TRANSPORT FOR NSW (TfNSW)

SPECIFICATION D&C R145

PAVEMENT MARKING (PERFORMANCE BASED)

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GUIDE NOTES

(Not Part of Contract Document)

USING SPECIFICATION TFNSW D&C R145

1. Introduction

Specification TfNSW D&C R145 is written as a performance type specification, setting out the initial, medium term and long term performance requirements of the pavement markings.

In a performance type specification, the Contractor is responsible for choosing the appropriate pavement marking material which will satisfy the performance requirements for any particular application.

Accordingly, D&C R145 does not specify which materials or application methods are to be used; this will be a matter for the Contractor and their material supplier(s) to decide.

However, for markings on new pavements which will be subjected to high traffic volumes (usually, but not always, in urban locations), longer life materials, such as thermoplastic or two part cold applied plastic material, may be specified and provision for doing this is made in Annexure R145/A.

2. Accredited Contractors

All pavement marking work under D&C R145 must be carried out by pavement marking organisations accredited to the "Painting Contractors Certification Program" (PCCP) administered by the Commonwealth Scientific and Industrial Research Organisation (CSIRO.)

3. Approved marking products

All pavement marking materials used under R145 must be approved under the Australian Paint Approval Scheme (APAS) administered by CSIRO. This includes glass beads.

4. Information to Be Supplied

Prior to commencement of work, the Contractor is required to submit to TfNSW (for reference) a list of materials that they propose to use under the Contract, including limitations on their use, such as seasonal constraints and incompatibility with other materials. A current Certificate of Product Conformity issued by APAS for the product proposed to be used must be submitted to the Principal.

The Contractor must also provide evidence that the work will be carried out by a pavement marking organisation holding PCCP accreditation.

5. Performance Requirements

The performance criteria specified in D&C R145 are for dry and wet retroreflectivity, skid resistance, colour including colour change, luminance factor and degree of wear. Other performance criteria may be specified for markings that have different considerations; e.g. markings that contain mixed colourings, or profile longitudinal pavement marking, which are required to address particular safety concerns.

The Contractor, in consultation with their material supplier(s), will still need to assure themselves that material issues, such as compatibility, have been resolved and that the application will satisfy the long term performance requirements.

6. Testing

As a minimum, the Contractor must perform field testing for dry retroreflectivity within the first 30 days after opening to traffic.

TfNSW may carry out its own field testing of the pavement marking for any or all of the performance criteria specified in TfNSW D&C R145. The results of this testing will be used by TfNSW to decide if any pavement marking needs to be remarked.

7. Innovation and Research & Development

Pavement marking material manufacturers or contractors proposing new materials or products designed to enhance pavement marking performance, road delineation and road safety generally may in the first instance contact the TfNSW Signs and Delineation Assets Manager (see Section 9 Contact Persons for Technical Enquiries), who will examine the proposals submitted and can arrange access to the road network for field testing if required.

8. (Not Used)

9. Contact Persons for Technical Enquiries

Enquiries regarding D&C R145 may be referred to standards@transport.nsw.gov.au

Transport for NSW

SPECIFICATION D&C R145

PAVEMENT MARKING
(PERFORMANCE BASED)

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FOREWORD

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When this document forms part of a deed

This document should be read in conjunction with all the documents forming the Project Deed.

When this document does not form part of a contract

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BASE SPECIFICATION

This document is based on Specification TfNSW R145 Edition 6 Revision 0.

TfNSW SPECIFICATION D&C R145

PAVEMENT MARKING (PERFORMANCE BASED)

1 GENERAL

1.1 SCOPE

1.1.1 General

This Specification sets out the requirements for the supply and application of pavement markings for works such as:

(a) installation of markings on new roads and for revised traffic schemes;

(b) reinstatement of markings after road works;

(c) maintenance of markings (e.g. marking over existing markings).

Unless specified otherwise in Annexure R145/A or on the Design Documentation drawings, you may use any pavement marking material of your choice which meets the required performance criteria, with the exception of solvent-borne paint which requires the approval of the Principal for its use.

1.1.2 School Zone Markings

This Specification does not cover all the requirements for markings for School Zones. For School Zones markings not covered by this Specification, contact the TfNSW Centre for Road Safety.

For details of "Dragon's Teeth" pavement markings at School Zones, refer to TfNSW Centre for Road Safety Technical Direction TD 2009/SR02, available at: http://home.rta.nsw.gov.au/dts/cserv/os/original/roadsafety/td2009sr02.pdf.

1.1.3 Bus Lane and Bicycle Lane Markings

This Specification includes the requirements for Bus Lane and Bicycle Lane markings, but not coloured surface coatings for Bus Lanes and Cycleways. For the latter requirements, refer to Specification TfNSW D&C R110.

1.2 STRUCTURE OF SPECIFICATION

This Specification includes a series of annexures and appendices that detail additional requirements.

1.2.1 Project Specific Requirements

Project specific details of work are shown in Annexure R145/A.

1.2.2 (Not Used)

1.2.3 Schedules of HOLD POINTS and Identified Records

The schedules in Annexure R145/C list the **HOLD POINTS** that must be observed. Refer to Specification TfNSW D&C Q6 for the definition of **HOLD POINTS**.

The records listed in Annexure R145/C are **Identified Records** for the purposes of TfNSW D&C Q6.

1.2.4 Planning Documents

The PROJECT QUALITY PLAN must include each of the documents and requirements listed in Annexure R145/D and must be implemented.

In all cases where this Specification refers to the manufacturer's recommendations, these must be included in the PROJECT QUALITY PLAN.

Notify the Principal of any proposed changes prior to their introduction. Any such information provided does not restrict you from introducing new technologies and materials.

1.2.5 Frequency of Testing

The Inspection and Test Plan must nominate the proposed frequency of testing to verify conformity of the item, which must not be less than the frequency specified in Annexure R145/L. Where a minimum frequency is not specified, you must nominate an appropriate frequency. Frequency of testing must conform to the requirements of TfNSW D&C Q6.

You may propose to the Principal a reduced minimum frequency of testing. The proposal must be supported by a statistical analysis verifying consistent process capability and product characteristics. The Principal may vary or restore the specified minimum frequency of testing, either provisionally or permanently, at any time.

1.2.6 Referenced Documents

Standards, specifications and test methods are referred to in abbreviated form (e.g. AS 1234). For convenience, the full titles are given in Annexure R145/M.

1.3 DEFINITIONS

The terms "you" and "your" mean "the Contractor" and "the Contractor's" respectively.

The following definitions are applicable to this Specification:

Longitudinal lines	All lines that are generally parallel to the direction of traffic flow, such as centre, lane, edge, turn, continuity and transition lines and outline markings.
Other markings	All diagonal and chevron markings, messages on the pavement including symbols, words, numerals and arrows, kerb markings and markings for parking.
Pavement markings	All longitudinal lines, transverse lines and other markings used on the road pavement and kerbs for the purpose of guiding traffic, but excluding raised pavement markers, which are covered in Specification TfNSW D&C R142.
Performance criteria	A series of subjective assessments and objective values of the colour, skid resistance, retention and day and night visibility of pavement markings by which the standard of pavement markings can be evaluated.

Skid resistance	An estimation of the adherence quality of a wet road surface measured by the friction at a low speed of a rubber slider upon this surface. The unit of measurement is "BPN".
Stripe	That part of longitudinal line marking comprising pavement marking material.
Transverse lines	All lines that are marked at right angles to the direction of the general traffic flow, such as "Stop/Give Way" lines and pedestrian crosswalk lines.

1.4 ACCREDITATION TO PAINTING CONTRACTORS CERTIFICATION PROGRAM

All works carried out using this Specification must be by pavement marking organisations accredited to the "Painting Contractors Certification Program" (PCCP), administered by CSIRO, under the appropriate classes from Category B "Pavement markings", as follows:

Class	Description
20	Long-run longitudinal pavement marking on major roads
21	Short to medium-run longitudinal pavement marking on minor roads
22	Audio tactile markings
24	Transverse pavement marking including intersection markings and messages
26	High friction surfacings
27	Pavement marking: removal
29	Short-run new or re-markings on major and minor roads

You must provide evidence to the Project Verifier that the pavement marking work is carried out by an organisation holding the appropriate PCCP accreditation.

1.5 TYPES OF MARKINGS

Details of the various types of pavement markings are shown on the following Appendices and Figures which are included at the back of this Specification:

Appendix 1 Longitudinal Lines

Appendix 2 Transverse Lines

Appendix 3 Markings and Symbols for Bicycle Facilities

Appendix 4 (Not Used)

Appendix 5 Markings at Roundabouts

(Figures 1 to 8 are not used)

Figure 9 Arrow shapes – (AR1, AR3(R), AR4(R))

Figure 10 Arrow shapes – (AR2, AR7, AR8, AR9)

Figure 11 Lane Change Arrows – (AR5-1(R), AR5-2(R))

Figure 12 (Not Used)

Figure 13 (Not Used)

Figure 14 Markings for Splayed Approach with Chevrons
Figure 15 Markings for Median
Figure 16 Markings for Left Turn Island
Figure 17 Pavement Marking in Advance of Open Level Crossings
Figure 18 Pavement Alphabet and Numerals
Figure 19 School Zone Speed Numeral Pavement Patch

2 MATERIALS

2.1 CHOICE OF MATERIALS

2.1.1 General

Unless specified otherwise in Annexure R145/A or on the Design Documentation drawings, you may use any pavement marking material of your choice which meets the required performance criteria (but subject to the limitations for profile pavement markings as stated in Clause 2.1.2).

Use of solvent-borne paint (refer to Clause 2.1.6) require the written approval of the Principal.

2.1.2 Australian Paint Approval Scheme (APAS) Products

Marking materials used are to be approved under APAS specifications AP-S0041/3 Cold Applied Plastic, AP-S0041/4 Thermoplastic, AP-S0041/5 Waterborne Paint and AP-S0042 Glass Beads. Evidence may be requested at any time. Use of non-approved pavement marking materials require the written approval of the Principal.

2.1.3 Profile (or Audio Tactile) Longitudinal Pavement Marking

Profile (or audio tactile) longitudinal pavement marking may be either:

(a) raised ribs applied at a regular interval over a base strip layer of the same material (**continuous type**); or

(b) raised ribs only, placed directly on the road surface (**discontinuous type**).

Material for profile longitudinal pavement markings must be either thermoplastic or two part cold applied plastic material.

Milled in pavement treatment may also be used to achieve profile (or audio tactile) effect.

2.1.4 Responsibility for Material and Method

The formulation of the pavement marking material and its method of application to the road pavement is your responsibility, but the proposed pavement marking materials must be appropriate for the pavement and traffic conditions under which they are applied and used, and must satisfy the performance criteria detailed in Clause 5 of this Specification.

2.1.5 Provide Details of Proposed Materials

You must provide to the Project Verifier a list of materials which you propose to use, and their limitations under the conditions for which they will be used under the Contract, such as seasonal constraints and potential or known incompatibility with other materials. A current Certificate of Product Conformity issued by APAS for the product proposed to be used must be submitted to the Principal.

2.1.6 Compatibility

The proposed marking materials must be compatible with the other materials with which they are in contact (but see Clause 3.1.4).

Do not use marking materials which may reduce the intended life of the pavement surface.

2.1.7 Solvent-borne Paint

Solvent-borne paint, where approved for use by the Principal, must also conform to the requirements of Specification TfNSW D&C 3351.

2.2 COLOUR

2.2.1 General

All pavement markings must be white in colour, unless otherwise detailed in the Design Documentation drawings or relevant TfNSW specifications or directed by the Principal.

2.2.2 Sample Panel

When requested by the Project Verifier, you must prepare a sample pavement marking material panel in accordance with AS 4049.4 Appendix F.

The colour of the sample must be at least an “approximate match”, as determined by unaided visual inspection in accordance with AS/NZS 1580.601.1, against the reference colours in AS 2700S, as follows:

White: Y35

Yellow: Y14

Red: R62

Black: B64

Other colours may be specified on a design drawing or by the Principal.

2.3 HEAVY METAL CONTENT

Glass beads used must comply with APAS Specification AP-S0042 Clause 6.2 “Heavy metal content”. The Project Verifier may request evidence of compliance at any time.

2.4 HANDLING, STORAGE AND MIXING

The pavement marking materials must be handled, stored, combined with other products and used in accordance with each individual manufacturer’s recommendations, such as the recommended application temperatures.

3 APPLICATION OF PAVEMENT MARKINGS

3.1 SURFACE PREPARATION

3.1.1 Responsibility for Surface Preparation

Surface preparation is, at all times, your responsibility.

Prior to the application of the marking material, you must carry out an assessment of the pavement surface, particularly for concrete or smooth or polished pavement surfaces, to determine the need for surface or other preparation such as grinding and/or the application of a tack coat to facilitate adhesion. It is intended that whoever is doing the checking, must note and take images etc., of any identified issue and raise them with the Principal. You must document findings and obtain the agreement of the Principal to the proposed solutions.

3.1.2 Surface Condition

The surface area to be marked must be dry and free of dirt, gravel and other loose or foreign material.

The area around the marking must also be free of dirt, gravel and other loose or foreign material to avoid tracking of such material on to newly applied markings.

Do not carry out the pavement marking work until the above conditions have been met.

3.1.3 Condition of Existing Marking

When marking over existing markings, and the existing marking material is flaking or chipping, or is of a type or is in such a condition that adhesion of the new marking to the road surface cannot be guaranteed for its required life, you must obtain the agreement of the Principal to the proposed method of surface preparation and its extent.

3.1.4 Incompatibility with Existing Surface

Where a pavement marking material to be applied may be incompatible with the existing marking or surface, you must prepare the marking or surface suitably before applying the pavement marking material.

3.1.5 Existing Curing Compound Film

Where a curing compound has been applied to a new rigid concrete pavement surface, you must remove the curing compound physically by abrasive means such as grinding or blasting, from the areas where the pavement marking material is to be applied.

3.2 POSITION OF MARKINGS

3.2.1 New Installation

New installation refers to the installation of markings on new roads and for revised traffic schemes.

