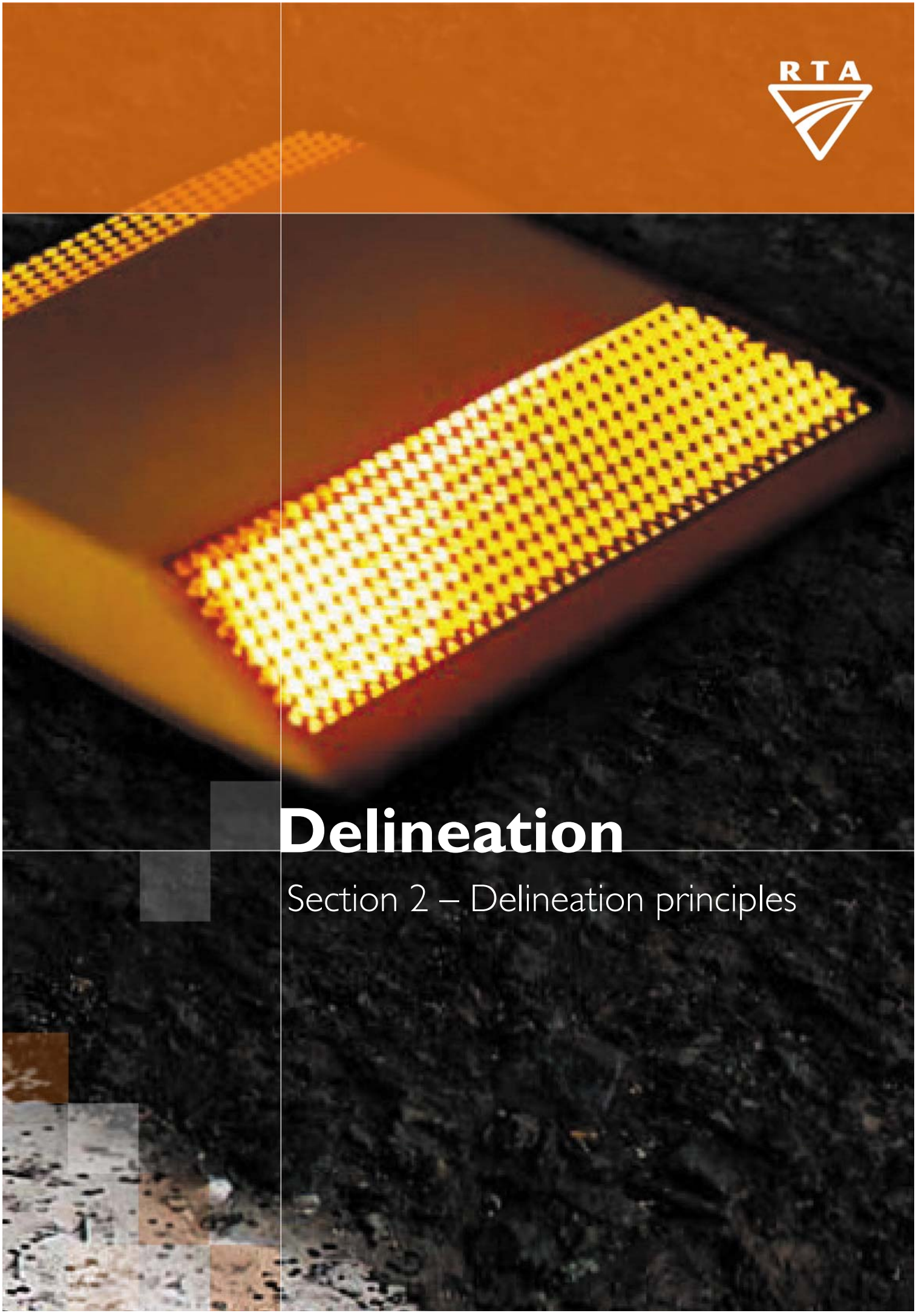

Delineation

Section 2 – Delineation principles

The delineation guidelines have been developed to assist in designing and maintaining a quality delineation system.

