential delays.

If "Approval in Principle" to proceed with the EDD / DE process is given by MRTE (or MSRP), the Designer should prepare a brief Position Paper or memo to demonstrate that the design is likely to meet EDD / DE requirements. The purpose of the Position Paper / memo is to clarify the issue

[1] MRTE would be responsible for all EDD/ DE issues related to Geometric Design issues.
The Senior Engineer Structures (SES) would be the first point of contact for all EDD / DE issues related to structures.
The Manager Materials Engineering (MME) would be the first point of contact for all EDD / DE issues related to pavement design.

which may highlight an alternative design approach which obviates the need for an EDD / DE approach.

Example 1 in Appendix 5 illustrates a case where the Designer, following standard practice, sought a dispensation for a reduced Design Speed because the Designer believed that design standards could not be met. A review by MRTE highlighted that the design parameters fall between “desirable” and “absolute” maxima and hence should be classified as meeting Normal Design Domain standards. This was then treated as a “departure from standards” since the Main Roads’ “desirable standard” was not met and required sign off by MRTE.



Notes:

1. MRTE – Manager Road & Traffic Engineering, MSRP – Manager Statutory Road Planning
2. Report / Workflow should demonstrate that Departure from Standard is recommended by Regional Manager, Director Metro Operations, Director South-West Operations, Branch Manager or Project Director
3. MRTE to review all EDD/DE issues related to Geometric Design. The Senior Engineer Structures (SES) to review all EDD/DE issues related to structures. The Manager Materials Engineering (MME) to review all EDD/DE issues related to pavement design.

Figure 4: EDD / DE Review and Approval Process

Following approval of the Position Paper / Memo, the designer proceeds with the EDD / DE Report, as discussed in Section 6.5.1. It should be noted that if the proposed design incorporates the application of EDD for Stopping Sight Distance, as per Section A3 of the Guide to Road Design Part 3: Geometric Design, the “Base Case” should be reviewed and approved by MRTE prior to applying the “Check cases”. The EDD / DE Report is submitted to MRTE (or SES / MME, as applicable) for review in terms of the Delegation of Authority who forwards it to EDPTS for final approval

Following approval of the EDD / DE Report by EDPTS, the final step is to save the EDD / DE Report in TRIM (Folder 20/1896 for EDD / DE Reports using EDD parameters only and folder 20/1894 for EDD / DE Reports that include the use of DE values). This report (or at least a summary of it in the case of lengthy reports) should also be included in the Design Report / Design Development Report so that any designers involved in later design stages are made fully aware of the design assumptions, implications and mitigation strategies.

6.6 Monitoring and Evaluation

Generally, the values chosen for parameters within the EDD have been found through research and / or operating experience by Road Agencies to provide a suitable solution in constrained conditions. The need to monitor and evaluate sites where EDD values have been implemented is not normally required.

On the other hand, sections of road where DE have been implemented need to be systematically monitored to validate the decisions made and to provide information to make improvements to the process. This is particularly the case where “trials” or “pilot projects” have been put in place. Normally these would be instigated in order to address a particular issue and would be based on an expectation of improved operational efficiency, economy, and / or safety.

Where it is found that the decision has not been successful in terms of maintaining or improving the substantive safety, the monitoring system should provide the information to allow appropriate modifications to be made to the road in question. A suitable system should collect data, analyse results and incorporate lessons learned in relevant guidelines and manuals.

Within Main Roads WA the Road Safety Branch has developed research capability and is actively involved in monitoring road network safety performance and assessing the effectiveness of road safety investments as well as collaborating with other road safety agencies in conducting research investigations, trials and evaluation studies. In addition, the Innovation & Research Program (Strategy Branch – Strategy and Communications Directorate) has been established to assess innovative ideas that propose or require research and development; evaluate, select and fund proposals for research; and facilitate the reporting and recording the research and development effort.

If the use of any DE values (including “trials” or “pilot projects”) are proposed as part of a design solution, the Designer should liaise with the above two branches to develop a suitable monitoring program. Moreover the Designer shall address the monitoring requirements as part of the EDD / DE Report.

Roads and Maritime Services (formerly RTA) in NSW requires the following questions regarding monitoring to be addressed in the Design Report (RTA-NSW, 2007):

> *What is the recommended monitoring that should be used to determine whether the original problems have been dealt with in an “on-going” manner?*
>
> *What are the issues that should be reviewed immediately after completion of the site works, after five years in service and at the end of fifteen years’ service?*

An essential input into the monitoring process will be the crash statistics for the site in question. It may be necessary to examine the performance of adjacent sections to determine whether the works had a "migration" effect where crashes did not reduce but migrated to an adjacent section of road. Stein and Neuman (FHWA, 2007) notes:

The rare and random nature of crashes means that several years of crash data may be needed before any conclusions can be drawn as to whether a crash problem is statistically significant and whether it is related to the design exception. In addition to reviewing crash data, in-service evaluation techniques can be implemented to obtain information over much shorter time periods. Predictions can be developed from this information on how well the location will perform, and additional or modified mitigation measures can be implemented. For example, speeds can be monitored at a curve that does not meet criteria for curvature or stopping sight distance.

7 ASSESSMENT OF EXISTING RURAL ROAD SECTIONS

The EDD / DE process was developed in June 2018. Experience showed that assessment and documentation of isolated geometric elements which did not meet NDD requirements was not onerous unless the length of road being assessed was long (say > 5km) or the number of substandard geometric elements was large (say, > 5 no.).

To facilitate the assessment and make the documentation easier, RTE Branch developed a spreadsheet tool in 2019 that utilises the visibility report from design software for a range of eye and object heights and compares these with the required Stopping Sight Distance, based on NDD or EDD parameters. The spreadsheet also utilises an operating speed model based on the horizontal geometry and may be used to identify substandard horizontal curves. KSI crash data can also be incorporated.

The output from the spreadsheet is a graph (for a particular direction) with SLK on the horizontal axis showing any deficiencies in sight distance along with substandard horizontal curves and KSI crashes. An example of the output from the Extended Design Domain Rural Road Assessment spreadsheet tool is shown in Appendix 7.

A link to the *Guidelines for the Detailed Assessment of Existing Rural Road Sections* is given here.

The Guidelines detail the methodology used in the assessment as well as the rationale behind the range of base and check cases to be used in WA. Links are provided to the spreadsheet tool as well as a step-by-step explanation of how to use the tool. A worked example is provided as well as a template for the EDD / DE Report.

8 REFERENCES

AASHTO. (2010). *Highway Safety Manual Edition 1.* Washington D.C.: American Association of State Highway Officials.
Austroads. (2010a). *Road Safety Engineering Risk Assessment Part 1: Relationship between Crash Risk and the Standards of Geometric Design Elements (Report AP-T146/10).* Sydney.
Austroads. (2010b). *Road Safety Engineering Risk Assessment Part 6: Crash Reduction Factors (Report AP-T151/10).* Sydney.
Austroads. (2015). *Guide to Road Design part 2: Design Considerations.* Sydney.
Austroads. (2016). *Guide to Road Design Part 3 - Geometric Design.* Sydney.
Austroads. (2017). *Guide to Road Design Part 4A: Unsignalised and Signalised Intersections.* Sydney.
Austroads. (2017). *Guide to Traffic Management Part 13: Road Environment Safety.* Sydney.
FHWA. (2007). *Mitigation Strategies for Design Exceptions.* Washington, D.C.: FHWA.
MRWA. (2016). *Road Trauma Treatments.* Perth.
Parker, T. L. (2012). *Tort Liability Defence Practices for Design Flexibility - NCHRP Legal Research 57.* Washington D.C.
Queensland DTMR. (2013). *Guidelines for Road Design on Brownfield Sites.* Brisbane: Queensland Department of Transport and Main Roads.
RTA-NSW. (2007). *Brownfields Road Design Guide.* Sydney.
Troutbeck, R. J. (2012). *Notes on the Crash Modification Factors for Wide Centreline Treatments (WCLT) - prepared for Queensland Department of Transport and Main Roads.* Brisbane.
VicRoads. (2017). *Context Sensitive Design - The Application of Design Domains and Design exceptions (Draft).* Melbourne: VicRoads.

