Queensland Guide to Smart Motorways

Supplement to Austroads Guide to Smart Motorways

March 2024

Queensland Government

Translating and interpreting assistance

The Queensland Government is committed to providing accessible services to Queenslanders from all cultural and linguistic backgrounds. If you have difficulty understanding this publication and need a translator, please call the Translating and Interpreting Service (TIS National) on 13 14 50 and ask them to telephone the Queensland Department of Transport and Main Roads on 13 74 68.

Feedback

Please send your feedback regarding this document to: tmr.techdocs@tmr.qld.gov.au

About this document

Austroads [Guide to Smart Motorways](#) (AGSM) provides valuable guidance to practitioners involved in the delivery of safe and efficient smart motorways.

This Guide has been compiled to provide a definitive, standardised set of smart motorway information, where previously it has been spread across publications such as the Road Planning and Design Manual (RPDM Part 5), ITS placement guideline, QGTM and AGSM (Austroads 2016d). Where the information within this document differs from existing content in the other Austroads *Guides*, this Queensland supplement will take precedence. Most practical issues can be well accommodated by the approach outlined in this *Guide*. While local conditions and circumstances may sometimes require unique or innovative approaches to design, it is important that practitioners still adhere to the principles for design and operation that are documented in the *Guide*.

How to use this document

The Department of Transport and Main Roads has agreed to adopt the standards published in Austroads *Guides* as part of national harmonisation. The department seeks to avoid duplicating information addressed in national guidance and has developed documents instead that provide Queensland-specific advice, while following the structure established in Austroads *Guides*.

Queensland-specific advice includes practices which vary from national practice because of local environmental conditions (such as geography, soil types, climate); different funding practices; local research; local legislation requirements; and to expand instruction on particular issues.

As such, this *Guide* takes precedence over the Austroads *Guide to Smart Motorways,* except where the Austroads *Guide* is accepted without changes.

This *Guide* is designed to be read and applied together with Austroads *Guide to Smart Motorways.* Readers must have access to the Austroads *Guide* to understand application in Queensland.

This Guide:

- sets out how the Austroads *Guide to Smart Motorways* applies in Queensland
- has precedence over the Austroads *Guide to Smart Motorways* when applied in Queensland, and
- has the same section numbering and headings as the Austroads *Guide to Smart Motorways.*

The following table summarises the relationship between the Austroads *Guide to Smart Motorways* and this document:

Applicability	Meaning
Accepted	The Austroads *Guide* section is accepted.
Accepted, with amendments	Part or all of the Austroads *Guide* section has been accepted with additions, deletions or differences.
New	There is no equivalent section in the Austroads *Guide*.
Not accepted	The Austroads *Guide* section is not accepted and does not apply in Queensland.

References

Reference to…	Means
AGSM	Austroads *Guide to Smart Motorways*
Engineering Policy (EP)	Department of Transport and Main Roads Engineering Policies
Queensland Guide to Traffic Management (QGTM)	*Queensland Guide to Traffic Management*
Queensland Manual of Uniform Traffic Control Devices (Queensland MUTCD)	Queensland *Manual of Uniform Traffic Control Devices*
Queensland (Q) series / Traffic Control (TC) sign	The TC signs are a collection of non-standard traffic control (TC) signs that have been 'officially approved' as required by the *Transport Operations (Road Use Management) Act* 1995. Included in this register are the MUTCD Q-series signs.
RPDM	*Road Planning and Design Manual, 2nd Edition*
Standard Drawing (SD)	Department of Transport and Main Roads Standard Drawings
Technical Specification (MRTS)	Department of Transport and Main Roads Technical Specifications
TRUM	*Traffic and Road Use Management Manual*

Relationship table

Section		Title	Queensland application
1.	**Introduction**		
	1.1	Guide Purpose	Accepted
	1.2	Smart Motorways	Accepted
	1.3	Guide Scope and Content	Accepted
	1.4	Safety and Operations Context	Accepted
	1.4.1	*Safe Systems*	Accepted
	1.4.2	*Systems Engineering*	Accepted
	1.5	Guide Use	Accepted with amendments
2.	**Smart Motorway Benefits**		
	2.1	Performance Issues	Accepted
	2.2	The Role of Active Management	Accepted
	2.3	Demonstrating the Benefits	Accepted
	2.4	Sustaining the Benefits	Accepted
3.	**Overview of Smart Motorway Elements**		
	3.1	Context within an Integrated Road Network Management System	Accepted
	3.2	Operational Objectives	Accepted with amendments
	3.3	Elements of a Smart Motorway	Accepted
	3.3.1	*Intelligence*	Accepted
	3.3.2	*Traveller Information*	Accepted
	3.3.3	*Control*	Accepted with amendments
	3.4	Foundation Systems and Infrastructure	Accepted
	3.4.1	*Central Control System*	Accepted
	3.4.2	*Communications System*	Accepted
	3.4.3	*Power System*	Accepted
	3.4.4	*Traffic Management Centre*	Accepted
4.	**Planning and Design for Smart Motorway Systems**		
	4.1	General Principles and Progress	Accepted with amendments
	4.2	Operations-driven Planning Frameworks	Accepted with amendments
	4.3	Defining Motorway Objectives and Targets	Accepted
	4.4	Ultimate Motorway Objectives and Targets	Accepted with amendments
	4.5	Whole-of-network Approach	Accepted
	4.6	Whole-of-lifestyle Approach	Accepted
	4.7	Operational Efficiency Audits	Accepted
	4.8	Traffic Analysis	New

Section		Title	Queensland application
5.	**Principles of Motorway Flow and Analysis**		
	5.1	Congestion Management Theory	Accepted
	5.1.1	*Flow Monitoring and Management*	Accepted
	5.1.2	*Two-phase HCM Model*	Accepted
	5.1.3	*Three-phase Model*	Accepted
	5.1.4	*Other Models of Flow Breakdowns*	Accepted
	5.2	Principles Underlying Smart Motorways	
	5.2.1	*Causes and Impacts of Flow Breakdown*	Accepted
	5.2.2	*Motorway Operational Capacity*	Accepted
	5.2.3	*Merge Capacity for a Smart Motorway with Ramp Signals*	Accepted
6.	**Selection of Smart Motorway Elements**		Accepted with amendments
7.	**Geometric Elements and Capacity Analysis**		
	7.1	Design Principles and Process	Accepted
	7.2	Example Performance Targets	Accepted
	7.3	Mainline	Accepted
	7.4	Interchange Spacing	Accepted
	7.4.1	*Major Single Entry Compared with Multiple Entrances*	Accepted
	7.5	Entry Ramps	Accepted
	7.6	Exit Ramps	Accepted
	7.7	Arterial Intersections	Accepted
	7.8	Mainline Priority Lanes	Accepted
	7.9	Emergency Stopping Bays	Accepted with amendments
	7.10	Other Roadside Items	Accepted
8.	**Foundation Infrastructure**		
	8.1	Communications Infrastructure	Accepted with amendments
	8.2	Power Network	Accepted with amendments
	8.3	Roadside ITS Cabinets	Accepted with amendments
9.	**Network Intelligence**		
	9.1	Vehicle Detection	Accepted with amendments
	9.1.1	*Types of Data Collection*	Accepted with amendments
	9.1.2	*Criteria for Provision*	Accepted with amendments
	9.1.3	*Detector Placement*	Accepted with amendments
	9.2	CCTV	
	9.2.1	*Applications*	Accepted with amendments
	9.2.2	*Types of CCTV Camera*	Accepted
	9.2.3	*Criteria for Provision*	Accepted with amendments

Section		Title	Queensland application
	9.2.4	*Viewing Requirements*	Accepted
	9.2.5	*Camera Placement*	Accepted
	9.2.6	*Mounting Structures and Camera Positioning*	Accepted
	9.3	Incident Detection	
	9.3.1	*Applications*	Accepted
	9.3.2	*Incident Detection Technologies*	Accepted
	9.3.3	*Criteria for Provision and Design Considerations*	Accepted
	9.4	Help Phones	
	9.4.1	*Application*	Accepted
	9.4.2	*Criteria for Provision*	Accepted with amendments
	9.4.3	*Help Phone Placement*	Accepted with amendments
	9.4.4	*Other Design Considerations*	Accepted with amendments
	9.5	Environmental Monitoring	Accepted with amendments
	9.6	Other Data Sources	Accepted
10.	**Roadside Traveller Information**		
	10.1	Applications and Benefits	Accepted
	10.1.1	*Applications*	Accepted
	10.1.2	*Benefits*	Accepted
	10.2	Criteria for Provision	Accepted
	10.2.1	*Mainline VMS*	Accepted
	10.2.2	*Arterial Road VMS*	Accepted
	10.3	VMS Messages	
	10.3.1	*General Principles for VMS Message Displays*	Accepted with amendments
	10.3.2	*Message Types and Priorities*	Accepted
	10.3.3	*Travel Time Message Format*	Accepted
	10.3.4	*Travel Time Message Calculations*	Accepted
	10.3.5	*Other Message Formats*	Accepted
	10.4	Mainline VMS Face Layout and Installation	Accepted
	10.4.1	*Sign Face Layout*	Accepted
	10.4.2	*Legibility Distance Requirements*	Accepted
	10.4.3	*Sign Size*	Accepted
	10.4.4	*Geometrical Considerations*	Accepted
	10.4.5	*Longitudinal Placement and Co-location*	Accepted with amendments
	10.4.6	*Mounting Arrangements*	Accepted
	10.4.7	*Sign Orientation*	Accepted
	10.4.8	*Horizontal and Vertical Clearances*	Accepted
	10.4.9	*Maintenance Access*	Accepted

Section		Title	Queensland application
	10.4.10	*Supporting Traffic Management Devices*	Accepted
	10.5	Arterial Road VMS Face Layout and Device Installation	Accepted
	10.5.1	*Sign Face Layout*	Accepted
	10.5.2	*Legibility Distance Requirements*	Accepted
	10.5.3	*Sign Size*	Accepted
	10.5.4	*Longitudinal Placement and Co-location*	Accepted
	10.5.5	*Mounting Arrangements*	Accepted
	10.5.6	*Horizontal and Vertical Clearances*	Accepted
	10.5.7	*Maintenance Access*	Accepted
	10.5.8	*Supporting Traffic Management Devices*	Accepted
	10.6	Operation of VMS	
	10.6.1	*Message Display and Approvals*	Accepted
	10.6.2	*Types of Control*	Accepted
	10.6.3	*Operational Principles*	Accepted
11.	**Coordinated Ramp Metering**		
	11.1	Principles and Benefits of Ramp Metering	
	11.1.1	*Principles*	Accepted
	11.1.2	*Benefits*	Accepted
	11.2	Criteria for Provision	Accepted with amendments
	11.3	Ramp Meter Control Fundamentals	Accepted
	11.3.1	*Control Logic*	Accepted
	11.3.2	*Types of Control: Local and Coordinated*	Accepted
	11.3.3	*Fixed-time and Dynamic Operation*	Accepted
	11.3.4	*Managing Ramp Demands*	Accepted
	11.3.5	*Managing Heavy Congestion and Incidents*	Accepted
	11.3.6	*Situations when Ramp Signals may have Limited Effectiveness*	Accepted
	11.4	Operation of Ramp Signals	Accepted
	11.4.1	*Dynamic Activation and Deactivation*	Accepted
	11.4.2	*Scheduled Start-up and Close-down*	Accepted
	11.4.3	*Operation During Incidents and Events*	Accepted
	11.4.4	*Manual Operation*	Accepted
	11.4.5	*Start-up and Close-down Control Sequences*	Accepted
	11.4.6	*Average Cycle Times*	Accepted
	11.4.7	*Minimum Red, Green and Yellow Times*	Accepted
	11.4.8	*Vehicle Release at the Stop Line*	Accepted
	11.4.9	*Ramp Signals Response to a Lane Closure*	Accepted

Section		Title	Queensland application
	11.4.10	*Ramp Signals Response to Changing Speed Limits*	Accepted
	11.4.11	*Ramp Signals Response to a Motorway Closure*	Accepted
	11.4.12	*Emergency Vehicle Access when Ramp Signals are Operating*	Accepted
	11.5	Design Elements of Ramp Metering	Accepted
	11.5.1	*Design Traffic Flows*	Accepted
	11.5.2	*Number of Metered Lanes at the Stop Line*	Accepted
	11.5.3	*Entry Ramp Queue Storage Requirements*	Accepted with amendments
	11.5.4	*Entry Ramp Lane Configuration*	Accepted with amendments
	11.5.5	*Stop Line Position Relative to the Nose*	Accepted with amendments
	11.5.6	*Acceleration and Merging Configuration*	Accepted with amendments
	11.5.7	*Traffic Management Devices*	Accepted with amendments
	11.5.8	*Priority Access Lanes*	Accepted with amendments
	11.5.9	*Motorway-to-motorway Ramps*	Accepted
	11.5.10	*Designing for Future Retrofitting of Ramp Signals*	Accepted
12.	**Lane Use Management Systems (Including Variable Speed Limits)**		
	12.1	Applications and Benefits	Accepted
	12.1.1	*LUMS Applications*	Accepted with amendments
	12.1.2	*VSL-specific Applications*	Accepted
	12.1.3	*Benefits*	Accepted with amendments
	12.2	Criterion for Provision	Accepted with amendments
	12.3	LUMS Symbols	Accepted with amendments
	12.4	Sign Face Layout and Installations	
	12.4.1	*Sign Face Layout*	Accepted with amendments
	12.4.2	*Legibility Distance Requirements*	Accepted
	12.4.3	*Sign Size*	Accepted with amendments
	12.4.4	*Geometrical Considerations*	Accepted
	12.4.5	*Longitudinal Placement and Co-location*	Accepted with amendments
	12.4.6	*Mounting Arrangements*	Accepted with amendments
	12.4.7	*Sign Orientation*	Accepted
	12.4.8	*Horizontal and Vertical Clearances*	Accepted
	12.4.9	*Maintenance Access*	Accepted
	12.4.10	*Enforcement Devices*	Accepted
	12.4.11	*Supporting Static Signing*	Accepted with amendments
	12.4.12	*Other Supporting Traffic Management Devices*	Accepted
	12.5	Operation of LUMS	Accepted

Section		Title	Queensland application
	12.5.1	*Types of Control*	Accepted
	12.5.2	*LUMS Field Response Rules*	Accepted with amendments
	12.5.3	*Operational Principles*	Accepted
	12.6	Side-mounted VSL	New
13.	**Provision of an Emergency Lane**		Accepted with amendments
	13.1	Applications and Benefits	
	13.1.1	*Applications*	Accepted
	13.1.2	*Benefits*	Accepted
	13.2	Criteria for Provision	Accepted
	13.3	Key Design Considerations	Accepted
	13.3.1	*General Traffic Use – Isolated Lengths*	Accepted
	13.3.2	*General Traffic Use – Extended Lengths*	Accepted
	13.3.3	*Queue Storage at Exit Ramps (Part – or Full-time)*	Accepted
	13.3.4	*Special Vehicle Applications (Part – or Full-time)*	Accepted
	13.4	Operations	Accepted
14.	**Arterial Road and Motorway Interface Management**		
	14.1	Improving Coordination at Interfaces	Accepted
	14.2	Guiding Principles for Achieving Network Optimisation	Accepted
	14.3	Managing of Entry Ramp Interfaces	
	14.3.1	*Specific Problems at Arterial Road / Exit Ramp Interfaces*	Accepted
	14.3.2	*Treatment Options for Arterial Road / Exit Ramp Interfaces*	Accepted
	14.4	Management of Exit Ramp Interfaces	
	14.4.1	*Specific Problems at Arterial Road / Exit Ramp Interfaces*	Accepted
	14.4.2	*Treatment Options for Arterial Road / Exit Ramp Interfaces*	Accepted
	14.5	Management of End-of-motorway Interfaces	
	14.5.1	*Specific Problems at End-of-motorway Interfaces*	Accepted
	14.5.2	*Treatment Options for End-of-motorway Interfaces*	Accepted
	14.6	Management of Motorway-to-motorway Interfaces	
	14.6.1	*Specific Problems at Motorway-to-motorway Interfaces*	Accepted
	14.6.2	*Treatment Options for Motorway-to-motorway Interfaces*	Accepted

Section		Title	Queensland application
15.	**Additional Considerations**		
	15.1	Localised ITS Safety Applications	Accepted
	15.2	Tunnel Traffic Management	Accepted
	15.3	Compliance and Enforcement	Accepted
	15.4	System Performance Management	Accepted
	15.5	Motorway Performance Evaluation	Accepted
	15.6	Emerging Technologies	Accepted
	15.7	Placement of Roadside Equipment	
	15.7.1	*Road Safety*	New
	15.7.2	*Theft and Vandalism*	New
Appendices			
A	**Complementary Austroads References**		Accepted
B	**Smart Motorway Benefit Evaluations**		Accepted
C	**Field Infrastructure for Smart Motorways**		Accepted
D	**LUMS Traffic Management Rules**		Accepted with amendments
E	**Typical Placement of Mainline Features**		New
F	**Typical Ramp Signal Layouts**		New
G	**Typical Acceleration Graph for Changing Gradients**		New
Glossary			Accepted with amendments

Contents

Tables

Figures

1 Introduction

1.5 Guide Use

Addition

In Queensland the use of this Guide as supplement to the AGSM shall not limit the requirements of Engineering Policy EP149 *Managed motorways*.