The guidelines are to comprise 19 sections and an appendix. These are initially being released individually and in no specific order. The sections which are to be released are as follows:

Part	Title
Section 1	Introduction
Section 2	Delineation principles
Section 3	Pavement markings
Section 4	Longitudinal markings
Section 5	Enhanced longitudinal markings
Section 6	Transverse markings
Section 7	Transverse markings - Pedestrian facilities
Section 8	Diagonal and chevron markings
Section 9	Messages on pavements
Section 10	Pavement arrows
Section 11	Pavement markings at roundabouts
Section 12	Pavement markings for bicycle facilities
Section 13	Pavement markings for kerbside parking restrictions
Section 14	Maintenance of pavement markings
Section 15	Raised pavement markers
Section 16	Guide posts and delineation of safety barriers
Section 17	Alignment signs and markers
Section 18	Delineation systems
Section 19	Delineation management and audit
Appendix A	Locating and setting out of dividing (barrier) lines

To determine which sections are currently available go to:

www.rta.nsw.gov.au/doingbusinesswithus/downloads/technicalmanuals/delineation_dl1.html

The information contained in the various parts is intended to be used as a guide to good practice. Discretion and judgement should be exercised in the light of the many factors that may influence the choice of delineation devices in any situation. The guidelines make reference, where relevant, to current Australian Standards and are intended to supplement and otherwise assist in their interpretation and application.

Section 2

DELINEATION PRINCIPLES

Special Note:

As from 17 January 2011, the RTA is adopting the Austroads Guides (Guide to Traffic Management) and Australian Standards (AS 1742, 1743 & 2890) as its primary technical references.

An RTA Supplement has been developed for each Part of the Guide to Traffic Management and relevant Australian Standard. The Supplements document any **mandatory** RTA practice and any complementary guidelines which need to be considered.

The RTA Supplements **must** be referred to prior to using any reference material.

This RTA document is a complementary guideline. Therefore if any conflict arises, the RTA Supplements, the Austroads Guides and the Australian Standards are to prevail.

The RTA Supplements are located on the RTA website at www.rta.nsw.gov.au

Roads and Traffic Authority
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APPROVED BY:

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To access electronic copies of these and other guidelines go to:

www.rta.nsw.gov.au/doingbusinesswithus/downloads/technicalmanuals/technicalmanuals_dl1.html

For the latest amendments (if any) to these guidelines go to:

www.rta.nsw.gov.au/doingbusinesswithus/downloads/technicalmanuals/delineation_dl1.html

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Contents

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2.1 Introduction

Delineation system refers to any method of defining the roadway operating area for the driver. Delineation system is an organised network of one or a combination of delineation devices over a specific section of roadway, that regulates, warns or provides tracking information and guidance to the drivers to carry out their driving task safely and efficiently.

Consistent delineation practice will provide improved guidance to the road users and influence their travel behaviour by allowing journeys to be undertaken with confidence and comfort. Improved driver behaviour by providing consistent driver information contributes towards optimum utilisation of the existing highway capacity, enhances traffic flow and traffic safety. This may compensate, to some extent, the increase in travel demand.

The vast range of delineation variables, human capability in vision and information processing, and the complexity of the interactions with the changing environmental conditions, make it difficult to formulate universally acceptable delineation system. When designing a delineation system, knowledge of delineation principles are necessary, which may be instrumental in selecting an effective delineation system that should be applied consistently throughout the state (Refer to Section 19 for Delineation audit strategy).

2.2 Purpose of delineation

A delineation system should fulfil at least one of the following five functions to safely guide vehicular movements over a specific section of roadway, during day, night, dry and wet conditions:

a. Controlling the position and movement of traffic

Figure 2.1: Delineation function - position and movement of traffic

b. Identifying safe and legal road limits

Figure 2.2: Delineation function - safe and legal road limits

c. Regulating lane changing and passing

Figure 2.3: Delineation function - lane changing and passing

d. Conveying information about road geometry ahead, including alignment, grading, changes in width and lane drops

Figure 2.4: Delineation function - conveying road geometry

e. Identifying potentially hazardous situations.