9 APPENDICES

Appendix	Title
Appendix 1	Examples of Design Element Combinations to be Avoided
Appendix 2	Applying the EDD and Design Exceptions to Project Types
Appendix 3	Mitigation Strategies
Appendix 4	Application of Crash Modification Factors
Appendix 5	Examples of EDD / DE Submissions
Appendix 6	EDD / DE Report Template
Appendix 7	Sample Output from the Extended Design Domain Rural Road Assessment Tool

Appendix 1: Examples of Design Element Combinations to be Avoided

Design exception	Combination with Geometric Minima
A substandard horizontal curve radius or substandard compound horizontal curve	• A tight crest curve, especially if the horizontal curve or compound curve starts after the crest curve • Inadequate perception of, or sight distance to the horizontal curve or compound curve • A hazardous roadside (for example, where there are large trees, deep drains, steep fills close to the roadside, etc.) • Inadequate superelevation • Long drainage paths on the road surface • A floodway • A narrow carriageway • A steep downgrade • An intersection
A substandard vertical crest curve	• A small radius horizontal curve or compound curve • A narrow carriageway • A hazardous roadside • A floodway just after the crest curve • A likelihood of hazards on the roadway • An intersection
A narrow bridge or culvert (one lane or two lane of substandard width)	• Limited visibility • Steep downgrades leading to it • A small radius horizontal curve or compound curve • Being located just after a small radius crest curve
Substandard sight distance	• A small radius horizontal curve or compound curve • A narrow carriageway • A minor leg of an non-signalised intersection

Not acceptable: A combination of substandard horizontal and substandard vertical geometry

Source: (VicRoads, 2017)

Appendix 2: Applying the EDD and Design Exceptions to Project Types

Road Design Type	Project Types	Geometric Changes	Typical Geometric Element Assessed*	Minimum Design Criteria
New Roads or Duplication Projects	• New roads or • Complex, high risk or expensive projects involving modification to existing roads. e.g.: ○ Duplication of existing roads where more than 500 m realignment of an existing road is needed. • New climbing or overtaking lanes	New alignments or major modifications to existing roads	All	• NDD • EDD** if a brownfield site and context warrants • DE if an exceptional circumstance

Restoration Project (major)	• Sealing of an unsealed road or
	• Restoration projects (roads and/or intersections) involving increases to the earthworks footprint for most of the project length. e.g.:
	  ○ shoulder widening
	  ○ overlay and widening
	• Full shoulder seal projects even if the earthworks footprint does not change or there is localised marginal change.
		Major cross-sectional changes including road widening	All. (It should be noted that the Extended Design Domain Rural Road Assessment tool is useful for assessing these type of projects – refer to Section 7)	• NDD
				• EDD** otherwise NDD
				• DE where prohibitively expensive to justify NDD

Restoration Project (minor)	Restoration projects (roads and/or intersections) where the earthworks footprint does not change or there is localised marginal change. This includes projects with: • significant increases in seal width • structural overlays • surface shape correction • full shoulder seal projects with an insignificant increase in driver speed • batter flattening or reshaping	Surface profile changes that do not require widening	• Crossfalls • Superelevation • Flow path depths at curve transitions	EDD** otherwise NDD
			Verge width and sight distance requirements, if retrofitting roadside barriers	• EDD** otherwise NDD • DE where prohibitively expensive to justify NDD
			Geometric elements associated with a significant crash history (in spite of existing appropriate mitigating devices)	• EDD** otherwise NDD (remove hazard); or • Apply suitable mitigating device
			All others	Retain the Design Exceptions

Maintenance Projects	Maintenance type projects that do not involve structural overlays, formation widening or significant increases in seal width, but where some heavy / specialised plant is required, as given by the examples in the dot points below: • Pavement rehabilitation • minor overlays (small height increase) • resheet unsealed roads • reseal • part shoulder seal • signs (such as advisory speed signs and CAMS) • Installing safety barriers Where the pavement is not being rehabilitated, the roadway must retain its shape with respect to crossfall and grade to classify as a maintenance project only.	None – restoring existing geometry (except for very minor and localised surface profile changes)	Verge width and sight distance requirements if retrofitting roadside barriers	• EDD** otherwise NDD, or • DE if prohibitively expensive to justify NDD
			Geometric elements with crash histories identified in road safety audits	Apply suitable mitigating devices
			All others	Retain the Design Exceptions

* In this table, geometric elements are defined as those that affect the shape of roadway formation, for example, those that affect the horizontal and vertical alignment, cross-section, intersection geometry etc. These may impact features such as lane width, batter slope, stopping sight distance, side friction, intersection turn treatment type and taper length.

**Where an EDD criterion exists.

Source: (VicRoads, 2017)

Appendix 3: Mitigation Strategies

The following table is reproduced and adapted from "Mitigation Strategies for Design Exceptions", Stein and Neuman (FHWA 2007). A PDF version may be found in HPE Records Manager (D18#362873)

Design Element	Objective	Potential Mitigation Strategies
1. Design Speed	Reduce operating speeds to the design speed.[1]	Cross-sectional elements to manage speed
		Introduce horizontal curves to reduce speeds
2. Lane Width & 3. Shoulder Width	Optimise safety and operations by distributing available cross-sectional width.	Select optimal combination of lane and shoulder width based on site characteristics
	Provide advance warning of lane width reduction.	Signing
	Improve ability to stay within the lane.	Wide pavement markings
		Enhanced pavement markings (higher retroreflectivity)
		Raised pavement markings
		Delineators
		Lighting
		Audio tactile centreline
		Audio tactile edgeline
	Improve ability to recover if driver leaves the lane.	Sealed or partially-sealed shoulders
		Safety edge (bevelled asphalt)
	Reduce crash severity if driver leaves the roadway	Remove or relocate fixed objects
		Traversable slopes
		Breakaway safety hardware
		Shield fixed objects and steep slopes
	Provide space for enforcement and disabled vehicles.	Pull-off areas
4. Bridge Width	Provide advance warning and delineation of narrow bridge. Improve visibility of narrow bridge, bridge rail, and lane lines.	Signing
		Reflectors on approach guardrail and bridge rail
		Post-mounted delineators
		High-visibility bridge rail
		Bridge lighting
		Enhanced pavement markings (higher retroreflectivity)
	Maintain pavement on bridge that will provide safe driving conditions.	Skid-resistant pavement
	Reduce crash severity if driver leaves the roadway.	Crashworthy bridge rail, approach guardrail and end terminals
	Provide space for disabled vehicles or emergencies on long bridges.	Pull-off areas.
	Provide quick response to disabled vehicles or emergencies on long bridges.	ITS Systems – surveillance cameras

5. Horizontal Alignment & 6. Superelevation	Provide advance warning	Signing
		Pavement marking messages
		Dynamic curve warning systems
	Provide delineation	Chevron Alignment Markers (CAMs)
		Post-mounted delineators
		Reflectors on barrier
	Improve ability to stay within the lane	Widen the roadway at horizontal curves
		Skid-resistant pavement
		Enhanced pavement markings (higher retroreflectivity, RRPMs)
		Lighting
		Audio tactile centreline
		Audio tactile edgeline
	Improve ability to recover if driver leaves the lane.	Sealed or partially sealed shoulders
		Safety edge (bevelled asphalt)
	Reduce crash severity if driver leaves the roadway	Remove or relocate fixed objects
		Traversable slopes
		Breakaway safety hardware
		Shield fixed objects and steep slopes
7. Vertical Alignment	See (8) Grade and (9) Stopping Sight Distance	
8. Grade	Provide advance warning	Signing for steep grades
	Improve safety and operations for vehicles ascending or descending steep grades.	Climbing lanes
		Downgrade lanes
	Capture out-of-control vehicles descending steep grades	Escape ramps / Arrestor beds
	Improve ability to stay within the lane.	Enhanced pavement markings
		Delineators
		Audio tactile centreline
		Audio tactile edgeline
	Improve ability to recover if driver leaves the lane	Sealed or partially-sealed shoulders
		Safety edge (bevelled asphalt)
	Reduce crash severity if driver leaves the roadway.	Remove or relocate fixed objects
		Traversable slopes
		Breakaway safety hardware
		Shield fixed objects and steep slopes
	Address drainage on flat grades	Adjusting gutter profile on curbed cross sections
		Continuous drains

9. Stopping Sight Distance	Mitigate sight distance restrictions	Signing and speed advisory supplementary plates (crest vertical curves)
		Lighting (sag vertical curves)
		Adjust placement of lane within the roadway cross section (horizontal)
		Lower-height barrier
		Increased shoulder width
		Cross-sectional elements to manage speed to suit reduced sight distance
	Improve ability to avoid crashes.	Wider shoulders
		Wider clear zones
	Improve driver awareness on approach to intersections.	Advanced warning signs
		Dynamic warning signs
		Larger or additional STOP/GIVE WAY signs
		Intersection lighting
10. Cross slope	Provide warning of slippery pavement	"Slippery When Wet" Signing
	Improve surface friction	Pavement grooving (PCC pavement).
		Open-graded friction courses (HMA pavement)
	Improve drainage	Transverse pavement grooving (PCC pavement)
		Open-graded friction courses (HMA pavement)
		Pavement edge drains
	Mitigate cross-slope break on the high side of superelevated curves.	Modified shoulder cross slope
11. Vertical Clearance	Advance warning	Signing (static or dynamic)
	Preventing impacts with low structures.	Alternate routes
		Large vehicle restrictions
12. Lateral Offset to Obstruction	Improve visibility of objects near the roadway	Delineate objects
		Lighting
	Optimise operations by distributing available cross-sectional width.	Provide full outside lane width and/or additional offset
	Improve visibility of the lane lines.	Enhanced pavement markings
13. Structural capacity	Not addressed in this guide.	