You must set out the work such that the markings are placed in accordance with the Design Documentation drawings and/or the Figures at the back of this Specification and within the tolerances listed in Table R145.1.

3.2.2 (Not Used)

3.2.3 Maintenance

You must apply markings directly over the existing markings within the tolerances listed in Table R145.1.

At locations where the existing markings are so badly worn that installation of new markings is required, then you must set these out to achieve the correct shape and position of the markings within the tolerances listed in Table R145.1.

3.2.4 Hold Point

HOLD POINT	
Process Held:	Application of pavement markings.
Submission Details:	Notification that set out is complete.
Release of Hold Point:	The Nominated Authority may inspect the set out prior to authorising the release of the Hold Point.

3.3 WATERBORNE PAINT WITH LARGE GLASS BEADS (TYPE D-HR)

3.3.1 Recommended Conditions for Application – General

As a guide to achieving optimum long term performance of pavement markings using waterborne paints with large glass beads (Type D-HR), apply the waterborne paint under the following conditions:

(a) air temperature and pavement temperature > 15°C;

(b) relative humidity < 70%;

(c) air movement > 10 km/hr (reasonable air movement);

(d) adequate protection of markings from traffic during the drying process.

Do not apply waterborne paint when relative humidity is above 85% or when air or road temperatures are below 10°C.

3.3.2 Newly Sprayed Bituminous Surfacings

For application of waterborne paint with large glass beads over newly sprayed bituminous surfacings, in order to meet the specified performance criteria, you may use either a two stage process or a single stage process.

(a) Two Stage Process

Apply the markings soon after the bituminous surfacing is placed as an initial sacrificial coat, and then apply a second coat within two to three months later, in a two stage process.

(b) Single Stage Process

To be able to meet the (critical) requirement of dry retroreflectivity of 200 mcd/lx/m^2 at between 365 days to 395 days after opening to traffic (refer Clause 5.1.2 (ii)), an initial (within 30 days after opening) dry retroreflectivity of not less than 400 mcd/lx/m^2 is required.

The following method may be used to consistently achieve this initial dry retroreflectivity level.

Apply an initial primer or base coat of paint and glass beads. After the primer coat is at least touch dry, apply a secondary coat of paint and glass beads directly over the primer coat.

Apply the paint using double angled spray guns at low pressure (less than 500 psi) and a static bead drop system, or using any other method that you consider to be appropriate. As a guide, for 14 mm sprayed seals, a wet film paint thicknesses of 600 µm and a bead drop rate of 600 g/m^2 will be suitable.

This double coat assists in overcoming some of the inherent difficulties of painted markings on new or resurfaced sprayed seals, due to the high surface texture, and the presence of aggregate precoating chemicals and volatile binder additives, and provide durability for the marking.

Notwithstanding the above, achievement of conformity remains your responsibility.

3.4 APPLICATION OF MARKINGS ON ASPHALT PAVEMENT SURFACES

Where practical, apply permanent pavement markings on asphalt wearing course surfaces only after at least seven days has elapsed after placing the asphalt, or a longer period if necessary, to avoid discolouration of the newly applied pavement markings due to the release of volatile chemicals from the placed asphalt and/or tracking of the chemicals from vehicle tyres onto the markings.

3.5 REINSTATEMENT OF PAVEMENT MARKINGS AFTER ROAD WORKS

3.5.1 Time Limits for Reinstatement

Reinstate the pavement markings as soon as possible after road works where the pavement markings have been removed or damaged, to maintain the delineation for road safety purposes.

3.5.2 Use of Temporary Raised Pavement Markers

You may use temporary raised pavement markers for delineation for up to 10 working days after opening to traffic, after which the permanent pavement markings must be reinstated.

Application of permanent pavement markings on asphalt surfaces must comply with Clause 3.4.

4 REDUNDANT PAVEMENT MARKINGS

4.1 GENERAL

Redundant pavement markings usually arise:

- as part of traffic switches during road construction or reconstruction (involving temporary removal or masking of the markings). In most cases, a final pavement surface will be re-laid, over which permanent markings are installed;
- as a result of a pavement marking/delineation scheme being changed due to traffic and road safety considerations (involving permanent removal of the markings);
- As a result of application error or equipment failure during application (e.g. spillage).

Remove pavement markings which are no longer required, and leave behind a clean and undamaged pavement with surface texture, reflectivity characteristics and colour comparable to the adjacent pavement surface.

4.2 METHODS AND PROCESS OF REMOVAL

4.2.1 Methods of Removal

Remove pavement markings in a manner that will not damage the pavement structure and minimise and change to the surface or texture. After removal of the markings, the condition of the resulting pavement surface must be suitable for bonding of new markings.

Remove pavement markings over expansion joints on concrete pavements by methods acceptable to the Principal.

4.2.2 Process of Removal

Where existing pavement markings are to be removed and replaced by other pavement markings, do not remove the pavement markings until you are ready to install the replacement markings.

Remove pavement markings in such order that the markings remaining in place at any time will not be in a pattern that will mislead or misdirect road users.

4.3 EXTENT OF REMOVAL OR MASKING

When removing or masking longitudinal and transverse lines such as edge lines, centre lines, lane lines, holding lines, or other lines, the removal or masking must cover a minimum of 200% of the total area of existing lines; i.e. minimum 50% extra coverage on both sides of the existing lines.

When removing or masking pavement markings such as arrows, numerals, letters, or other pavement markings, the removal or masking must take the form of a rectangular area or block around such markings.

4.4 TEMPORARY MASKING

4.4.1 Permanently Redundant Markings

Any permanently redundant markings are to be removed from the pavement surface by methods appropriate for that surface type. Method of removal is to be agreed to by the Principal or asset owner.

Blacking out of permanently redundant markings is not permitted.

Where existing pavement markings are to be removed and replaced by other pavement markings, removal must not commence until adequate provisions have been made to complete the installation of the replacement markings. Reinstatement of markings must be done as soon as possible.

When removal operations are completed, the pavement surface must be clear of any residue or debris. A minimum of 90 percent of the existing visible marking must be removed to uniformly expose the existing pavement surface.

Any damage to the pavement, pavement joint materials or the pavement surface caused by the removal of pavement markings must be repaired. The pavement surface must be left in a condition that will not mislead or misdirect road users.

Alternatively, if permanent removal on any surface is difficult to achieve, resurfacing of flexible pavements can be considered.

You may only paint over or apply an overlay (i.e. "blackout"), as a temporary masking measure, over any new markings which have been applied incorrectly.

Remove permanently within 48 hours any such temporarily masked redundant markings.

4.4.2 Temporarily Redundant Markings

You may mask markings which will be temporarily redundant for a period of time, using black non-reflective pavement marking tapes specially designed for the purpose. Regular checks should ensure the functionality of any temporary masking tape. If excessive traffic movements are expected which may shift the tape markings, permanent removal may need to be considered.

Remove the marking tapes to expose the masked marking when the marking is once again required.

Renew the marking tapes where they are to remain longer than 6 months after application.

4.5 REPAIR AND INSPECTION

4.5.1 Repair of Damage Caused by Markings Removal

Repair, by methods acceptable to the Principal, any damage to the pavement structure, pavement surface or pavement joint caused by the markings removal.

4.5.2 Inspection

Inspect areas where removal of redundant markings has been carried out, to verify that:

(a) redundant markings have been completely removed;

(b) pavement area has been cleaned up and waste material removed from the Site;

(c) any damage to the pavement caused by the marking removal has been repaired;

(d) guidance provided by the delineation to road users is clear and not misleading.

4.6 DISPOSAL OF REMOVED MARKING MATERIAL

Promptly remove any material deposited on the pavement resulting from the markings removal by the methods stated in the PROJECT QUALITY PLAN. On completion of the markings removal, clear the pavement surface of any residue or debris.

Do not leave any marking material that has been removed from the pavement at the Site. Dispose of marking material removed in accordance with current EPA guidelines.

5 PERFORMANCE CRITERIA

5.1 RETROREFLECTIVITY

5.1.1 General

The dry and wet retroreflectivity of any pavement marking, when measured in accordance with AS 4049.4 Appendix K, using the MX30 instrument or an equivalent retroreflectometer that uses 30 m geometry, must comply with the performance criteria in Clauses 5.1.2 and 5.1.3 respectively.

5.1.2 Dry Retroreflectivity

The dry retroreflectivity of white markings must be a minimum of:

(i) 350 mcd/lux/m^2, within the first 30 days after opening to traffic;

(ii) 200 mcd/lux/m^2, at between 365 and 395 days after opening to traffic;

(iii) 150 mcd/lux/m^2 before re-marking is required – this is the intervention level.

The dry retroreflectivity of yellow markings must be a minimum of:

(i) 200 mcd/lux/m^2, within the first 30 days after opening to traffic;

(ii) 150 mcd/lux/m^2, at between 365 and 395 days after opening to traffic;

(iii) 100 mcd/lux/m^2 before re-marking is required – this is the intervention level.

5.1.3 Wet Retroreflectivity

The wet retroreflectivity of white or yellow markings must be a minimum of 80 mcd/lux/m^2 at any time after application.

5.2 SKID RESISTANCE

The skid resistance of any pavement marking must be a minimum of 45 BPN when tested in accordance with AS 4049.4 Appendix J at any time after application.

For profile pavement markings, measure and report the skid resistance only when the profile pavement marking is of the continuous type. The skid resistance is to be measured on the flat strip in between the raised ribs.

5.3 COLOUR

5.3.1 Mixed Colour Markings

Where mixed colour markings are used, with different colours providing different daytime colour contrasts to deliver a message, assess each individual colour for compliance with the colour specified, and clarity of definition of the markings, both between the different colours, and between the coloured marking and the pavement, as well as the retention of the message.

5.3.2 Colour Change

When non-white colour pavement markings in the wheel path are assessed for colour change against a reference sample in accordance with AS 4049.4 Appendix G, the grey scale rating must be 3 or greater.

5.4 LUMINANCE FACTOR

When white pavement markings in the wheel path are tested for the luminance factor in accordance with AS 4049.4 Appendix H, Method 2, the test marking must be lighter than Natural Colour System (NCS) swatch S 2500-N (see SS 01 91 02).

When yellow pavement markings in the wheel path are tested for the luminance factor in accordance with AS 4049.4 Appendix H, Method 2, the test marking must be an approximate match to Natural Colour System (NCS) swatch S 1070-Y20R.

To improve contrast on lighter coloured pavement surfaces such as concrete, consideration should be given to the application of a black surround to white markings. Concrete pavements will naturally darken as they age.

5.5 DEGREE OF WEAR

When pavement markings are tested for the degree of wear in accordance with AS 4049.4 Appendix L, the pavement marking tested must be “70% of area intact” or better, in accordance with AS 4049.4 Appendix M.

5.6 THICKNESS

5.6.1 Non-profile Pavement Marking

The thickness of any non-profile pavement marking must not exceed 5 mm, as shown in Table R145.1.

5.6.2 Profile Pavement Marking

The thickness of profile pavement marking must be in accordance with Table R145.2.

6 SAMPLING AND TESTING

6.1 STATISTICAL SAMPLING PLAN

Develop and provide to the Project Verifier a robust statistical sampling plan for assessing the dry retroreflectivity performance of pavement markings, in accordance with AS 4049.5 Appendix D.

6.2 TIMES FOR SAMPLING AND TESTING

6.2.1 All Contracts

For all Contracts, sample and test the pavement markings for their dry retroreflectivity performance within the first 30 days, and at between 365 and 395 days, after opening to traffic, unless specified otherwise in the Contract documents.

6.2.2 (Not Used)

6.2.3 Times for Submission of Test Results to Project Verifier

Provide the results of your testing to the Project Verifier within 10 working days of carrying out the test.

6.3 PRINCIPAL'S OWN SAMPLING AND TESTING

The Principal will carry out its own sampling and testing at subsequent times (i.e. after the first 30 days) for retroreflectivity and other performance criteria to verify conformity with the requirements of this Specification.

7 CONFORMITY

In addition to the performance criteria stated in Clause 5, installed pavement markings must conform to the requirements stated in Clauses 7.1 to 7.3.

7.1 POSITIONS, DIMENSIONS AND TOLERANCES

7.1.1 General

Installed pavement markings must comply with the tolerances shown in Table R145.1.

Table R145.1 – Pavement Marking Positions, Dimensions and Tolerances

Position or Dimension	New Installation [1, 2]	Maintenance [3]
1. Longitudinal line marking		
(a) Distance between centreline of new and old line marking	N.A.	< 15 mm
(b) Start of new stripe relative to start of old stripe	N.A.	Lesser of: ± 5% of stripe length or ± 100 mm
(c) Position of centreline of new line marking	< 50 mm from positions shown on Design Documentation drawings	N.A.

Position or Dimension	New Installation [1, 2]	Maintenance [3]
(d) Length of new stripe (and for maintenance: total length of new and old stripe, unless otherwise directed)	Lengths shown in Appendix 1 ± 50 mm	Old stripe length ± lesser of: 5% of old stripe length or 100 mm
(e) Width of new line marking (and for maintenance: total width of new and old line marking, unless otherwise directed)	Widths shown in Appendix 1 ± 5 mm	Width of old line marking ± 10 mm
(f) Gap between double lines	Gap shown in Appendix 1 ± 10 mm	Gap shown in Appendix 1 ± 10 mm
2. Transverse and other markings		
(a) Position of centreline of transverse marking	< 50 mm from positions shown on Design Documentation drawings	N.A.
(b) Length of new marking	Lengths shown in Appendices 2, 3 and 5, ± 10 mm	Length of old marking ± 10 mm [4]
(c) Width of new marking	Widths shown in Appendices 2, 3 and 5, ± 10 mm	Width of old marking ± 10 mm [4]
3. Markings in advance of open level crossings		
(a) Length of new marking	Length shown in Figure 17 ± 50 mm	Length of old marking ± 10 mm [4]
(b) Width of new marking	Width shown in Figure 17 ± 10 mm	Width of old marking ± 10 mm [4]
4. Arrows, chevrons, marked medians, marked left turn islands, speed markings		
(a) Each dimension	Dimensions shown in Figures 9 to 11, 14 to 16, and 18 to 19, ± 50 mm	Dimensions of old marking ± 50 mm [4]
5. Thickness of all pavement markings, other than profile pavement marking	≤ 5 mm (unless directed otherwise by the Principal)	≤ 5 mm (unless directed otherwise by the Principal)

Notes:

[1] For New Installation markings, set out the markings such that, at the ends, any disruption to the marking pattern to which it links is minimised.