Figure 2.5: Delineation function - Identifying potentially hazardous situations

2.3 Types of delineation

To fulfil delineation functions described in Section 2.2 various delineation devices are employed that are classified into two broad categories:

(a) Short range delineation

(b) Long range delineation

2.3.1 Short range

Short range delineation fulfils the delineation function that enables the drivers to control the placement of the vehicle and identify safe and legal limits of travel. The devices in this category include:

(a) Pavement markings

(b) Raised pavement markers

Figure 2.6: Short range delineation - pavement markings and raised pavement markers

2.3.2 Long range

Long range delineation enables drivers to judge the alignment of the road ahead, regulate the direction of travel and recognise potentially hazardous situations. The devices in this category include:

(a) Guide posts

(b) Alignment signs and markers

Figure 2.7: Long range delineation - guide posts and alignment signs

2.4 Delineation characteristics

2.4.1 Information needs

The driving task is information-driven and requires the driver to select and sample inputs from the road traffic system. The factors given in Table 2.1 should be taken into account when designing a delineation system.

2.4.2 Minimum preview distance

Delineation devices provide drivers with information about the vehicle position within the lane and information about which lanes are available for use. They also provide the driver with a preview of upcoming changes in the roadway geometry, including curves, lane drops, narrowing, the start and end of overtaking zones, pedestrian crossings, and intersections. There is a perception-reaction time delay between seeing a change in the road path and responding to it and between making a steering input and the vehicle responding; therefore, several seconds of preview are required for good lane positioning. Good delineation generally results in better driver performance and greater driver comfort.

International Commission on Illumination recommends a minimum preview time of 3 seconds and a desirable preview time of 5 seconds. The sharper the curve, the greater the preview distance required to allow for the time it takes to perceive and react to the curvature by dropping speed. Short range delineation (e.g. Pavement markings) is sufficient for providing 3 seconds of preview time on tangent sections. Change in road geometry and approaches to potentially hazardous locations require longer preview distance and the use of long range delineation devices. For example, at 100 km/h, a preview time of 3 seconds would be equivalent to a driver being able to see a minimum 3 RRPMs ahead at the recommended spacing for a straight section, and minimum 3 guide posts or 2 CAMs at the recommended spacing at the curve approaches.

Factor	Statement	Relevance to delineation	Example
Information Processing	Driving task (navigation, guidance and control of vehicle) requires driver to receive inputs (mostly visual) and process them.	Avoid sudden imposition of demand, when driving load is already high. Provide series of simple rather than single complex information.	Lane merges should be avoided over a crest or around a curve. 
Expectancy	Driving behaviour is largely governed by experience and expectation.	Information should encourage predictable behaviour and decrease uncertainty.	Chevron alignment marker is always associated with a sub-standard curve. 
Reaction Time	Expectancies reduce reaction time through familiarity.	Encourage familiarity. Minimise number of alternatives. Provide positive information and warning.	Information such as 'duplicated' curve warning and advisory speed sign reduces reaction time by providing positive guidance. 
Memory	Information conveyed through delineation normally fades away after being made use of.	Critical information should be reinforced by repetition.	Where the section of winding road extends over a number of kilometres, winding road sign may be repeated with appropriate changes to the supplementary distance plates.
Credibility	Information conveyed should be true and relevant.	Avoid unnecessary use of signs/devices. Use consistency in delineation treatments.	

Table 2.1: Driver information needs

Figure 2.8: Minimum 2 CAMs should be visible at curves

Refer to Section 15 (for information on RRPMs) and Section 17 (for information on CAMs). Table 2.2 gives the recommended preview distances.

85th Speed (km/h)	Minimum preview distance for short range devices (m) [1]	Minimum preview distance for long range devices (m) [2]
40	34	56
50	42	70
60	50	84
70	54	97
80	67	112
90	75	125
100	84	139
110	92	153

Notes:
1 Based on a 3 second preview time
2 Based on a 5 Second preview time

Table 2.2: Minimum preview distance

2.4.3 Visibility needs

The majority of the information used by the driver is visual; the remainder is audible and tactile. Vision is so important to the driving task and is indeed the only way that information provided by traffic signs, and delineation devices actually gets to the driver. It is therefore necessary to have some awareness of visual characteristics. Table 2.3 outlines the main characteristics.