Notes:

1. This differs from the issue addressed in Section 4.3.1 where the Design Speed is lowered to match the measured (or anticipated) operating speed.

Appendix 4: Application of Crash Modification Factors

Crash Modification Factors (CMF's) are used to establish the change in crash frequency when a road's attribute is changed from a benchmark configuration. Typically, a CMF is defined as follows:

A CMF is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site. The CMF is multiplied by the expected crash frequency without treatment. A CMF greater than 1.0 indicates an expected increase in crashes, while a value less than 1.0 indicates an expected reduction in crashes after implementation of a given countermeasure. For example, a CMF of 0.8 indicates an expected safety benefit; specifically, a 20 percent expected reduction in crashes. A CMF of 1.2 indicates an expected degradation in safety; specifically, a 20 percent expected increase in crashes.

The AASHTO Highway Safety Manual, Edition 1 (AASHTO 2010) has guidance on the application of CMF's. The application of CMF's relate to crash type (e.g.: run off road, head-on etc) and the specific mitigation treatment applied to combat that crash type event. The following is one method that can be considered to determine the resultant number of crashes at a site.

Step 1 - Previous/Current Situation

(A) Identify "number of" & "description/type of" crashes along road project length.

(B) Identify previous traffic volume per km over previous project accident life

(e.g.: AADT x 365days x number of years relevant to crash history record)

Baseline CMF Formula = 1.00 (ie: Number of crashes in history period per traffic volume per km)

Step 2 - Projected/Predicted Situation using CMF for particular treatment

(A) Identify predicted traffic volume ie: AADT x (traffic growth %) x Design Life (yrs)

(B) Identify number of predicted crashes in future Design life without mitigation treatments

Crash Rate (from Step 1) x Step 2(A)= Number of crashes/traffic volume/km

Resultant Number of Crashes = CMF x Step2(B) (Crash Number per Vehicle volume/km)

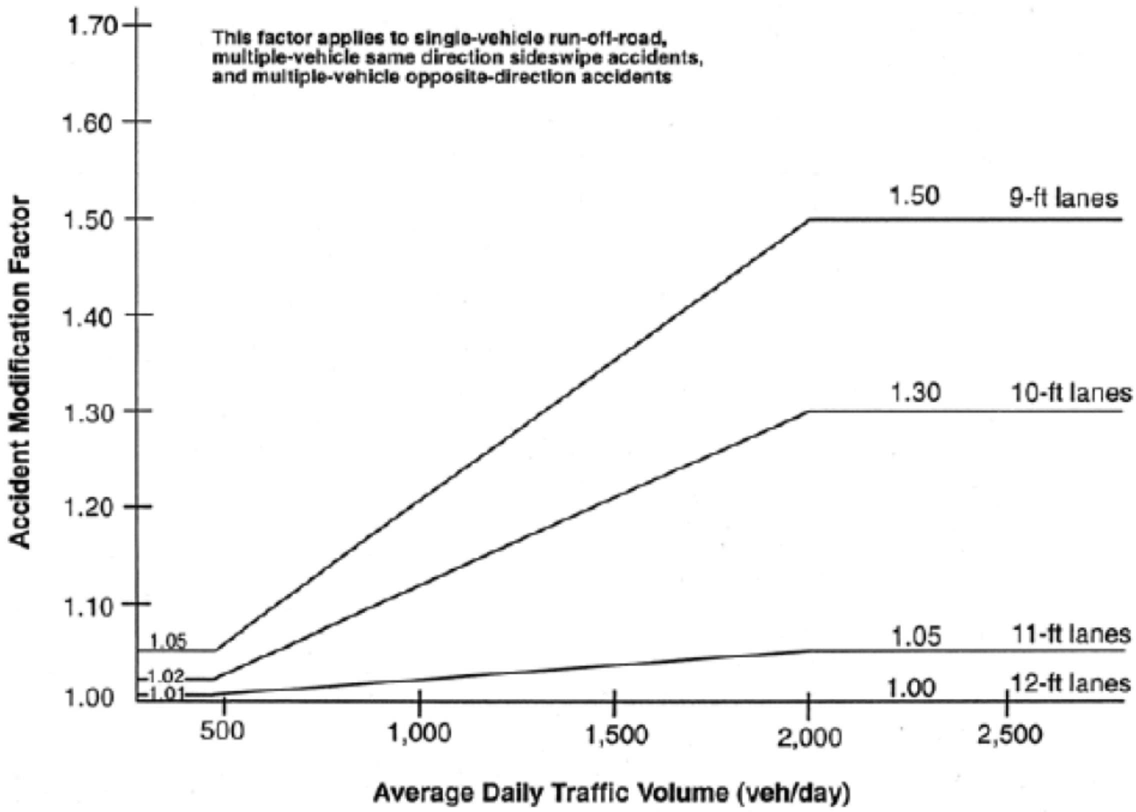


Figure A1: Crash Modification Factors for Traffic Lane Width (Stein & Neuman 2007)

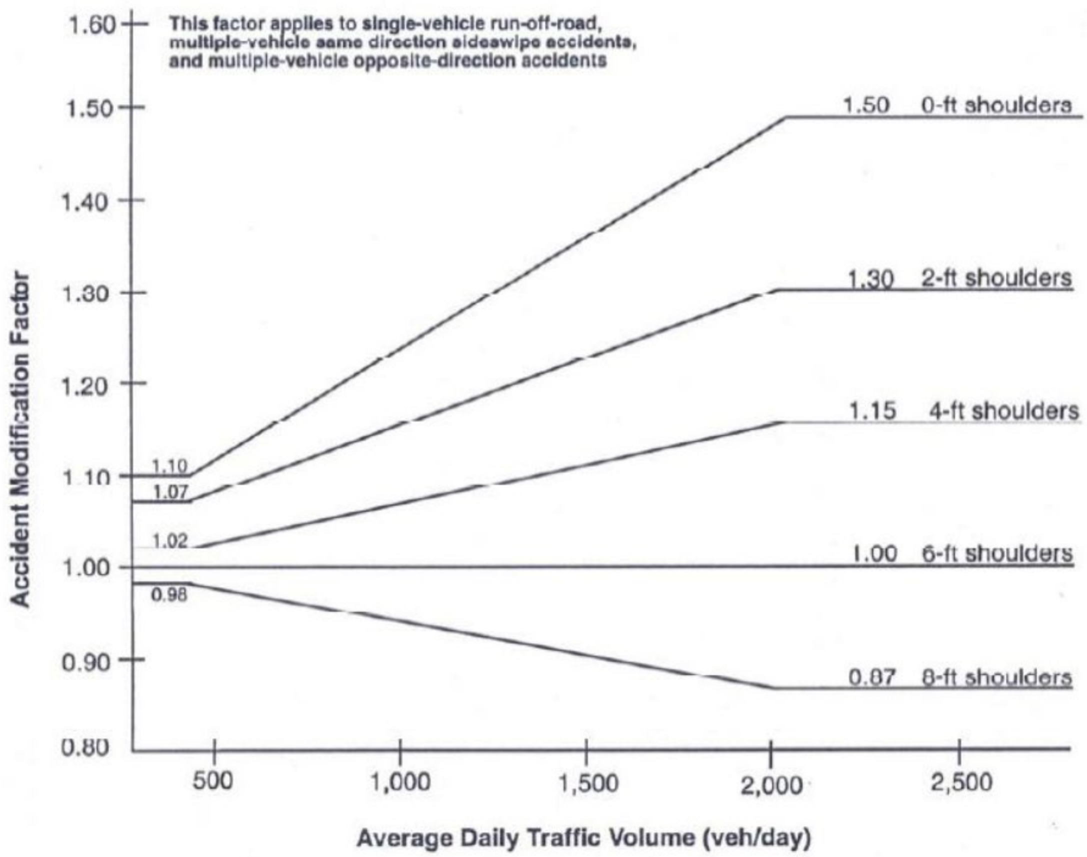


Figure A2: Crash Modification Factors for Shoulder Width on two lane rural highways

(NCHRP Report 500 Vol 6)

Appendix 5: Examples of EDD / DE Applications

Design Example 1: Reduced Design Speed (not approved)

The Designer was faced with the following scenario:

Posted speed limit = 70 km/h (by default adopted Design Speed = 80 km/h)

Horizontal Curve Radius = 230m (constrained conditions tying into an existing road)

Initial Design:

From the Horizontal Curve Tables, the maximum design speed for a 230m radius horizontal curve is given as 70 km/h with a superelevation of 5%.