If further information or assistance with this Guide is required, please contact Director (Network Optimisation), Statewide Network Operations Branch, Department of Transport and Main Roads.

3 Overview of Smart Motorway Elements

3.2 Operational Objectives

Addition

Operational objectives in Queensland are outlined in Engineering Policy EP149 *Managed motorways*.

3.3 Elements of a Smart Motorway

3.3.3 Control

Addition

Note: Queensland is currently reviewing the application of emergency lane running and all-lane running (without compliant shoulders) in motorway environments."

4 Planning and Design for Smart Motorway Systems

4.1 General Principles and Progress

Addition

The primary objective of a smart motorway system is to provide a safe and reliable level of service that maximises productivity of the motorway. This objective cannot be achieved simply by adding ITS to an existing motorway to control flow without consideration of the motorway's geometric design and traffic demands (Austroads, 2016). ITS treatments cannot be used to correct for poor geometric design, and in some cases, it is not advisable to retrofit Smart Motorway Systems to an existing motorway without first undertaking civil works to correct geometric deficiencies. This may not always be the case and it is important to consult with smart motorway design experts when considering retrofitting of smart motorway controls on an existing motorway facility.

For a major motorway upgrade, it is important to ensure that the general motorway layout has well-designed geometric features that optimise capacity and minimise traffic flow turbulence so that the ITS control interventions can manage the motorway mainline to provide optimal traffic outcomes.

Design development is an iterative process that often involves changes when output from a project stage indicates the need to revisit an earlier decision. Table 4.1 shows the general planning and design process for a smart motorway project and outlines the design considerations for each Stage.

Table 4.1 – Planning and design development process

Project Stage	Design Check List
Network Planning (Pre-concept Phase)	• Develop a strategic operational concept for an integrated smart motorway network. • Prioritise a list of network needs and desired outcomes.
Proposal and Options Analysis (Concept Phase)	• Develop detailed Concept of Operations (ConOps) for motorway corridors / sections being considered for delivery. • Following completion of initial traffic analysis and development of ConOps, an options analysis is used to determine which solution is progressed to business case. • As required, determine where corridor preservation for storage at entry ramps is needed. This requires understanding of design year demand modelling for storage calculations.
Business Case (Project Planning Phase)	• Operations: preferred solution aligned with the operations concept, including details of major ITS elements (operational safety, technology systems, maintenance and construction interface). • Consideration of ongoing maintenance and operational funding needs to be included in the business case. • Assessment: robust business case (high-level traffic analysis - economic and environmental). • Infrastructure: most efficient infrastructure design (highways, geometrics, structures, technology). • Crash history and Incident Analysis. • Analysis of existing motorway operation including identification of existing bottlenecks. • Refinement to produce more detailed corridor level ConOps. • Ramp storage requirements based on design year demands.
Preliminary Design	• Detailed traffic analysis. • Geometric road design to address identified mainline bottlenecks and support ConOps. • Geometric design of ramp storage requirements for inclusion during interchange, entry ramp and surrounding arterial network design. • Concept design for mainline device placement in accordance with placement requirements. Devices include detector loops, Lane Use Management Systems (LUMS), Variable Speed Limits (VSL), CCTV and Variable Message Signs (VMS) and so on). • Detector and device placement for ramp signal design. • Design for maintenance access to all ITS devices. • Operational efficiency audit (see glossary) of concept design against ConOps objectives.
Detailed Design	• Refine detector and device placement based on design constraints. • Finalise design for gantry (for example, type of gantry) or mounting structures (for example. side mounted for VSL signs). • Document ITS design ready for construction with appropriate specifications and standards. • Operational efficiency audit of detailed design against ConOps objectives. • Generation of STREAMS schematic.
Construction	• Amend design based on site conditions, as required. • Support STREAMS configuration activities through provision of accurate as-constructed drawings and information. • Design support for testing and commissioning processes. • Post construction benefits realisation for ITS treatments.

4.2 Operations-driven Planning Frameworks

Addition

Operations led design, recognises that effective operations are critical to achieving successful outcomes and that operational needs must be considered right from the start of the project.

Transport and Main Roads have developed a Concept of Operations (ConOps) template to step through the core elements of the process. A ConOps that clearly identifies the operational requirements and outcomes should be developed for all smart motorway schemes. Network planning activities should define current network problems and needs, which will inform the motorway's objectives and targets. The adoption of these objectives and targets will ensure that the project scope and ITS elements are aligned with the ConOps.

The ConOps should ensure that the requirements of Engineering Policy EP149 *Managed Motorways* have been met. The ConOps template can be requested from the Director (Network Optimisation), Statewide Network Operations Branch.

4.4 Ultimate Motorway Objectives and Targets

Addition

Future roadway widening shall be considered when positioning detector equipment, sensors, and associated underground infrastructure.

Strategic planning of designs in urban areas may prove most useful when provisioning for future expansion. This includes both the detection devices and the real estate required for these devices. The roadways design should include real estate for poles, cabinets and other roadside furniture, in order to reduce future expansion / relocation costs.

Designers may also need to consider that ITS deployment may be on a temporary and/or 'early works' basis to overcome issues during construction. While provision of ITS applications may not be required immediately, land acquisition and civil works should be undertaken to allow these to occur easily in future.

4.8 Traffic Analysis

New

Analysis is an important component in defining the motorway objectives and targets, as set out in the ConOps. Traffic analysis should identify existing and future mainline bottlenecks, frequent crash locations, congested arterial impacts at the exit ramps, entry ramps and potential diversions.

The following should be considered for the design of ITS placement:

- Bottleneck locations should be identified and classified to ensure the appropriate mainline treatment is applied. Existing bottlenecks may be identified by reviewing CCTV footage or travel times.
- A recent five-year crash history for the relevant section of roadway should be obtained to help guide analysis.
- The relevant Traffic management centre should be consulted to inform driver behaviour analysis.

- Entry ramp traffic demands, for the project's final design year, should be specified to ensure that the ramp design has adequate provision for storage with ramp metering.
- Exit ramp traffic demands and arterial intersection design should be reviewed. The design of the exit ramp should consider the impacts of arterial queue spillback from the exit ramp onto the motorway.
- Design (forecast) mainline traffic flows should be reviewed to ensure that they are within the capacity of the smart motorway. Consideration should also be given to the basic number of lanes to maintain lane continuity and minimise frequent changes in cross-section.

6 Selection of Smart Motorway Elements

Addition

Engineering Policy EP149 *Managed Motorways* provides direction as to the minimum requirements for the selection of smart motorway elements on Queensland motorways and takes precedence over elements similarly addressed in Table 6.1.

7 Geometric Elements and Capacity Analysis

7.9 Emergency Stopping Bays

Addition

TC1340 provides layout, pavement marking, and sign guidance for emergency stopping bays (with and without help phones) on motorways.

8 Foundation Infrastructure

8.1 Communications Infrastructure

Addition

For requirements of smart motorway communication infrastructure, refer to MRTS245 *ITS Telecommunications Network*.

8.2 Power Network

Addition

For requirements relating to power networks refer to TRUM Volume 4 Part 3 *Electrical Design for Roadside Devices*.

8.3 Roadside ITS Cabinets

Addition

For requirements relating to ITS cabinet placement refer to MRTS200 *General Requirements for Intelligent Transport Systems (ITS) Infrastructure*.

9 Network Intelligence

9.1 Vehicle Detection

Addition

For requirements relating to data accuracy refer to MRTS204 *Vehicle Detectors*.

9.1.1 Types of Data Collection

Addition

Data collection devices deployed within a Smart Motorways corridor shall be limited to those included on the department's approved products lists. The use of data collection devices not on an approved products list shall be agreed upon on a case-by-case basis.

9.1.2 Criteria for Provision

Addition

The ConOps for a smart motorway project will identify the operational objective of the corridor. These objectives will then determine the required provisions in accordance with Engineering Policy EP149 *Managed motorways*.

9.1.3 Detector Placement

Addition

Detectors shall be placed immediately upstream of the entry ramp stop line to enable cycling of the ramp signals when the ramp metering system is operational. Placement of detectors shall be such that it minimises possible double counting of vehicles caused by weaving.

In principle, mainline detectors shall be placed in accordance with each of the following:

- upstream of the entry ramp nose (separate detectors for ramp and mainline traffic)
- downstream of the exit ramp nose (separate detectors for ramp and mainline traffic)
- at the end of all entry ramp merges (generally, 0 m to 20 m downstream of the end of ramp taper). This is the primary detector site for ramp metering control
- upstream of potential bottleneck locations where traffic flow needs to be managed (for example, just upstream of lane drops, on steep upgrades, tight curves and road narrowing), and
- downstream of the bottleneck, where possible, to provide for a VSL sign to reinstate the mainline speed.

Detector placement shall comply with the following:

- One detector site associated with each VSL site.
- Adequate distance between VSL sites and downstream detector sites (these sites will feed data to the upstream associated VSL sites).
- No detectors in merge and diverge areas (such as: entry ramp, exit ramp, steep grades and lane drop tapers). Detectors in these areas may result in data abnormalities which will impact the algorithm's performance; however, in some circumstances this may be unavoidable.

For general layouts of entry ramp detector placement, see Appendix B.

9.2 CCTV

9.2.1 Applications

Addition

All CCTV imaging devices shall comply with MRTS155 *Policy for Road Operations Imagery* and MRTS225 *Imaging*.

9.2.3 Criteria for Provision

Addition

The ConOps for a smart motorway project will identify the operational objective of the corridor. These objectives will then determine the required provisions in accordance with Engineering Policy EP149 *Managed motorways*.

9.4 Help Phones

9.4.2 Criteria for Provision

Addition

The planning and operational installation decision for help phones shall be undertaken in accordance with EP149 *Managed motorways* and IMD Advice Note 3: *New help phones on current and future projects*. To obtain a copy of IMD Advice Note 3 email: TIManagement@tmr.qld.gov.au.

9.4.3 Help Phone Placement

Addition

The design and technical specifications of help phones should be undertaken in accordance with the following TMR documents:

- MRTS221 *Help Phones*
- RPDM Volume 3 Part 6B: *Roadside Environment*
- TC1430

9.4.4 Other Design Considerations

Addition

For requirements relating to help phones refer to MRTS221 *Help Phones*.

9.5 Environmental Monitoring

Addition

Weather stations should be considered at locations where traffic conditions are significantly impacted by adverse weather. The location of weather stations along motorways should suit weather conditions typically experienced in the area. Weather stations should be placed to achieve the operational outcomes specified within the ConOps.

Weather detectors shall be mounted on a pole at a maximum 12 m height and at distance less than 6 m from the left edge line (measured at grade). The weather station should be positioned to minimise adverse impacts on the sensors (for example, clear of trees, noise barriers, batter slopes, and so on). Further details are provided in MRTS231 *Road Weather Monitor (RWM) Systems*.

10 Roadside Traveller Information

10.3 VMS Messages

10.3.1 General Principles for VMS Message Displays

Addition

The planning and operational decisions for variable message signs shall be in accordance with the department's Organisational Policy *Display of Information on Variable Message Signs*.

10.4 Mainline VMS Face Layout and Installation

10.4.5 Longitudinal Placement and Co location

Addition

Co-location

Requirements for co-location are detailed in QGTM Part 10 *Collocation of gantry-mounted variable speed limit signs with static and monochrome variable message signs*.

11 Coordinated Ramp Metering

11.2 Criteria for Provision

Addition

The ConOps for a smart motorway project will identify the operational objective of the corridor. These objectives will then determine the required provisions in accordance with Engineering Policy EP149 *Managed motorways*.

11.5 Design Elements of Ramp Metering

11.5.3 Entry Ramp Queue Storage Requirements

Addition

Desirable minimum storage

A "rule of thumb" wait time considered reasonable for ramp signal design is four minutes, although it may be beneficial to maximise storage for a six-minute wait time. However, this may not be achievable on existing entry ramps connecting to the arterial network due to additional storage length required.

In locations where modifying the ramp to provide the desirable storage (4-minute wait time between the ramp entrance and the ramp signals stop line) is not feasible, a lower storage value may need to be considered. In these situations, typically a minimum 3-minute wait time queue length (25% reduction compared with the desirable) may need to be adopted for design. This amount of storage will generally be sufficient to accommodate storage for turning vehicles arriving in a platoon from the arterial road / ramp intersection signals.

Where a short ramp is to be provided (for example 3-minute storage) due to physical site constraints, the sum of the ramp storage provided by the adjacent two or three upstream ramps should average to 4-minute ramp storage. For example, (3+4.5+4+4.5)/4=4 min. This enables the coordinated system to provide equitable access, whilst maintaining control of the motorway. Care should be taken with adopting reduced storage on major entry ramps which will act as the “master” ramp for coordinated ramp metering. Because of the increased demand at these significant ramps, it is possible that the system may not be able to sufficiently utilise the additional storage at the minor upstream ramps to offset the storage deficiency at the master ramp.