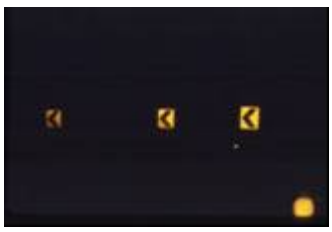
Factor	Relevance to delineation
Visual field	Size and location should be within the driver's cone of vision. Angle of visual field decreases with increase in speed. Research evidence also suggests that as fatigue develops, peripheral vision is reduced, with the field of vision narrowing and drawing closer to vehicle. 
Eye and head movement	It is necessary that the visual information be separated in time and space. 
Illumination	Situations imposing sudden changes in the level of illumination should be given more attention.  
Conspicuity	Delineation devices should be visible during day and/or night.  

Table 2.3: Driver visibility needs

2.4.4 Retro-reflection

Pavement markings convey regulations and warnings and provide vehicle tracking guidance to the driver. Much of the visual information needed by a driver to navigate safely in a variety of conditions, including daylight, darkness, and adverse weather, is provided by pavement markings. To meet the requirement of visibility at night, delineation devices use the method of retro–reflection.

2.4.4.1 Basic principles

Retro-reflectivity is the property of a material that returns light to the source. For example, when the light source shines on pavement markings, the optical elements, typically the glass beads, retro-reflect the light back toward the light source. In the context of highway delineation, retro-reflective materials are delineation devices and the source is usually the headlights of a vehicle. Because a driver's eyes are close to a vehicle's headlights, some of the light returned from retro-reflective materials reaches the driver's eyes. The amount of light from an object reaching the driver's eyes will have a great impact on how bright that object appears to the driver. Therefore, retro-reflective materials that are efficient in returning light to a driver's eyes may appear brighter to the driver than materials that are not as efficient.

This is important because traffic engineers use signs and markings to communicate important information to drivers. At night, if the signs and markings are not illuminated by other means, the retro-reflective characteristics are important to increase the chance that a driver receives the information.

2.4.4.2 Types

There are two basic technologies that make retro-reflectivity possible. The first uses very small round glass beads. These tiny glass spheres are applied to paints, thermoplastics and other binders to make pavement marking materials retro-reflective. Smaller glass spheres are manufactured into sheeting, which is then applied to signs and other traffic control devices to make them retro-reflective. The second basic technology uses prismatic reflectors consisting of cube-corner elements manufactured into sheeting material that is applied to delineation devices and signs.

2.4.4.3 Mechanism

To meet the requirement of visibility at night, delineation devices use the mechanism of retro–reflection. This principle is based on redirecting the light, back towards the source (headlight) thus facilitating visibility of delineation devices. Retro-reflection makes the delineation devices visible in night, only when there is some one to benefit from it. Delineation devices incorporate this property by using tiny glass beads (e.g. in pavement markings) or corner cube (prismatic) elements (e.g. in some raised pavement markers).

Figure 2.9: Glass beads embedded in pavement marking material

Figure 2.9 illustrates the principle of retro-reflection in delineation devices using glass beads and corner cubes (prisms).

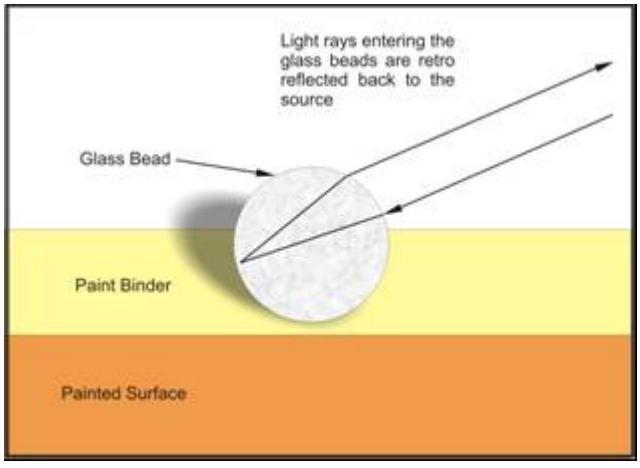


Figure 2.10: Mechanism of Retro–reflection

Typical initial retro-reflectivity value (minimum) for a white RRPM is 300 millicandela per lux. A typical value of 100 millicandelas per lux per square metre is considered to be the minimum acceptable level of retro-reflectivity for pavement markings.