[2] (Not Used)

[3] The alignment of longitudinal line marking must be a smooth and continuous apparent line when viewed in the direction of the line.

[4] (Not Used)

7.2 PROFILE PATTERN DIMENSIONS

7.2.1 General

The profile pattern must conform to the dimensions shown in Table R145.2.

Table R145.2 – Profile Longitudinal Pavement Marking Dimensions

Description	Requirement
Height of raised ribs, proud of pavement surface (excluding surface applied beads)	10 ± 2 mm
Thickness of strip in between raised rib sections (if applicable)	≤ 2 mm
Clear spacing of raised ribs (in longitudinal direction)	250 ± 50 mm
Length of raised ribs (in longitudinal direction)	60 ± 10 mm
Slope angle of raised rib lead and trail faces	45° (approximately)

7.2.2 Measurement

Measure and record the height of the raised ribs, and the thickness of the strip in between the raised rib sections (if applied), of the profile pavement marking material applied to the road pavement with a vernier or a suitable dry film thickness gauge.

7.2.3 Milled Strip Profile

The width (perpendicular to longitudinal line) of milled pavement ATLM may be either 205 mm or 305 mm. Milled pavement ATLM length is dependent on the milled depth and as a guide, length of each milled cut is as follows:

- 10 mm depth with 160 mm length of cut;
- 12 mm depth with 167 mm length of cut;
- 14 mm depth with 175 mm length of cut.

The standard wavelength of each mill is 310 ± 10 mm. The wavelength of mill may be increased to 610 ± 10 mm.

Note 1: Milled strip profile ATLM requires local asset representative agreement for suitability of use.

Note 2: Milling through pavement joints is not permitted.

7.3 SHAPE AND APPEARANCE

Completed markings must be uniform in appearance, texture, width and thickness. The surface must be free from unbeaded areas, traffic damage or other defects. Black or grey markings must not contain glass beads.

Markings must be straight or with smooth even curves where intended. All edges must have a clean sharp cut off.

7.4 NONCONFORMITY

You must remove any marking material beyond the defined marking, leaving a neat marking on the wearing surface of the pavement.

Pavement markings which do not comply with this Specification and the Design Documentation drawings are nonconforming and must be dealt with in accordance with your quality management system requirements and/or your PROJECT QUALITY PLAN.

ANNEXURE R145/A – PROJECT SPECIFIC REQUIREMENTS

Refer to Clause 1.2.1.

A1 (NOT USED)

A2 PROJECT SPECIFIC PREFERRED MARKING MATERIALS

NOTES TO TENDER DOCUMENTER: (Delete this boxed text after customising Annexure R145/A)

Insert here any particular preferred pavement marking material for:

- *longitudinal lines;*
- *transverse lines;*

etc. Refer to Clause 1.5 for types of markings. Note that material for profile longitudinal markings is limited to either thermoplastic or two part cold applied plastic material.

ANNEXURE R145/B – (NOT USED)

ANNEXURE R145/C – SCHEDULES OF HOLD POINTS AND IDENTIFIED RECORDS

Refer to Clause 1.2.3.

C1 SCHEDULE OF HOLD POINTS

Clause	Description
3.2.4	Set out of pavement markings.

C2 SCHEDULE OF IDENTIFIED RECORDS

The records listed below are Identified Records for the purposes of TfNSW D&C Q6.

Clause	Description of Identified Record
6.2	Test results of dry retroreflectivity performance.

ANNEXURE R145/D – PLANNING DOCUMENTS

Refer to Clause 1.2.4.

The following documents are a summary of documents that must be included in the PROJECT QUALITY PLAN. The requirements of this Specification and others included in the Contract must be reviewed to determine additional documentation requirements.

Clause	Description
1.4	Evidence of accreditation to the "Painting Contractors Certification Program".
2.1.4	List of materials proposed for use, and details of their limitations under the conditions for which they will be used, such as seasonal restrictions and compatibility with other materials. A current Certificate of Product Conformity issued by APAS for the product proposed to be used must be submitted to the Principal.
4.2	Details of materials and methods for masking or removal of redundant pavement markings.

ANNEXURES R145/E TO R145/L – (NOT USED)

ANNEXURE R145/M – REFERENCED DOCUMENTS

Refer to Clause 1.2.6.

TfNSW Specifications

TfNSW D&C R110	Coloured surface coatings for bus lanes and cycleways
TfNSW D&C R142	Retroreflective Raised Pavement Markers
TfNSW D&C Q6	Quality Management System (Type 6)
TfNSW D&C 3351	Road Marking Paint

Austroads Specifications

ATS 4110	Longitudinal Pavement Marking

Australian Standards

AS/NZS 1580.601.1	Paints and related materials – Methods of test – Method 601.1: Colour – Visual comparison
AS 1742.2	Manual of uniform traffic control devices – Part 2: Traffic control devices for general use
AS 2700	Colour standards for general purposes
AS 2700S	Colour standards for general purposes – Swatches
AS 4049	Paints and related materials – Pavement marking materials
AS 4049.4	Part 4: High performance pavement marking systems
AS 4049.5	Part 5: Performance assessment of pavement markings

Australian Paint Approval Scheme (APAS) Specifications

AP-S0041/3	Pavement Marking Material – Cold Applied Plastic
AP-S0041/4	Pavement Marking Material – Thermoplastic
AP-S0041/5	Pavement Marking Material – Waterborne Paint
AP-S0042	Glass Beads (And Glass Particles) – For Use in and with Pavement Marking Materials

Natural Colour System (NCS) Colour Swatches

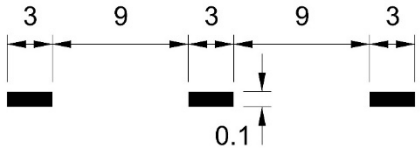
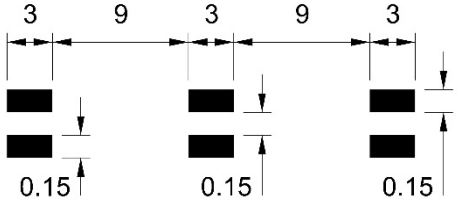
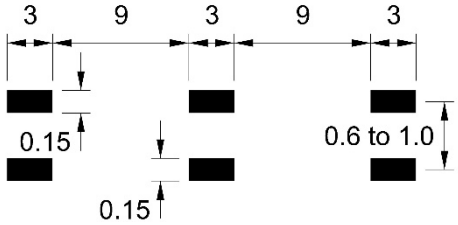
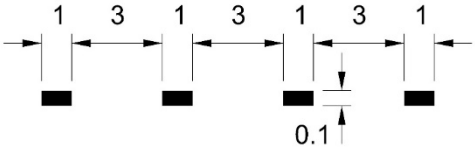
NCS SS 01 91 02

NCS S 1070-Y20R

APPENDICES 1 TO 5

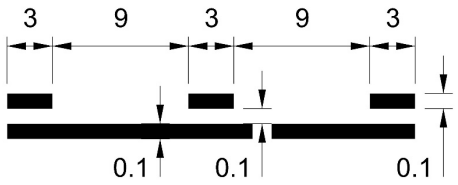
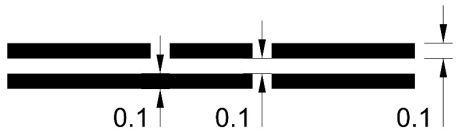
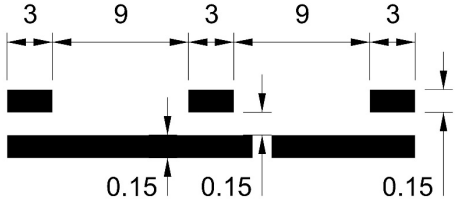
APPENDIX 1 – LONGITUDINAL LINES

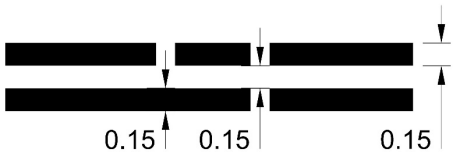
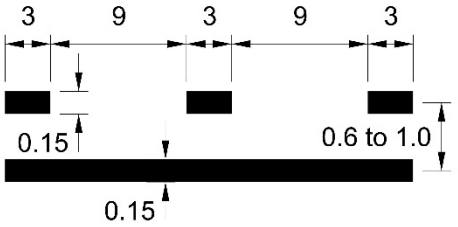
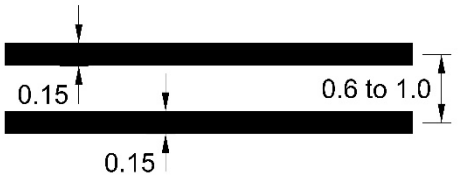
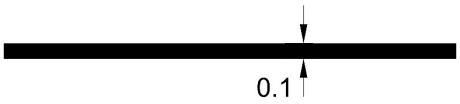
Dividing lines

Line type	Name	Dimensions (m)	Colour
DL1	Single Broken Dividing Line		White
DL4	Double Broken Dividing Line		White
DL4 WCL	Double Broken Dividing Wide Centre Line		White
DLP	Single Broken Dividing Line - Path		White

Note: For areas which experience snow, dividing lines may be Colour No. Y14 Golden Yellow as specified by AS 2700.

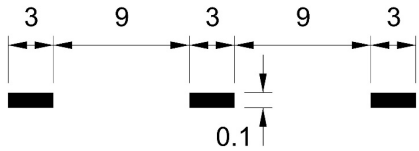
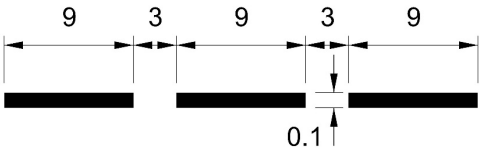
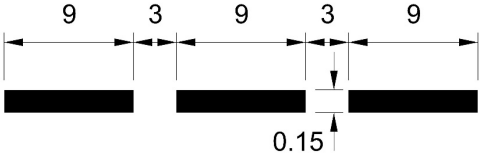
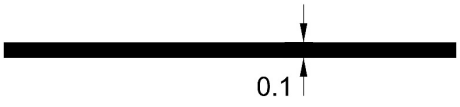
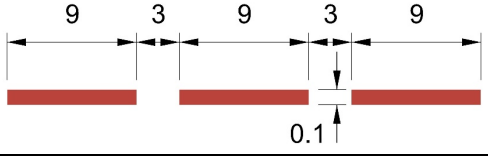
Barrier lines

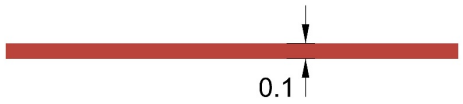
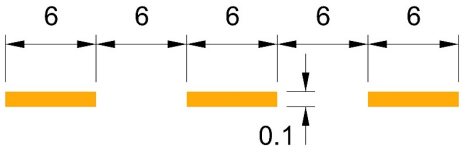
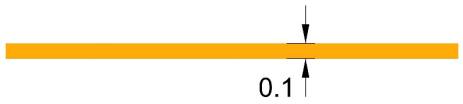
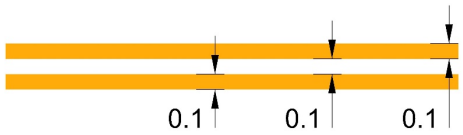
Line type	Name	Dimensions (m)	Colour
BL1	Double one-way barrier Line		White
BL2	Double two-way barrier line		White
BL5	Double one way barrier line (special purpose)		White

BL6	Double two way barrier line (special purpose)		White
BL5 WCL	Double one way barrier (special purpose wide centre line)		White
BL6 WCL	Double two way barrier (special purpose wide centre line)		White
BLP	Single two-way barrier line - Path		White

Note: For areas which experience snow, barrier lines may be Colour No. Y14 Golden Yellow as specified by AS 2700.

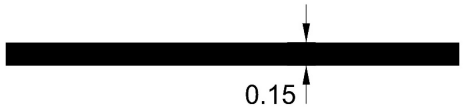
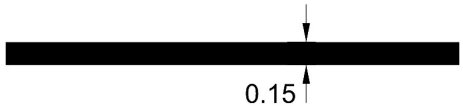
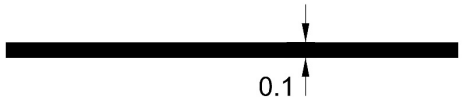
Lane lines

Line type	Name	Dimensions (m)	Colour
LL1	Single broken lane line		White
LL2	Single broken lane line (special purpose)		White
LL3	Single broken lane line (special purpose)		White
LL4	Single continuous lane line		White
BU1	Single broken lane line - Bus		Red

Line type	Name	Dimensions (m)	Colour
BU2	Single continuous lane line - Bus		Red
TR1	Single broken lane line - Tram		Yellow
TR2	Single continuous lane line - Tram		Yellow
TR3	Double continuous lane line - Tram		Yellow

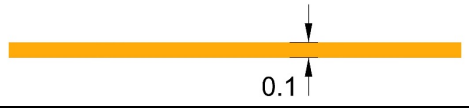
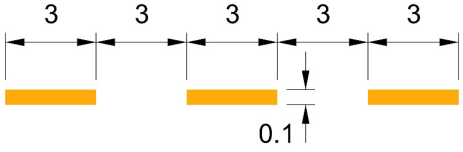
Note: For areas which experience snow, LL1, LL2, LL3 and LL4 lanes lines may be Colour No. Y14 Golden Yellow as specified by AS 2700.