RADIUS 230

Design Speed (km/h)		**30**	**40**	**50**	**60**	**70**
Desirable Minimum Length of Circular Curve including plan tranistions (m)	V2/36	25	44	69	100	136
Superelevation (%)		3.0%	3.0%	3.0%	4.0%	5.0%
Superelevation Development Length (m) (Le)	1 Lane (3.5m)	23	23	28	41	51
	2 Lane (7.0m)	32	32	37	49	62
	3 Lane (10.5m)	37	37	42	57	73
Tangent Runout Length (m) (Lt)	1 Lane (3.5m)	11	11	14	18	19
	2 Lane (7.0m)	16	16	18	21	23
	3 Lane (10.5m)	18	18	21	24	27
Superelevation Runoff Length (m) (Ls)	1 Lane (3.5m)	12	12	14	23	32
	2 Lane (7.0m)	16	16	19	28	39
	3 Lane (10.5m)	19	19	21	33	46
Shift (m)	1 Lane (3.5m)	*0.026*	*0.026*	*0.036*	*0.096*	*0.186*
	2 Lane (7.0m)	*0.046*	*0.046*	*0.065*	*0.142*	0.276
	3 Lane (10.5m)	*0.065*	*0.065*	*0.080*	*0.197*	0.383
Plan Transition Length (m) (Lp)	1 Lane (3.5m)					
	2 Lane (7.0m)					
	3 Lane (10.5m)					46
Stopping Sight Distance (m) (SSD)		31	45	62	81	102
Offset to Line of Sight (m) 1 Lane	1.0 SSD	0.5	1.1	2.1	3.6	5.7

Proposed Design Standard

The Designer seeks a Departure from Standards to adopt a Design Speed equal to the Posted Speed Limit of 70 km/h, claiming that site constraints restrict the radius to a maximum of 230m.

Review of Design Proposal

Based on a Design Speed of 80 km/h, the friction factor (f) is calculated as:

$$f = V^2 / (127\ R) - e$$

Where,

f = Side friction factor
V = Design Speed in km/h
R = Horizontal Curve Radius in m
e = Superelevation in m/m

$$f = 80^2 / (127 \times 230) - 0.05 = \mathbf{0.17}$$

From Table 7.5 in the Guide to Road Design Part 3: Geometric Design (Austroads, 2016), this value is above the “desirable maximum” friction factor for both cars and trucks (0.16 and 0.13 respectively), but below the “absolute maximum” friction factor for cars and trucks (0.26 and 0.20 respectively).

Table 7.5: Recommended side friction factors for cars and trucks

Operating speed (km/h)	*f*			
	Cars		Trucks	
	Des max	Abs max	Des max	Abs max
40	0.30	0.35	0.21	–
50	0.30	0.35	0.21	0.25
60	0.24	0.33	0.17	0.24
70	0.19	0.31	0.14	0.23
80	0.16	0.26	0.13	0.20
90	0.13	0.20	0.12	0.15
100	0.12	0.16	0.12	0.12
110	0.12	0.12	0.12	0.12
120	0.11	0.11	0.11	0.11
130	0.11	0.11	0.11	–

Outcome of Design Proposal Review

Since the friction factor value falls between the “desirable maximum” and “absolute maximum” values for an 80 km/h Design Speed, the value is considered to fall within the Normal Design Domain.

Accordingly, the proposal to adopt a 70 km/h Design Speed is not supported and the Designer was instructed to use an 80 km/h Design Speed.

It should be noted, that the Designer was correct in referring this design issue to MRTE since, even if they had adopted an 80 km/h Design Speed from the beginning, it would still have represented a “departure from standards” since Main Roads practice is to adopt the values in the Horizontal Curve Tables in the first instance. These values are based on the “desirable maximum” friction factors for trucks.

Design Example 2: Reduced Vertical Curve

mainroads
WESTERN AUSTRALIA

EDD / DE Report

M026 Toodyay Rd
SLK 16.16 – 16.70

Reduced vertical curve approval request

Table of Contents

1. INTRODUCTION

This report applies to Toodyay Road (M026) road reconstruction and summarises the rationale behind the intention to deviate from standard design practice in the application of Normal Design Domain (NDD) design values and to use design values considered to fall within the Extended Design Domain (EDD) range. The report explains the reason for the proposed departure, the justification for the departure, the expected impacts and mitigation measures to address the impacts. A risk assessment is documented to show residual risk.

1.1 Project Purpose

- Toodyay Road is classified as a primary distributor road and has a traffic mix of heavy and light vehicles. The scope of the detailed design is to improve road safety and route efficiency.

2. BASIC INFORMATION

- EDD Domain is required for the vertical curve located between slk 16.16 to slk 16.70.
- Toodyay Road (M026) is a state road that is designated as a Network 4 (27.5m prime mover) Restricted Access Vehicle (RAV) route.
- A map indicating the location of the vertical curve in question has been provided in Appendix A.

2.1 Traffic

2.1.1 Speed

- The current posted speed is 100km/h. The proposed speed once the reconstruction has been completed will be 110km/h.
- The 85th percentile speed used for calculations is 110km/h.
- The design speed used under NDD is 110km/h which will also be used for EDD.

2.1.2 Traffic Volumes

- The existing traffic volumes and future estimates are summarised in the table below:

Traffic Statistics
2016/17
Mon-Sun AADT: 3790
% Heavy (Class 3-12): 18%
Traffic Growth Rate: 2.5%
Design Life: 20 years
Design AADT: 6245

2.1.3 Composition of Traffic

- The details of the composition of traffic obtained from MRWA IRIS Reporting Centre have been attached to Appendix C.

2.2 Crash History

- Refer to Appendix D – Crash Statistics for detailed and summary of crash history obtained from MRWA IRIS Reporting Centre. The detailed and summary crash history covers the period 1/01/13 to 31/12/17.
- A summary of the killed and seriously injured (KSI) statistics are shown below. Over the 5 year period there were four KSI's. None of the crashes are associated with the vertical curve in question (slk 16.16 – 16.70).

SLK	Intersection/Midblock	Severity	Crash Type
16.99	Midblock	Hospital	Off right bend into object
19.43	Midblock	Hospital	Same Lane Rear End
20.23	Midblock	Medical	Off cway left bend
23.78	Midblock	Medical	Off Right Bend Into Object

3. DESIGN ELEMENT & CRITERIA

- The design element to which EDD design values apply is for the vertical curve K value located between slk 16.16 to slk 16.70.
  At present the existing road presents a K value of ≈22 and is located on a straight. This k value is suitable for a design speed of 70km/h under NDD.
- As per Austroads Guide to Road Design Part 3 (2016), table 8.7, the NDD value for the minimum size crest, based on stopping sight distance for a car (design speed of 110km/h, deceleration factor of 0.36 and a reaction time of 2.5s), requires a k value of 97.3
- The proposed EDD k value is 66.
- As per Austroads Guide to Road Design Part 3 (2016) Appendix A, base and check cases have been calculated in order to verify the suitability of the proposed value to meet EDD for stopping sight distance. The calculations can be found in Appendix D.
- The base case is as follows and was approved by MRTE on 24/05/2018. Copy of approval can be found in Appendix G.

Design speed: 110km/h
Proposed k value: 66.0
Driver eye height (car): 1.1m
Driver eye height (truck): 2.4m
RAV route: Network 4

(Austroads GRD Part 3 – Appendix A – Table A4)
Object height (car): 0.4m (high likelihood of dead animals being on the road)
Object height (truck): 0.8m (normal min. object height for the Truck-Day base case)

(Austroads GRD Part 3 – Appendix A – Table A6)
Coefficient of deceleration 'd' for cars: 0.46 (normal braking condition on sealed road)
Coefficient of deceleration 'd' for trucks: 0.29 (truck braking)

(Austroads GRD Part 3 – Appendix A – Table A5)
Reaction time: 2s (Normal driving situations in rural areas)

The table below summarises which design conditions have been tested for the various EDD sight distance models:

Case type	Case code	Stopping Sight Distance Required	Available Sight Distance	EDD case met?
Base case	Norm-Day	165	193	Yes
	Truck-Day	191	281	Yes
Check case	Norm-Night	165	165	Yes
	Truck-Night	191	220	Yes
	Mean-Day	149	193	Yes
	Mean-Night	149	165	Yes
Optional check case	Skill-Day	131	193	Yes
	Skill-Night	131	165	Yes

4. EXPLANATION

4.1 Why are EDD / DE values being proposed?

- The EDD k value of 66 is proposed in order to minimise the amount of earthwork required in a rocky section of Toodyay Road and limit the amount of vegetation clearing required.
- To implement NDD criteria (k value 97.3) a maximum cut depth of 8.9m would be required compared to a maximum cut depth of 5.9m if EDD (k value 66) is adopted.
  A profile providing a visual comparison between the two values can be found in Appendix F.
  A volumetric analysis using both NDD and EDD design criteria has been produced with the results summarised in the table below:

	NDD criteria – k 97.3	EDD criteria – k 66.0	Difference in %
Cut Volume	71666 m^3	32717 m^3	-54.3%
Cut Area	16807 m^2	11973 m^2	-28.7%
Maximum Cut Depth	8.93 m	5.96 m	-33.3%
Average Depth	4.26 m	2.73 m	-35.9%

Based on excavation and disposal rate of \$37.34/m^3, the expected savings in earthwork alone are:
38949 m^3 x 37.34 \$/m^3 = \$1454355

4.2 Alternative solutions

The alternative solution would be to use NDD design criteria, with a crest vertical curve of minimum k 97.3. As can be seen in the above table, the impacts in adopting NDD would require larger earthworks and thus increase in cost, and a larger clearing area in a native vegetation area. Additionally the use of NDD would place the earthworks outside the road reserve which would require the acquisition of additional land.