Design options to accommodate ramp storage requirements

Ramps should be designed to accommodate queues, allowing the ramp queues to be managed within the ramp length. However, at locations where high entry ramp demands cannot be satisfied (it may not always be feasible to increase ramp storage), the traffic queues may need to extend onto the arterial road network. In this situation, the additional storage length required should be provided in such a way as to avoid interference with arterial road flows.

Where queues are expected to extend onto the arterial road on a regular basis, the designer shall provide queue detection on the arterial road and provisions to accommodate overflows.

Strategies that may mitigate these overflows are listed below. These strategies are only examples, and site-specific queue management strategies will need to be developed with the arterial road operator for each entry ramp:

- Queuing traffic should be separated from local traffic where possible. In some places, additional lanes may be provided on the arterial network to separate queuing traffic from local traffic.
- In situations where traffic queuing for ramp signals approaches from multiple origins, queues might extend back onto several local routes. Separation should be maintained on all routes.
- Where the ramp storage requirement is expected to extend back through intersections on the arterial network, options to address end-of-queue issues should be considered.
- Where queues extend through signalised intersections or roundabouts, pavement marking and signing should inform motorists not to queue through the intersection. It may be necessary to signalise the intersection, particularly if queued vehicles obstruct the visibility for drivers selecting gaps in the traffic stream(s).
- It is desirable that queues on the local network do not queue past property access points. Where this is unavoidable, consideration should be given to left-in, left-out only movements.
- Where routes are expected to experience queuing, pedestrian crossings shall be signalised.
- Signal timings should be optimised and coordinated on the upstream signalised intersection to ensure the length of the platoon arriving at the ramp signal does not exceed the available storage within each cycle.
- Shared lanes (for example, general traffic and bicycle lanes) may result in conflict points where cyclist movements need to cross ramp traffic and shall be avoided on routes where queuing may occur.

- Buses and bus stops should remain separate from ramp queues.
- To discourage queue jumping, consideration should be given to the use of line marking, such as a single continuous line, to separate ramp queues from traffic queueing at intersections.

Where ramp metering is specified as part of a new motorway, motorway upgrade or as a singular implementation, funding for the ramp metering scheme must consider the changes required to the local road network to manage queue overflows. The ability to store vehicles in a manner that reduces the impact on the local road network is imperative to the success of the ramp metering scheme and, hence, the performance of the motorway.

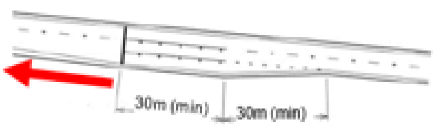
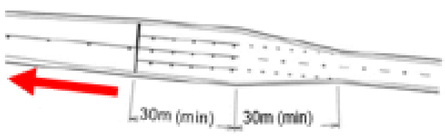
11.5.4 Entry Ramp Lane Configuration

Addition

Localised flaring can be used to increase the number of lanes at the stop line and enable the required number of vehicles to be released per green at the ramp signals. For example, to increase the number of vehicles being released per green from two to three, while maintaining a release rate of one vehicle per green per lane, an additional short lane may be provided.

Experience has shown that utilisation of short add lanes can be problematic and therefore 30 metres (minimum) storage length and 30 metres (minimum) taper length as shown in Figure 11.5.4 is considered the absolute minimum length for short lanes. This provides greater opportunity for vehicles to make use of storage and maximises departure flow from signals. To maximise lane utilisation of the short lane, it is strongly recommended that short lane length is maximised. This is especially important when there are heavy vehicles in the traffic mix.

Figure 11.5.4 – Examples of Localised Flaring to Increase the Number of Lanes at the Stop Line

Three lanes at the stop line	Four lanes at the stop line
	
Three vehicles/green (One vehicle/green/lane)	Four vehicles/green (One vehicle/green/lane)

11.5.5 Stop Line Position Relative to the Nose

Difference

Replace Figure 11.8 and Figure 11.9 with Figure F.5.

11.5.6 Acceleration and Merging Configuration

Addition

Two lanes

When determining the acceleration length and location of the stop line, the design standards for two-lane, single-entry ramps (single lane at ramp nose) are based on the following principles:

When ramp signals are off, merging to a single lane is to be completed prior to the ramp nose at a design speed of 80 km/h. The two-lane to one-lane merge within the ramp is based on an acceleration lane lateral movement merge rate of 1.0 m/s. This results in an 80 m minimum merge length from the stop line to the ramp nose.

Other provisions include:

- The motorway shoulder is fully developed at the ramp nose as a run-out area.
- Speed limit signs for the motorway entry are located after leaving the stop line, typically 20-40 metres upstream of the nose.

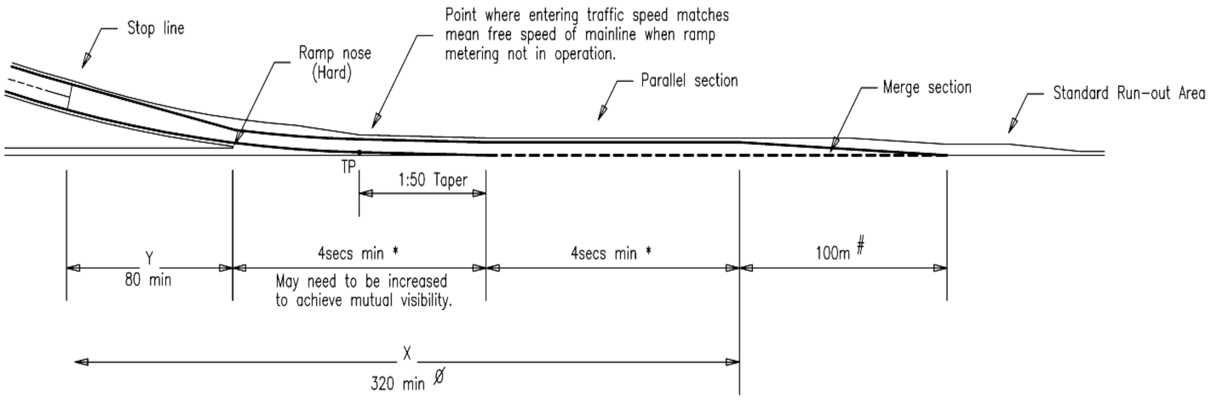
When ramp signals are on, the design is based on the acceleration distance from the stop line to merging with the mainline traffic as follows:

Adopt a mainline operating speed in the left lane of 10 km/h less than the posted speed (for example, 90 km/h in a 100 km/h posted speed motorway). This is consistent with free-flow operational data and operating speeds when ramp signals would be operating.

Adopt a 10 km/h speed differential for merging relative to the motorway left lane operating speed (that is, acceleration from zero to an 80 km/h merging speed in a 100 km/h posted speed motorway). In general, ramp signalling is activated when mainline traffic volumes are high and speeds have been adjusted.

Figure 11.5.6 shows the typical geometric arrangement for a two-lane entry ramp.

Figure 11.5.6 – Typical Geometric Arrangement



Notes:

X & Y need to be adjusted for upgrades >2% in accordance with the graph shown in Appendix G.

* at mainline operating speed under light traffic conditions.

or 1.0 m/s lateral shift for motorway mean free speed.

∅ for motorway posted at 100 km/h, 320 m allows vehicles to accelerate to a mean free speed of approximately 90 km/h.

The following matters may also need to be considered:

- The stop line distance to the ramp nose may need to be increased for site specific conditions (for example, to 100 m or 120 m) with consideration given to the type of vehicle which needs to accelerate from a stopped position. Where a high proportion of heavy vehicles utilise the entry ramp (and no unmetered bypass facility is provided), the distance from the stop line to the ramp nose may be increased if adequate storage is available. The speed reached by a heavy vehicle at the start of the final merge taper should desirably be no more than 20 km/h below the mean speed reached by cars starting from the stop line. In very constrained circumstances involving upgrade, a minimum truck speed of 60 km/h may need to be accepted. Reefer to Figure 3.11 in AGRD Part 3 to determine the appropriate truck speed at the final merge taper.
- Sight distance concerns at the merge point also need to be addressed during design.
- The length of an existing ramp may need to be increased by extending the ramp nose and/or the overall merge distance (for example, where existing acceleration length is longer than the typical length of 420 m, allowing the ramp nose to be extended).

Note: Acceleration distances for vehicles accelerating from 0 to 80 km/h on various grades is based on AGRD Part 4A modified to increase the 80 m merge taper to 100 m taper (1 in 28.6) for motorway merging.

Three lanes

Ramp layouts with three lanes at the stop line require greater distances between the stop line and the nose for the merging movements, particularly if three lanes merge to a single lane at the nose. When considering the operation of the ramp when the signals are on or off, the distance also varies according to whether the third lane along the ramp is continuous (full time use) or an auxiliary lane at the stop line (part time use when the signals are on).

If two lanes are provided at the nose, that is, two-lane merge onto the motorway or a single lane merge plus an added lane, the merge distance for vehicles leaving the stop line is like the two-lane layout.

The general layouts for ramps with three metered lanes at the stop line are shown in Appendix F.

Four lanes

Ramp layouts with four lanes at the stop line require greater distances between the stop line and the nose for the merging movements. The layouts generally involve two, two-to-one lane merges alongside each other, so 120 m between the stop line and ramp nose is desirable, recognising the complex decision making involved with a larger number of vehicles being released at the same time.

The general layouts for ramps with four metered lanes at the stop line are shown in Appendix F.

11.5.7 Traffic Management Devices

Addition

Line marking

Line marking associated with the ramp metering shall be provided in accordance with the Queensland MUTCD and the following principles:

- Longitudinal line marking shall include a 30 m continuous lane line on the approach to the stop line to discourage lane changing.
- Edge lines are to be provided on both sides of the ramp. Downstream of the stop line, the left edge line provides guidance for merging traffic.
- Continuity lines shall be used to indicate a lane diverge (increase in the number of lanes) upstream of the stop line, where applicable.
- Where bypass lanes are provided, a delineated clearance zone of at least 0.7 m shall be provided between the bypass lane(s) and general-purpose lane(s).
- Lane reductions shall be signed, and line marked in accordance with the requirements of the Queensland MUTCD Part 2 (i.e., zip merges where the lane reduction occurred within a posted 80 km/h or less zone on the ramp).
- The stop line shall be located 10 m upstream of traffic signals (for pedestals and overhead gantries).
- Appropriate pavement marking shall be provided for priority access lanes.

Difference

Replace the first dot point under the subheading "*Controllers, pedestals and lanterns*" with":

Signal poles or overhead structures should be located downstream of the stop line to enable a driver in a stopped vehicle to observe the signals, taking into consideration the necessary viewing angle required to maximise a driver’s visibility of the signals when waiting at the stop line. A signal pole at the stop line is not required.

Depending on the number of lanes, signals may be installed on pedestals or overhead structures. The following guidelines apply (see Appendix F for more detail):

- One to four general purpose stand-up lane signal lanterns shall be installed on pedestals on both sides of the ramp or on an overhead structure 10 metres downstream of the stop line.
- General purpose stand-up lanes plus bypass lane signal lanterns shall be installed on an overhead structure above the centre of each lane and on each structures leg either side of the ramp. The overhead structure shall be positioned 10 metres downstream of the stop line.
- The lanterns should be easy to access for maintenance.

Replace the second dot point under the subheading "Controllers, pedestals and lanterns" with":

The signal cabinet should be positioned so that:

- It is easy to access for maintenance. An all-weather area is to be provided for vehicles and personnel. If necessary, an access path to the cabinet must be provided, for example a gravel track through terrain that is difficult to traverse.

- Maintenance personnel can see the displayed signals from the signal cabinet. This is especially important for VSL and LUMS signs.
- It does not impact drivers' sight lines.
- It is protected from or out of the way of a potential errant vehicle.
- It is protected against vandalism, or damage caused by regular maintenance services such as slashing or mowing.

The signal cabinet should be located on the outer verge of the ramp near the ramp entrance. Alternatively, it may be located between the stop line and the signal display with safety barrier used to shield maintenance personnel, the maintenance vehicle and the pedestal. If an enforcement bay is provided, consideration should be given to locating the signal cabinet near the enforcement bay for maintenance and access to the cabinet.

In Table 11.3, the pedestal options for 2 metered lanes also apply where 3 or more metered lanes are provided. Gantries are not used for this purpose in Queensland.

Replace the third dot point under the subheading "Controllers, pedestals and lanterns" with":

Standard 200 mm (300 mm may be used for overheads) three-aspect signal lanterns shall be used for ramp signals. The signals perform the following functions for motorists:

- Warning – to alert the approaching drivers to the presence of traffic signal control.
- Stopping – to inform approaching drivers sufficiently in advance of the stop line that they are required to stop.
- Starting – to inform drivers stopped at the stop line when they may proceed.

Signals are mounted such that they are aimed towards the ramp entrance, or in the case of a curved ramp, to maximise sight distance.

Signals installed on pedestals shall be mounted at a height of 2.4 m (to the bottom of the target board), with ONE VEHICLE ONLY ON GREEN SIGNAL (GE9-Q03) signs for single lane ramp or ONE VEHICLE PER LANE ON GREEN SIGNAL (GE9-Q04) signs installed underneath.

For signals mounted overhead on a gantry type structure, the minimum height clearance to the signals shall be 6.1 m, unless stated otherwise. The signals installed on each side leg of the overhead structure shall be mounted at a height of 2.4 metres (to the bottom of the target board). ONE VEHICLE PER LANE ON GREEN SIGNAL (GE9-Q04) signs shall be installed on the signal poles or overhead structure as shown in Appendix F.

Electronic ramp control signs

Advance warning signs RAMP SIGNALS ON (TC2290_1) and PREPARE TO STOP (TC2290_2) should be used to advise motorists when ramp metering is in operation (see Figure 11.5.7).

Figure 11.5.7 – Ramp signal warning signs TC2290_1 and TC2290_2.

11.5.8 Priority Access Lanes

<u>*Deletion*</u>

Delete Figure 11.15 and Figure 11.16.

See Appendix F for Queensland layouts for priority access lanes.

12 Lane Use Management Systems (Including Variable Speed Limits)

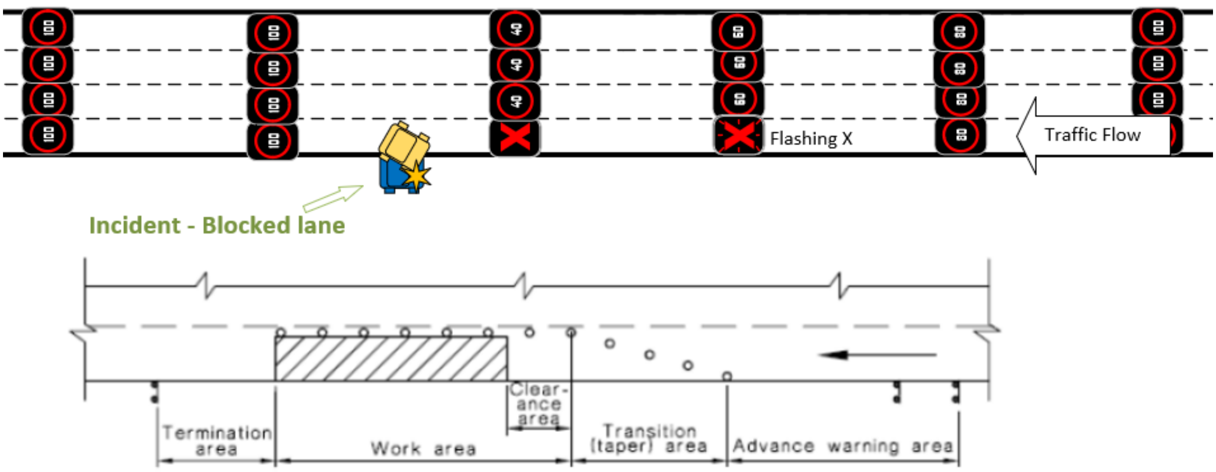
12.1 Applications and Benefits

12.1.1 LUMS Applications

<u>*Difference*</u>

Replace Figure 12.2 with Figure 12.1.1 below.