Wet weather has a significant impact on the performance of line-marking. Under wet conditions lines can become almost invisible because the beads become covered by a film of water that stops the light being reflected back to the driver. Instead of retro-reflection, specular (or mirror) reflection takes place. The degree to which a line is subject to this phenomenon depends largely on the size of the glass beads – the larger the diameter of the beads, the prouder they can stand above the water film and thus continue to retro-reflect.

RTA Specifications for various delineation devices contain detailed discussion and should be referred to find acceptable levels of retro-reflectivity.

2.5 Delineation variables

When adopting a delineation system, key variables such as road geometry, weather and climate, traffic volume and composition, type of pavement and ageing driving population should be taken into account.

2.5.1 Road geometry and pavement surface

Each type of road geometry has a unique set of driver information needs and associated delineation requirements. Straight sections, horizontal curves, pavement width reductions, merging and diverging area etc require different delineation systems in terms of types of delineation devices (Pavement markings, RRPMs, Chevron alignment markers etc), material (Paint, thermoplastic, class 1A reflective sheeting etc), width of pavement markings, spacing, sizes and their configuration. Section 18 describes delineation system for different geometric situations.

Figure 2.11: Road geometry and types of pavement surface affect selection of delineation devices

Variations in type and condition of the substrate determine, to a large extent, the durability and visibility of the pavement marking. The pavement surfaces upon which pavement markings are applied, fall into the three types of surface courses. They are spray (or chip) seals, asphaltic concrete and cement concrete. See Section 1.6 under definitions and abbreviations for more information.

New spray seal surfaces must be swept clean of all loose aggregate. A waiting period between application of the spray seal and the liquid pavement markings is desired to allow vehicles to wear-off all loose aggregate from the road surface. Refer to RTA specification 1012 -Sprayed Bituminous Surfacing for information on curing time of spray seals.

Asphaltic concrete could be a dense-graded or open graded road surface. Water accumulation on dense grade asphalt may prevent pavement markings from retro-reflecting incident light for some time during heavy rains. Use of open-graded asphalt minimizes the time during a rain that the delineation is ineffective. Greater quantities of paint or hot applied thermoplastic materials are required with the open-graded AC because of its porous nature and with pavement markers (RRPMs), the problems in obtaining a secure bond with the rough surface results in a higher percentage of dislodged markers.

The life of pavement is significant, particularly when considering the application of long-tern delineation. For example, RRPMs or thermoplastic markings could outlive an aging AC surface under certain circumstances. The high initial cost of these treatments is justified by their durability and longevity. In general, CC pavement will last about twice as long as AC pavement.

2.5.2 Weather and climate

Prevailing climate and weather conditions influence the effectiveness of a delineation system. Adverse weather conditions such as rain and fog make driving difficult, particularly at night. Headlight glare, slippery pavement surface, reflection from wet pavement, coupled with degraded retro-reflectivity of pavement markings require enhanced delineation system such as the use of large glass beads in pavement markings, profile line-marking etc.

Figure 2.12: Adverse weather conditions influence the effectiveness of delineation system

Summer heat also affects pavement markings. High temperatures distort thermoplastic on asphalt pavement. Ultra violet rays may affect the colour and life of delineation devices.

2.5.3 Traffic volume and composition

Traffic volume and composition play a vital role in the selection of a suitable delineation system. AADT is often the major criterion used to select the delineation devices.

Traffic survey sites in NSW are either designated as sample (short survey duration) stations or as permanent (continuous survey duration) stations. As either axle pair passes or actual vehicles may be counted, the AADT Type is represented as either:

(a) The number of vehicles passing during a 24 hour period averaged over a year, or;

(b) The number of axle pair passes during a 24 hour period averaged over a year

For example, with axle pair passes, a typical car is represented by one axle pair, a three axle truck by one and a half axle pairs and a six axle semi trailer as three axle pairs.

Highways with higher traffic volume may be well served with installation of more durable delineation devices. They avoid the need of frequent maintenance and reduce the exposure of crews to traffic. The higher initial cost can be offset against the safety and economic benefits of more durable treatments.

Figure 2.13: Highways with heavy traffic require durable delineation devices

Traffic composition can also affect the service life of delineation devices. A high percentage of heavy vehicles may wear out the markings much faster than passenger cars.