Edge and outline lines

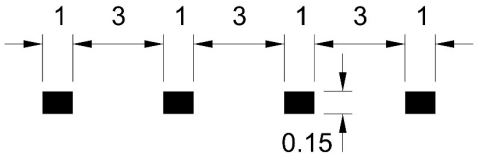
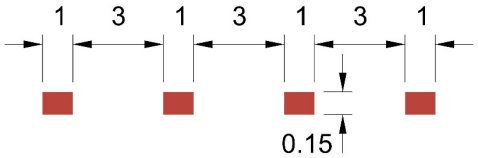
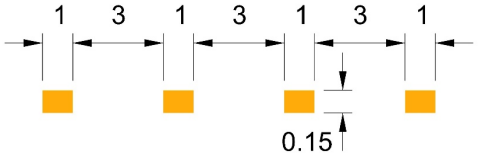
Line type	Name	Dimensions (m)	Colour
EL1	Edge Line		White
OL1	Outline Marking		White
ELP	Edge line - Path		White

Note: For areas which experience snow, edge lines may be Colour No. Y14 Golden Yellow as specified by AS 2700.

Parking control lines

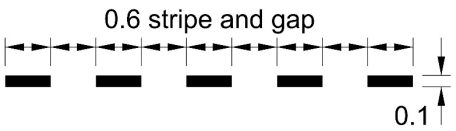
Line type	Name	Dimensions (m)	Colour
NS1	Continuous line - No Stopping		Yellow
NS2	Broken line - Zone (special purpose)		Yellow

Continuity lines

Line type	Name	Dimensions (m)	Colour
CL1	Continuity line		White
BU4	Continuity line – Bus		Red
TR4	Continuity line – Tram		Yellow

Note: For areas which experience snow, CL1 may be Colour No. Y14 Golden Yellow as specified by AS 2700.

Turn line

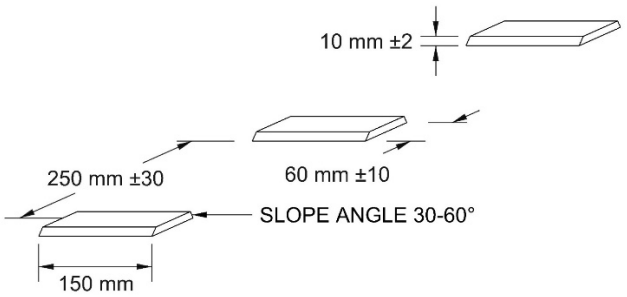
Line type	Name	Dimensions (m)	Colour
TL	Turn Line		White

Note: For areas which experience snow, turn lines may be Colour No. Y14 Golden

Notes:(all dimensions in m unless stated otherwise)

* Section in TfNSW Delineation Manual

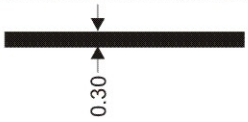
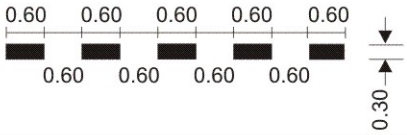
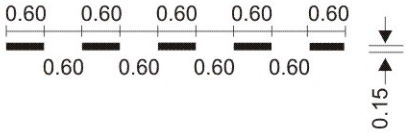
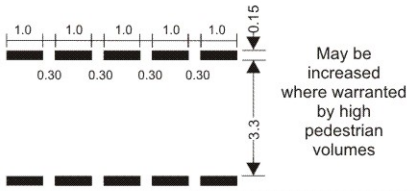
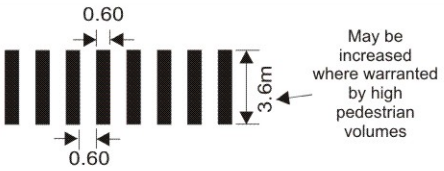
General profile ATLM dimensions



Profile (or audio tactile) lines

ATLM line code	Line code	Details
ATP BL/DL	DL1, DL4, BL1, BL2, BL5, BL6	A single line of profile ATLM
ATM BL/DL	DL1, DL4, BL1, BL2, BL5, BL6	A single line of milled ATLM
ATP WCL	DL4 WCL, BL5 WCL, BL6 WCL	Two lines of profile ATLM
ATM WCL	DL4 WCL, BL5 WCL, BL6 WCL	Two lines of milled ATLM
ATP OL	OL1	A single line of profile ATLM
ATM OL	OL1	A single line of milled ATLM
ATP EL – Black	EL1	A single line of black profile ATLM
ATP EL – White	N/A	A single line of white profile ATLM This ATLM functions as the visible edge line.
ATM EL	EL1	A single line of milled ATLM
ATP LL	LL1	A single line of profile ATLM for the visible section of the line.
ATM LL	LL1	A single line of milled ATLM for the visible section of the line

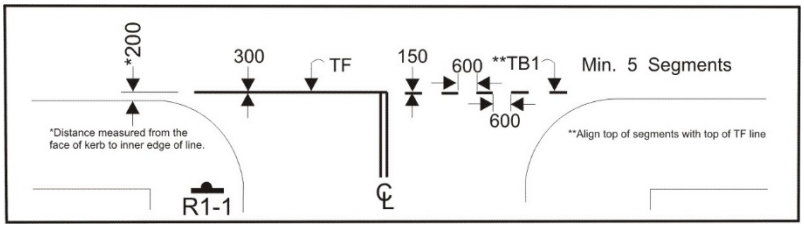
APPENDIX 2 – TRANSVERSE LINES

Line Type	Use	Dimensions (m)	Colour
TF	Stop line		White
TF1		NO LONGER USED	
TF2		NO LONGER USED	
TB	Give Way Line (Used with signs)		White
TB1	Give Way Line (Used on right side of road)		White
PCW	Pedestrian Cross Walk Lines		White
PX	Pedestrian Crossing		White

Dimensions in m unless stated otherwise

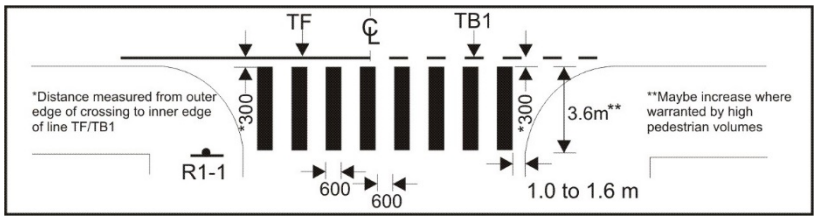
Transverse line at a stop sign

(all dimensions in mm unless stated otherwise)



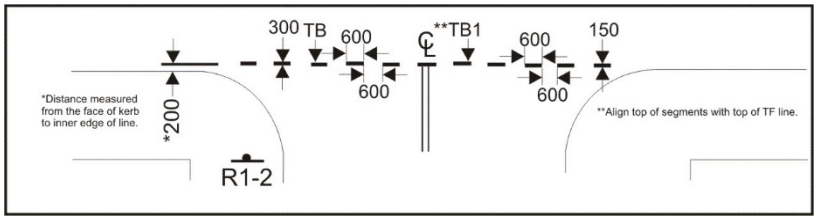
Transverse line at a stop sign with pedestrian crossing

(all dimensions in mm unless stated otherwise)



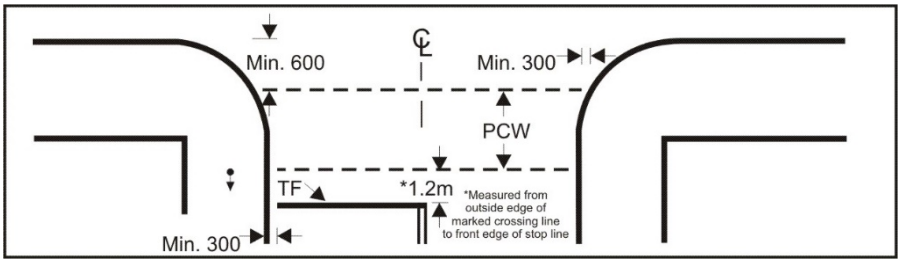
Transverse line at a give way sign

(all dimensions in mm unless stated otherwise)

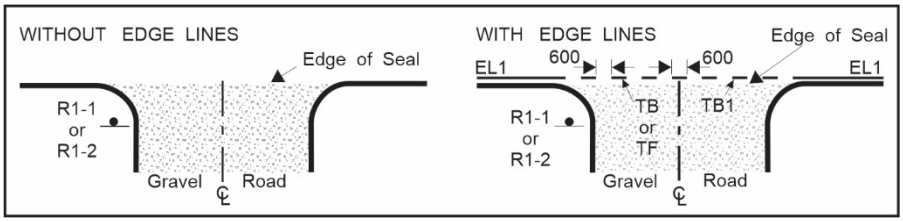


Transverse lines at traffic signals

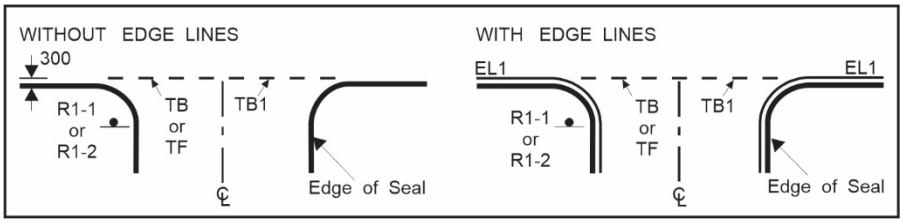
(all dimensions in mm unless stated otherwise)



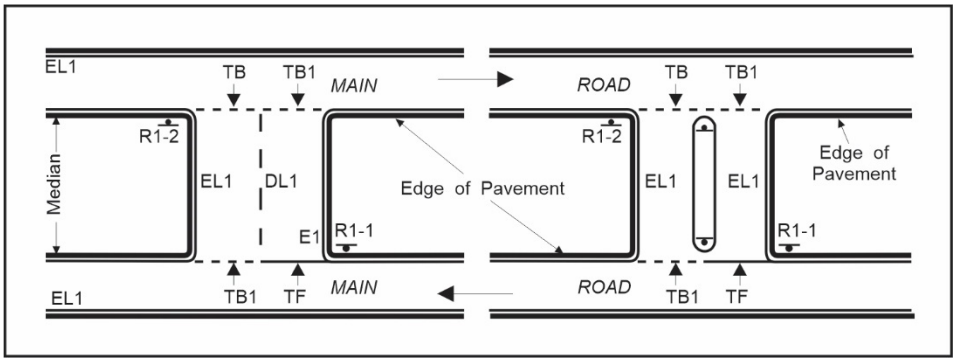
Transverse lines at a stop & give way sign at a junction with gravel road.



Transverse lines at a stop & give way sign at a junction with sealed road

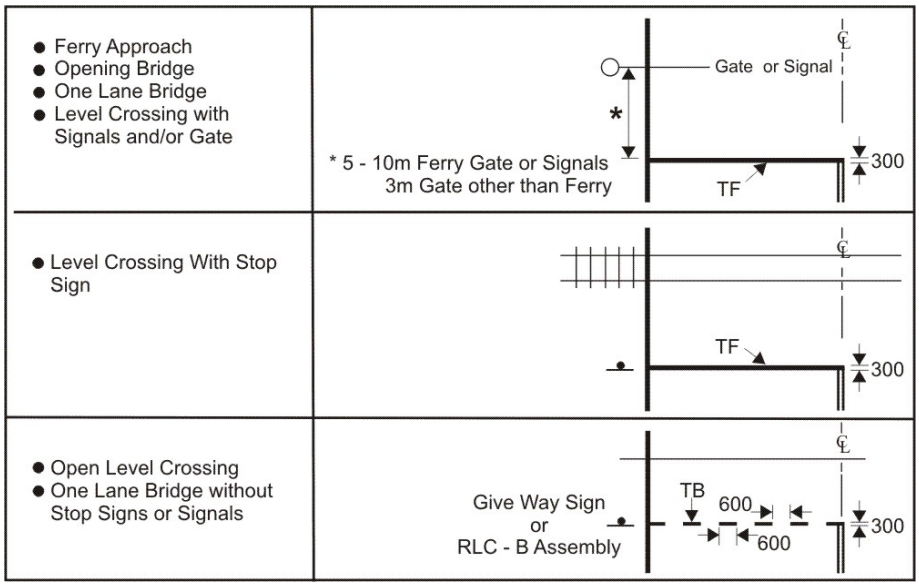


Transverse line at a stop & give way sign connecting road on a dual carriageways.