4.3 Potential Impacts

The potential impacts in using a k value of 66 is the reduced available sight distance, from 209m in NDD to 172m in EDD (calculated for driver height of 1.1m to an object height of 0.2m). This creates a reduction in safety as the reaction time available is reduced from 2.5s to 1.3s for a car travelling at 110km/h with a co-efficient of deceleration of 0.36, providing drivers with less time to avoid a hazard on the road.

5. MITIGATION

5.1 Mitigation measures considered

- The following mitigation measures were considered:
  - 1.5m fully sealed shoulders to provide minimum shoulder/traversable width
  - Flashing warning signs
  - Road safety barrier at edge of shoulders
  - Road safety barrier in median
  - Wide centreline treatment (1.0m)
  - Crest warning sign

5.2 Mitigation measures to be implemented

- The following mitigation measures are to be implemented in the design:
  - 1.5m fully sealed shoulders to provide minimum shoulder/traversable width
  - Wide centreline treatment (1.0m)
  - Crest warning sign

6. RISK ASSESSMENT

- Extended Design Domain / Design Exception Risk Assessment and Register was used to analyse the 3 risks identified in the project and are listed below.
  1. Hit object on carriageway.
  2. Left off carriageway to avoid object on carriageway - hit table drain.
  3. Right off carriageway to avoid object on carriageway - head on crash with opposite traffic.

  The risk ratings of hit object and left off carriageway were rated to be medium and right off carriageway to be high.

- The mitigating treatments to the 3 risks identified above and are listed below.
  1. Hit object on carriageway.
     - Provide a wider shoulder based on Guide to Road Design Part 3 Table A12.
     - Provide a wide centreline treatment
     - Provide crest warning signs.
  2. Left off carriageway to avoid object on carriageway - hit table drain.
     - Provide a wider shoulder based on Guide to Road Design Part 3 Table A12.
     - Provide a wide centreline treatment
     - Provide crest warning signs.
  3. Right off carriageway to avoid object on carriageway - head on crash with opposite traffic.
     - Provide a wider shoulder based on Guide to Road Design Part 3 Table A12.
     - Provide a wide centreline treatment
     - Provide crest warning signs.

  The risk ratings for all the 3 risks were reduced from Medium and High to Low.

  A copy of the Risk Assessment matrix can be found in appendix B.

7. REVIEW AND APPROVAL

This EDD / DE Report has been recommended, reviewed and approved in terms of Main Roads' Delegation of Authority Manual.

1. To be completed by RM, DMO, DSWO,BM or PD

The use of EDD / DE (delete not applicable) design values are recommended to be used on this project:

Craig Manton	[signature]	Regional Manager	30/05/2018
Name	Signature	Position	Date

Comments:

2. To be completed by MRTE, SES or MME

The use of EDD / DE (delete not applicable) design values have been reviewed by me and are recommended / not recommend (delete not applicable) for approval to be used on this project:

Dave Landmark	[signature]	MRTE	8/06/18
Name	Signature	Position	Date

Comments:

3. To be completed by EDPTS

The use of EDD / DE (delete not applicable) design values are approved / not approved (delete not applicable) be used on this project:

Doug Morgan	[signature]	EDPTS	8/06/2018
Name	Signature	Position	Date

Comments:

8. REFERENCES AND RELATED DOCUMENTS

Document Number	Description

9. APPENDICES

Appendix	Title
Appendix A	Locality Map
Appendix B	Risk Assessment Spreadsheet
Appendix C	Traffic Composition
Appendix D	Crash History
Appendix E	Calculations for Stopping Sight Distance for vertical crest curve of k 66
Appendix F	Visual Comparison between profiles
Appendix G	Base case approval

9.1 Appendix A

Locality Map

9.2 Appendix B

Risk Assessment Spreadsheet

Extended Design Domain / Design Exception Risk Assessment and Register

	Project / Location:	**Toodyay Road Fernie Section SLK 16.16 - 16.70**		**Date:**		23-May-18					
Ref No.	**Risk Event / Hazard** (what can happen?)	**Causes of the Event** (How can it happen?)	**Consequences** (What is the Impact if the hazard / deficiency is not mitigated?)	**Initial Risk Analysis**			**Mitigating Treatment**	**Residual Risk Analysis**			
				Consequence	**Likelihood**	**Risk Rating**		**Consequence**	**Likelihood**	**Risk Rating**	
	1: Geometric Issues										
1	Hit object on carriageway	Insufficient stopping sight distance 1.1m eye height to 0.2m object height for 110km/h. 209m required but 172m is available based on 66K	Injury, property damage	Moderate	Possible	Medium 9	Provide a wider shoulder 1.5m based on Guide to Road Design Part 3 Table A12. Crest warning sign. Widened Centreline Treatment.	Minor	Rare	Low 2	
2	Left off carriageway to avoid object on carriageway - Hit table drain	Insufficient stopping sight distance 1.1m eye height to 0.2m object height for 110km/h. 209m required but 172m is available based on 66K	Injury, property damage	Moderate	Possible	Medium 9	Provide a wider shoulder 1.5m based on Guide to Road Design Part 3 Table A12. Crest warning sign. Widened Centreline Treatment.	Minor	Rare	Low 2	
3	Right off carriageway to avoid object on carriageway - Head on crash with opposite traffic	Insufficient stopping sight distance 1.1m eye height to 0.2m object height for 110km/h. 209m required but 172m is available based on 66K	Fatal, injury, property damage	Catastrophic	Possible	High 15	Provide a wider shoulder 1.5m based on Guide to Road Design Part 3 Table A12. Crest warning sign. Widened Centreline Treatment.	Minor	Rare	Low 2	

9.3 Appendix C

Traffic Composition

SITE 51981

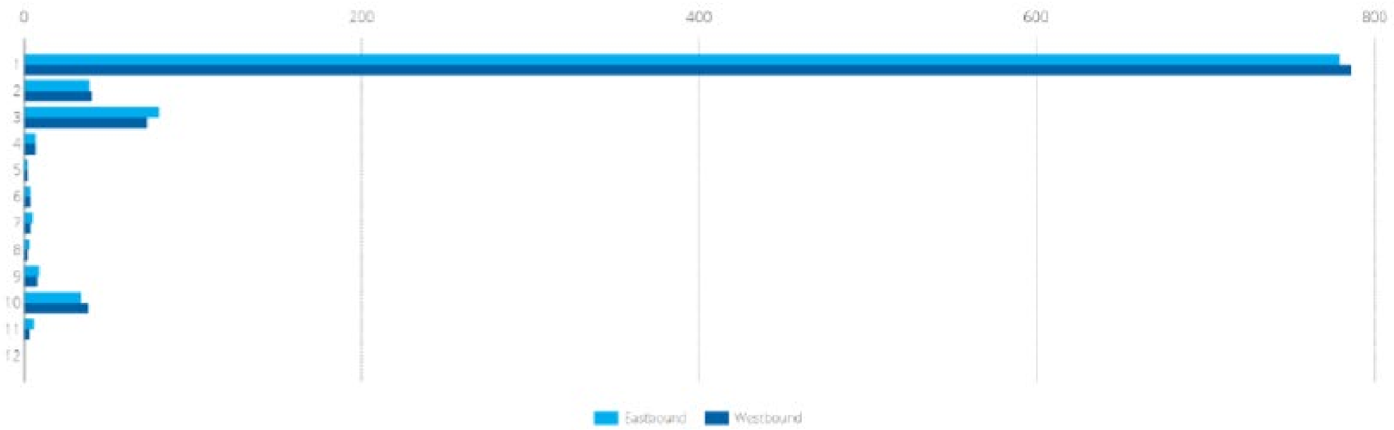
Vehicle Type

Toodyay Rd (M026)

West of Fernie Rd (SLK 16.20)