Figure 12.1.1 – Comparison of LUMS layout with typical worksite traffic management



12.1.3 Benefits

<u>*Addition*</u>

Note: Queensland is currently reviewing the application of all-lane running and part- time use of the emergency lane", in motorway environments.

12.2 Criterion for Provision

Addition

The ConOps for a smart motorway project will identify the operational objective of the corridor. These objectives will then determine the required provisions in accordance with Engineering Policy EP149 *Managed motorways*.

12.3 LUMS Symbols

Addition

A flashing red cross shall be used on the approach to a lane closure to indicate that the lane ahead is closed.

Deletion

Merge arrows shall not be shown on LUMS signs in Queensland.

12.4 Sign Face Layout and Installations

12.4.1 Sign Face Layout

Addition

Electronic sign face displays shall comply with the relevant Queensland Q-series / TC sign design.

12.4.3 Sign Size

Difference

Replace:

> In accordance with AS 1742.4 and the findings of the research report *Review of Sign Size for Electronic Regulatory Speed Signs* the preferred LUMS and VSL sign size for motorways, including ramps, is size ‘C’ (i.e., 900 x 900 mm for square dimensions).

With:

> LUMS and VSL sign size for motorways, including ramps, shall be size 'C' (i.e., 900 x 900 mm for square dimensions).

Addition

Where installation of TC1568 is warranted, the size installed shall be such that the red annulus and corresponding speed limit are no less than that required by the Queensland MUTCD Part 4.

12.4.5 Longitudinal Placement and Co-location

Deletion

Delete the subsection titled "*Placement for parallel routes*".

Addition

LUMS site placement

The operational impact of LUMS rules (for example, speed control, lane closures and soft closures) should be considered for LUMS site placement. For more information on permissible frame combinations and rules, refer to MRTS206 *Provision of Variable Speed Limit and Lane Control Signs*.

A LUMS site may serve a dual function, in that it may be a VSL site as well as a lane control site to meet operational outcomes sought in the ConOps. A lane control sign is used to indicate that a traffic lane is open, closed, or closing, and is also used to advise motorists when exit ramps are open or closed to traffic.

LUMS sites shall be installed in accordance with the following design principles:

- LUMS sites shall not be located over a one or two-lane carriageway, as a one or two-lane incident may entirely close the facility. A gantry may be located over three or more lanes. See Section 12.4.6.
- LUMS sites shall not be located within lane drops, merge or diverge tapers.
- The operational impacts should be understood for LUMS sites in an added lane.
- A VSL site shall not be located between LUMS sites and vice versa.

VSL signs or LUMS sites should be provided 200 m to 400 m after the end of an entry ramp taper (for both taper and parallel merges). For some parallel merges, this distance may vary according to the site conditions. Where a lane is added at an entry ramp, the VSL sign or LUMS site should be located 200 m to 400 m downstream of the painted nose area.

VSL sign placement

A VSL site is required to be placed downstream of a motorway entrance ramp to reinforce the variable speed limit as drivers enter a variable speed limit zone. Entering a motorway requires drivers to be attentive to accelerating to the speed limit, merging with mainline traffic and observing the road conditions ahead.

Therefore, a speed limit reinforcement with a VSL site should be provided after high demand driving tasks have been observed, and hence VSL signs must not be placed in areas where drivers are merging.

The spacing between mainline VSL signs should be between a minimum of 400 m and a maximum of 750 m. Where the VSL site is located downstream from the end of the entry ramp taper, there may be physical constraints which prevent the minimum or maximum distances from being met. If spacing falls outside of these values, a design exception is required for approval by Statewide Network Operations Branch.

Table 12.4.5 outlines key design principles for VSL sign placement.

Table 12.4.5 – Key design principles for VSL sites

Key Design Principles	Reason
The maximum distance between the end of merge taper and the downstream VSL site should not exceed 400 m. It is acceptable to increase this distance if physical constraints make 400 m unattainable. The distance between the upstream VSL site and downstream VSL site should however not exceed 750 m.	To ensure that drivers are informed, within a reasonable distance after merging, of the mainline speed limit.
The minimum distance between the end of merge taper and the downstream VSL site should not be less than 200 m. The distance between the upstream VSL site and downstream VSL site should however not be less than 400 m.	This is intended to limit driver distraction and speed differentials within the merge area.
Minimum one detector site downstream of each VSL site	In the absence of a detector site between VSL sites, the VSL site can only act as a repeater sign.
Entry and exit ramp detector sites	Entry and exit ramp detector sites are required.
One detector site at key bottlenecks	For queue detection and queue protection response.
Adequate distance between VSL sign and the downstream detector site.	Improves queue detection and protection responses and speed differential prior to queue propagation to upstream VSL sign. Adequate distance, desirable 300 m*, between VSL sign and downstream detector site.
One detector upstream of bottlenecks	Quick incident verification (not mandatory but highly recommended).
Quantity of VSL sites on motorway-to-motorway interchange ramps	Provision of insufficient quantity will result in decreasing speed buffer reductions propagating upstream onto the intersecting motorway via ramp(s).
VSL placement on motorway to motorway interchange ramps	Refer to Figure B.4 - Two to three ramp VSL sites may be required to minimise the impact of a mainline speed reduction propagating buffer speed reductions upstream to the alternate motorway.

* The 300 m minimum distance is based on a conservative queue propagation speed of 300 m/min. If, by way of traffic analysis, the typical queue propagation speed is found to be or predicted to be greater than 300 m/min, this minimum distance should be increased (for example, 500 m/min requires a queue length of 500 m).

Appendix E provides typical placement of the above mentioned key design principles. Some relaxations of the principles, presented in Table 12.4.5, which may be used in the case of unusually long ramps, are given from highest to lowest preference below:

- Place the downstream VSL (or LUMS) closer to the end of ramp taper than 200 m – the assumption is that, for very long entry ramps, most drivers have completed the merge before the end of the merge taper.
- Move the upstream VSL (or LUMS) closer to the hard nose – queues are likely to develop in the area of turbulence near the hard nose and then propagate upstream, so this option is less preferable than 1) above.
- Do a design exception if the above two options cannot bring the separation under the maximum – the process for this would need to be on a case-by-case basis. Some investigation as to the distribution of the distance required for vehicles to merge will need to be done.

12.4.6 Mounting Arrangements

<u>*Addition*</u>

Mounting structures for ITS devices may add significant cost to a project, so it is important to evaluate different mounting arrangements based on the requirements specified in the ConOps for example lane control is not possible with side-mounted signs.

The selection of mounting structures should consider the following:

- cost (including operational and capital costs)
- road design requirements (including geometry and medians)
- road user and maintenance worker safety when accessing for maintenance activities, for example elevated work platforms may be required, and a safe area for vehicle parking
- supporting infrastructure and cabling (including cabinets), and
- equipment requirements (including tolerances, reliability and sensitivity to vibration).

Engaging with the local maintenance contractor may provide additional insight on the preferred mounting structures.

VSL and LUMS shall be installed in accordance with Table 12.4.6.

Table 12.4.6 – Mounting Arrangement for Signs by Number of Lanes

Number of lanes (ramp / mainline)	Sign type	Mounting arrangement required
1-2	VSL	Side mounted VSL sign(s)*.
3-5	VSL or LUMS	Side mounted, or overhead structure. Informed by ConOps operational requirements.
6 or more	VSL or LUMS	Overhead structure.

* Duplication of side mounted VSL to be determined based the requirements of the Queensland MUTCD.

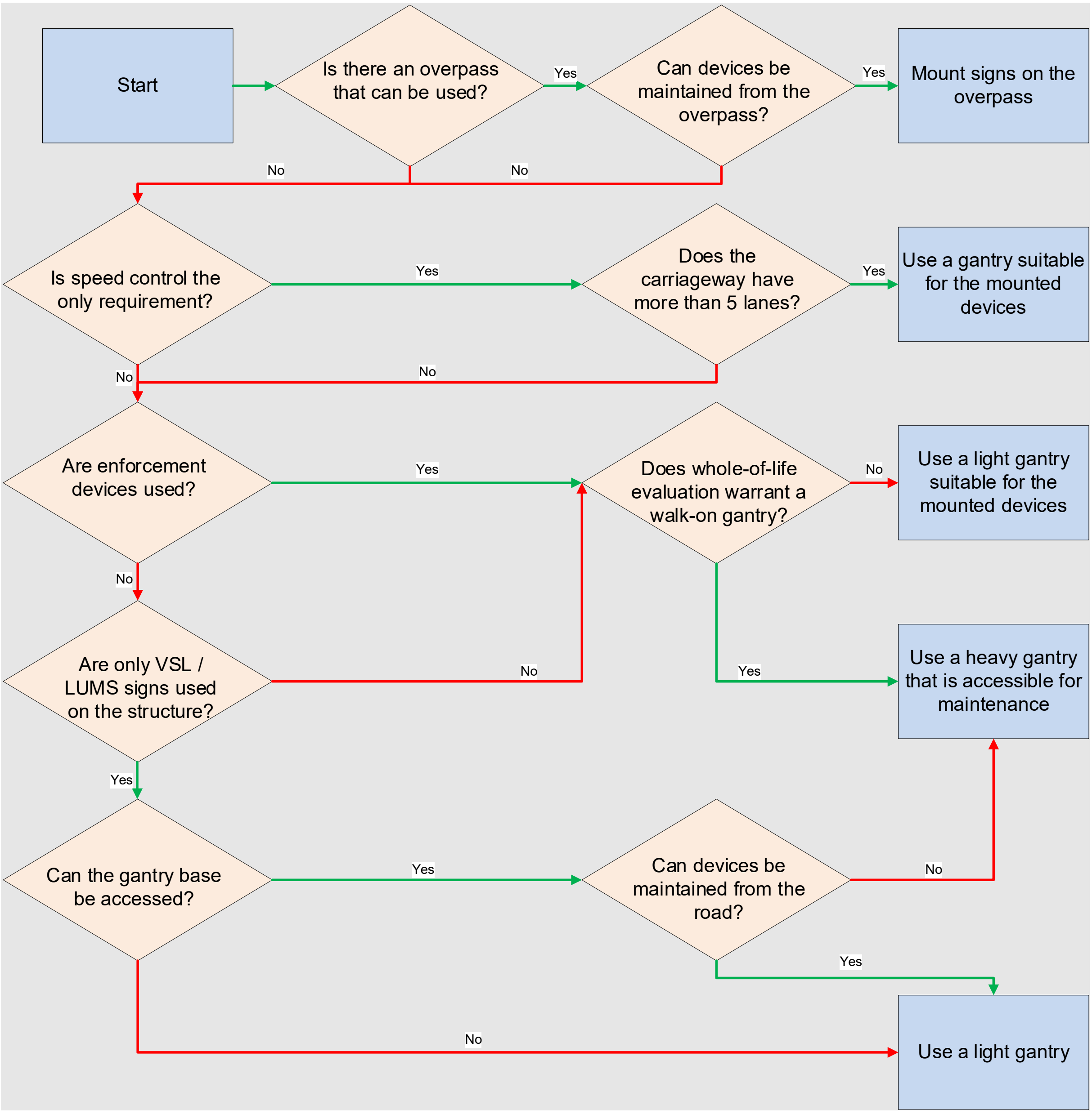
In some instances, the road cross section prevents the mounting methods as specified in Table 12.4.6 from being applied. In this case, alternative solutions consistent with the requirements of the Queensland MUTCD should be implemented to ensure that adequate presentation of the sign face to drivers is achieved.

The flowchart in Figure 12.4.6 provides guidance on the selection of gantry type for VSL and LUMS and other signs. It is recommended to consider all applicable gantry options such as existing overpasses, lightweight structure or heavy gantry during the Concept Phase of a project.

Tilt pole

Tilt poles may be used to mount ITS devices to allow maintenance without the need for an elevated work platform. If a tilt pole is used, adequate space shall be provided to tilt safely without intruding into the traffic lane. The tilt pole shall be positioned such that maintenance personnel face oncoming traffic while tilting the pole.

Figure 12.4.6 – Determination of Gantry Type for ITS Devices

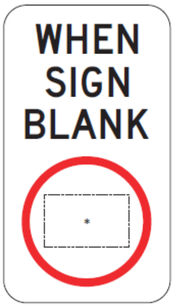


12.4.11 Supporting Static Signing

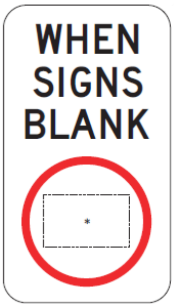
Addition

The following signs are used to advise motorists of the maximum posted speed limit in the event a VSL sign is failed and blank. The longitudinal and lateral placement of static signs shall be in accordance with the requirements of the Queensland MUTCD.

a) SPEED LIMIT …km/h WHEN SIGN IS BLANK (TC1568)



TC1568_3



TC1568_6

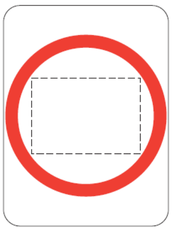
The TC1568 sign is used to impose a speed limit when electronic speed limit signs are blank. It shall only be used as follows:

- Where road users are entering a VSL or Lane Control zone TC1568 shall be installed at the entrance site or gantry. Entrances include the first gantry / site of a VSL or Lane control zone as well as entry ramps that connect into a Variable Speed Limit or Lane Control Zone.
- Where there is a change in default / maximum speed limit, to ensure road users are informed of the road design speed in case of electronic sign failure.

An appropriate TC1568 sign layout shall be used for a VSL sign or for a LUMS site. TC1568 sign should be accessible so that the speed restriction sign may be easily covered during road works, if required. It is preferred that TC1568 be accessible by a worker on foot.

The installation of a new default speed limit sign (TC1568) is not required at the end of a VSL or LUMS zone.

b) Speed restriction (R4-1)



R4-1

The Speed Restriction sign shall be used to reinstate the speed limit after the end of a VSL or LUMS zone. It shall be installed 500 m to 750 m after the end of a VSL or LUMS zone, and in accordance with the requirements of the Queensland MUTCD.

c) LANE CONTROL ENDS (TC9060)

TC9060

The Lane Control Ends sign shall be used to indicate the end of lane control zone and is used to reopen all previously closed lanes. It shall be installed 500 m to 750 m after the end of a LUMS zone and be installed on both the left and right hand side of the carriageway.