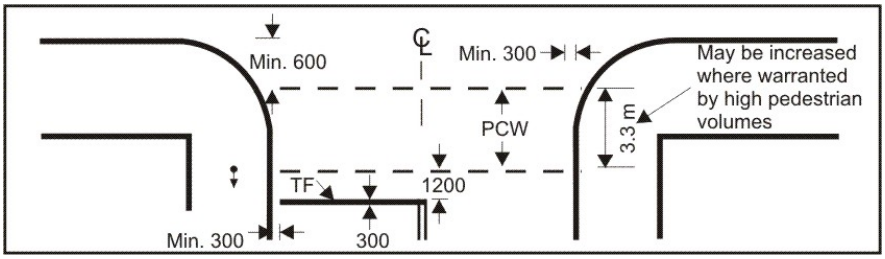
Transverse lines for other applications

(all dimensions in mm unless stated otherwise)

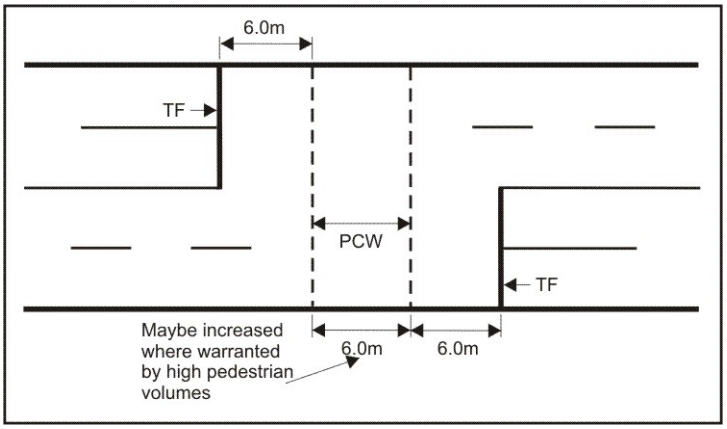


Typical pedestrian crosswalk lines at an intersection with a marked foot crossing

(all dimensions in mm unless stated otherwise)

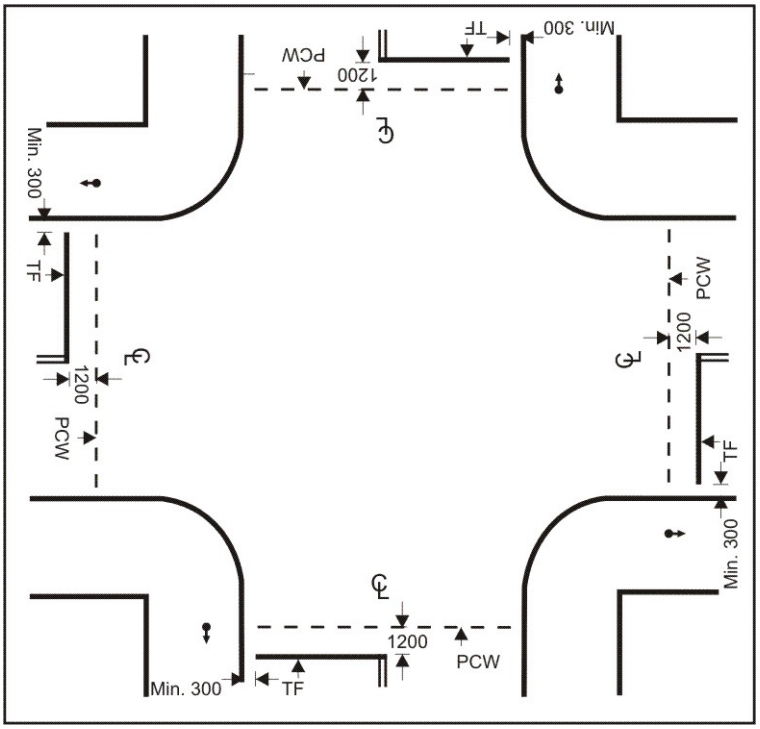


Typical pedestrian crosswalk lines at mid-block marked foot crossing

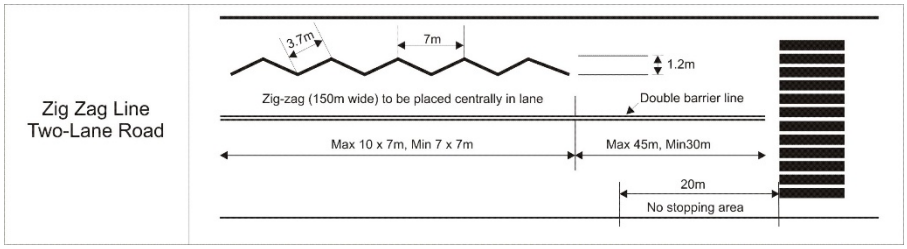


Transverse lines for scramble crossing

(all dimensions in mm unless stated otherwise)

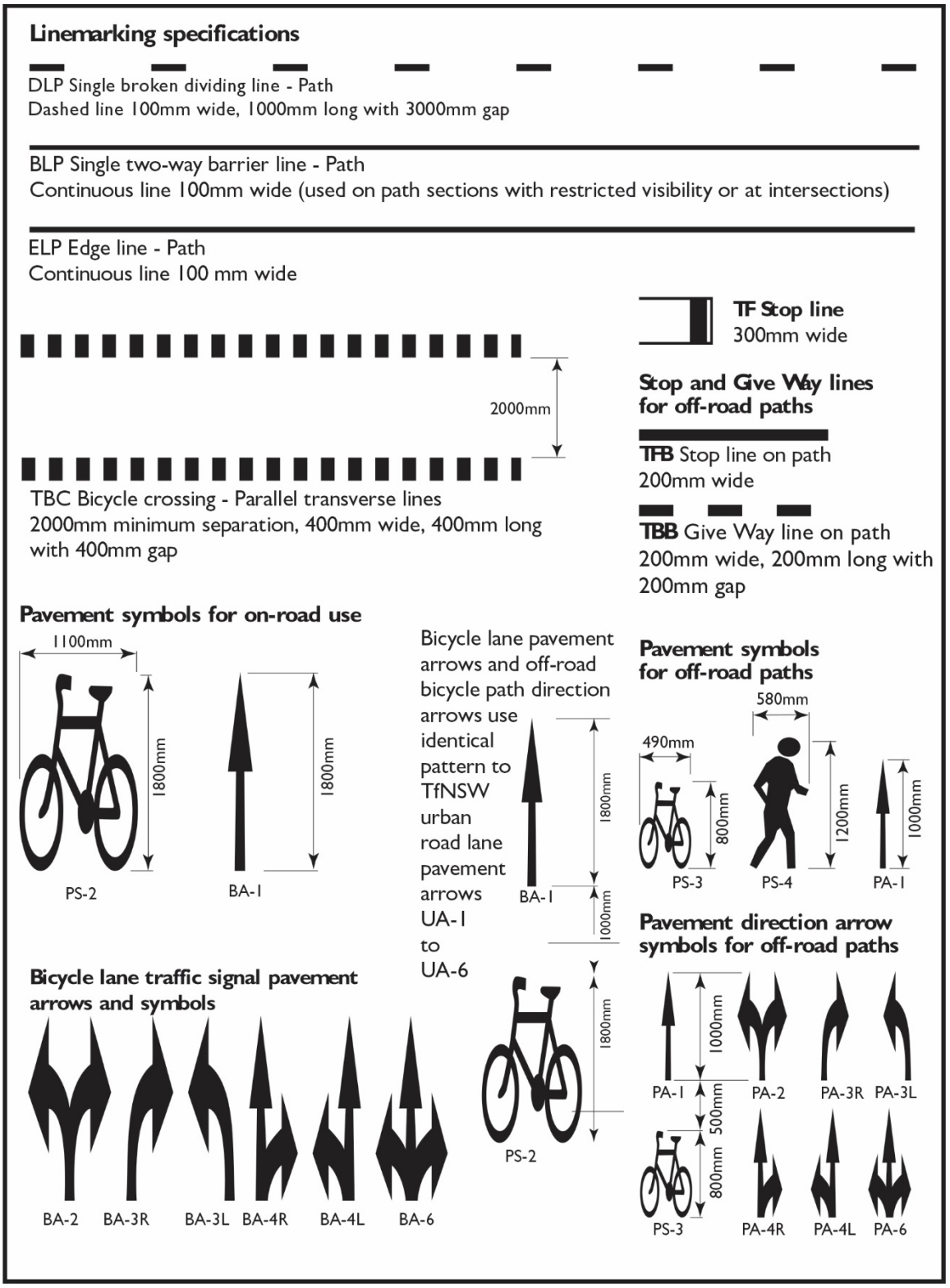


Zig Zag Markings



(Ref. AS 1742.2 Fig. 5.8)

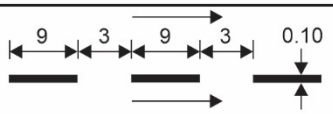
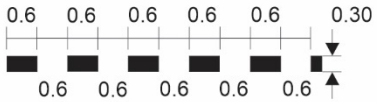
APPENDIX 3 – MARKINGS AND SYMBOLS FOR BICYCLE FACILITIES



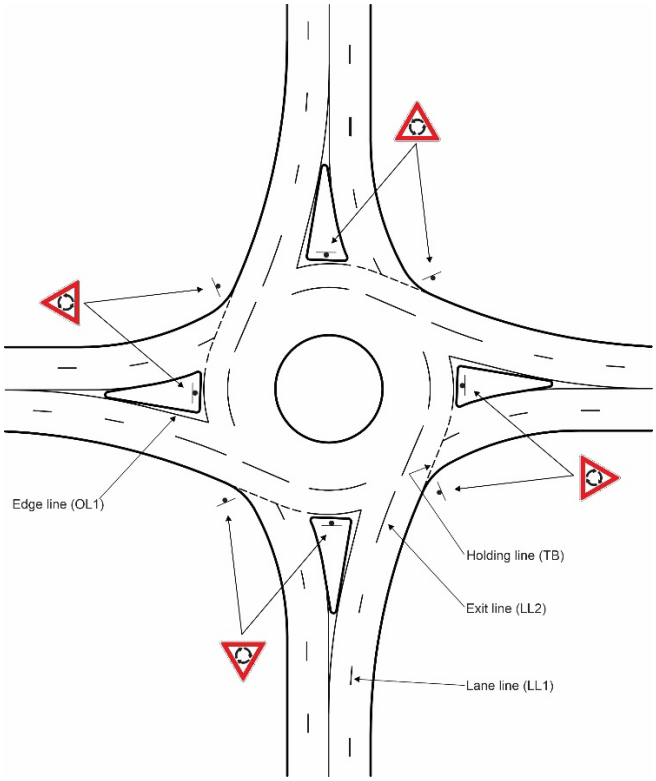
APPENDIX 4 – MARKINGS FOR BUS LANES

Comply with Traffic Engineering Technical Direction TTD 2020/02 for bus lane markings, available at
https://roads-waterways.transport.nsw.gov.au/trafficinformation/downloads/ttd_2020-02.pdf

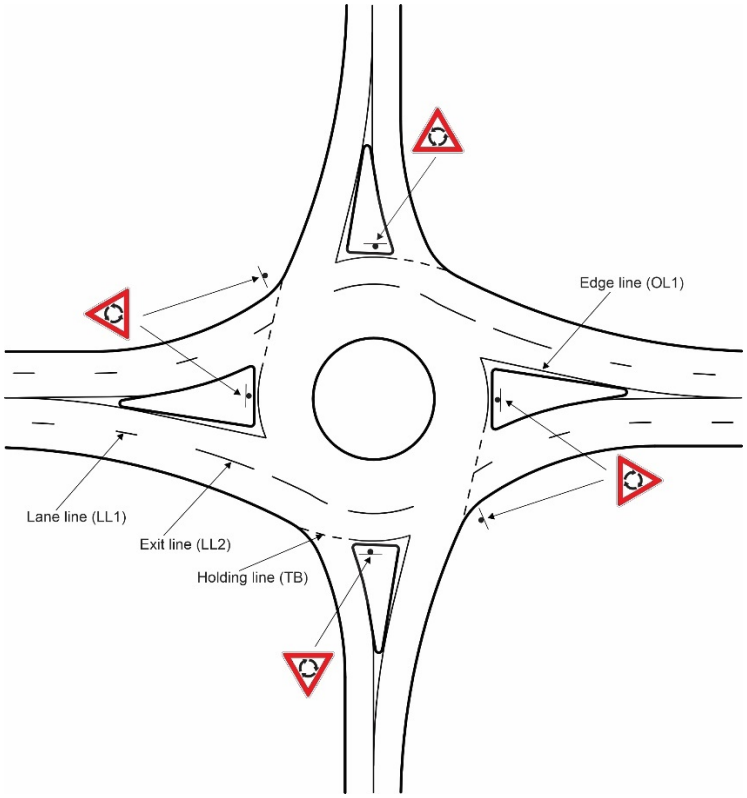
APPENDIX 5 – MARKINGS AT ROUNDABOUTS

Line Type	Use	Dimensions (m) (for dimensions shown * see marker spacing column)	Colour
LL2	Exit lane line on multilane roundabouts		White
TB	Holding Line		White

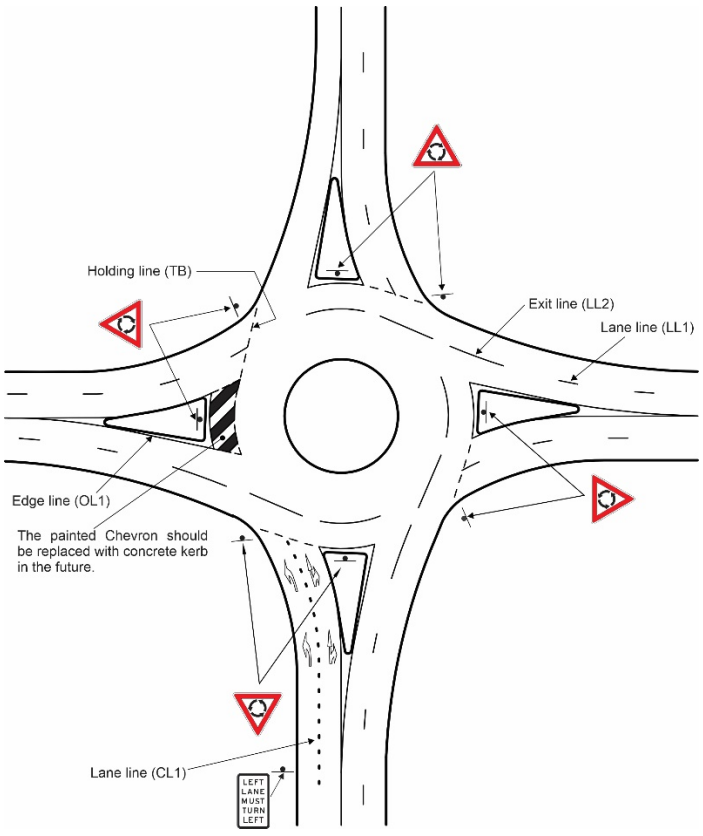
Roundabout Pavement Markings, four 2 lane entry/exits