2016/17

Monday to Sunday



	Austroads Classification Scheme 1994													
	1	2	3	4	5	6	7	8	9	10	11	12	Heavy	Total
E	779	39	80	7	2	4	5	3	9	34	6	0	150	968
%	80.5	4.0	8.3	0.7	0.2	0.4	0.5	0.3	0.9	3.5	0.6	0.0	15.5	
W	786	40	73	7	2	4	4	2	8	38	3	0	141	967
%	81.3	4.1	7.5	0.7	0.2	0.4	0.4	0.2	0.8	3.9	0.3	0.0	14.6	
E/W	1565	79	153	14	4	8	9	5	17	72	9	0	291	1935
%	80.9	4.1	7.9	0.7	0.2	0.4	0.5	0.3	0.9	3.7	0.5	0.0	15.0	

9.4 Appendix D

Crash History

Detailed Crash History

Report Criteria

Road	SLK	CWY
M026 - Toodyay	16.90 to 24.18	All

Parameter	Value	Description
From Date	01/01/2013	
To Date	31/12/2017	
Crash Type	All	
Severity	All	

Road	SLK	CWY	True Dist	Loc End Date	Dist Error	Intersection	Date	Day	Time	Severity	Crash No.	Type	Light Cond	Road Cond	Speed Limit	Traffic Control	Road Feature	Road Alignment	Speed Factor	MR Nature	Location	RUM	Unit	Unit Type	From Dir	To Dir	Veh/Ped Move	First Object Hit	Second Object Hit	Third Object Hit	Target Impact Point
M026	16.99	S	16.99				07/03/2015	Saturday	2122	Hospital	2015052646	Midblock	Dark - Street Lights Not Provided	Dry	100	No Sign Or Control		Curve	No	Hit Object	On Left Verge After Leaving Cway	82:Off Path On Curve: Off Right Bend In Obj	Colliding	Station Wagon	W	E	Out Of Control: Other	Tree			
	19.43	S	19.43				11/04/2013	Thursday	1125	Hospital	2013089361	Midblock	Daylight	Dry	110	No Sign Or Control		Curve	No	Rear End	On Cway	31:Same Dirn: Same Lane Rear End	Colliding	Prime Mover & 1 Trailer	W	E	Straight Ahead: Not Out Of Control				
																							Target	Bicycle	W	E	Straight Ahead: Not Out Of Control				Rear
	20.15	S	20.15				06/07/2017	Thursday	1110	PDO Major	2017227276	Midblock	Daylight	Dry		No Sign Or Control	Driveway	Straight		Sideswipe Same Dirn	On Cway	56:Overtaking: Into Right Turn	Target	Utility	W	E	Overtaking: Passing On Right				Side
																							Colliding	Station Wagon	W	S	Turning: To Make Right Turn				
	20.23	S	20.23				13/06/2016	Friday	0230	Medical	2016097846	Midblock	Dark - Street Lights Not Provided			No Sign Or Control		Curve		Non Collision	On Left Verge After Leaving Cway	83:Off Path On Curve: Off Cway Left Bend	Colliding	Utility	W	E	Out Of Control: Gravel Shoulder				
	20.43	S	20.43			FERNIE RD (007052)	13/11/2016	Sunday	1030	PDO Major	2016356856	Intersection	Daylight	Dry		No Sign Or Control	3-way Intx (T-junction)	Curve		Rear End	On Cway	31:Same Dirn: Same Lane Rear End	Colliding	Motor Cycle	E - TOODYAY	W - TOODYAY	Straight Ahead: Not Out Of Control				
																							Target	Motor Cycle	E - TOODYAY	W - TOODYAY	Straight Ahead: Not Out Of Control				Rear
							07/05/2017	Sunday	0615	PDO Major	2017170403	Intersection	Dawn Or Dusk	Dry		No Sign Or Control	3-way Intx (T-junction)	Straight		Rear End	On Cway	33:Same Dirn: Same Lane Right Rear	Colliding	Panel Van	W - TOODYAY	E - TOODYAY	Straight Ahead: Not Out Of Control				
																							Target	Car	W - TOODYAY	E - FERNIE RD	Stopped: Prepared To Turn Right				Rear
							03/10/2017	Tuesday	0900	PDO Major	2017268635	Intersection	Daylight			No Sign Or Control	3-way Intx (T-junction)			Non Collision	On Cway	77:Loss Of Control: Right Turn - Intx	Colliding	Prime Mover & 1 Trailer	W - TOODYAY	E - FERNIE RD	Out Of Control: Gravel Shoulder				
	23.76	S	23.76				27/08/2015	Thursday	0220	Medical	2015277490	Midblock	Dark - Street Lights Not Provided			No Sign Or Control		Curve		Hit Object	On Right Verge After Leaving Cway	82:Off Path On Curve: Off Right Bend In Obj	Colliding	Car	W	E	Swerving: To Avoid Animal	Tree			

9.5 Appendix E

Calculations for EDD Stopping Sight Distance for vertical crest curve of k 66

Construct Base Case for Normal – Day and Truck – Day

Reaction time (secs)	Object Height (m)		Co-efficient of deceleration, d	
	Cars	Trucks	Cars	Trucks
2.0	0.4	0.8	0.46	0.29
Table A5 – Normal driving in rural areas	Table A4 – Dead animal	Table A4 – Truck Day base case	Table A6 – Normal braking on sealed roads	Table A6 – Truck braking

EDD Stopping Capability – SSD (Available Sight Distance ≥ SSD)

EDD Case	Operating Speed (km/h)	Reaction Time (secs)	Driver Eye Height (m)	Object Height (m)	Co-efficient of deceleration, d	SSD (m)	Crest K value (S<L)	Available sight distance (m)	EDD case met?
Base Case (Normal Day)	110	2.0	1.1	0.4	0.46	165	48.16	193	Yes
Base Case (Normal Truck)	100	2.0	2.4	0.8	0.29	191	30.55	281	Yes

EDD Manouvre Capability – (Available distance ≥ Required Manoeuvre Sight Distance)

EDD Case	Operating Speed (km/h)	Reaction Time (secs)	Driver Eye Height (m)	Object Height (m)	Min Shoulder Traversable Width (m) (Table A12)	Min Manoeuvre Time M_T (s) (Table A12)	Required Manoeuvre Sight Distance (m)	Available distance[1] (m)	EDD case met?
Base Case (Normal Day)	110	2.0	1.1	0.4	1.5	3.5	107	172	Yes
Base Case (Normal Truck)	100	2.0	2.4	0.8	Normal	N/A	N/A	281	Yes

(1) Available distance based on 0.2m object height for a car and 0.8m object height for a truck

Construct Check Case for Normal – Night and Truck – Night

Reaction time (secs)	Headlight Height (m)		Object Height (m)		Co-efficient of deceleration, d	
	Cars	Trucks	Cars	Trucks	Cars	Trucks
2.0	0.65	1.05	0.4	0.8	0.46	0.29
Table A5 – Normal driving in rural areas	Table A4 – see notes	Table A4 – see notes	Table A6 – Normal braking on sealed roads	Table A6 – Truck braking	Table A6 – Normal braking on sealed roads	Table A6 – Truck braking

EDD Stopping Capability – SSD (Available Sight Distance ≥ SSD)

EDD Case	Operating Speed (km/h)	Reaction Time (secs)	Headlight Height (m)	Object Height (m)	Co-efficient of deceleration, d	SSD (m)	Crest K value (S<L)	Available sight distance (m)	EDD case met?
Check Case (Normal Day)	110	2.0	0.65	0.4	0.46	165	65.77	165	Yes
Check Case (Normal Truck)	100	2.0	1.05	0.8	0.29	191	49.53	220	Yes

Construct Check Case for Mean – Day and Mean – Night

Reaction time (secs)	Eye Height (m)	Headlight Height (m)	Object Height (m)		Co-efficient of deceleration, d
	Mean - Day	Mean - Night	Mean - Day	Mean - Night	
2.5	1.10	0.65	0.4	0.4	0.41
Table A5 – 0.5 secs added to normal reaction time	Table A4 – see notes	Table A4 – see notes	Table A4 – Same as Normal day base case	Table A4 – Same as Normal night	Table A6 – See notes regarding Mean – day and Mean – night

EDD Stopping Capability – SSD (Available Sight Distance ≥ SSD)

EDD Case	Operating Speed (km/h)	Reaction Time (secs)	Headlight Height (m)	Object Height (m)	Co-efficient of deceleration, d	SSD (m)	Crest K value (S<L)	Available sight distance (m)	EDD case met?
Check Case (Mean Day)	93.5	2.5	1.10	0.4	0.41	149	39.27	193	Yes
Check Case (Mean Night)	93.5	2.5	0.65	0.4	0.41	149	53.63	165	Yes