12.5 Operation of LUMS

12.5.2 LUMS Field Response Rules

Policy rules

Difference

Replace the title of subheading "*Policy rules*" with "*Recommendations*":

Table 12.4 is not applicable to Queensland practice. Further information on detailed LUMS field response rules configured in Queensland, please contact Director (Network Optimisation), Statewide Network Operations Branch, Department of Transport and Main Roads.

Use of LUMS for temporary works

Addition

For further information on the use of LUMS during temporary works refer to the Guideline for Traffic Management at Works on Roads Chapter 2 Section 2.

13 Provision of an Emergency Lane

Addition

Note: Queensland is currently reviewing the application of all-lane running (without compliant shoulders) in motorway environments.

15 Additional Considerations

15.7 Placement of Roadside Equipment

15.7.1 Road Safety

New

Placement of equipment shall adhere to Transport and Main Roads roadside safety policies and guidelines.

Equipment may pose a roadside hazard if not adequately offset from the travelled edge of pavement or protected by barrier. The use of road safety barriers in ITS installations will serve to protect motorists from the danger of a collision with roadside furniture and protect the equipment itself. Road safety barriers also increase the safety of the site for maintenance personnel.

For further information on road safety barriers refer to the RPDM Volume 3 Part 6 *Roadside Design, Safety and Barriers*.

15.7.2 Theft and Vandalism

New

As ITS equipment is typically both expensive and susceptible to damage, the threat of vandalism has become a restriction in some areas. Equipment such as solar panels should only be used in these areas if it can be obscured from general view, is suitably protected and/or mounted out of reach of unauthorised users.

ITS equipment installed on the roadside near a steep upward slope should maintain at least 3.5 m clearance from the ground in order to deter vandalism.

Using the Crime Prevention Through Environmental Design (CPTED) principles in the design, and equipment which is physically and technology robust and reliable.

For further information refer to the Road Landscape Manual Part C Chapter 5: *Safety*.

Appendix D

LUMS Traffic Management Rules

Difference

Queensland does not support the display of Merge Arrows. For each of the typical layouts presented in Appendix D, the merge arrow is replaced with a flashing X, as a flashing red cross shall be used on the approach to a lane closure to indicate that the lane ahead is closed.

For information on the application of LUMS Traffic Management Rules in Queensland, please contact Director (Network Optimisation), Statewide Network Operations Branch, Department of Transport and Main Roads.

Appendix E

Typical Placement of Mainline Features

New

Figure E.1 to Figure E.4 assist in addressing known bottleneck locations. In general, a motorway bottleneck can be classified into one of four types:

- Type I - Traffic demand surges (entry ramp)
- Type II - Geometric bottlenecks (for example, mainline lane drops, steep gradient, sharp curve)
- Type III - Weaving sections (that is, entry and exit ramp closely spaced in combination with weaving demand)
- Type IV – Queue spillback from exit ramps

NOTE: These bottleneck classifications replace those in the ITS Placement Guidelines.

Figure E.1 – Type Ia: Traffic Demand Surge: Entry Ramps with Parallel or Taper Merge

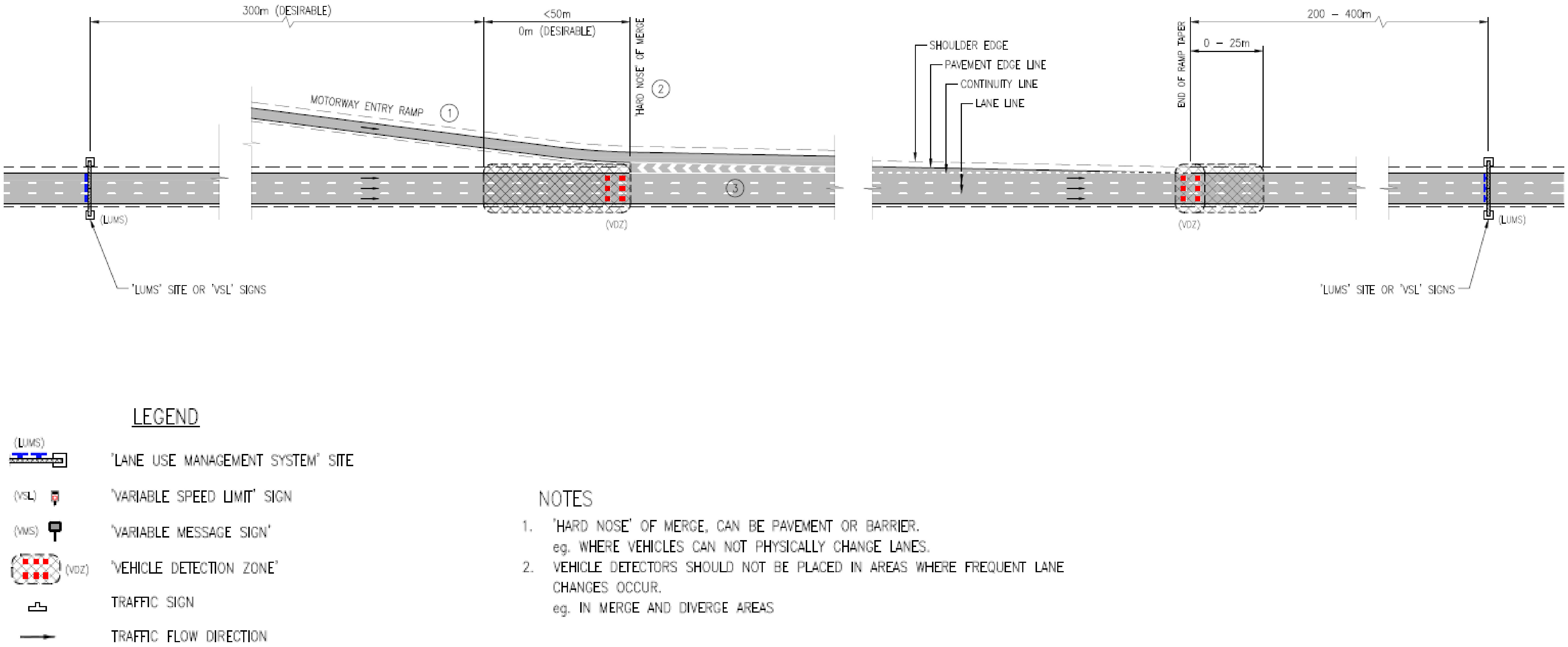


Figure E.1 – Type Ia: Traffic Demand Surge: Entry Ramps with Parallel or Taper Merge (continued)

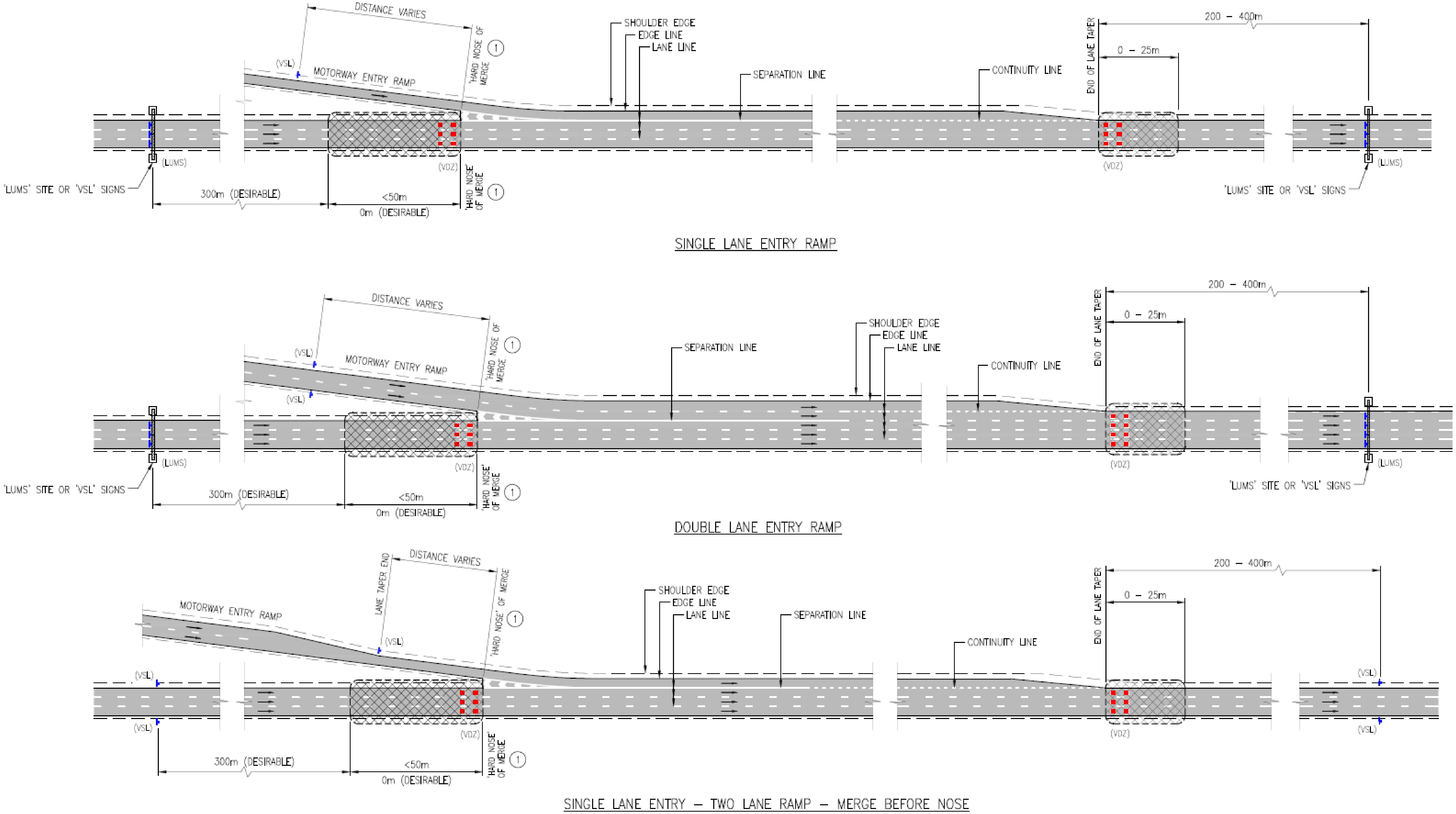
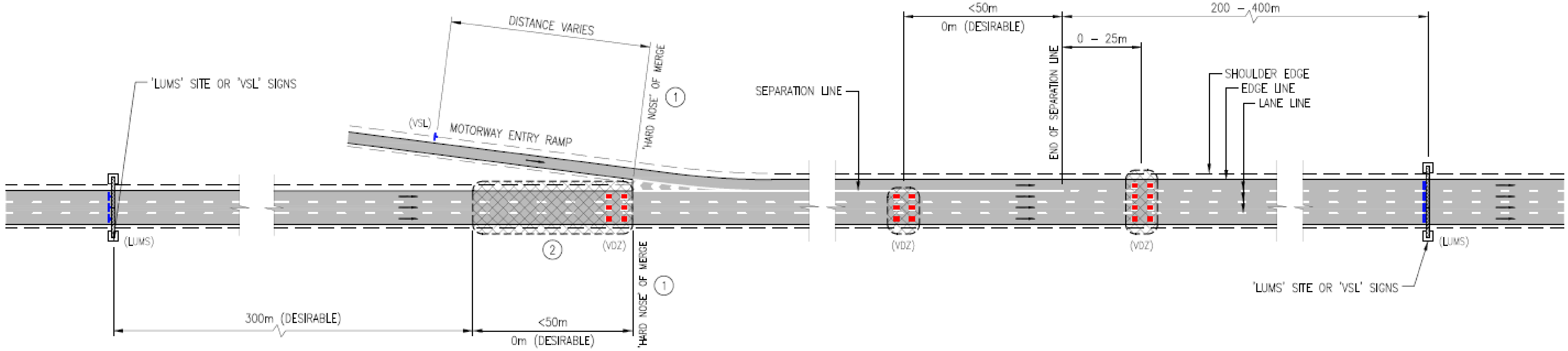


Figure E.2 – Type Ib: Traffic Demand Surge: Entry Ramp Lane-Add – General Layout



LANE–ADD AT ENTRY RAMP

LEGEND

(LUMS) 'LANE USE MANAGEMENT SYSTEM' SITE

(VSL) 'VARIABLE SPEED LIMIT' SIGN

(VMS) 'VARIABLE MESSAGE SIGN'

(VDZ) 'VEHICLE DETECTION ZONE'

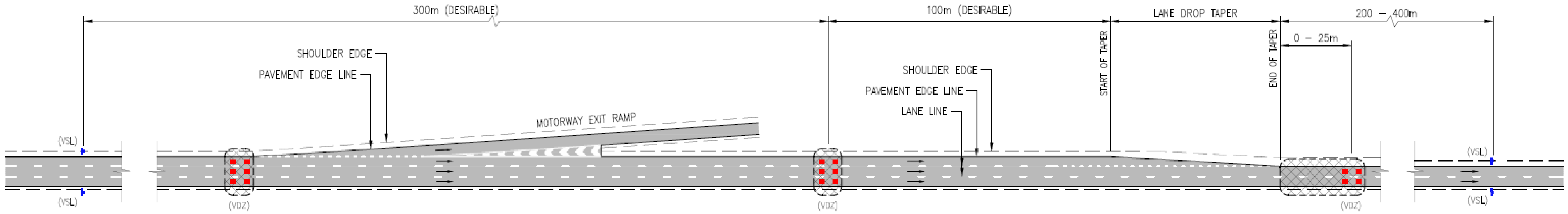
TRAFFIC SIGN

TRAFFIC FLOW DIRECTION

NOTES

1. 'HARD NOSE' OF MERGE, CAN BE PAVEMENT OR BARRIER.
   eg. WHERE VEHICLES CAN NOT PHYSICALLY CHANGE LANES.
2. VEHICLE DETECTORS SHOULD NOT BE PLACED IN AREAS WHERE FREQUENT LANE CHANGES OCCUR.
   eg. IN MERGE AND DIVERGE AREAS

Figure E.3 – Type II: Geometric Bottlenecks: Mainline Lane Drop – General Layout



SINGLE LANE DROP AT EXIT RAMP

LEGEND

(LUMS) 'LANE USE MANAGEMENT SYSTEM' SITE

(VSL) 'VARIABLE SPEED LIMIT' SIGN

(VMS) 'VARIABLE MESSAGE SIGN'

(VDZ) 'VEHICLE DETECTION ZONE'