2.5.4 Implication of variables

The ideal form of delineation is that which performs best based on driver behaviour, safety, efficient movement of traffic and cost. Various delineation techniques may be used individually or collectively as appropriate.

Figure 2.14: Ideal delineation system depends on variables

There is no universal delineation configuration that equally satisfies all needs. To achieve the best balance among driver requirements, safety aspects, and economic considerations, each of the variables discussed must be assessed to determine its impact on effectiveness. Sections 3 to 18 describe the current delineation practices which will help in the decision process.

2.6 Delineation checklist

Before installing a delineation system, it must be ensured that the following requirements are met:

The delineation system fulfils the function it is designed for, i.e., at least one of the five functions discussed in Section 2.2,

The delineation system satisfies all the five driver information needs listed in Table 2.1,

The delineation system satisfies all the four driver visual needs listed in Table 2.3.

The delineation system must take into account delineation variables such as road geometry, weather, traffic volume, driver psychology, and vehicle limitations described in Section 2.5.

The delineation system and its components must be installed in accordance with the guidelines given in Sections 3 to 18.

The basic delineation system should be maintained at all times as discussed in Section 19.

Figure 2.15 illustrates the delineation checklist schematically.

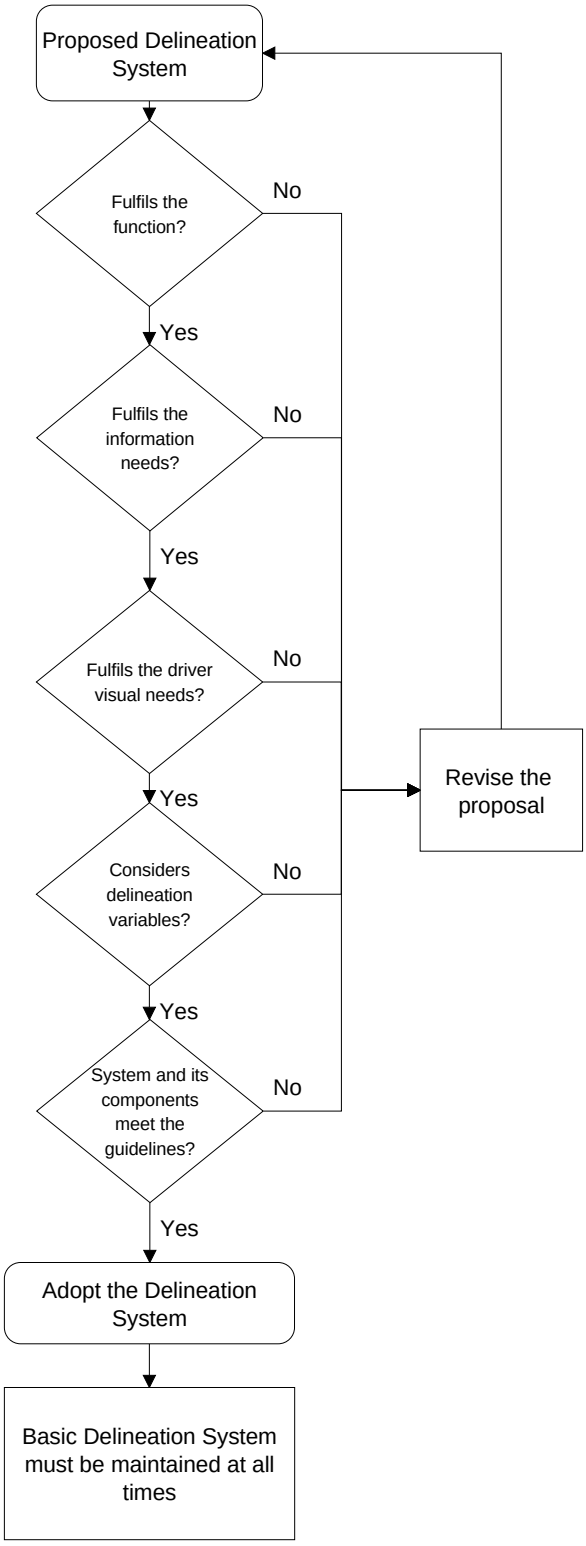


Figure 2.15: Delineation Checklists

Notes

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