Construct Check Case for Skill – Day and Skill – Night

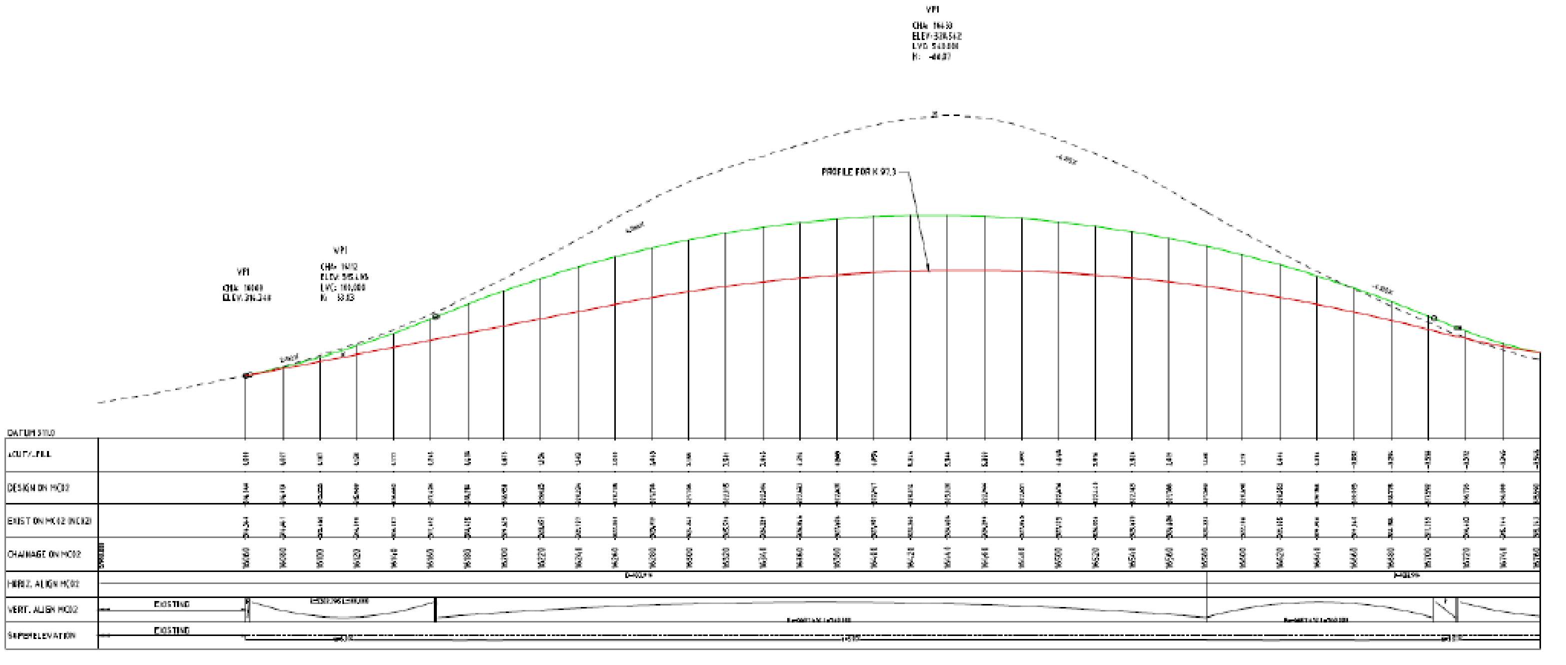
Reaction time (secs)	Eye Height (m)	Headlight Height (m)	Object Height (m)		Co-efficient of deceleration, d
	Skill - Day	Skill - Night	Skill - Day	Skill - Night	
1.5	1.10	0.65	0.4	0.4	0.56
Table A5 – see notes on skill driving	Table A4 – same as normal day	Table A4 – same as normal night	Table A4 – Same as Normal day base case	Table A4 – Same as Normal night	Table A6 – See notes regarding skill braking on sealed roads

EDD Stopping Capability – SSD (Available Sight Distance ≥ SSD)

EDD Case	Operating Speed (km/h)	Reaction Time (secs)	Headlight Height (m)	Object Height (m)	Co-efficient of deceleration, d	SSD (m)	Crest K value (S<L)	Available sight distance (m)	EDD case met?
Check Case (Skill - Day)	110	1.5	1.10	0.4	0.56	131	39.27	193	Yes
Check Case (Skill - Night)	110	1.5	0.65	0.4	0.56	131	53.63	165	Yes

9.6 Appendix F

Visual comparison between profiles



9.7 Appendix G

Base case approval

WILLEMSEN Guillaume (SRD)

From:	LANDMARK Dave (MRTE)
Sent:	Thursday, 24 May 2018 11:55 AM
To:	WILLEMSEN Guillaume (SRD)
Subject:	RE: EDD - Base case proposal for Toodyay road (slk 16.16-16.70)

Guillaume,

The base case as set out below is approved.

Regards,

Dave Landmark
Manager Road & Traffic Engineering
Planning & Technical Services Directorate
p: +61 9323 5441
w: www.mainroads.wa.gov.au

mainroads WESTERN AUSTRALIA

METRO TRAFFIC   REGIONAL TRAFFIC   f   in

From: WILLEMSEN Guillaume (SRD)
Sent: Thursday, 24 May 2018 11:52 AM
To: LANDMARK Dave (MRTE) <dave.landmark@mainroads.wa.gov.au>
Subject: EDD - Base case proposal for Toodyay road (slk 16.16-16.70)

Hi Dave,

following our conversation, I am seeking your review and approval to proceed with the development of an EDD report for the reduced vertical curve k value on Toodyay Rd (slk 16.16 to slk 16.70).

The following values are proposed for the base case:

Design speed:	110km/h
Proposed k value:	66.0
Driver eye height (car):	1.1m
Driver eye height (truck):	2.4m
RAV route:	Network 4

The following values have been taken from Appendix A - Table A4 – Austroads GRD Part 3 2016

Object height (car):	0.4m (high likelihood of dead animals being on the road)
Object height (truck):	0.8m (normal minimum object height for the Truck-Day base case)

The following values have been taken from Appendix A - Table A6 – Austroads GRD Part 3 2016

Coefficient of deceleration 'd' for cars:	0.46 (normal braking condition on sealed road)
Coefficient of deceleration 'd' for trucks:	0.29 (truck braking)

Let me know if you require any further information.

Regards,

Guillaume Willemsen
Senior Road Designer
Road and Traffic Engineering

1

Appendix 6: EDD / DE Report Template (D18#363238)

EDD / DE Report

Project / Road name & no.

Location

SUBHEADING IF REQUIRED

Consultant / Designer (Logo if required)
Contact Details

TRIM No. (if applicable)
Month Year

Contents

Document Control

Owner	
Custodian	
Document Number	
Issue Date	

Amendments

Revision Number	Revision Date	Description of Key Changes	Section / Page No.

– INTRODUCTION

This report applies to < State the Project Name and Road Name & no > and summarises the rationale behind the intention to deviate from standard design practice in the application of Normal Design Domain (NDD) design values and to use design values considered to fall within the Extended Design Domain (EDD) or Design Exception (DE) range. The report explains the reason for the proposed departure, the justification for the departure, the expected impacts and mitigation measures to address the impacts. A risk assessment is documented to show residual risk. Where the design values are considered DEs, the monitoring requirements are documented.

○ Project Purpose

- Outline the project purpose and objectives. If this is a road safety project give a description of the issue(s) that the project aims to address.

– BASIC INFORMATION

[The format of this report in sections 2 to 7 is based on the assumption that only one design element is being considered in the report. On larger projects where there may be any number of locations or design elements where EDD or DE design values are proposed to be used, the Designer may choose to repeat Sections 2 to 7 for each location or design element. Common information such as RAV Route designation, locality map, traffic volumes or traffic composition could be included up front.]

- State the location where Extended Design Domain (EDD) or Design Exception (DE) design values are to be used (SLK xxx to SLK xxx for existing roads) (Cha xxx to Cha xxx for new roads).
- Provide the RAV Route designation.
- Provide a location diagram or map (Appendix A).

○ Traffic

▪ Speed

- State the posted speed limit.
- For existing roads, state the 85th percentile speed limit and provide supporting evidence in the Appendices (MetroCount data, or similar).
- For new roads state the expected operating speed and provide supporting data from similar roads.
- State the Design Speed that would be used under Normal Design Domain (NDD). If this is also the proposed Design Speed, state this. (Note, if the proposed Design Speed is less than the NDD Design Speed, this will be covered in Section 3.).

▪ Traffic Volumes

- State the existing traffic volumes (AADT or Peak Hour volumes).
- State the future AADT (10 year horizon) and the basis on which this was estimated.

▪ Composition of Traffic

- Sate the percentage heavy vehicles and give a breakdown of the vehicle classes (if available).
- Are drivers likely to be familiar with this road? State whether the road is part of a tourist route or whether a significant number of “Grey Nomads” or “vehicles towing caravans, trailers or boats” are expected on the route.

Crash History

- For existing roads provide the most recent 5-year crash history at the relevant location. Provide details of:
    - Crash type
    - Location
    - Time
    - Severity
    - Number
- For intersections provide a crash diagram.
- Provide insights into any trends or patterns.