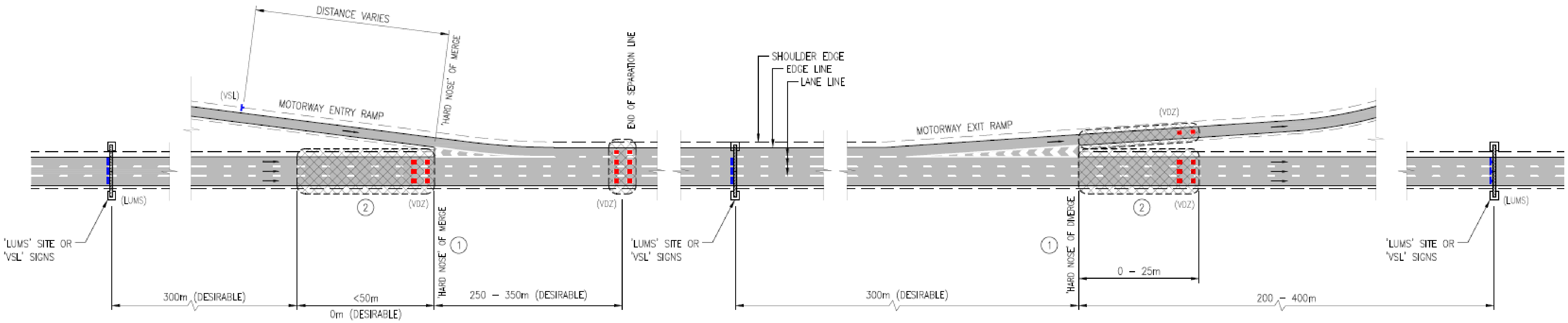
TRAFFIC SIGN

TRAFFIC FLOW DIRECTION

NOTES

1. 'HARD NOSE' OF MERGE, CAN BE PAVEMENT OR BARRIER.
   eg. WHERE VEHICLES CAN NOT PHYSICALLY CHANGE LANES.
2. VEHICLE DETECTORS SHOULD NOT BE PLACED IN AREAS WHERE FREQUENT LANE CHANGES OCCUR.
   eg. IN MERGE AND DIVERGE AREAS

Figure E.4 – Type III: Weaving Bottleneck – General Layout



SINGLE LANE ENTRY / EXIT RAMP – WEAVING LANE

LEGEND

(LUMS) 'LANE USE MANAGEMENT SYSTEM' SITE

(VSL) 'VARIABLE SPEED LIMIT' SIGN

(VMS) 'VARIABLE MESSAGE SIGN'

(VDZ) 'VEHICLE DETECTION ZONE'

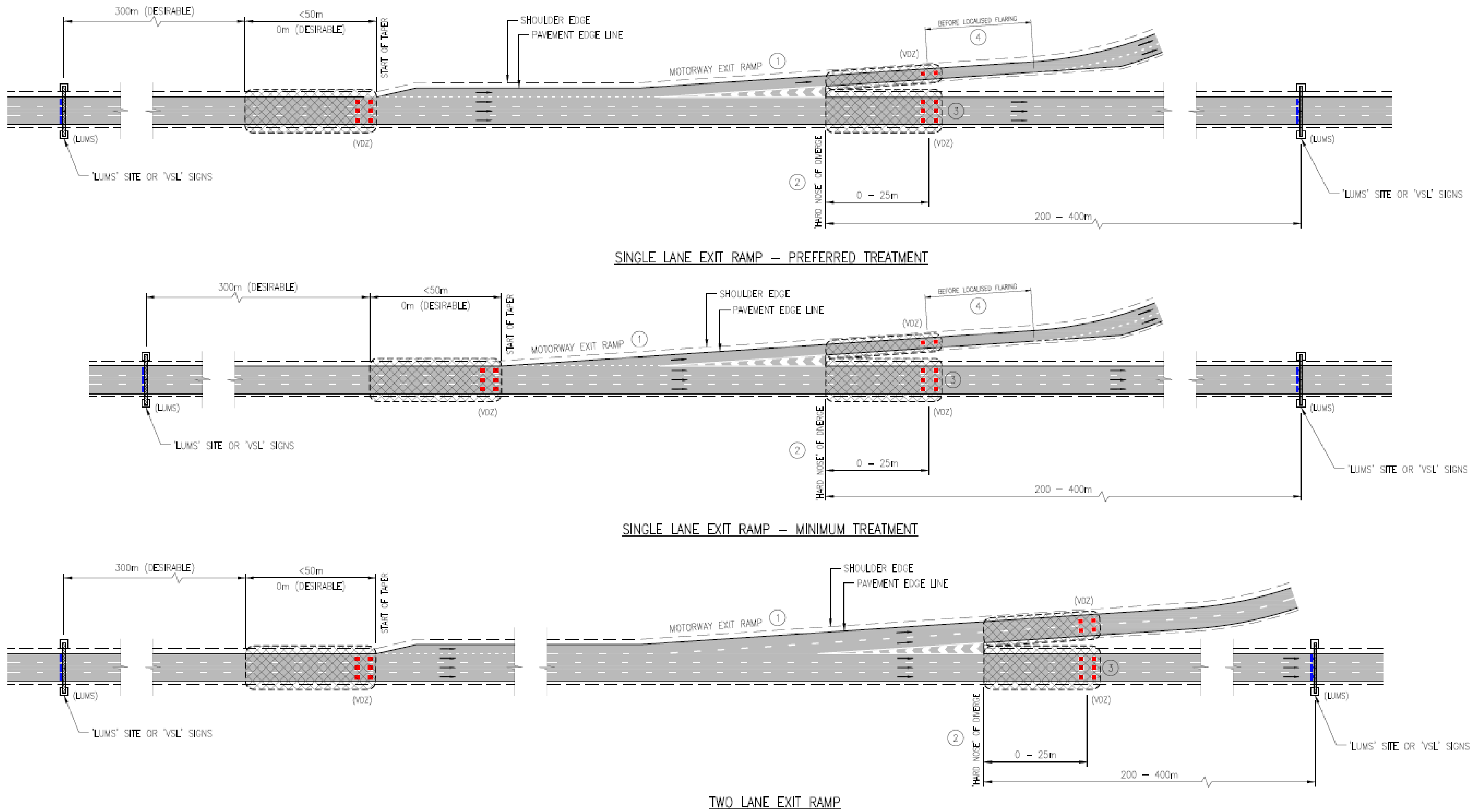
TRAFFIC SIGN

TRAFFIC FLOW DIRECTION

NOTES

1. 'HARD NOSE' OF MERGE, CAN BE PAVEMENT OR BARRIER.
   eg. WHERE VEHICLES CAN NOT PHYSICALLY CHANGE LANES.
2. VEHICLE DETECTORS SHOULD NOT BE PLACED IN AREAS WHERE FREQUENT LANE CHANGES OCCUR.
   eg. IN MERGE AND DIVERGE AREAS

Figure E.5 – Arterial Queue Spillback at Exit Ramp – General Layout



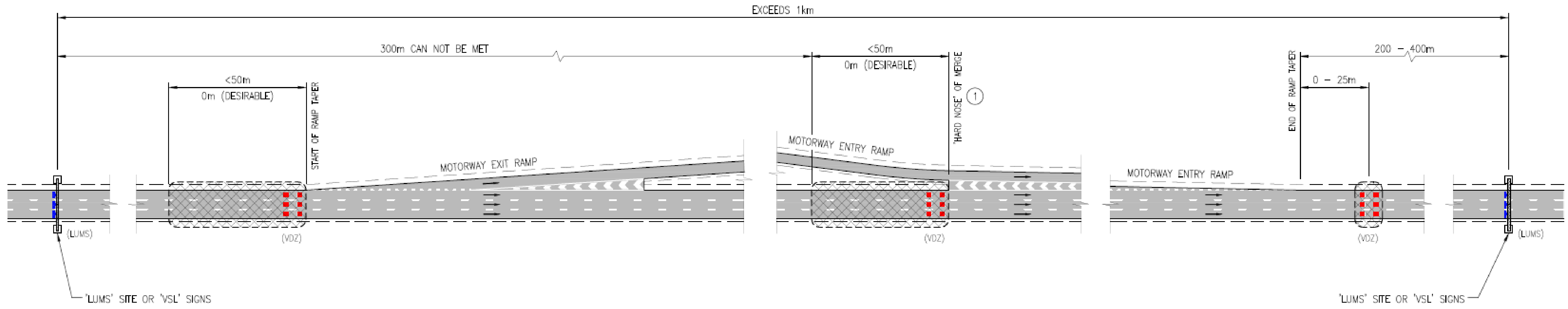
LEGEND

(LUMS)	'LANE USE MANAGEMENT SYSTEM' SITE
(VSL)	'VARIABLE SPEED LIMIT' SIGN
(VMS)	'VARIABLE MESSAGE SIGN'
(VDZ)	'VEHICLE DETECTION ZONE'
	TRAFFIC SIGN
	TRAFFIC FLOW DIRECTION

NOTES

1. 'HARD NOSE' OF MERGE, CAN BE PAVEMENT OR BARRIER.
   eg. WHERE VEHICLES CAN NOT PHYSICALLY CHANGE LANES.
2. VEHICLE DETECTORS SHOULD NOT BE PLACED IN AREAS WHERE FREQUENT LANE CHANGES OCCUR.
   eg. IN MERGE AND DIVERGE AREAS
3. DETECTORS FOR QUEUE FLUSH AT NEARBY TRAFFIC SIGNALS SHOULD BE PLACED INDEPENDENTLY TO THE MAINLINE DETECTORS.

Figure E.6 – Recommended VSL Site Placement for Closely Spaced Exit / Entry Ramps



CLOSELY SPACED RAMPS – SINGLE LANE EXIT AND ENTRY
SCENARIO 1

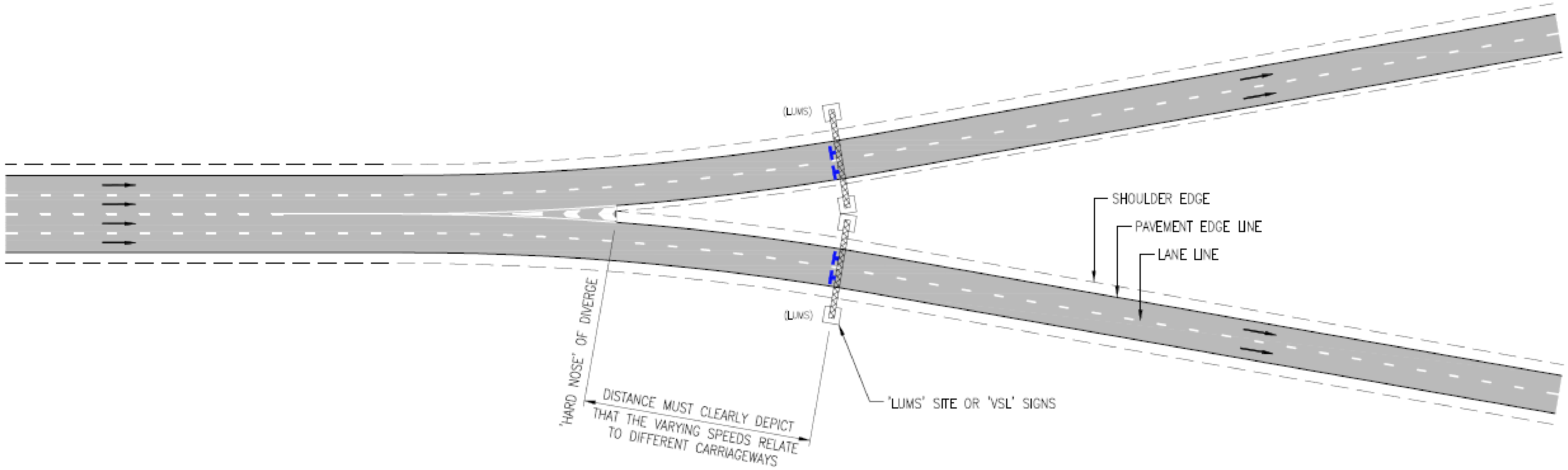
LEGEND

- (LUMS) 'LANE USE MANAGEMENT SYSTEM' SITE
- (VSL) 'VARIABLE SPEED LIMIT' SIGN
- (VMS) 'VARIABLE MESSAGE SIGN'
- (VDZ) 'VEHICLE DETECTION ZONE'
- TRAFFIC SIGN
- TRAFFIC FLOW DIRECTION

NOTES

1. 'HARD NOSE' OF MERGE, CAN BE PAVEMENT OR BARRIER.
   eg. WHERE VEHICLES CAN NOT PHYSICALLY CHANGE LANES.
2. VEHICLE DETECTORS SHOULD NOT BE PLACED IN AREAS WHERE FREQUENT LANE CHANGES OCCUR.
   eg. IN MERGE AND DIVERGE AREAS

Figure E.7 – Example Placement at Major Diverge



MOTORWAY TO MOTORWAY MERGE
DOUBLE LANE MAJOR FORK (DIVERGENCE)

LEGEND

(LUMS)	'LANE USE MANAGEMENT SYSTEM' SITE
(VSL)	'VARIABLE SPEED LIMIT' SIGN
(VMS)	'VARIABLE MESSAGE SIGN'
(VDZ)	'VEHICLE DETECTION ZONE'
	TRAFFIC SIGN
	TRAFFIC FLOW DIRECTION

NOTES

1. 'HARD NOSE' OF MERGE, CAN BE PAVEMENT OR BARRIER.
   eg. WHERE VEHICLES CAN NOT PHYSICALLY CHANGE LANES.
2. VEHICLE DETECTORS SHOULD NOT BE PLACED IN AREAS WHERE FREQUENT LANE CHANGES OCCUR.
   eg. IN MERGE AND DIVERGE AREAS

Appendix F

Typical Ramp Signal Layouts

New

Figure F.1 – Typical Entry Motorway Ramp Signals – Two Lanes

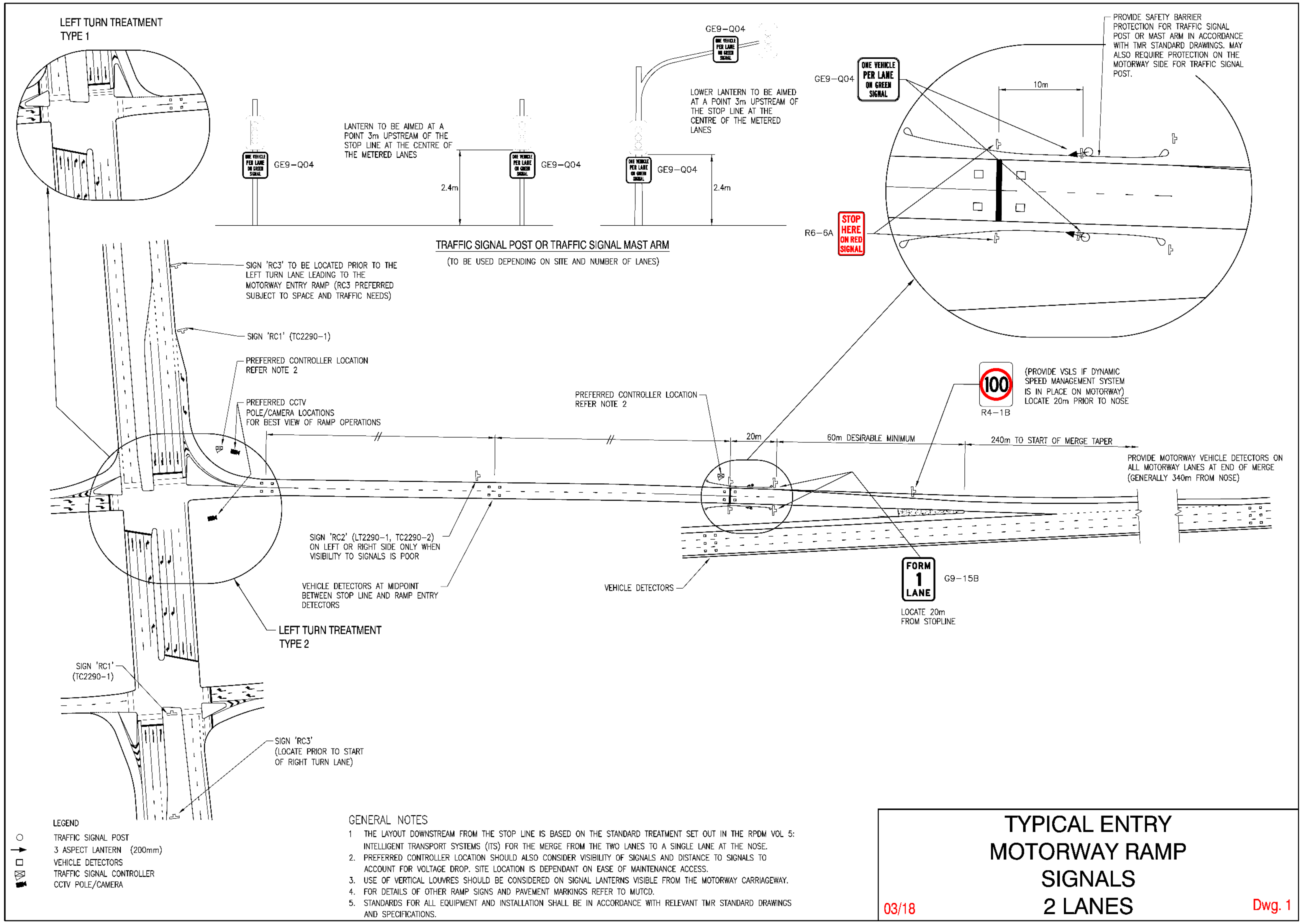


Figure F.2 – Typical Entry Motorway Ramp Signals for Two Lanes Plus Metered Priority Lane