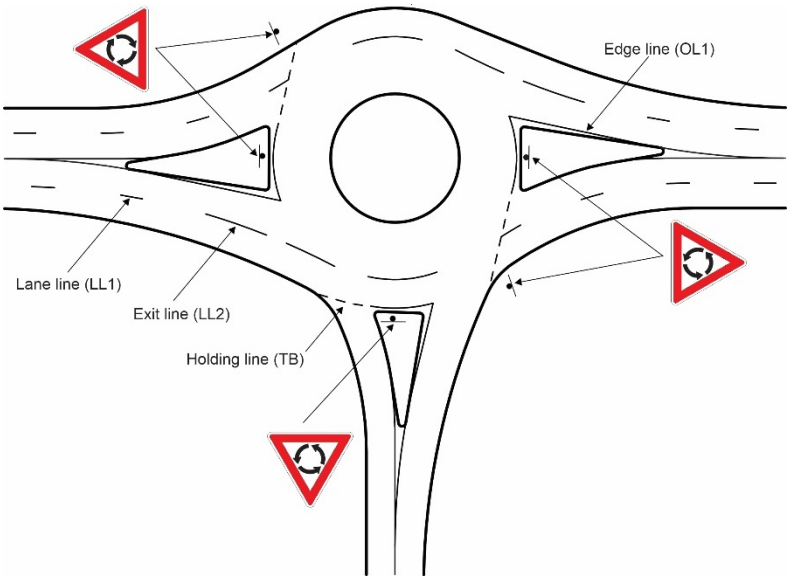
Roundabout pavement markings, two 2 lane entry/exits with two 1 lane entry/exits



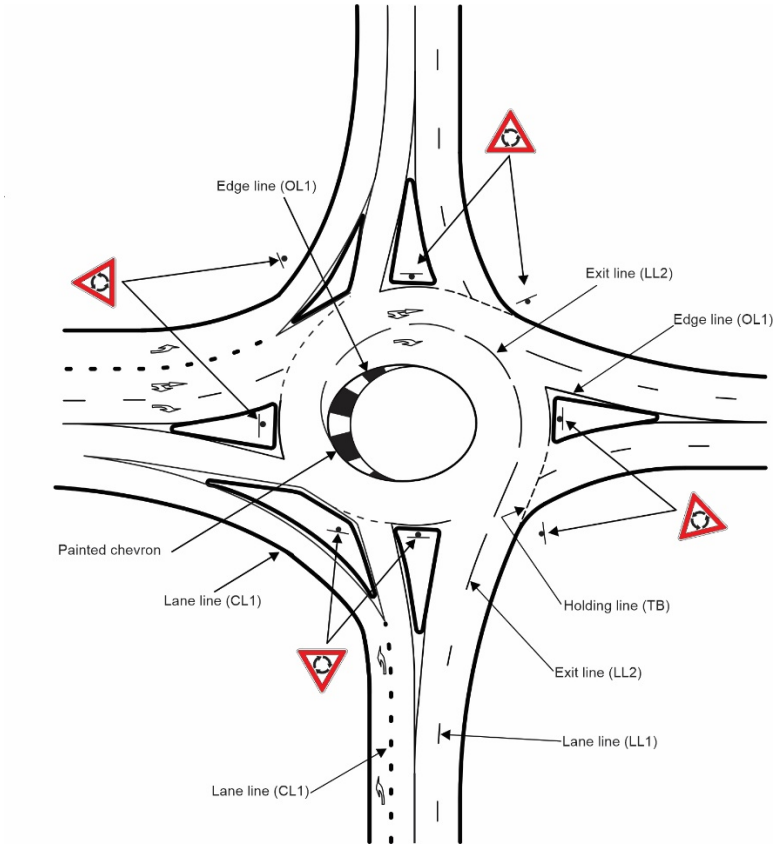
Roundabout pavement markings, four 2 lane entry/exit with one exclusive left turn lane



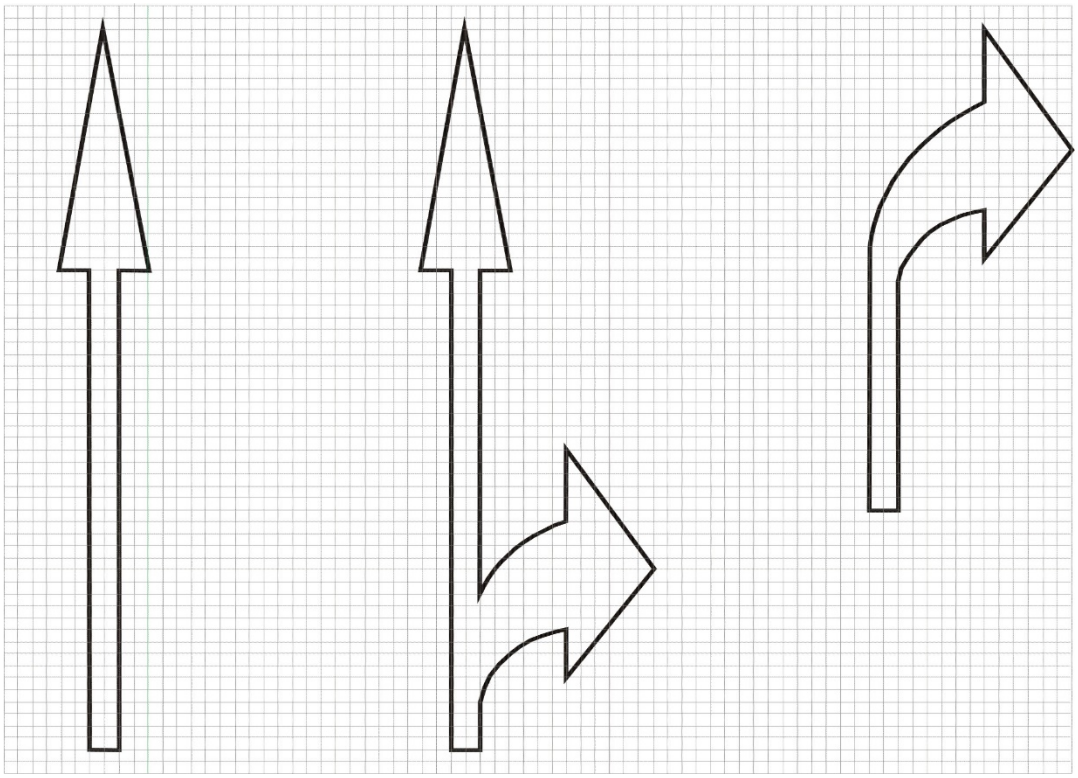
Roundabout pavement markings, T junction with two 2 lane and one 1 lane entry/exit



Roundabout pavement markings, dual right turn on one approach



FIGURES 9 TO 19

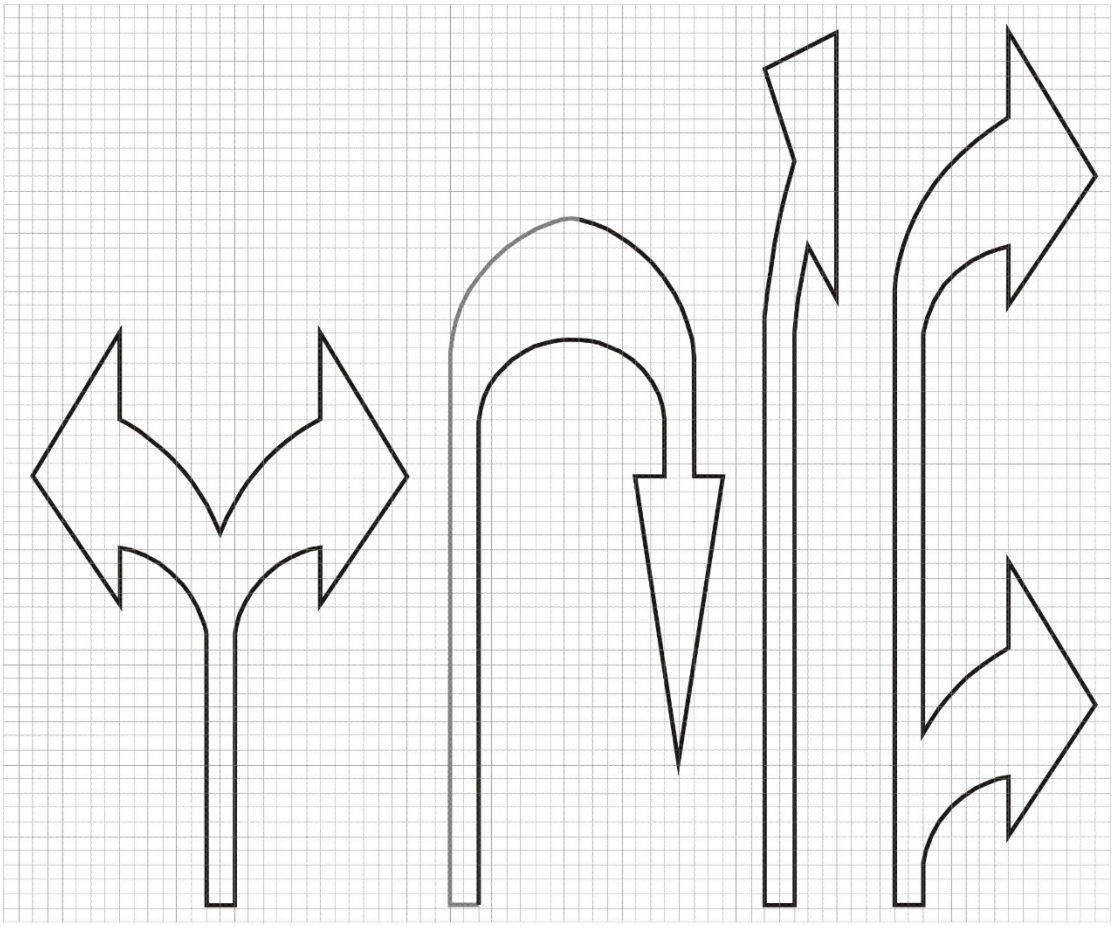


(a) Straight ahead	(b) Combination – straight ahead and turn	(c) Exclusive turn
AR1	**AR4(R)**	**AR3(R)**

Notes:

1. Minimum length of arrow:
   (a) Straight ahead arrow and combined arrow = 6 m;
   (b) Turn arrow = 4 m.
2. The width of grid squares is constant at 100 mm. The height of the grid is 100 mm minimum.

Figure 9 – Arrow shapes – (Ref. Pavement Delineation Part 10)



(a) Double turn **AR2**

(b) U-turn **AR7**

(c) 45° turn **AR9**

(d) Sequential turns **AR8**

Notes:

1. Minimum length of arrow:
   (a) Double turn arrow = 4 m;
   (b) U-turn arrow = 5 m;
   (c) 45° turn and Sequential turns arrows = 6 m.
2. The width of grid squares is constant at 100 mm. The height of the grid is 100 mm minimum.

Figure 10 – Arrow shapes – (Ref. Pavement Delineation Part 10)