DESIGN ELEMENT & CRITERIA

- State the design element to which the EDD or DE design values apply.
- State the value(s) or range which would normally be applied (NDD values) and the source. (eg. Guide to Road Design Part 3: Geometric Design, Austroads, 2016)
- State the minimum (or maximum, as applicable) value or range of the EDD / DE parameter being considered and the source.
- State the EDD / DE value being proposed.

  [In the case of the application of EDD for Stopping Sight Distances (Section A,3 in Guide to Road Design Part 3: Geometric Design, Austroads, 2016) the Designer shall develop and justify the base case prior to applying the checking cases. The base case should be signed off by MRTE before applying the process to the check cases.]

  [In the case of Design Speed, for EDD purposes, the adopted value should not be less than the Operating Speed, which is taken to be the 85th percentile speed of cars at a time when traffic volumes are low and drivers are free to choose the speed at which they travel. The adopted Design Speed shall be justified based on recorded speed data or speed profiles.]

EXPLANATION

Why are EDD / DE values being proposed?

- Describe the reasons for the proposed use of EDD or DE design values.
- Describe the site constraints.
- Describe and, if possible, quantify the costs and impacts involved **with fully meeting NDD criteria**. Some costs, such as construction and right-of-way costs, are relatively easy to quantify. Social costs, such as impacts to communities or the natural environment, are more difficult to quantify but are still very important. Use tables, charts, and drawings as appropriate to illustrate and clarify the impacts. (e.g. for an isolated crest vertical curve on an existing road, it may be too costly to excavate through 10m of rock to achieve an acceptable K value. This could be illustrated using a profile drawing.)

Alternative solutions

- Describe (any) other alternatives that were considered. If any of these alternatives are based on NDD values quantify the costs and impacts involved with fully meeting NDD criteria.

Potential Impacts

- Discuss the potential impacts (of the proposed design) on any of the following aspects, as applicable:
    - Health & Safety
    - Transport Services, e.g. operational efficiency
    - Financial (construction, additional land)
    - Reputation & Trust (Political, Stakeholders and Community)
    - Business or Project Operations
    - Environmental
    - Legal & Compliance

MITIGATION

Mitigation measures considered

- Describe the mitigation measures that were considered.

Mitigation measures to be implemented

- Describe the mitigation measures that will be implemented. Include drawings if appropriate.

RISK ASSESSMENT

- Document the risk assessment process. **The focus of the initial assessment is on the use of EDD / DE design values before applying mitigation measures**. Comment on the value of the Risk Rating.
- Document the final step of the risk assessment process with the mitigation measures proposed to be implemented in place (residual risk). Comment on the value of the residual risk rating.
- Provide a copy of the Risk Assessment matrix in Appendix B. [A copy of the spreadsheet may be found in TRIM (D18#363243]

SUPPORTING INFORMATION

- For locations where an existing feature that does not meet criteria is being maintained and current crash data are available, quantify the substantive safety of the location and how it compares to similar facilities.
- If any research or other technical resources were consulted as part of the evaluation process, identify them.

– REVIEW AND APPROVAL

This EDD / DE Report has been recommended, reviewed and approved in terms of Main Roads' Delegation of Authority Manual.

1. To be completed by RM, DMO, DSWO,BM or PD

The use of EDD / DE (delete not applicable) design values are recommended to be used on this project:

…………………………..	………………………..	………………………	……….
Name	Signature	Position	Date

Comments:

---

2. To be completed by MRTE, SES or MME

The use of EDD / DE (delete not applicable) design values have been reviewed by me and are recommended / not recommend (delete not applicable) for approval to be used on this project:

…………………………..	………………………..	………………………	……….
Name	Signature	Position	Date

Comments:

---

3. To be completed by EDPTS

The use of EDD / DE (delete not applicable) design values are approved / not approved (delete not applicable) be used on this project:

…………………………..	………………………..	………………………	……….
Name	Signature	Position	Date

Comments:

– REFERENCES AND RELATED DOCUMENTS

Document Number	Description

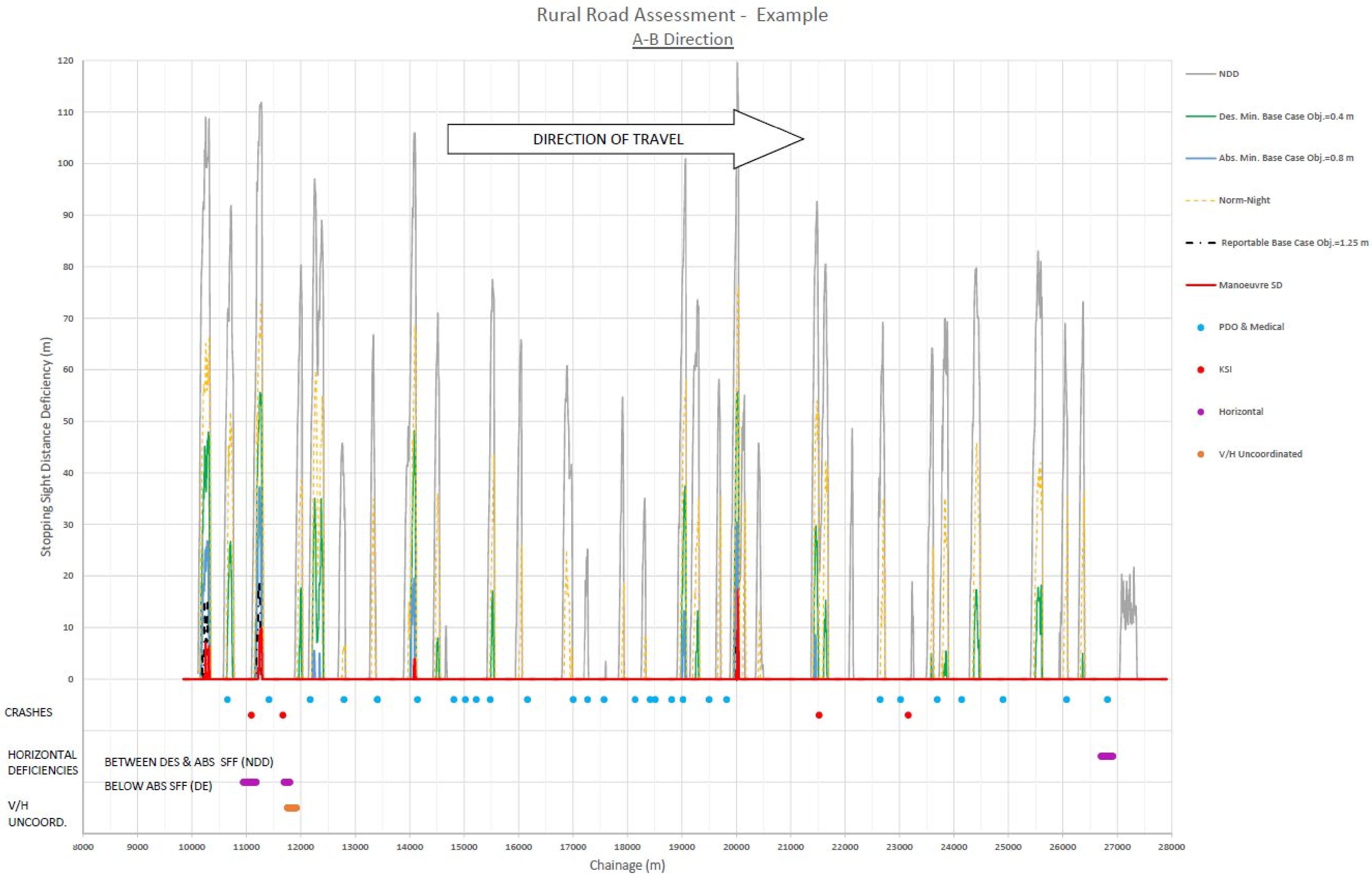
– APPENDICES

Appendix	Title
Appendix A	Locality Map
Appendix B	Risk Assessment Spreadsheet
Appendix C	
Appendix D	
Appendix E	

Appendix A: Locality Map

Appendix B: Risk Assessment Spreadsheet

Appendix 7: Sample Output from the Extended Design Domain Rural Road Assessment Tool


Rural Road Assessment - Example
A-B Direction
DIRECTION OF TRAVEL
Stopping Sight Distance Deficiency (m)
Chainage (m)
CRASHES
HORIZONTAL DEFICIENCIES
BETWEEN DES & ABS SFF (NDD)
BELOW ABS SFF (DE)
V/H UNCOORD.
NDD
Des. Min. Base Case Obj.=0.4 m
Abs. Min. Base Case Obj.=0.8 m
Norm-Night
Reportable Base Case Obj.=1.25 m
Manoeuvre SD
PDO & Medical
KSI
Horizontal
V/H Uncoordinated