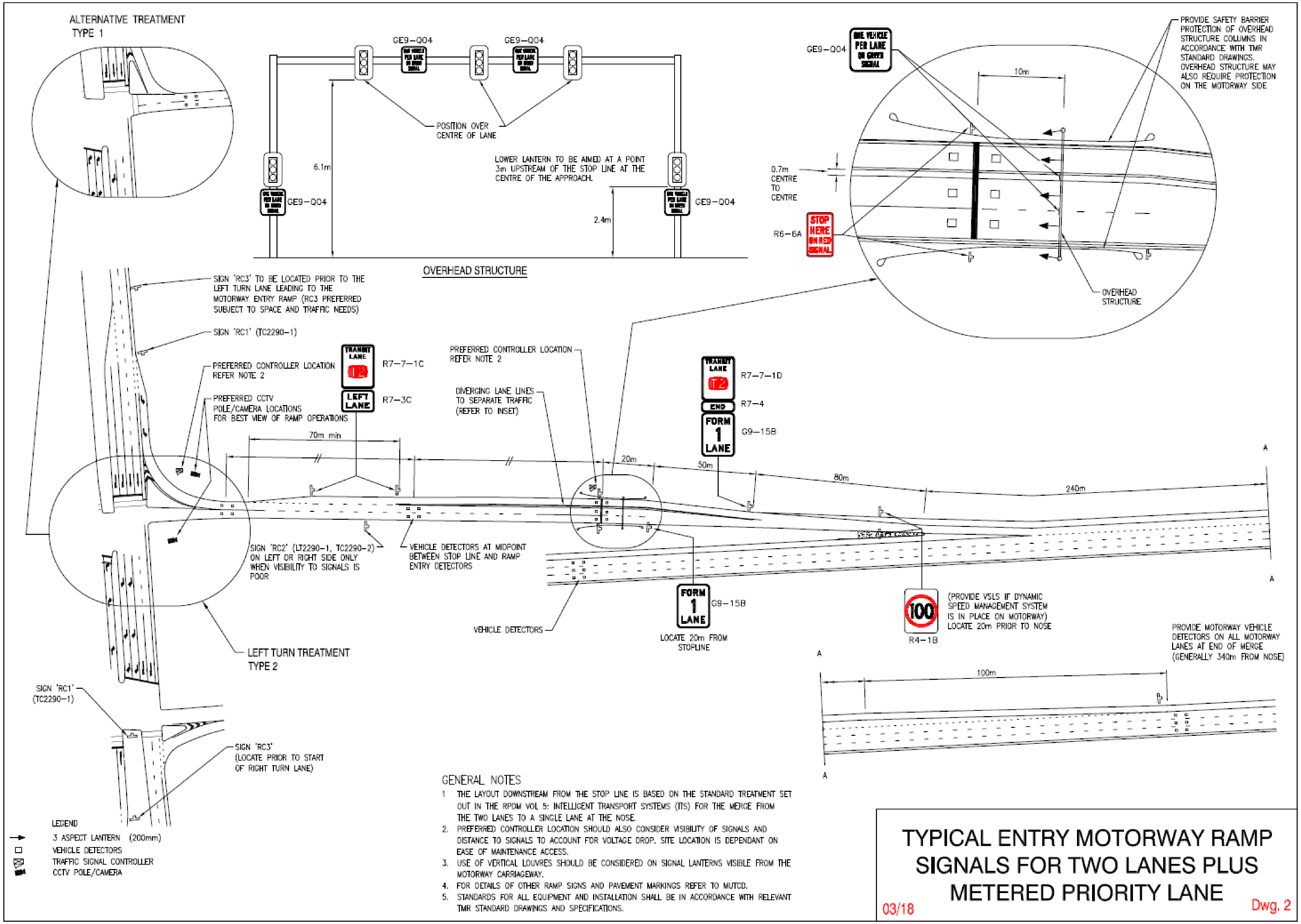


Figure F.3 – Typical Entry Motorway Ramp Signals for Two Lanes Plus Free Flow Priority Lane

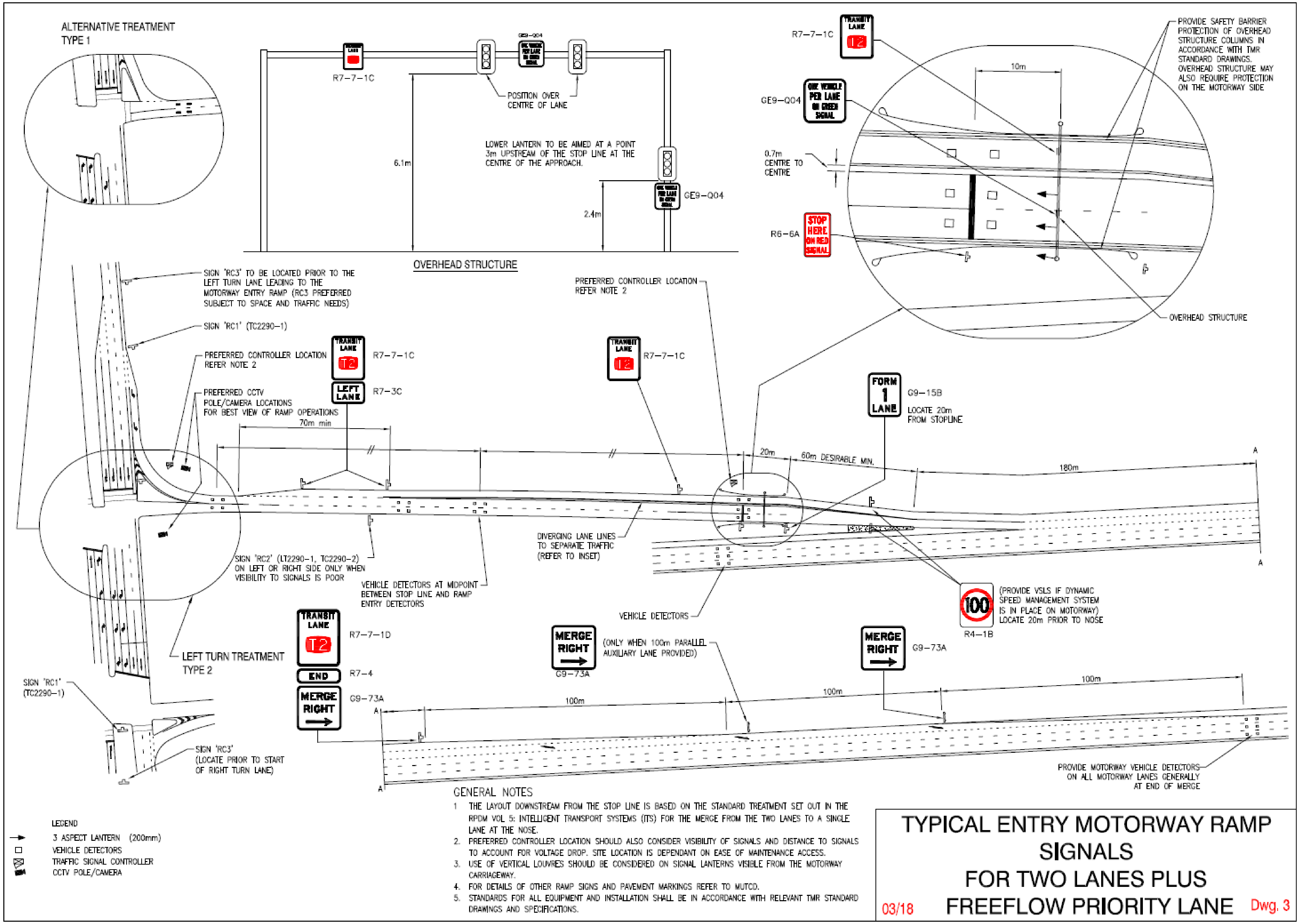


Figure F.4 – Typical Motorway Ramp Signals Layout – Motorway to Motorway Interchange