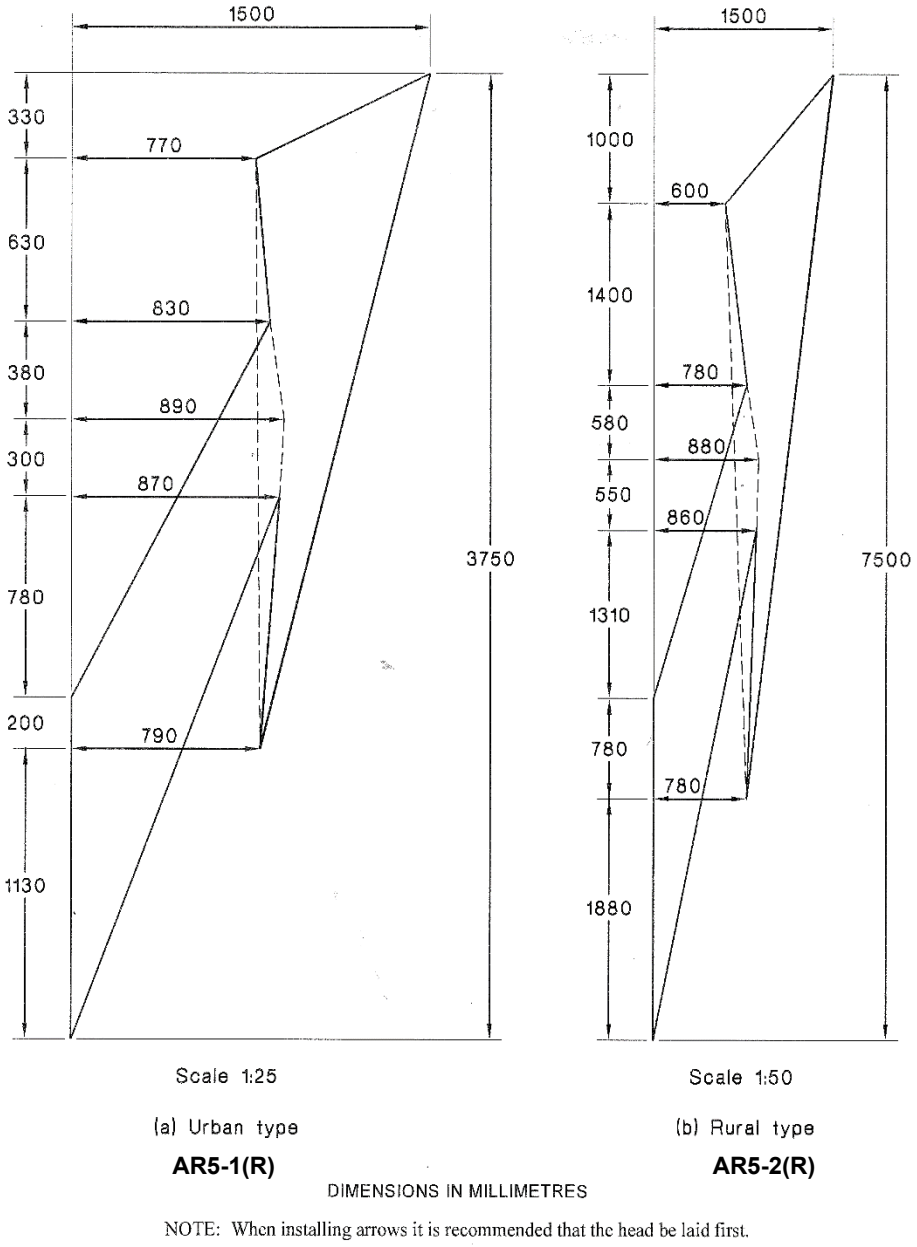
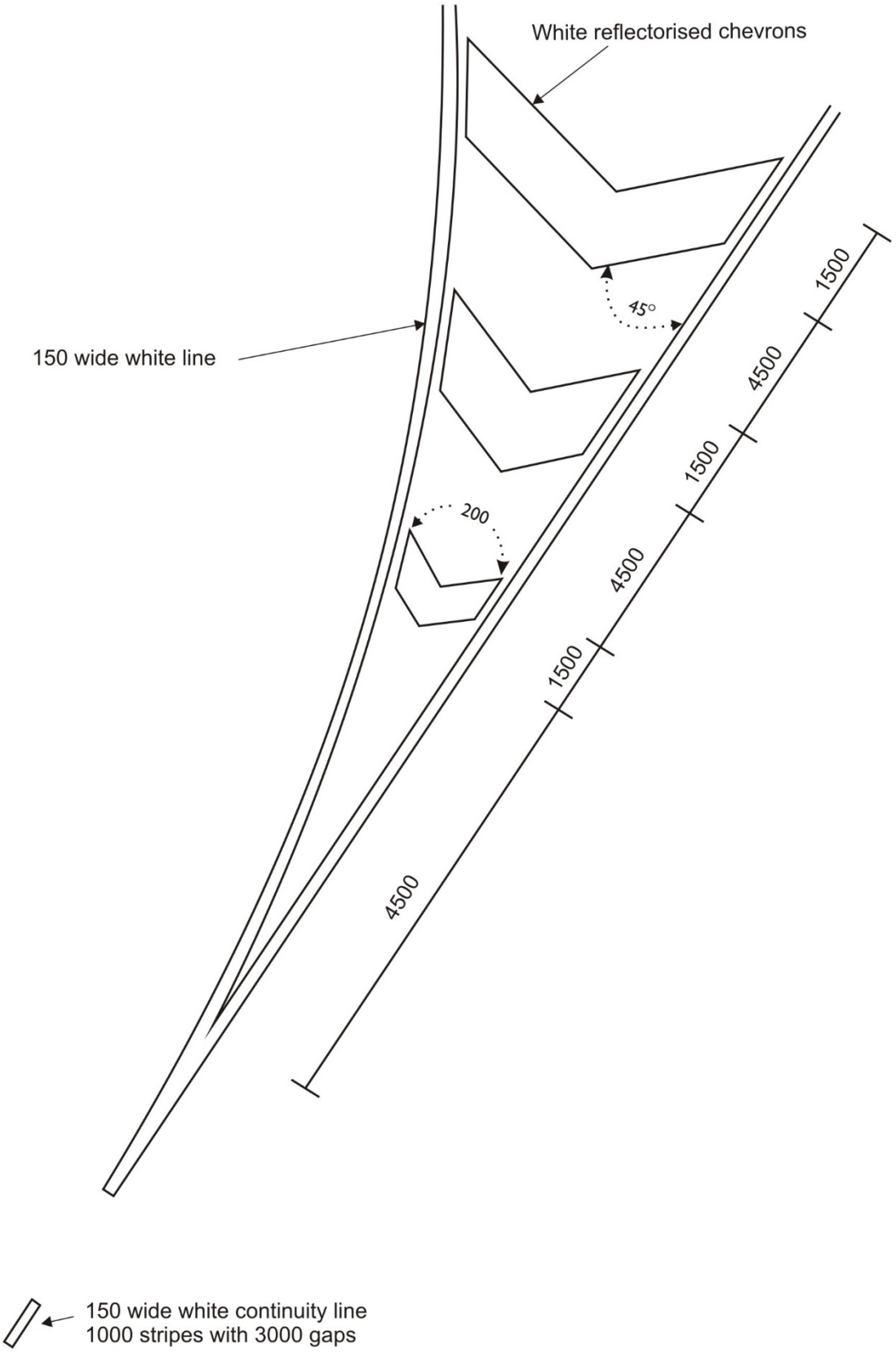


Figure 11 – Lane Change Arrows (Pavement Delineation Part 10)

Figure 12 – (Not Used)

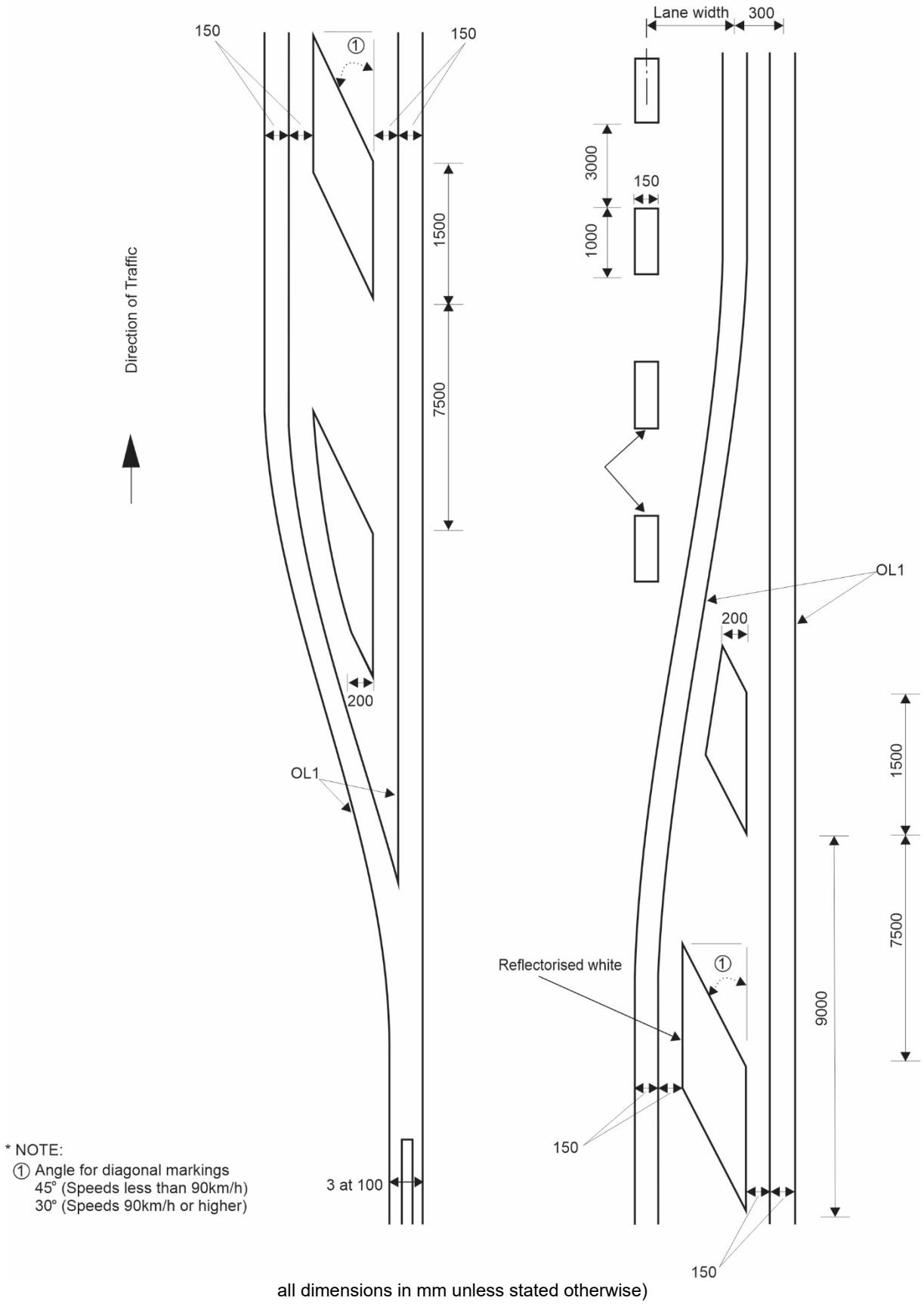
Figure 13 – (Not Used)



(all dimensions in mm unless stated otherwise)

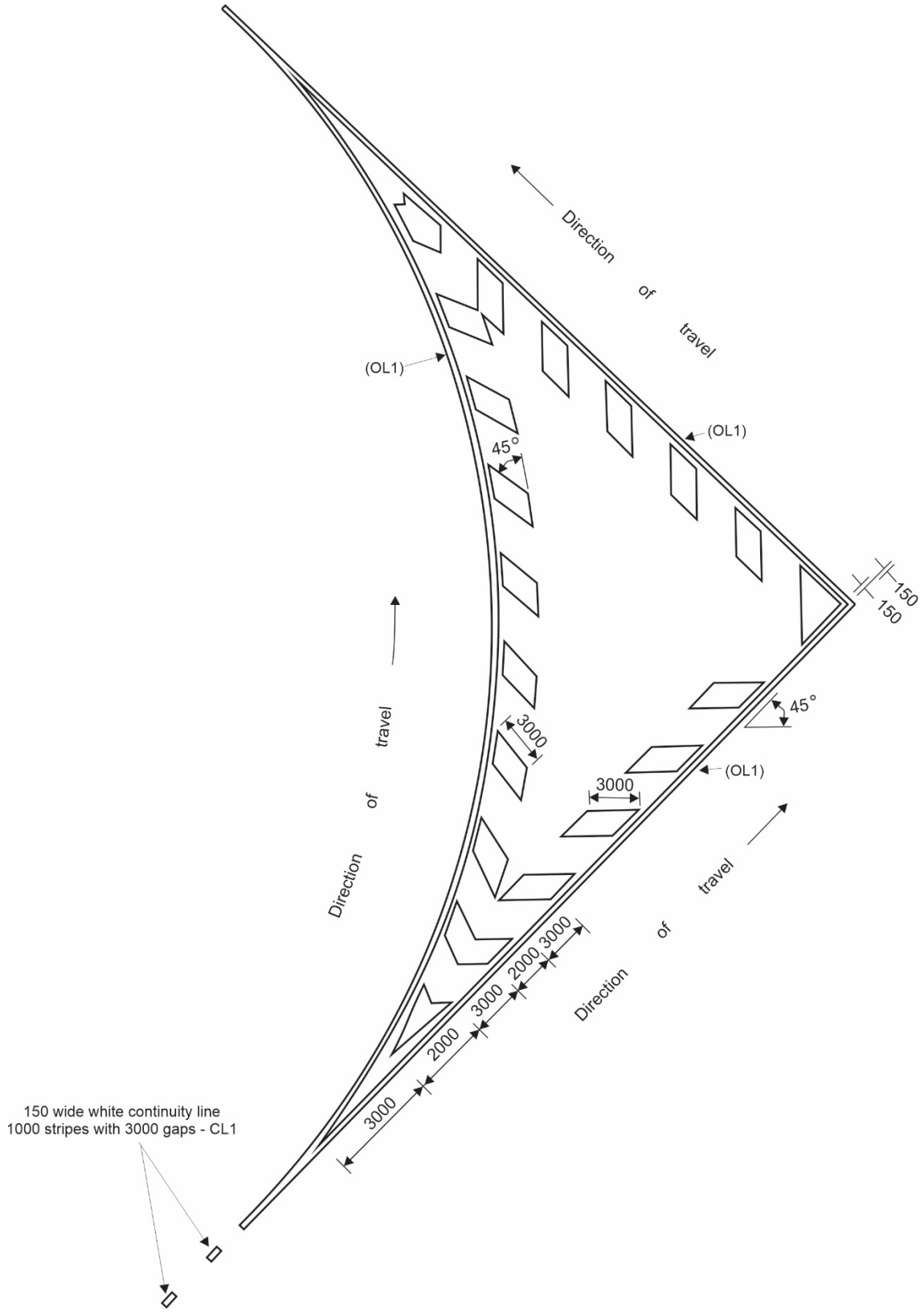
Figure 14 – Markings for Splayed Approach with Chevrons

(



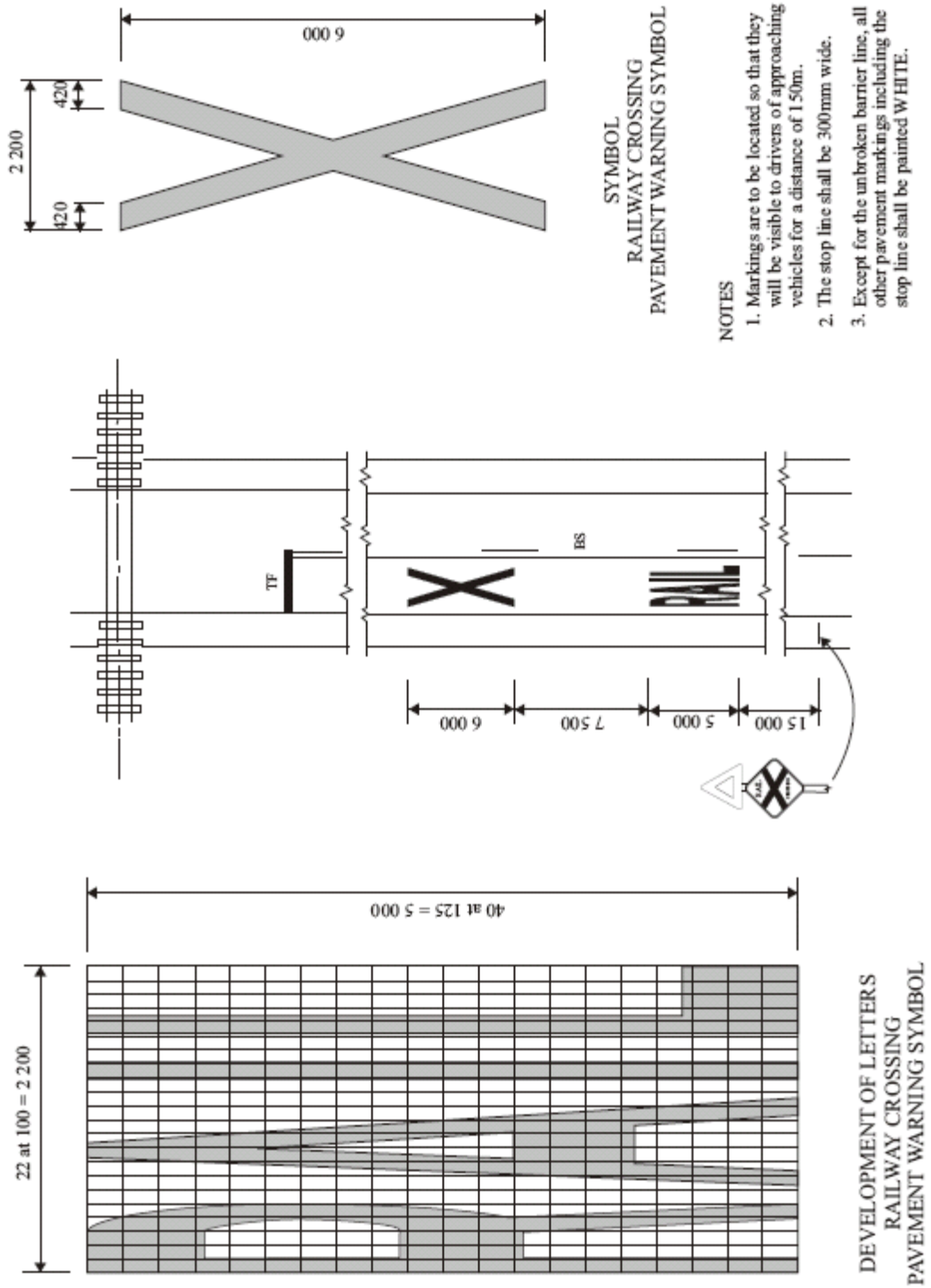
all dimensions in mm unless stated otherwise)