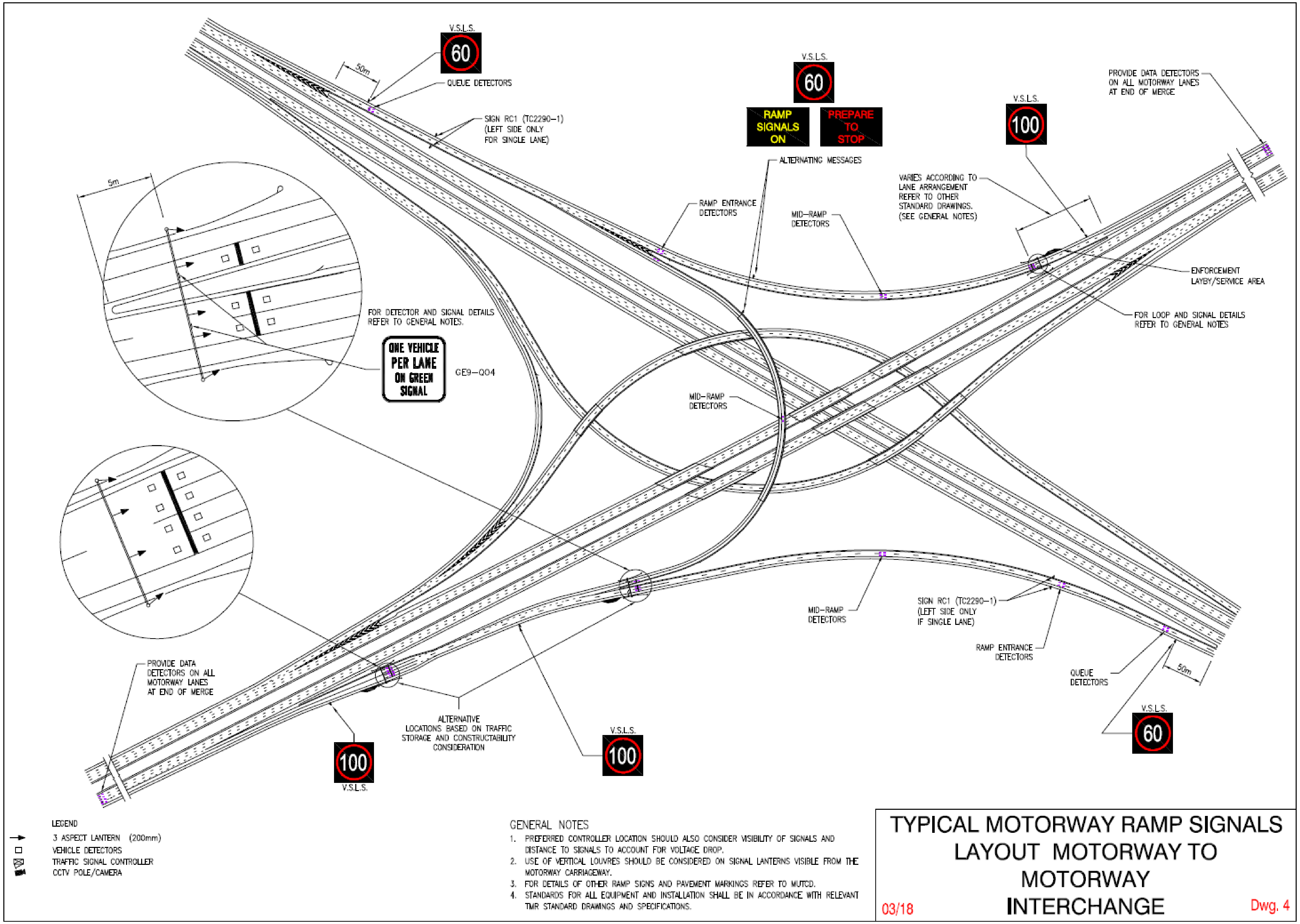


Figure F.5 – Merge Layouts Motorway Ramp Signals – Three Lanes

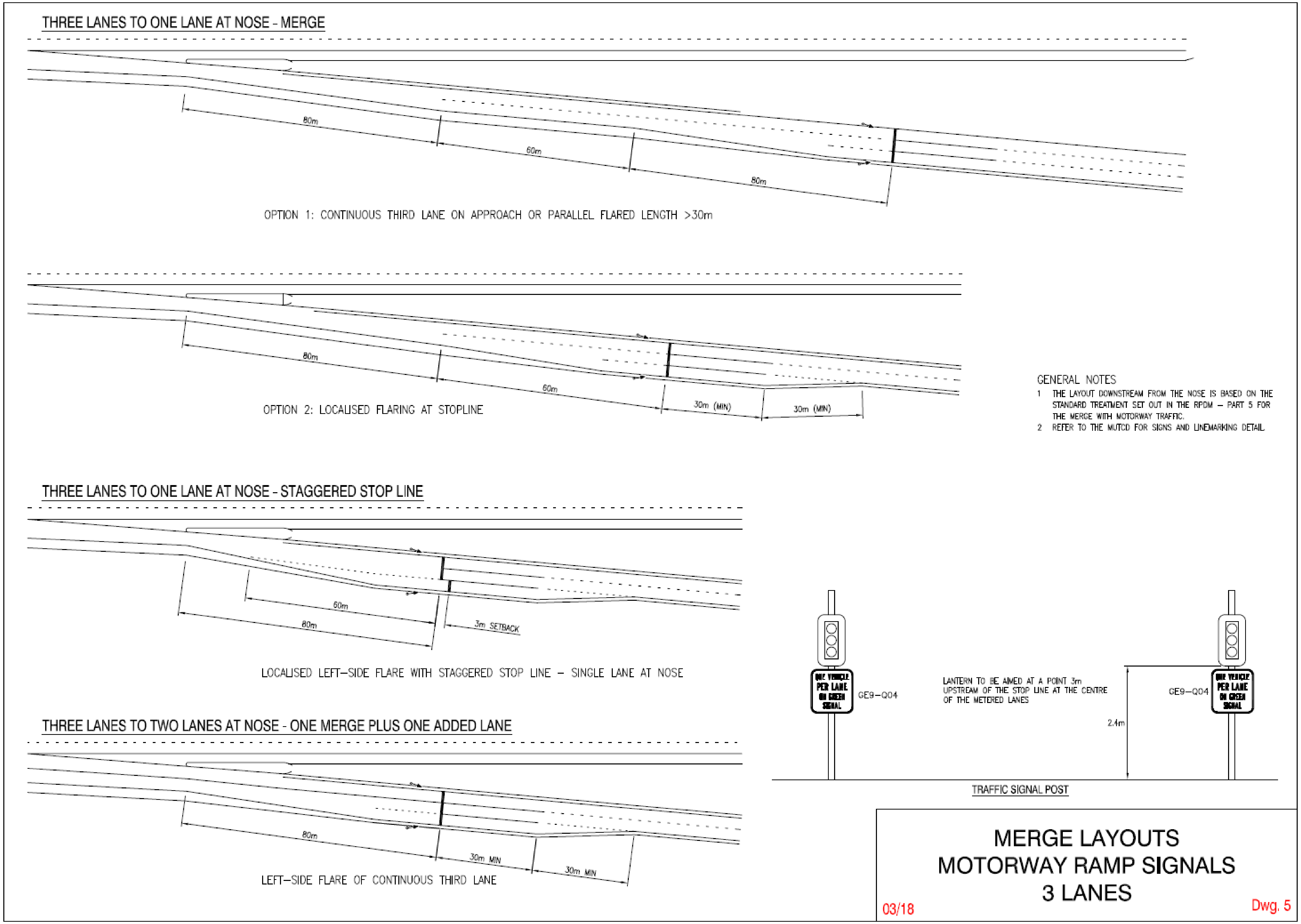
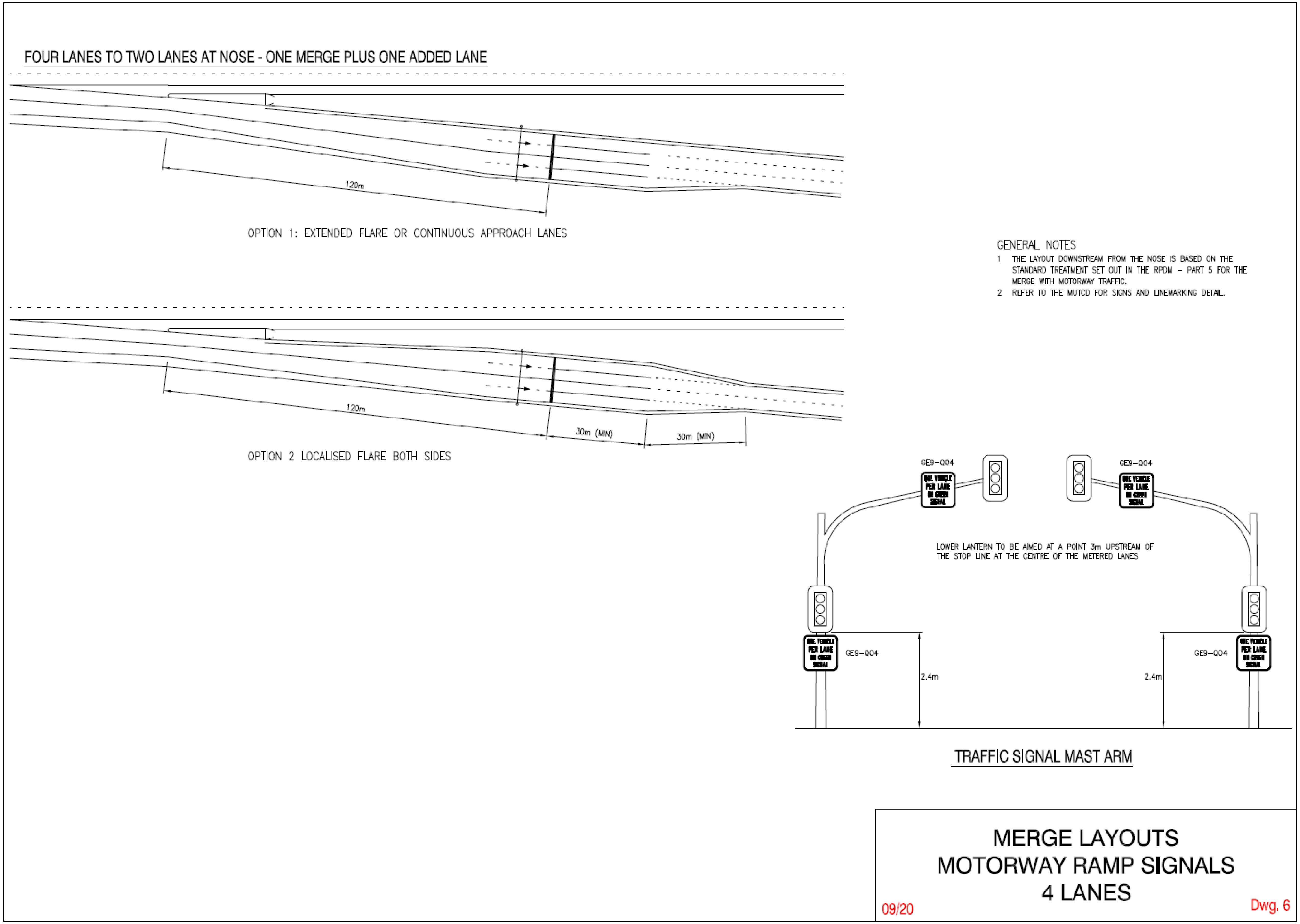


Figure F.6 – Merge Layouts Motorway Ramp Signals – Four Lanes

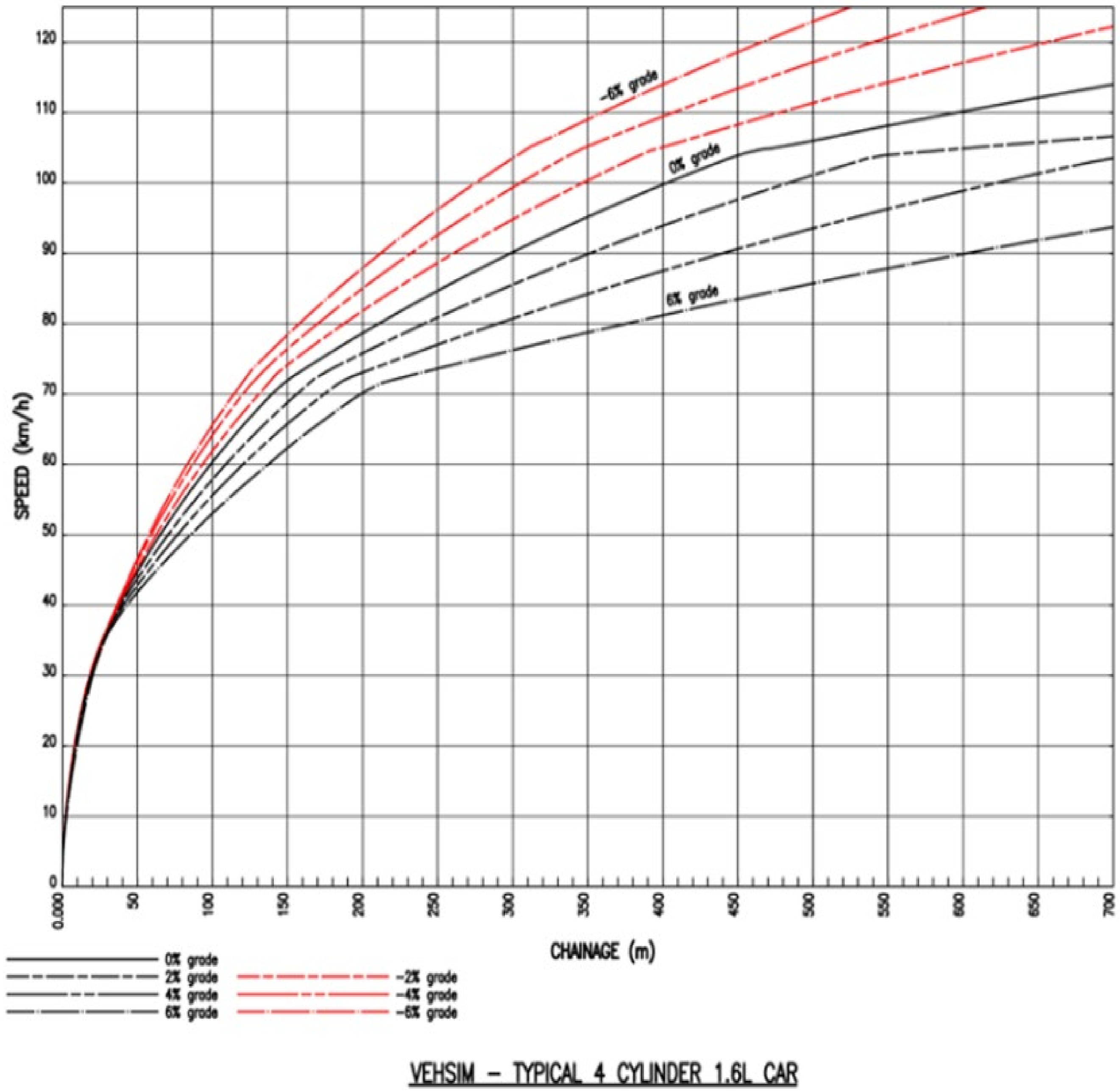


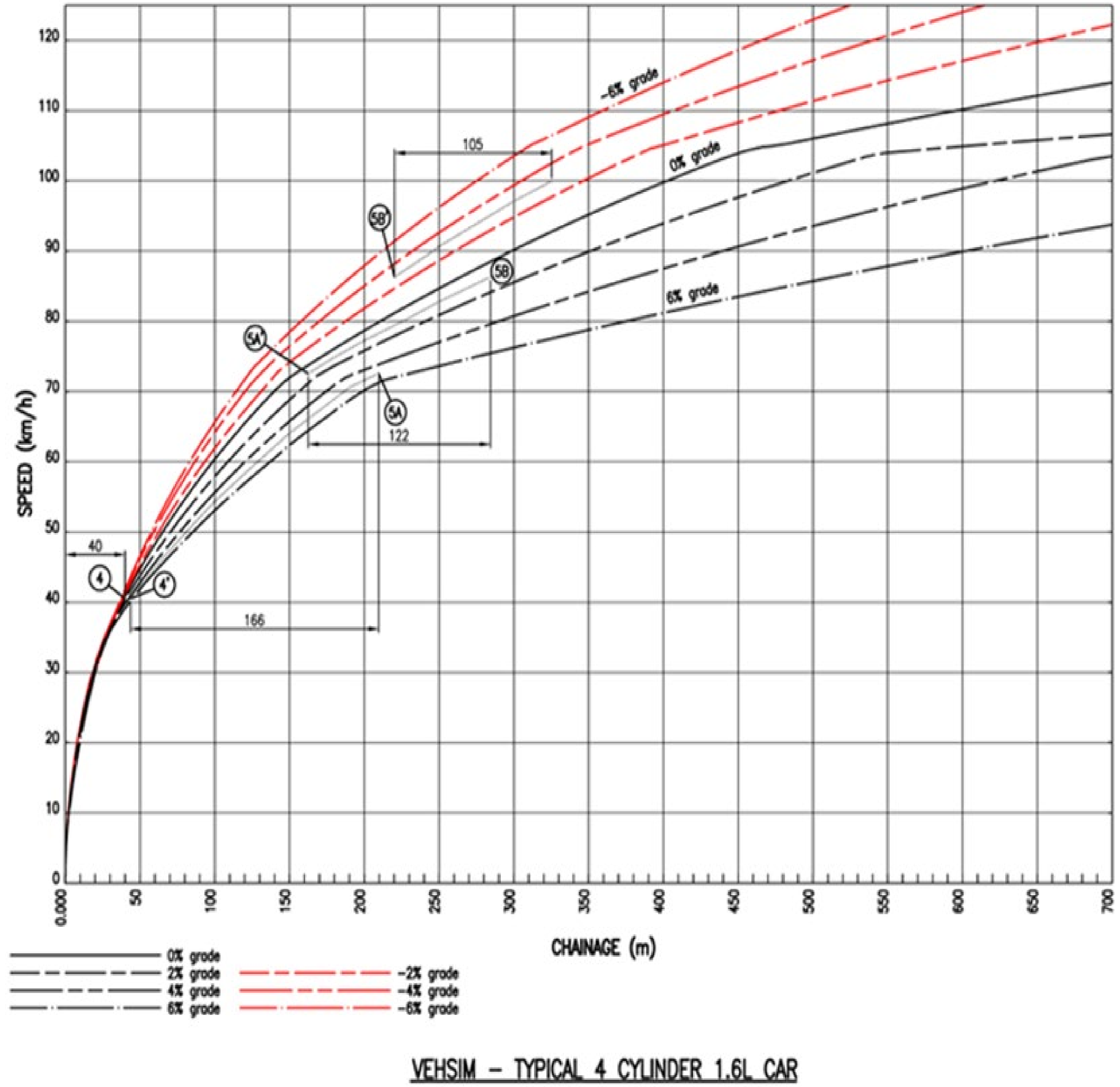
Appendix G

Typical acceleration graph for changing gradients

New

Figure G.1 – Typical Acceleration Graph for Changing Gradients





Glossary

Addition

The following definitions apply when reading the Queensland *Guide to Smart Motorways*.

Term	Definition
Ramp nose	The ramp nose is the triangular area where two roads either meet or split. Also known as ramp gore. A soft ramp nose refers to the point at which two roads meet by the painted line; there is no physical barrier other than line marking, which separates the two roadways. A hard ramp nose refers to the point at which physical barriers of the two roads either meet or split; motorists cannot cross at this point and the roads are physically separated.
Ramp signal	The control of traffic entering a freeway by means of traffic signals on the entry ramps. Also known as ramp metering.
Ramp storage	Entry ramps are used to store vehicles during ramp metering. As such, the ramp length and width determine the storage amount.
RPEQ	Registered Professional Engineer of Queensland.
Smart motorway	A motorway system in which traffic movements are actively managed using a range of ITS tools. It has the necessary infrastructure and ITS tools to manage upstream demand and operations to meet downstream capacity. The smart motorway standard allows the road operator to dynamically manage operations to minimise congestion due to traffic flow breakdown and achieve both safety and performance improvements for the carriageway.
Static sign	A board, plate, screen, or another device, whether or not illuminated, displaying words, figures, symbols or anything else to regulate, direct or warn road users (but does not include traffic signals).
Throughput	The maximum traffic volume achieved at a given point during a specified time period.
Traffic volume	The number of vehicles passing a given point on a lane or carriageway during a specified period of time.