Figure 15 – Markings for Median



(all dimensions in mm unless stated otherwise)

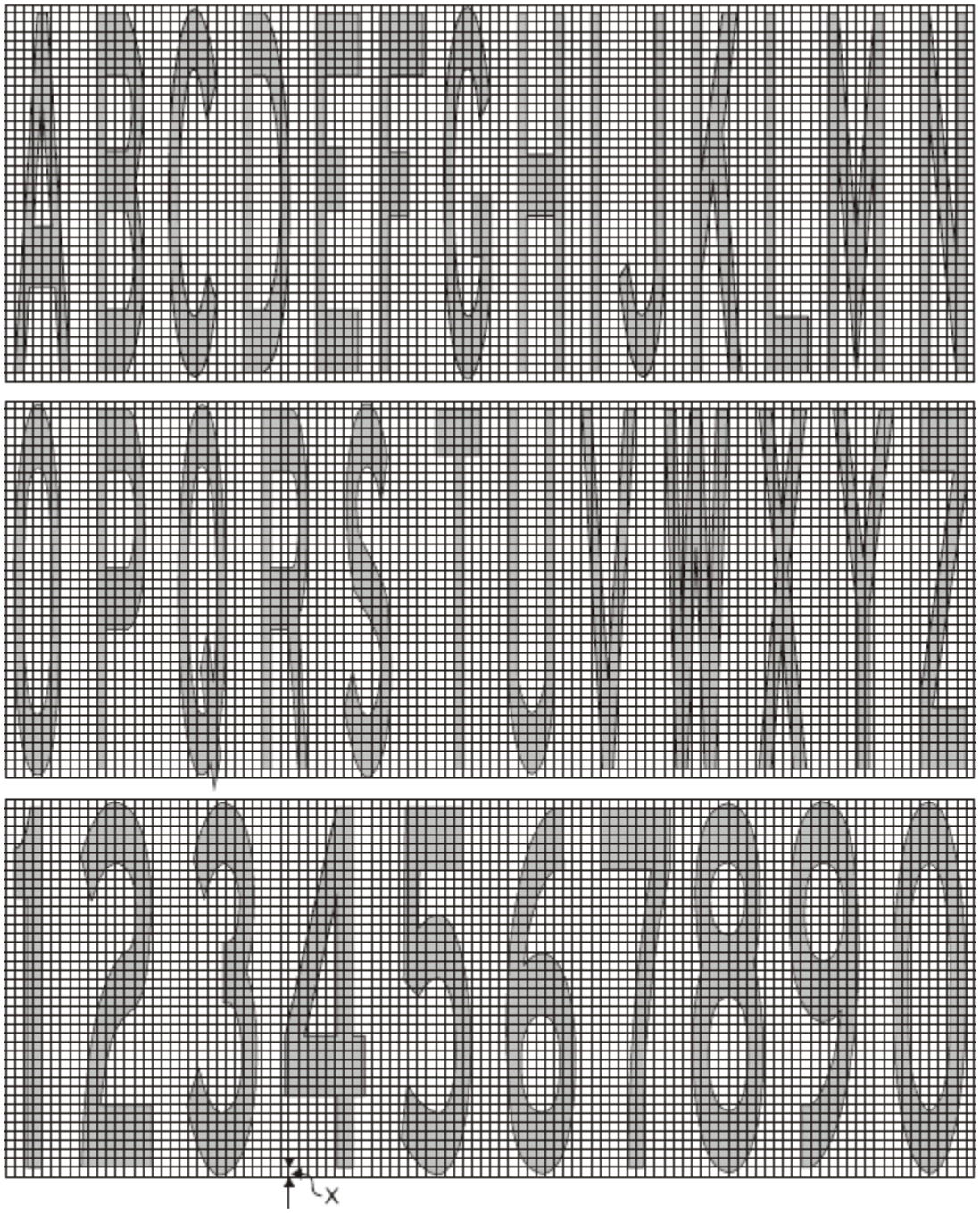
Figure 16 – Markings for Left Turn Island



Measurements are in mm, unless otherwise stated

PAVEMENT MARKING IN ADVANCE OF OPEN LEVEL CROSSINGS

Figure 17

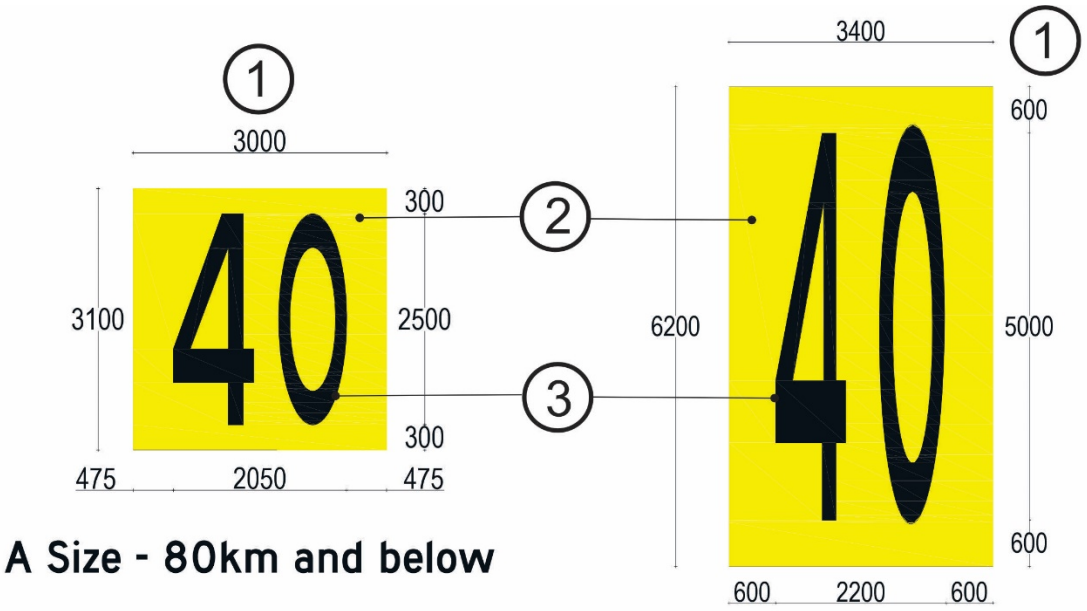


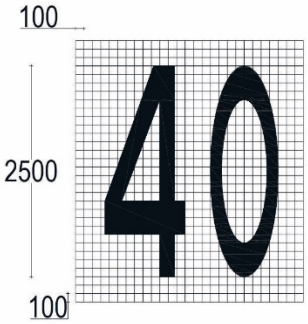
Note: 1. The grid width is constant at 100mm but the grid height "X" may vary.

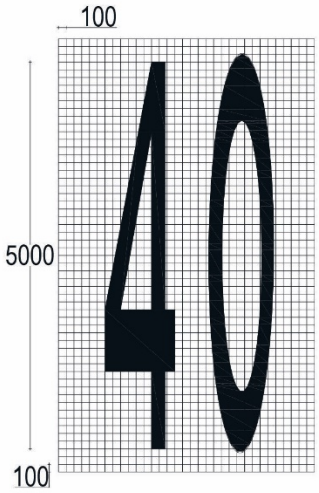
2. The grid height X = $\frac{\text{height of letter or numeral required in mm}}{40}$

PAVEMENT ALPHABET AND NUMERALS

Figure 18







NOTES:

① For School Zones where lane lines are not marked, patch to be positioned:

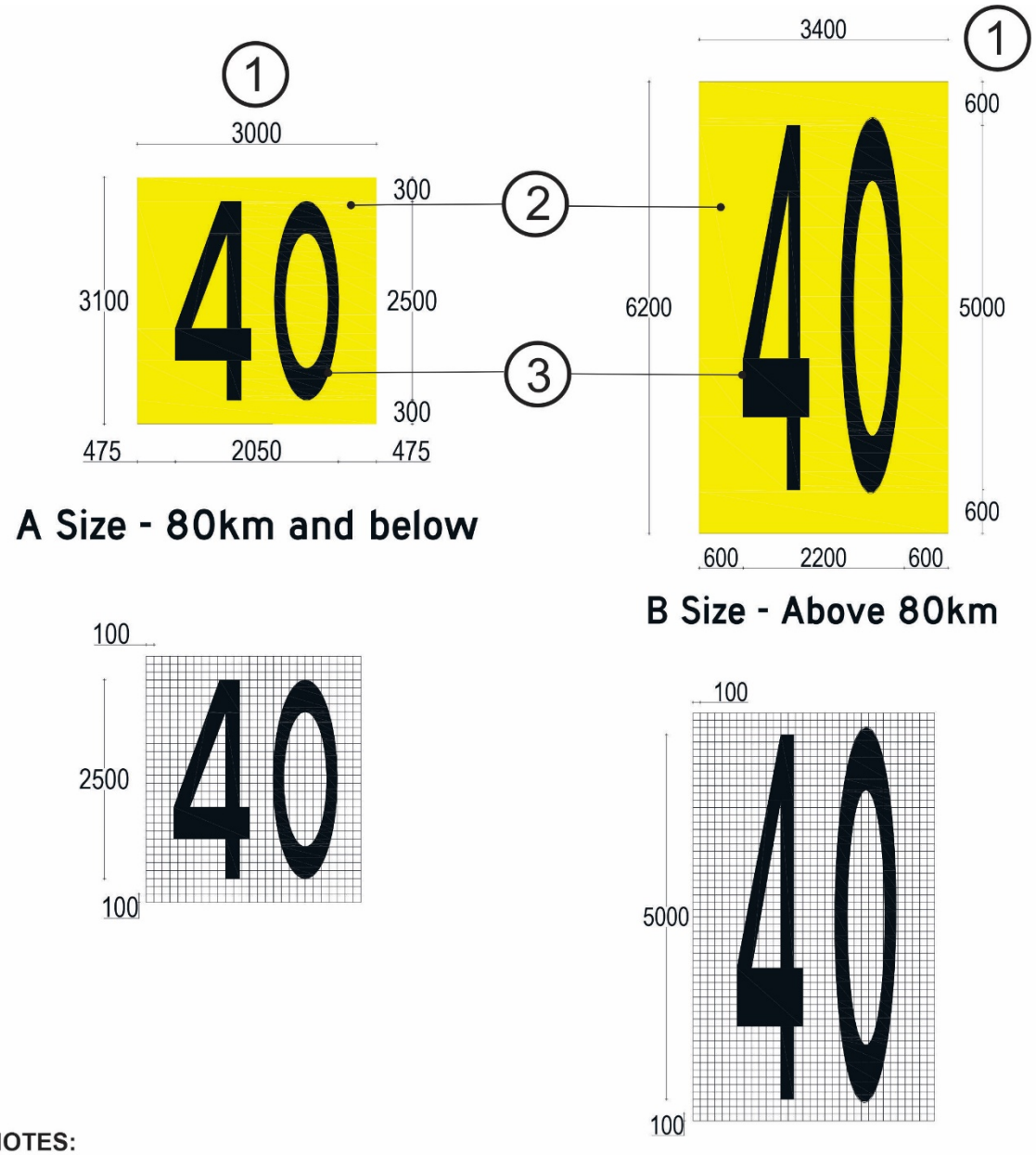
- centrally between the separation line / centre of road and edge of pavement / bitumen where a parked vehicle would not obscure any part of the patch when the zone is in effect.
- 300mm from the separation line / centre of road where a parked vehicle would obscure any part of the patch when the zone is in effect.

For school zones and school bus stop zones where the lane lines are marked, patch to be positioned centrally in each lane. Do not position patch in a kerbside lane where a parked vehicle would obscure any part of the patch when the zone is in effect.

② Square, yellow for school zone

③ Numberals, black.

④ For installation sepcification, refer to School Zones.



NOTES:

① For School Zones where lane lines are not marked, patch to be positioned:

- centrally between the separation line / centre of road and edge of pavement / bitumen where a parked vehicle would not obscure any part of the patch when the zone is in effect.
- 300mm from the separation line / centre of road where a parked vehicle would obscure any part of the patch when the zone is in effect.

For school zones and school bus stop zones where the lane lines are marked, patch to be positioned centrally in each lane. Do not position patch in a kerbside lane where a parked vehicle would obscure any part of the patch when the zone is in effect.

② Square, yellow for school zone

③ Numberals, black.

④ For installation specification, refer to School Zones.

Figure 19 – Markings for school zones